EFFECTIVE TEACHING PRACTICES IN ONLINE PHYSICAL EDUCATION: THE RELATIONSHIP BETWEEN VIDEO FEEDBACK GUIDANCE AND PERFORMANCE

By

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ABSTRACT

Video feedback is one of the most common suggestions for online physical education teachers to use. This method can effectively teach motor skill learning in face-to-face settings but lacks the same empirical backing in online environments. Therefore, this study aimed to examine the effects of providing different forms of pedagogical guidance with video feedback in an online environment while students learned two disc golf skills; the spin putt (SP) and backhand throw (BT).

The participants were 43 college students from four different classes at two universities who practiced the SP and BT during four practice sessions. SP and BT techniques were measured in pre (day 1), post (day 14), and retention tests (one week after post). During each practice session, participants used the Flip app to record themselves performing three sets of five SP or BT trials. Participants were randomized into one of three video feedback guidance groups to watch their videos: use a visual cue sheet (VCS), a self-assessment (SA) of their best trial, or received 48-hour delayed teacher feedback (TF).

Results indicate that the SA ($M = 22.69, p = .02$) and VCS ($M = 22.95, p = .02$) groups showed a significant increase in BT technique scores at the posttest; all three groups showed a significant increase in SP technique at the posttest; TF group ($M = 23.06, p < .001$), SA group ($M = 15.95, p = .02$), VCS group ($M = 17.66, p = .01$). Only the VCS group was able to maintain these improvements for both skills at the retention test; SP =($M = 23.27, p < .01$), BT ($M = 20.23, p = .04$), and the TF group were able to maintain their improvement for the SP ($M = 20.36, p < .01$). No significant differences were found among groups at the posttest or retention test; to indicate a more beneficial use of video guidance. In addition, moderating factors from pre to posttest were reported.

Utilizing video feedback in an online setting can positively affect motor performance. Additionally, the findings suggest that pairing video feedback with in-the-moment guidance is the most beneficial for motor performance in an online environment. Ultimately the results help demonstrate that OLPE does not have to be an entirely fitness-based industry; psychomotor learning can be addressed and should be included.

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CHAPTER I: INTRODUCTION

Online instruction steadily grew before the 2020 Covid pandemic (Digital Learning Collaborative [DLC], 2020; Seaman & Seaman, 2019). From 2012 to 2019, higher education online course enrollment steadily increased from about 4.5 million to 6.1 million students (Seaman & Seaman, 2019). During this same time, K-12 online course enrollments reached over 1.5 million (DLC, 2020). In step with this growth, enrollment in K-12 online physical education (OLPE) settings is firmly increasing. For example, in the 2014-2015 school year, K-12 OLPE course enrollment represented 3.5% of all enrollments; two years later, it represented 8% of all enrollments (DLC, 2019), and in some states, OLPE represented 12% of all online course enrollments (Harris & Metzler, 2019). While data does not exist for total course enrollments in higher education, it could be possible that this area is experiencing similar growth in OLPE course enrollments. Given these statistical trends, OLPE will most likely stay a prevalent and possibly expanding content area for online education post-pandemic.

Many practitioners have indicated a need for additional research in OLPE (Buschner, 2006; Mohnsen, 2012), a "call for action" (Mosier, 2012, p. 8) that echoes throughout research reviews on this topic (Daum & Buschner, 2014, 2018; McNamara et al., 2022; Killian et al., 2019). In addition, a common theme stressed by these researchers is the need for research demonstrating effective teaching practices that lead to psychomotor learning (Daum, Goad, Mosier, et al., 2021). Furthermore, no research exists on effective teaching practices that lead to psychomotor learning in OLPE students.

While some scholars believe that research conducted during the Covid-19 pandemic can help inform effective teaching practices for OLPE (e.g., Centeio et al., 2021; Foye & Grenier, 2021; Mercier et al., 2021), others have doubts (Marttinen, 2021). Those with doubts note that these students and teachers were forced into online learning; therefore, results help inform the niche field of emergency remote teaching rather than OLPE more broadly (Ferri et al., 2020). However, no research has been published after the pandemic's start on students and teachers traditionally enrolled in OLPE; that is to say, students and teachers who choose the online medium.

While research on OLPE is lacking, video feedback is one of the most common suggestions for OLPE teachers to integrate into their curriculum for students to use (Daum, 2020; Goad et al., 2019; Jenny et al., 2020; Killian et al., 2021; Mohnsen, 2012; SHAPE America, 2018). This suggestion would have students record their practice attempts, then watch their videos to help detect and fix errors in their performance. However, while this method can effectively teach motor skill learning in face-to-face classes (Han et al., 2022; Mödinger et al., 2021; Rhoads et al., 2014), it lacks the same empirical depth in OLPE settings. Furthermore, video feedback is typically less effective without teachers guiding students on what to look for (Han et al., 2022; Mödinger et al., 2021; Zhou et al., 2021).

The most common form of guidance in face-to-face environments is teachers providing in-the-moment verbal feedback, either by giving corrective feedback (Palao et al., 2015) or informational feedback (Zetou et al., 1999) while students watch their videos. Corrective feedback involves identifying what the students did wrong, then prescribing what students need to do to fix their errors (Zhou et al., 2021). In contrast, informative feedback has students focus on the most critical aspects of the skill as they watch their videos, sometimes called cueing (Han et al., 2022). Since almost all OLPE classes are delivered asynchronously (DLC, 2020; Harris & Metzler, 2019; Mosier, 2010), most OLPE teachers would have to deliver any verbal feedback in a delayed format. Any form of delayed feedback is considered less valuable the longer it takes for students to apply it (Haibach et al., 2017). Another downside to implementing verbal guidance in face-to-face classes is that it can be time-consuming for the teacher; therefore, all students might receive feedback in lower quantities (Kok et al., 2020; Palao et al., 2015; Potdevin et al., 2018).

Thus, it is advantageous for teachers to find ways to guide students that do not require so much time. Having students self-assess their video performance is one way for face-to-face physical education teachers have provided time-consuming in-the-moment guidance (Nowels & Hewit, 2018; O’Loughlin et al., 2013; Potdevin et al., 2018). This guidance has students watch their performance and make a formal evaluation. While this can be teacher-guided (Potdevin et al., 2018), it can also be implemented with a simple non-visual rating scale (Nowels & Hewit, 2018) or using a visual rubric (O’Loughlin et al., 2013). These different forms of self-assessment guidance have students evaluate critical elements in one or multiple trials. For example, in one trial, “Do you think you were in a straight line during this attempt” (Potdevin et al., 2018, p. 563) compared to multiple trials, “on your last five trials . . . did you always, sometimes, never . . . dribbled towards the basket with my head up” (Potdevin et al., 2018, p. 179).

The final form of in-the-moment guidance is teachers providing a visual cue sheet to help students analyze and fix their errors (Kok et al., 2020; Souissi et al., 2021). Unlike students self-assessing their video, a visual cue sheet does not ask students to evaluate their video performance. Instead, this method provides a visual and written representation of what elements are the most critical aspect of the movement for students to focus on while watching their performance. Visual cue sheet guidance has recently been used in an asynchronous learning environment. Souissi et al. (2021) reported that older elementary-age children (4th and 5th graders) could utilize an asynchronous video feedback method that led to significant motor learning gains in the weightlifting snatch skill. Additionally, providing a cue sheet to help students guide their self-made video produced even more motor performance gains.

It should be noted that the participants utilized in Souissi et al. (2021) study were not traditional OLPE students due to the study being "conducted under a strict COVID-19 health protocol" (p.3), forcing students online. Furthermore, if the participants wanted, they could receive verbal feedback during practice—something that asynchronous OLPE teachers could not utilize. Regardless, the results of Souissi et al. (2021) constitute a promising development in creating evidence-based practices in OLPE. This finding demonstrates that not only can motor learning happen in an online environment, but implementing effective methods does make a difference in students' motor learning. Now the need is to identify effective teaching practices in the OLPE environment.

Statement of Purpose

Over the last 25 years, OLPE has become a popular option for students and schools—with no indication that its increase in enrollment will slow down. While some existing research does help answer concerns and support the viability of OLPE (e.g., J.M. Jackson, 2015), many questions still need to be studied. Daum and Buschner (2018) emphasize that the profession of physical education needs to move past questioning if OLPE should exist and instead focus on ensuring a quality product is delivered.

Therefore, the need is to understand better what makes up quality instruction in OLPE, particularly effective teaching strategies that improve motor skill performance and learning. The purpose of this study is to identify which form of video feedback guidance is most effective for university students learning disc golf skills.

Research Questions

Three research questions guide the current study:

RQ1: What form of pedagogical guidance is the most effective in improving online students' disc golf motor performance from pretest to posttest?

RQ2: Is there a relationship between participants' self-assessment accuracy and their disc golf performance?

RQ3: To what extent are participants' disc golf motor performance influenced by moderating factors?

RQ4: What form of pedagogical guidance is the most effective in improving online students' disc golf motor performance from pre to post to retention test?

Assumptions

This study was based on the following assumptions:

1. All student participants will answer all questions accurately.
2. All student participants will be motivated to perform all tasks according to the instructions to the best of their abilities.
3. Utilizing video feedback during practice can be an effective method to help provide external feedback to individuals.

Delimitations

This study was delimited in the following ways:

1. Student participants were selected from current courses at different universities based on convenience.
2. Disc golf was selected as the content.
3. The study focuses on participants improving the process of their spin putt and backhand throw.

Definition of Terms and Abbreviations

Asynchronous online learning: A course that students complete all assignments and course interaction between instructor and other students through a web portal.

Backhand Throw (BT): A fundamental technique that is used for the drive and approach throws in disc golf (Educational Disc Golf Experience [EDGE], 2013). See Appendix G for an overview of the critical elements.

Blended learning: Uses online resources to supplement face-to-face delivery method (DLC, 2022)

Digital/Distance learning: Includes online, hybrid, and blended learning and can refer to any use of these delivery methods (DLC, 2022)

Hybrid learning: A course that students complete most coursework outside of class and may meet periodically face-to-face for instruction or assessment (Seaman & Seaman, 2019)

Online physical education (OLPE): An alternative to face-to-face physical education courses typically delivered to secondary students (SHAPE, 2018). Instruction can occur in a hybrid or fully asynchronous online learning environment.

Physical Education Teacher Education (PETE): Preparation programs for physical education teachers.

Self-Assessment (SA) Guidance: A form of video feedback guidance in which the students evaluate their video performance.

Spin Putt (SP): A fundamental putting technique in disc golf (EDGE, 2013). See Appendix F for an overview of the critical elements.

Teacher Feedback (TF) Guidance: A form of video feedback guidance in which the teacher gives verbal feedback on students' performance or how to watch their video performance. In this study, TF guidance was given in a delayed format.

Video Feedback: A form of augmented visual feedback that is used in instructional settings to provide knowledge of performance feedback to students. Sometimes called video analysis (Laughlin et al., 2019), self-modeling (Barzouka et al., 2015), or visual feedback (Zhou et al., 2021)

Visual Cue Sheet (VCS): A form of video feedback guidance in which the students watch their video performance with visual and written representations of what elements are the most critical aspect of the movement to focus on.

Face-to-face (F2F) courses: Any course that meets in a brick and motor building. The primary mode of instruction is delivered through *traditional* methods. However, it can include forms of blended and hybrid learning.

CHAPTER II: LITERATURE REVIEW

Distance learning has been around in America since the 1800s and, in its early beginnings, was primarily structured as correspondence courses—which deliver content for credit to students who are not in a traditional school setting (Pierre, 1998). With time, teachers utilized various methods to deliver content—typically adopting the most current educational technology to their program. From audiotapes to VHS lessons, and now with internet-enabled mobile technologies, distance education courses can reach more people than ever (Goad et al., 2019; Pierre, 1998; Schwirzke et al., 2018). During the 1990s, a new trend of internet-based distance learning emerged. Distance learning was typically intended for adults and implemented by higher education institutions; however, 1996 is credited to the rise of K-12 virtual schools (Mosier, 2012; Schwirzke et al., 2018), which provided online learning opportunities. In 2008, Christensen et al. (as cited in Schwirzke et al., 2018) predicted that this new trend would lead to at least 50% of all high school courses being delivered online by 2019. While that prediction was off by one year, the Covid-19 pandemic in early 2020 shifted nearly all students and teachers to this online environment.

Before the pandemic, online instruction had been steadily growing (Digital Learning Collaborative [DLC], 2020; Seaman & Seaman, 2019). From 2012 to 2019, higher education online course enrollment steadily increased from about 4.5 million to 6.1 million students (Seaman & Seaman, 2019). During this same time, K-12 online course enrollments reached over 1.5 million (DLC, 2020).

While OLPE might seem like an "oxymoron" (Mohnsen, 2012, p.42) to some scholars, Daum and Buschner (2018) argue that "the question should not be if K-12

OLPE should exist, the question should be how to ensure K-12 OLPE meets the needs of the stake-holders, meets educational learning standards, and promotes lifelong physical activity" (p. 330). With regard to these questions and to better understand how to provide quality OLPE programming, the following is a review of relevant literature on OLPE. This chapter is split into two sections: an overview of higher education OLPE and video feedback. A review of K-12 OLPE is provided in Appendix K.

Overview of Higher Education Online Physical Education

This section will provide a historical overview of OLPE in higher education by describing its early beginnings to current trends. Within this first subsection, course organization and policies are discussed. Then, delivery methods are discussed to help highlight the unique context of higher education OLPE. To conclude, student characteristics and outcomes are discussed to understand better who is attracted to higher education OLPE and the benefits this environment provides students. Throughout this section, comparisons will be made between K-12 and higher education OLPE to understand the differences between the two environments better.

Policies and History of Online Physical Education in Higher Education

While most states require physical education credit to graduate high school (SHAPE America, 2016), the same is not true in order to graduate with your undergraduate degree in most tertiary intuitions (Szarbajko & Cardinal, 2023). This lack of physical education requirements contrasted starkly with the early 1920s when almost all higher education institutions required physical education credit to graduate (Cardinal et al., 2012). Predictably, since the late 1980s, physical education course enrollment in higher education has steadily declined (Cardinal, 2017). As a result of decreased enrollment and requirement reduction over the years, higher education intuitions have implemented more OLPE courses to combat this trend (Brock et al., 2018).

By the late 1990s, OLPE entered the scene in higher education. Pierre (1998) notes that an increasing number of higher education intuitions offered OLPE courses through "internet access" (p. 344). 1998 Brigham Young University (Davis & Mendenhall, 1998) and Kutztown University (Cider & Garman, 1998, as cited by Pierre, 1998) offered an online fitness and wellness course. One year later, Malone College offered a *Fitness for Life* course (Carr, 1999, as cited by Brewer, 2001). By 2000, Rio Salado Community College offered a personal wellness and safety course online (Brewer, 2001). By the early 21st century, students participated in OLPE courses in many higher education institutions.

Similar to secondary OLPE, the most common course of higher education OLPE today are physical activity and wellness courses (Brown, 2003; Cox et al., 2019; Goad, Jones, et al., 2021; Todorovich, 2012; Vaughn et al., 2019). However, before the start of the 2020 pandemic, research suggests that OLPE courses started offering more individualized activities and team sports classes (Cox et al., 2019). This trend continued during the pandemic; Appalachia State offered basketball, rugby, floor hockey, parkour, circuit training, caving, swimming, and yoga (Towner et al., 2023); Hong Kong University offered modern dance, physical conditioning, taekwondo, Tai Chi, track and field, yoga, badminton, squash, table tennis, tennis, basketball, soccer, softball, volleyball, and handball (Choi et al., 2023); some Korean Universities offered yoga, dance, and swimming (Yu & Jee, 2021).

A common practice in most higher education institutions is to have OLPE courses be taught by graduate teaching assistants or adjunct faculty (Brock et al., 2018; Brown, 2003; Cox et al., 2019; Melton et al., 2016; Russell et al., 2014; Goad, Jones, et al., 2021). However, this appears to be a relatively newer trend, as early adopters of OLPE were full-time faculty and were previously teaching the equivalent F2F course (Brewer, 2001; Davis & Mendenhall, 1998; McNamara et al., 2008). Next, delivery methods of higher education are explored.

Delivery Methods

2008 birthed a new form of learning in higher education: massive open online courses (MOOCs). Allen and Seaman (2016) identify that MOOCs differ from traditional online courses in that no credit is given, they are typically free, and most students are not registered students at the school—anyone can enroll in the course. The number of higher education institutions in the United States offering MOOCs increased from 2.6% in 2012 to 11.3% in 2015 (Allen & Seaman, 2016). In 2015, McGill University launched the first MOOC in OLPE titled the body matters (Griffin & Shrier, 2016). This course enrolled over 30,000 students from over 200 countries in its first edition. The University of Edinburgh (n.d.) offers a MOOC on increasing physical activity starting June 18th, 2023.

While MOOCs are delivered asynchronously, the hybrid method is the most common in higher education OLPE courses. During the early 2000s to the late-2010s, higher education OLPE courses were primarily delivered in a hybrid method (Brewer, 2001; McNamara et al., 2008; Milroy et al., 2013; Okazaki et al., 2014; Russell et al., 2014; Sidman et al., 2011; Sidman et al., 2014; Vaughn et al., 2019). It is important to note that not all hybrid higher education courses are organized the same. One hybrid method utilizes a few F2F sessions to help orient students to the online environment, and then the rest of the course is delivered asynchronously online (Lim et al., 2008; McNamara et al., 2008; Okazaki et al., 2014). This hybrid structure is similar to how some secondary OLPE courses are organized (Harris & Metzler, 2019; Karp & Woods, 2003). Another hybrid method utilizes F2F interaction throughout the course, e.g., weekly fitness labs (Milroy et al., 2013; Sidman et al., 2011; Sidman et al., 2014), instead of just at the beginning. This weekly F2F hybrid delivery method was common for some higher education OLPE courses during and after the Covid-19 pandemic (Chang & Reekie, 2021; Choi et al., 2023). One new hybrid delivery method that arose during the Covid-19 pandemic is entirely online but combines asynchronous and synchronous instruction (Choi et al., 2023; Lee et al., 2021). Instead of providing F2F interaction, this new hybrid method utilizes synchronous sessions, either content lectures or guided physical activity. This blend of synchronous and asynchronous instruction was also experienced in K-12 OLPE during the Covid-19 pandemic (Centeio et al., 2021; Foye, 2022). It is not clear if this new hybrid method will fade or if it is here to stay in OLPE courses.

The last delivery method utilized in higher education OLPE courses is fully asynchronous. This method was utilized before the 2020 pandemic (Goad, Jones, et al., 2021; Hager et al., 2012; Milroy et al., 2013; Sidman et al., 2011; Sidman et al., 2014) and remains a common method after (Choi et al., 2023; Lee et al., 2021; Towner et al., 2023). One main difference between the delivery method for K-12 and higher education OLPE is that hybrid appears to be used more often in higher education. This trend could be because K-12 online education grew out of asynchronous distance education programs (Schwirzke et al., 2018). It could also be that hybrids use in higher education is easier to implement with students who have their own transportation or live on campus. However, before the start of the 2020 pandemic, online synchronous instruction in other K-12 content areas was starting to become more popular (DLC, 2020).

The OLPE landscape has dramatically evolved from the early to late 1990s. There has been an increase in the quantity and variety of courses. There have even been two new online learning formats; MOOCs and fully online hybrid (asynchronous and synchronous instruction). To better understand why students enroll in higher education OLPE courses, student characteristics that make up these classes will be examined next.

Student Characteristics and Outcomes

Higher education students enroll in OLPE courses for a variety of reasons. Davies and Mendenhall (1998) conducted one of the earliest studies on undergraduate students' perspectives on learning fitness and lifestyle management information. Results revealed that students enrolled in the online format for personal flexibility and social benefits—i.e., being able to work out with friends who are not in the class. Brewer (2001) found similar advantages regarding higher education students wanting flexibility and convivence of the asynchronous online environment. Students wanting flexibility support similar findings to K-12 students' OLPE course enrollment motivations (J. A. Jackson, 2000; J.M. Jackson, 2015; Williams et al., 2020).

Additional factors unique to higher education settings help explain why students enroll in OLPE courses. Higher education OLPE students tend to be older than their F2F counterparts (Lim et al., 2008; Milroy et al., 2013; Sidman et al., 2011) and are more likely to be employed (Milroy et al., 2013; Sidman et al., 2011). Additionally, higher education students might choose the online medium because they are more prepared for the online environment. Lim et al. (2008) identified that higher education OLPE students have better technical skills and are more likely to have had previous online course experience than F2F students. Milroy et al. (2013) identified that higher education OLPE students are more likely to value autonomy and be more self-directed than their F2F counterparts, which may explain why they are motivated to enroll in OLPE courses.

While higher education OLPE students might be well prepared for the online environment, Goldstein et al. (2018) results raise caution that students willing to take higher education OLPE courses tend to be less active and have lower physical activity self-efficacy than people willing to take F2F courses. Regardless of this concern, higher education OLPE courses can improve students' physical activity levels (Hager et al., 2012; Okazaki et al., 2014). However, these results may depend on what form of OLPE course students experience. Research has shown that students who were enrolled in fully asynchronous higher education OLPE courses do not significantly improve their fitness ability (e.g., muscular strength) when compared to their F2F counterparts (Hager et al., 2012; McNamara et al., 2008). However, compared to students enrolled in a hybrid higher education OLPE course do just as well at improving their fitness as their F2F counterparts' course (Brewer, 2001; McNamara et al., 2008), which supports similar results in a secondary hybrid OLPE course (Futrell, 2009).

Additionally, during the start of covid-19, Yu and Jee (2021) discovered that higher education OLPE students in Korea felt like they improved their physical activity and motor skill ability. This report from Yu and Jee (2021) is the first to report any psychomotor benefits in an OLPE course. While Yu and Jee's (2021) data was self-reported by students, it does support similar psychomotor gains in online courses in physical therapy (Plummer et al., 2021) and paramedic students (Garratt, 2014).

Despite the lack of fitness gains in higher education OLPE students, research indicates that students do better or as well as their F2F counterparts in cognitive knowledge acquisition (Brewer, 2001; Brown, 2003, Lim et al., 2008; McNamara et al., 2008; Sidman et al., 2014). To this point, Sidman et al. (2014) and Lim et al. (2008) hybrid students did better on cognitive assessments than their F2F counterparts. Similar cognitive knowledge acquisition has also been identified in secondary OLPE courses (DeCarlo, 2016; Harris & Metzler, 2019).

Summary

Higher education OLPE and K-12 OLPE both started around the mid-1990s. Regardless, there is more depth of higher education OLPE research. This difference could be because it is easier to access higher education programs and students than K-12. Nevertheless, this increased amount of research provides countless insights.

For example, throughout the years, there has been a theme that the hybrid format is a better delivery method for K-12 OLPE (Daum, 2020; Daum & Woods, 2015; Killian et al., 2021; NASPE, 2007; SHAPE America, 2018). While results in K-12 OLPE are limited to support this finding, research in higher education OLPE helps confirm that hybrid typically offers more benefits than fully asynchronous delivery methods. Additionally, synchronous OLPE appears to be increasing in both higher education and K-12, and thus being a newer trend, little research exists on its effectiveness.

To conclude, another insight is that both higher education and K-12 OLPE courses lack evidence that helps support specific teaching practices that lead to motor skill learning. In fact, no research can be found in either area where motor performance was studied as an outcome variable. This lack of focus could be because secondary and higher education OLPE courses are more likely to be oriented on improving physical activity and wellness than specific motor skills. Regardless, motor skills are being taught in both environments, and it could be beneficial to practitioners to have evidence-based practices that they could utilize.

Video Feedback Research

Video instruction is a beneficial instructional strategy in F2F physical education classes (Jenny et al., 2020; Obrusnikova & Cavalier, 2018; Sargent & Calderón, 2021). In OLPE, the use of video feedback has been a recommended best practice to use (Daum, 2020; Daum, Goad, Mosier, et al., 2021; Foye & Grenier, 2021; Jenny et al., 2020; Killian et al., 2021; Goad et al., 2019; Mohnsen, 2012; Ransdell et al., 2008; SHAPE America, 2018; Waller & Schempp, 2022). This recommendation corresponds with a variety of research that indicates that video feedback can enhance motor skill learning (Clark & Ste-Marie, 2007; Han et al., 2022; Mödinger et al., 2021; Rhoads et al., 2014). These results show that video feedback is most commonly used in athletics and sport club settings. However, a growing trend is seeing the use of video feedback in physical education settings that aid in motor skill learning (Han et al., 2022; Mödinger et al., 2021). Conversely, some evidence suggests that video feedback is not beneficial in physical education settings (Zhou et al., 2021). This finding can be explained by the fact that any feedback method's effectiveness depends on various factors (Haibach et al., 2017; Han et al., 2022; Mödinger et al., 2021). Therefore, to better understand how video feedback can be used in an OLPE setting, this section will review relevant research to understand better the most effective method of providing video feedback. Forms of guidance, implementation, best practices, and tips will be reviewed. First, a brief review of the benefits of video feedback research in physical education will be reviewed.

Benefits

Video feedback is a form of extrinsic visual feedback that can be used in motor skill learning (Haibach et al., 2017). This strategy would have students record their practice attempts of any motor skill and then watch their video to help detect and fix errors in their performance. This information helps augment individuals' internal sensory systems (i.e., vision, proprioception, and hearing) by providing additional information on the quality of their movement or knowledge of performance.

Video feedback in physical education has been shown to positively impact motor skill learning in the shot put technique and distance (Kok et al., 2020), hurdle technique and execution (Palao et al., 2015), swimming front crawl technique (Kretschmann, 2017), tennis forehand technique (Boyce et al., 1996), long jump technique and distance (Puklavec et al., 2021), soccer game performance of tactical skills (Harvey & Gittins, 2014), various volleyball skills technique (Barzouka et al., 2015; Zetou et al., 1999), numerous basketball skills technique (Boyce et al., 1996; O'Loughlin et al., 2013), and several gymnastic skills technique (Brooker & Daley-James, 2013; Potdevin et al., 2018). Furthermore, video feedback has positively impacted motor performance in collegiate physical education classes (Giannousi et al., 2017; Nowels & Hewit, 2018; Yu et al., 2020) as well as with children in lab settings (Souissi et al., 2021) and athletic clubs and teams (Clark & Ste-Marie, 2007)

Besides various motor skill learning and performance benefits, video feedback in physical education has benefited other forms of learning. For example, video and teacher feedback helped improve high school students' knowledge of track and field (Palao et al., 2015). Casey and Jones (2011) found that 7th-grade PE students had a deeper understanding of throwing and catching with the use of video technology—the video was also used for instruction and other digital technology. Brooker and Daley-James (2013) noted that the use of video feedback helped motivate 2nd-grade physical education students to participate and fix errors, which corresponds with older physical education students (Casey & Jones, 2011; Kretschmann, 2017 O'Loughlin et al., 2013). Kok et al. (2020) also demonstrated that self-regulated video feedback increased 9th-grade physical education students' shot-put self-efficacy.

One last benefit that might help influence motor skill learning is that video feedback has improved students' ability to self-assess (Hastie et al., 2012; Nowels & Hewit, 2018; O'Loughlin et al., 2013; Potdevin et al., 2018). O'Loughlin et al. (2013) found that using a visual rubric, which 5th-grade students would use to evaluate their performance while watching their video, positively impacted their performance of various basketball skills. Potdevin et al. (2018) found that 7th-grade physical education students could significantly improve the self-assessment accuracy of their front handstand performance just after one lesson of video-feedback use. Furthermore, results from this study showed that prolonged use of video feedback would continue to help improve students' self-assessment ability as scores significantly improved from the first to the last (number 5). In another study, video feedback helped improve military cadets' flank vault self-assessment accuracy (Nowels & Hewit, 2018). This improvement led to decreased self-assessment scores, which were more aligned with their actual performance. A similar overestimating of ability was found with 3rd-grade physical education students' self-assessment of their basketball dribbling ability (Hastie et al., 2012).

While Nowels and Hewit (2018) suspect that this improved self-assessment accuracy led to cadets being more willing to receive and apply feedback, Hastie et al.'s (2012) students only used video feedback to self-assess and not to help improve motor skill performance. Furthermore, Hastie et al. (2012) found that boys were more accurate and girls were more likely to overestimate their ability; therefore, girls benefited the most from using video feedback to help improve their self-assessment ability. While O'Loughlin et al. (2013) found no significant gender differences in self-assessment scores, Casey and Jones (2011) reported that girls benefited more from including video devices for instruction and feedback. Additionally, O'Loughlin et al. (2013) reported that girls valued self-assessments more than boys. These studies show that video feedback makes students more accurate with their assessments.

Forms of Guidance

Improved self-assessment accuracy might help explain why students have improved cognitive function and motor skill performance using video feedback. However, besides self-assessment accuracy, other factors help distinguish video feedback effectiveness. The most critical factor for the successful implementation of video feedback in physical education is the need to provide in-the-moment guidance to students while they watch their videos (Clark & Ste-Marie, 2007; Madou & Cottyn, 2015; Rucci & Tomporowski, 2010). This guidance helps students focus on specific aspects of the movement being analyzed. Additionally, this guidance is essential for novice learners—

i.e., those that typically fill physical education classrooms—as video feedback can provide too much information (Haibach et al., 2017).

There appear to be four primary forms of pedagogical guidance that teachers and researchers have utilized with video feedback: (1) verbal feedback (Barzouka et al., 2015; Boyce et al., 1996; Brooker & Daley-James, 2013; Harvey & Gittins, 2014; Kretschmann, 2017; Palao et al., 2015; Puklavec et al., 2021; Zetou et al., 1999); (2) self-assessment (O'Loughlin et al., 2013); (3) visual cue sheet (Kok et al., 2020; Souissi et al., 2021); (4) and a combination of methods (Nowels & Hewit, 2018; Potdevin et al., 2018). Verbal feedback can either be corrective or informative feedback. Corrective feedback typically involves identifying what the students did wrong (evaluative feedback) and then prescribing what students need to do to fix their errors. For example, Puklavec et al.'s (2021) students would watch their video of performing a long jump, and the teacher would provide the most important error that was made and provide a verbal cue to fix that error; i.e., error, "front torso tilt at take-off" verbal cue, "keep the torso straight during take-off" (p.111). While corrective feedback is the most popular form of verbal guidance, Boyce et al. (1996) and Zetou et al. (1999) utilized informative feedback, sometimes called cueing. This method involves verbal instructions to focus on the most important aspects of the skill. For example, Zetou et al.'s (1999) teacher provided verbal prompts on specific aspects of the volleyball serve while students watched videos; "watch the ball touching point" (p. 133). Unlike corrective feedback, informative feedback does not tell students what they did correctly or wrong. While it is recommended that novices receive informative feedback while watching their video for the first time, corrective feedback is considered the most beneficial (Haibach et al., 2017).

While the teacher typically provides verbal feedback guidance, some studies have used peers to help guide students' use of video feedback (Harvey & Gittins, 2014; Kok et al., 2020; Palao et al., 2015; O'Loughlin et al., 2013). For example, Harvey and Gittins (2014) had students watch their teams' soccer video performance and then lead out in a debate of ideas where students evaluate their individual and team performance in order to make improvements for the next game (peer corrective feedback guidance). Palao et al. (2015) had students working in small groups to help provide each other with corrective feedback on their hurdle performance. While this method led to students significantly improving their hurdle technique and the highest level of quality practice, it did not improve students' cognitive knowledge. Palao et al. (2015) recommended training students on how to give peer feedback, which students can be trained to accurately give in just one twenty-minute training session (Alstot, 2018).

Working with peers is a standard method for self-assessment (O'Loughlin et al., 2013) or visual cue sheet (Kok et al., 2020) guidance. While peers did not provide verbal guidance in O'Loughlin et al.'s (2013) study, they did assist in recording their peer's performance so they could watch their videos. This process required students to record a specific basketball (six different skills were used in the study) five times by a peer and then view their video and self-assess with a simple face-based marking system (a 1-3 rating scale): a smiley face for always, a blank face for sometimes, and a sad face for never. Kok et al. (2020) had pairs of students working together to record each other's shot-put performance to analyze together. While students did not record a formal evaluative assessment (i.e., O'Loughlin et al., 2013), the teacher did provide a visual cue sheet that included a visual and written representation of the current focus of that days shot-put technique; this cue sheet was similar in style to O'Loughlin et al.'s (2013) visual rubric—just missing a formal evaluation of their performance. Furthermore, the cue sheet provided to Kok et al.'s (2020) students included procedural instructions for students on what to do while watching the video and to discuss with their partners what they will do for the next practice round—it is unclear if the peers provided any verbal feedback or if students just communicated their plan for improved performance.

If they did, this study (Kok et al., 2020) would be an example of providing multiple guidance modes. To this point, Potdevin et al. (2018) provided two methods of guidance: having students make formal self-assessments and the teacher providing corrective verbal feedback. Nowels and Hewit (2018) provided the same two forms of guidance, but students self-assessed after seeing their video and receiving corrective teacher feedback. Potdevin et al.'s (2018) students self-assessed before watching their video, which researchers thought would help students focus while watching their video and be more receptive to listening to teachers' corrective feedback. Researchers providing self-assessment guidance had students evaluate the whole skill (Nowels & Hewit, 2018) or evaluate critical features of a skill (O'Loughlin et al., 2013; Potdevin et al., 2018). While Nowels and Hewit (2018) students were enrolled in a F2F physical education class, they were military cadets (college students); this can explain why they evaluated the whole skill instead of individual aspects of the skill. Furthermore, Potdevin et al. (2018) had students self-assess the same critical feature each time, whereas O'Loughlin et al. (2013) had students evaluate four different critical elements. This lengthier assessment practice could be explained by the unit length being twice as long in Potdevin et al.'s (2018) study than O'Loughlin et al. (2013); five weeks vs. ten weeks.

While these forms of pedagogical guidance exist, only a few studies examined the benefits of different forms of guidance provided to students (Palao et al., 2015; Souissi et al., 2021). While Palao et al. (2015) found verbal peer corrective guidance (feedback) and verbal teacher corrective guidance to be beneficial to improving students' hurdle technique and performance, verbal teaching guidance provided more overall results as this method also increased superior cognitive knowledge learning. Souissi et al. (2021) participants who viewed their video feedback with a visual cue sheet showed superior motor learning gains in their snatch technique than the group that received no guidance—they were just told to watch their video to detect and correct errors in their performance. While Souissi et al.'s (2021) participants were middle school-age children (~11 years old), the setting was not conducted in a physical education class or with a physical education teacher—it was done in an online virtual lab learning environment.

While non-OLPE settings make results hard to translate into practice, they confirm that individuals can benefit from different forms of guidance while watching video feedback. For example, female college athletes benefited from receiving corrective verbal guidance while learning the hang power clean. In contrast, the group that received no guidance on their video feedback showed no motor learning gains (Rucci & Tomporowski, 2010). Individuals (age 15-40) learning to throw at a target with their eyes closed and with their non-dominate hand benefited from receiving corrective and informational feedback guidance with their video feedback than the group that just watched their video (Kernodle & Carlton, 1992). Furthermore, corrective feedback guidance was more beneficial than informative feedback. Regardless of how students are guided to watch their video feedback, it is clear that its inclusion will benefit all learners—even highly skilled athletes benefit from receiving guidance when viewing their video feedback (Haibach et al., 2017). Overall, these studies suggest that corrective feedback guidance is superior to informative feedback that can be delivered from either peers or the teacher.

While some forms of guidance may be more effective than others, there are other factors that physical education teachers should consider when trying to create effective guidance. In particular, the learner's age, experience level, and the number of elements to include should all be considered. For example, younger learners need cues in a language they can understand (i.e., simple language and more figurative language); comparatively speaking, older learners may need more detailed cues/guidance (i.e., more complex and literal language)-"e.g., "step with your foot' versus 'make a long step forward with the opposite foot" (Obrusnikova & Rattigan, 2016, p. 26).

Additionally, novice and younger learners will benefit from fewer elements while they watch their videos, as they lack the attentional focus needed (Haibach et al., 2017; Obrusnikova & Rattigan, 2016). While some studies (i.e., Potdevin et al., 2018) had students only focusing on one element at a time, Zetou et al. (1999) focused on six critical features during each video feedback session. While students were relatively the same age (11.7 and 12.6 years old), this difference could be because Zetou et al. (1999) utilized 16 sessions—the greatest amount of any other research—compared to just five (Potdevin et al., 2018). Furthermore, Clark and Ste-Marie (2007) had students as young as six conduct a verbal think-out loud while they watched their video; participants were asked to verbalize what they thought while they watched their video. Essentially these children were not given any elements to focus on. Overall, it is recommended to take a less is more approach regarding the number of elements students should focus on while watching their videos (Darden & Shimon, 2000). “A check sheet with too many elements will encourage thoughtless, randomized and inaccurate analysis of the tape, and likely result in disinterest” (Darden & Shimon, 2000, p.18).

This concern highlights why some practitioners recommend progressing the guidance throughout the learning sessions (Beseler & Plumb, 2019; Darden & Shimon, 2000). This progression can be done by changing the visual cue sheet focus during each practice session (Kok et al., 2020). With this in mind, it could be more beneficial to have initial sessions start with informative feedback guidance and then provide corrective feedback when students are ready (Haibach et al., 2017). Additionally, Beseler and Plumb (2019) recommended that older students, who still might be novices, can utilize more elements to focus on by providing a progressive checklist. This checklist is organized from the easiest component to fix first, and students only move to the next component when they can answer *yes* to that component. Conversely, if students answer *no,* they should go and practice until they can answer *yes* to that component. Additionally, the checklist has corrective information to help students improve if they do not know what to do.

Additional Best Practices and Tips

While providing in-the-moment guidance to students while they watch their video feedback is essential in implementing video feedback successfully, other elements should be considered. Specifically, finding ways to reduce time constraints, the number of sessions that should be provided, priming students for successful use, and having a feedback schedule are all important factors to consider.

Time Constraints The use of video feedback in settings has been reported as time-consuming by many researchers and teachers (Boyce et al., 1999; Casey & Jones, 2011; Palao et al., 2015). Furthermore, teachers are typically concerned with implementing video feedback because it would lead to less practice time for students and would not be practical for students' motor learning. To this point, one study showed that when video feedback was used in a 30-minute class, the average practice time was almost a third less than in the group that only got teacher verbal feedback (Boyce et al., 1999). However, this less practice time did not result in any significant learning differences compared to students who only received teacher or peer feedback. Furthermore, a 20-minute practice session with video feedback in a university physical education class was considered enough time by the teacher (Beseler & Plumb, 2019). Regardless of how much time is spent in one class period, using video feedback is recommended not to be used the entire lesson time, as students can become bored (Boyce et al., 1999). Educators should not worry about decreased practice time when using video feedback, as students will still learn.

Another way to reduce the time-consuming process when implementing video feedback is to utilize mobile devices (i.e., digital cameras, cellphones, or tablets) with video analysis applications (Beseler & Plumb, 2019; Goad et al., 2019; Kok et al., 2020; Kretschmann, 2017; Laughlin et al., 2019; Nowels & Hewit, 2018). Initially, using video feedback required expensive equipment and a great deal of effort to set up. For example, Casey and Jones (2011) outline the time-consuming process of making video feedback mobile and the equipment needed; it required a digital camera, tripod, data projector, laptop, and spare laptop battery. Now many schools provide mobile technology to their students and classrooms, even allowing students to bring their mobile devices to school (Nowels & Hewit, 2018). For example, Kok et al. (2020) had students record with classroom iPads and analyze their video with the application Coach’s Eye; similarly, Nowels and Hewit (2018) used an iPad to record but used the device's own video features to help students analyze; and Souissi et al. (2021) had students record their trials using a chair, and students own smartphone. Additionally, using these mobile devices and applications could help eliminate the need for expensive equipment and video editing software that most schools typically do not have (Barzouka et al., 2015; Clark & Ste-Marie, 2007). For example, Kinovea is a free video analysis application that has been used in a variety of video feedback research (Potdevin et al., 2018; Puklavec et al., 2021; Souissi et al.,2021)—however, it is only available for Mac and Windows laptops and desktops. Regardless of what device or app is used, these mobile technologies have allowed the adaptation of video feedback in settings that were not originally thought possible, e.g., swimming (Kretschmann, 2017) and OLPE (Goad et al., 2019).

Once a teacher has decided what technology they will use for video feedback, teachers need to help familiarize students with the technology they are about to use. When students first use video feedback, they are typically more concerned with their appearance and can be shocked to see themselves on TV for the first time (Darden & Shimon, 2000). Karp and Woods (2003) secondary OLPE students report a similar novelty effect with using an online learning management system that felt overwhelming when using new technology. Even teachers have reported an “oohah” (Casey & Jones, 2011, p. 62) feeling when implementing video feedback. To help limit this effect and to help students become more comfortable with seeing themselves on video, the adaption of the use of video feedback should not be used as a one-time pedagogical strategy but embedded throughout the entire curriculum (Beseler & Plumb, 2019; Laughlin et al., 2019). Additionally, using the same guidance protocol will help students become more efficient with subsequent use. Furthermore, teachers should spend time practicing and understanding how to use whatever video analysis app they decide to use for their students so they can help answer questions that may arise (Laughlin et al., 2019).

One last way teachers can reduce time constraints is by utilizing stations. This method has been recommended to incorporate video feedback in physical education settings that maximize students' and teachers' time (Darden & Shimon, 2000). Stations can be implemented with peer assistance (Kok et al., 2020; Palao et al., 2015) or the teacher positioned at the video feedback station to help guide students (Potdevin et al., 2018). With this in mind, Palao et al. (2015) stress the importance of using technology that does not require large amounts of teacher intervention. To this point, peer feedback with stations has the potential to give students more feedback than teacher-guided, increased student ownership of their learning, and can free the teacher up to work with students who need more of their attention (Beseler & Plumb, 2019). Leveraging mobile technologies and then familiarizing that technology with students throughout the curriculum through stations can help reduce time constraints when implementing video feedback.

Priming Students for Successful Use While practicing and utilizing video feedback throughout the curriculum will help prime students for successful use, there are other factors to consider. First, students should learn the critical features of the skill before using video feedback for the first time (Beseler & Plumb, 2019); this can be done utilizing traditional in-class teacher demonstrations (Nowels & Hewit, 2018; O'Loughlin et al., 2013). For example, Beseler and Plumb (2019) recommend assigning this task as homework that requires students to watch a video demonstration.

This video recommendation, called an expert video model, represents the most common method to present the skill to students and help them learn the critical features of that skill (Barzouka et al., 2015; Casey & Jones, 2011; Kok et al., 2020; Palao et al., 2015; Puklavec et al., 2021; Souissi et al., 2021). An expert model is a video sequence of a motor skill with cues of the most critical elements played visually (overlay text on the video) that can include audio of the same visual cue being played (Obrusnikova & Rattigan, 2016). Additionally, the entire motor skill without the audio and visual cues should be played at the beginning and end of the expert video model. Furthermore, the individual who is used as the expert model can be the teacher but is typically another adult expert or peer expert. For example, Barzouka et al. (2015) used a student-athlete that was the same age as the participants as their expert, while Zetou et al. (1999) and Palao et al. (2015) used elite Olympic athletes as their expert models.

Obrusnikova and Rattigan (2016) recommend creating multiple versions of each expert video model, which allows students to make better generalizations for learning. These versions can include different angles, settings, or people demoing the skill (e.g., adult and peer experts). To this point, Barzouka et al.'s (2015) two-minute expert model included two angles (side and front) and played in standard and slow-motion; similarly, Zetou et al. (1999) expert model was also two minutes in length and included the same two angles but did not use slow-motion and included four trials from each angle Kok et al. (2020) watched the expert model three times before each video feedback session.

Slow motion has also been used in research as a way for students to watch their performance (Barzouka et al., 2015; Kretschmann, 2017; Souissi et al., 2021).

Utilizing an expert video model can have many benefits. It can create a more engaging environment than traditional teaching methods; one teacher noted that “the use of images and videos for explaining the classes captured their attention better than my demonstrations” (Palao et al., 2015, p. 59). Furthermore, the use of an expert video model can be helpful for students when giving peer feedback, as evident in Casey and Jones (2011) as many students referenced the expert model to help them interact with their peers, “like we saw in the video” (p. 59). In addition to using an expert model to help introduce the skill for the first time or before each video feedback session, many researchers have let students reference the expert model during video feedback sessions to help students self-analyze (Barzouka et al., 2015; Kok et al., 2020; Souissi et al., 2021). One unique way to leverage expert model videos during video feedback sessions is to use a side-by-side function included in many video analysis apps (Laughlin et al., 2019). Barzouka et al.’s (2015) students experienced this feature as they watched their video performance of a volleyball pass next to an expert model being played simultaneously. These studies help highlight how utilizing an expert video model can help students rely less on the teacher and take more responsibility for their learning.

Besides utilizing an expert model, providing optimal practice conditions will also help prime students for successful use of video feedback. Unsurprisingly, practice is considered a more important factor in motor learning than feedback (Haibach et al., 2017). Additionally, the practice should always follow a video feedback session, as long delays can negatively affect learning and performance. Even though Barzouka et al.’s

(2015) students received delayed video feedback for at least one to three days, they still got to practice immediately after watching their video. With this in mind, instant video feedback is considered superior to delayed video feedback (Mödinger et al., 2021; Rhoads et al., 2014).

Whether practice sessions happen before or after using video feedback, they should include the movement's goal (Rucci & Tomporowski, 2010). For example, this can be done by instructing students to jump as far as possible (Puklavec et al., 2021) or throw as far as possible with the correct form (Kok et al., 2020). It is also considered best practice not to provide feedback after every trial, as students need time to use their intrinsic feedback to make corrections (Haibach et al., 2017; Potdevin et al., 2018). For example, Souissi et al.'s (2021) participants practiced ten times before viewing their snatch performance; Potdevin et al.'s (2018) practiced five trials before viewing their handstand performance; Kok et al. (2020) practiced just two trials before viewing their shot-put performance. Additionally, students can watch all practice trials (Kok et al., 2020; O'Loughlin et al., 2013; Souissi et al., 2021) or just the last one (Potdevin et al., 2018). Watching fewer trials may also help reduce time-constraints

The last suggestion to prime students for success is to spread out the use of video feedback. This use plan can be done by having an initial lesson dedicated to learning the skill using traditional methods (Nowels & Hewit, 2018). It could also be beneficial to spread out physical practice lessons with lessons that utilize video feedback (Darden & Shimon, 2000). For example, during a 10-lesson unit on basketball skills, O'Loughlin et al. (2013) utilized video feedback halfway through and at the end of the unit (5 and 10 weeks apart). Spreading out the use, instead of chunking, of all video feedback sessions incorporates a beneficial practice condition known as mixed and distributed practice (Haibach et al., 2017).

The Number of Sessions That Should Be Provided Along the same lines of spreading out the use of video feedback sessions is figuring out how many sessions should be used. Teachers need to understand the benefits of just a few video feedback sessions on student learning. Initially, video feedback was thought to be only valuable with ten or more sessions (Haibach et al., 2017). However, recent research has shown that it can be just as beneficial to motor learning with five or fewer uses (Mödinger et al., 2021; Rhoads et al., 2014). For example, ninth-grade physical education students' shot-put distance and form improved in just four sessions (Kok et al., 2020); in just three sessions, third-graders' overhead basketball pass technique and fifth-graders forehand striking technique had improved (Boyce et al., 1999); fifth graders utilizing video feedback twice saw benefits to learning six different basketball skills (O'Loughlin et al., 2013); eighth-grade students saw increased soccer performance (tactical skills) just after one session (Harvey & Gittins, 2014). Fewer sessions also appear to be slightly connected with age, as students can benefit from fewer video feedback sessions as they age. This age benefit could explain how college students improved their flank vault just after one video feedback session (Nowels & Hewit, 2018).

Feedback Schedule The last important factor to consider when implementing video feedback is having a feedback schedule. Typically, novices need more feedback than experts (Haibach et al., 2017). However, overuse of video feedback may be detrimental to learning because it can cause students to become dependent on watching the video and never try to utilize their internal sources of feedback (Obrusnikova &

Rattigan, 2016). Nevertheless, it can be difficult for teachers to know when to start fading the use of video feedback, especially since there is no universal method to reduce feedback in physical education. Additionally, feedback frequency is moderated by a variety of factors: the ability level of the learner, the complexity of the learning task, and the skill being learned (Haibach et al., 2017; Han et al., 2022).

Furthermore, finding an effective way to reduce the use of video feedback may be in opposition to typical best practices. For example, knowledge of performance feedback is typically more effective in closed skills where the environment is stable. However, research suggests that video feedback, a form of providing knowledge of performance feedback, is more effective in open skills (Rhoads et al., 2014); this implies that video feedback could fade faster in open skills than in closed skills. Furthermore, research supports that video feedback has a more significant benefit for continuous skills such as swimming versus discrete skills such as a volleyball serve (Clark & Ste-Marie, 2007).

With this in mind, two studies investigated the effects of two different video feedback schedule strategies on physical education students. (Kok et al., 2020; Puklavec et al., 2021). Kok et al. (2020) utilized a learner-regulated video feedback strategy with freshman physical education students learning the shot-put. Learner-regulated feedback allows students to decide when they want to receive feedback. This strategy is considered superior to teacher-regulated feedback in promoting motor skill learning with children in lab settings as it encourages learners to take a more active role in processing their feedback and can increase motivation (Wulf & Lewthwaite, 2016). Additionally, learners using this strategy will naturally fade their request for feedback. While students in the learner-regulated group significantly improved their shot-put performance and technique, it did not lead to superior learning gains compared to the teacher-regulated video feedback and teacher-regulated (no video feedback) groups (Kok et al. 2020). This study suggests teachers can effectively use teacher- or learner-regulated video feedback strategies. However, utilizing learner-regulated video feedback may benefit self-efficacy and perceived learning more than teacher-regulated video feedback (Kok et al., 2020).

Another video feedback schedule strategy utilized with 6^{th}-grade physical education students while learning the long jump was bandwidth feedback (Puklavec et al., 2021). This strategy eliminates the issue of providing too much feedback, as learners only receive feedback when they are outside a predefined range of accuracy (Haibach et al., 2017). This strategy naturally incorporates a fading schedule as novices will receive more feedback than skilled performers as they will be performing outside the acceptable range (i.e., the bandwidth) more often. Additionally, the absence of feedback can provide positive reinforcement, as individuals know they have performed correctly if they do not receive feedback. Puklavec et al. (2021) determined the bandwidth to be the top three of 14 agreed-upon errors from 21 expert coaches. Both video groups received video and verbal teacher corrective feedback, with one group receiving this feedback on 100% of errors while the other on just the top three errors. Results show that the group receiving feedback on all errors improved their long jump distance the most, with no consistent differences between groups' long jump techniques. Puklavec et al. (2021) acknowledge they may have made a mistake when determining the bandwidth. This strategy may only benefit children if it provides positive feedback when they are in the bandwidth (Haibach et al., 2017). Additionally, this study suggests that students may benefit from using video feedback supported by teacher corrective guidance more often when learning a new skill.

Furthermore, when students become more experienced, it may be advantageous to start utilizing a learner-regulated video feedback schedule. This advice aligns with Obrusnikova and Rattigan (2016) of only utilizing video feedback if students commit high errors.

To summarize, this section provided implications for teachers considering utilizing video feedback in physical education. There are many factors that teachers must consider when incorporating this strategy, e.g., the age of the students, the type of skill being learned, and the ability level of students. However, what appears to be the most important factor is that video feedback must be paired with some form of in-the-moment pedagogical guidance. This guidance can be verbal (informative or corrective feedback) supplied by teachers or peers, self-assessment (evaluative feedback), or utilizing a visual cue sheet. Providing multiple forms of guidance can also be effective (e.g., Potdevin et al., 2018). Besides providing pedagogical guidance, teachers should consider various other factors. These factors include fading feedback, mixing the use with traditional teaching methods, creating adequate practice conditions, utilizing expert video models, the number of sessions to use, and ways to manage effective use (e.g., utilizing mobile devices).

Summary

Sir Isaac Newton is attributed to the saying that *what we know is a drop, what we do not know is an ocean* (Spence, 1858). This review indicated a dearth of OLPE research to adequality inform practice to improve psychomotor performance. This limited research and concerns from practitioners have not stopped the wide-scale use of OLPE. Over the last 25 years, OLPE has become a popular option for students and schools—and there is no indication that it will slow down. Research on students in OLPE has increased in recent years, especially during the pandemic, which has helped inform best practices. While video feedback represents one of the many recommended best practices in OLPE, its implementation lacks the same robust evidence as it does in F2F settings (Han et al., 2022; Södinger et al., 2021; Rhoads et al., 2014).

CHAPTER III: METHODS

The primary purpose of this study was to examine the impact of providing different forms of pedagogical guidance to students' use of video feedback on improving their spin putt (SP) and backhand throw (BT) techniques. The underlining assumption is that students can improve their disc golf skills while utilizing video feedback during practice sessions. This chapter is organized into six sections: (a) theoretical framework, (b) research questions and hypotheses, (c) research design, (d) data collection methods and procedures, (e) participants and setting, and (f) data analysis plan. Approval of the research methods was obtained from the Institutional Review Board before the study began.

Theoretical Framework

The theoretical framework used to inform this study is the Optimizing Performance Through Intrinsic Motivation and Attention for Learning (OPTIMAL) Theory of Motor Learning (Wulf & Lewthwaite, 2016). This theory has two main aspects that help improve motor performance and learning: motivation and attention. Motivation has two main factors: autonomy and enhanced expectations. Autonomy refers to the urge to direct one's own life. Enhanced expectation refers to anticipating a good experience or performance and can be produced by the learner or teachers. The last factor, an external focus of attention, directs learners to focus on the goal of the movement; e.g., a teacher might tell a student shooting a basketball jump shot to *focus on putting spin on the ball*. OPTIMAL Theory of Motor Learning states that enhanced performance expectations and perceptions of autonomy combined with an external focus create a virtuous cycle; as motor performance and learning are improved, self-efficacy and positive affect will increase, leading to increased levels of motor performance and learning.

Video feedback has been used in a variety of physical education contexts to demonstrate the application of different variables in the OPTIMAL Theory of Motor Learning (Kok et al., 2020; Legrain et al., 2015; Potdevin et al., 2018; Roure et al., 2019; San et al., 2022). These studies reveal that video feedback can help improve motor learning, motivation, assessment ability, and self-regulation. Furthermore, video feedback has positively impacted motor performance in collegiate physical education classes (Giannousi et al., 2017; Nowels & Hewit, 2018; Yu et al., 2020). However, video feedback research has not been applied to online physical education (OLPE). Additionally, applying the OPTIMAL Theory of Motor Learning to the OLPE context aligns with why students choose to enroll in online education (J.M. Jackson, 2015; Kane, 2004; Williams, 2013); autonomy. Therefore, it is assumed in this study that applying aspects of the OPTIMAL Theory of Motor Learning through video feedback practice sessions will benefit students' disc golf skills.

Research Questions and Hypotheses

RQ1: What form of pedagogical guidance is the most affective in improving online students' disc golf motor performance from pretest to posttest?

Null hypothesis: No significant differences exist between feedback groups in SP and BT technique scores from the pretest to the posttest

H1a: A significant difference exists in SP performance from the pretest to the posttest in the self-assessment (SA) group.

H1b: A significant difference exists in SP performance from the pretest to the posttest in the visual cue sheet (VCS) group.

H1c: A significant difference exists between the SA group and the VCS group in SP performance from the pretest to the posttest when compared to the teacher feedback (TF) group.

H1d: A significant difference exists in BT performance from the pretest to the posttest in the SA group.

H1e: A significant difference exists in BT performance from the pretest to the posttest in the VCS group.

H1f: A significant difference exists between the SA group and the VCS group in BT performance from the pretest to the posttest when compared to the TF group.

RQ2: Is there a relationship between participants' SA accuracy and their disc golf performance?

Null hypothesis: No significant relationships or differences exists between participants' SA accuracy and their motor performance

H2a: A significant difference relationship between participant's SP SA accuracy and their posttest SP scores

H2b: A significant difference relationship between participant's BT SA accuracy and their posttest BT scores

RQ3: To what extent are participants' disc golf motor performance influenced by moderating factors?

Null hypothesis: No significant interaction effect exists between participants' disc golf performance and their SA scores, prior disc golf experience, current disc golf habits, the *self-rated score of their SP ability, their self-rated score of their BT ability, interest in learning how to play disc golf, age, major, or gender.*

H3a: A significant interaction effect between individuals with more disc golf experience on their pre to posttest on both SP and BT.

H3b: A significant interaction effect between individuals with a higher number of times they have played disc golf in the last year on their pre to posttest on both SP and BT.

H3c: A significant interaction effect between individuals with a higher SA score on their pre to posttest on both SP and BT.

H3d: Physical Education Teacher Educator (PETE) students will have significantly higher overall SA accuracy than all other participants.

H3e: PETE students will have a significantly higher motor performance score on their posttest on their SP than all other participants

H3f: PETE students will have a significantly higher motor performance score on their posttest on their BT than all other participants

RQ4: What form of pedagogical guidance is the most affective in improving online students' disc golf motor performance from pre to post to retention tests?

Null hypothesis: No significant differences exist in overall motor performance from pre to post to retention test between the different feedback groups within the SP and BT skills.

H4a: A significant main effect for time for SP and BT technique with significant differences from pretest to posttest and pretest to retention test.

H4b: A significant time difference for the SA and VCS groups for SP and BT techniques from pretest to posttest and pretest to retention test.

H4c: A significant interaction effect with group differences for the posttest and retention test for either the SA and VCS groups for SP and BT technique

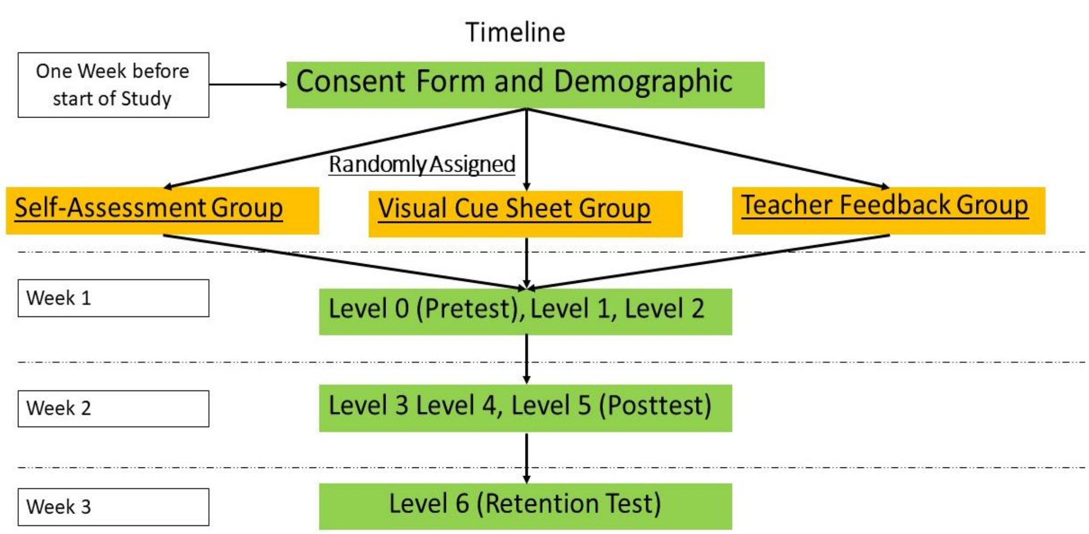
Research Design

A quasi-experimental factorial design was implemented to answer the research questions. Students enrolled in a university health-related fitness class or PETE class were recruited to participate in the study. Students were randomly assigned to one of three groups: (a) SA, (b) VCS, or (c) delayed TF. Pre, post, and retention performance scores of the BT and SP were collected to determine which method of pedagogical guidance is most affective for student movement learning through online instruction. In addition to the pre/post/retention scores, data on moderating factors was collected and analyzed to help explain differences.

Each class completed the study over a three-week interval, with participants completing seven sessions, including pre, post, and retention test sessions (see Figure 1). Each session took about 30 minutes and was labeled as a level to the students, i.e., level 1, level 2, and so on. Students were to work through each session asynchronously and independently. One week before the start of the study, student participants filled out the consent form and demographic survey so they could be randomly assigned to one of the three group conditions. The demographic survey asks students what their prior disc golf experience, current disc golf habits, a self-rated score of their SP ability, a self-rated score of their BT ability, interest in learning to play disc golf, age, major, and gender (see Appendix J). This data was used to assign participants into random groups by putting an equal amount of PETE majors in each group and then an equal number of males and females; this was done because video feedback in some cases has affected individuals based on gender differently (Casey & Jones, 2011; Hastie et al., 2012); additionally, PETE majors typically experience more coursework to improve their performance and practice skill analysis than non-PETE majors (Tsuda et al., 2019; Ward et al., 2018). Students could check out five discs from their corresponding university during the study if needed. Students were to complete levels 0-2 during the first week, levels 3-5 during the second week of the study, and level 6 seven days after completing their posttest measurements (level 5).

Figure 1

The Timeline of the Study



Note. TF = Teacher Feedback; SA = Self-Assessment; VCS = Visual Cue Sheet.

Table 1 outlines the checkpoints that students were given to help guide students. While this checklist was meant to guide students, it was expected for them to complete half of the sessions (levels 0-2) by the first week and the remaining sessions the following week (levels 3-5); the checklist allowed an additional two days for students to complete levels if they fell behind. Students could work ahead of the proposed checkpoints but not behind the weekly deadlines. Levels 0-2 and 3-5 were made available to students in chunks in order for them to work at their desired pace. Level 0 opened to students as soon as they completed the consent form and demographic survey one week before the start of the study. Level 6, the retention test, was scheduled to release to students seven days after they completed their posttest measurements (level 5).

Table 1

Overview of Checkpoints That Will be Given to Student

Item to be Completed	Checkpoint
Level 0 (pretest)	Day 1 (Week 1: Monday)
Level 1	Day 3 (Week 1: Wednesday)
Level 2	Day 5 (Week 1: Friday)
Level 3	Day 8 (Week 2: Monday)
Level 4	Day 10 (Week 2: Wednesday)
Level 5 (posttest)	Day 12 (Week 2: Friday)
Level 6 (retention test)	Day 18-21 (Week 3: Friday/Sunday)

Data Collection Methods and Procedures

All learning activities and data collection began as links in this study's Google Classroom, including assignment links to Google Forms and Flip to collect student video responses (see Table 2). There were seven sessions, with the first being a pretest measurement and the last two being the post and retention test. Each main session (levels 1-4) had students access all learning materials and activities uploaded to Google Classroom as assignments through Google Forms. These Google Form assignments included fidelity checks that students followed the instructions correctly. For example, if students did not answer *yes,* they received a prompt to go back and do it correctly until they answered *yes*. Additionally, each Google Form included individualized group-based screencast videos explaining how to complete each level and a one-question quiz to ensure students knew how to record themselves.

Table 1

Overview of Each Level and What Students Will Do

Level	Name of Assignment	What students are doing
N/A	#000 Consent and Demographic survey	Students filled out the consent form and demographic survey
Level 0 (pretest)	#001 Equipment Check Quiz	Agreed to have all the required equipment & identified where they will practice
	#002 How to Record Instructions and Quiz	Learned how to record themselves using Flip
	#003 SP Pretest	Recorded five throws of SP
	#004 BT Pretest	Recorded five throws of BT
Level 1	#005 Learn SP with Video Analysis Practice	Students watched an instructional video on SP and reflected on the most important features of the skill. Then they recorded themselves performing three sets of five SP throws. Students watched videos after each set to improve future performance.
Level 2	#006 SP Video Analysis Practice	Recorded themselves performing three sets of five SP throws. Students watched videos after each set to improve future performance.
Level 3	#007 Learn BT with Video Analysis Practice	Students watched an instructional video on BT and reflected on the most important features of skill. Then they recorded themselves performing three sets of five BTs. Students watched videos after each set to improve future performance.
Level 4	#008 BT Video Analysis Practice	Recorded themselves performing three sets of five BTs. Student watch videos after each set to improve future performance.
Level 5 (posttest)	#009 SP Posttest	Recorded five throws of SP
	#010 BT Posttest	Recorded five throws of BT
	#011 Exit Survey	Answered questions about how they completed the research study
Level 6 (Retention)	#012 SP Posttest	Recorded five throws of SP
	#013 BT Posttest	Recorded five throws of BT

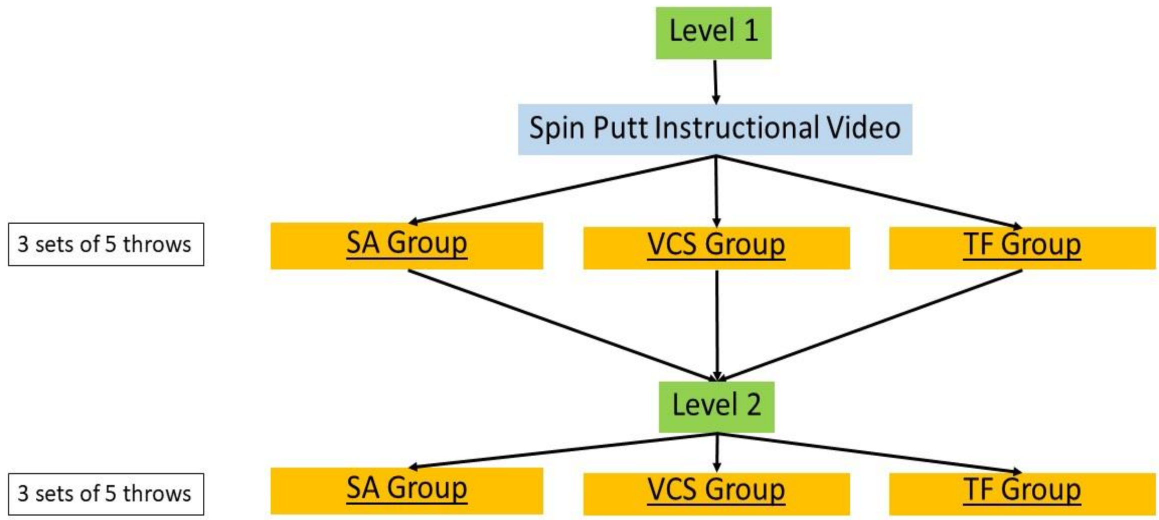
Student consent forms were disturbed to students through a Qualtrics survey linked as the first activity to be completed in the Google Classroom for this study (assignment #000). Within this assignment, students filled out the demographic survey. The demographic survey asked students about their prior disc golf experience, current disc golf habits, SP self-efficacy, BT self-efficacy, interest in learning about playing disc golf, age, major, and gender (see Appendix J). Current disc golf habits asked students how many rounds of disc golf they have played in the last year; this was later transformed into a dichotomous variable of two or more rounds to indicate better which participants are actively playing disc golf. SP self-efficacy, BT self-efficacy, and interest in learning how to play disc golf 0-100 slider scales. For the self-efficacy sliders, the following benchmarks were given: 0-20 represented not accurate, 21-40 slightly accurate, 41-60 moderately accurate, 61-80 very accurate, and 81-100 extremely accurate. Likewise, the following benchmarks for the interest in learning disc golf slider were given: 0-20 not interested at all, 21-40 slightly interested, 41-60 moderately interested, 61-80 very interested, and 81-100 extremely interested.

The pre-session, labeled level 0 to the students, consists of two components. The first component had students learning how to use the technology for the disc golf unit and confirming that students have the required equipment for the study; the second component consisted of recording pretest measures. These measures include participants recording a video of their SP disc golf performance (5 throws) and a video of their BT performance (5 throws). Before students recorded their pretest measures, they learned to record themselves and took a Google Forms quiz to verify their ability. The first thing students did in level 0 was confirmed they had all the required equipment and identify where they would complete practice trials for the study. Next, students used the Flip app to record disc golf pretest measures. Before recording each pretest measure, students were instructed to watch an expert model of the skill they were about to record. In the expert model video, a right-handed professional disc golf player performed the SP and BT from three angles; side, back, and overhead. In addition, the expert model video contained two trials of the focus skill played at a quarter speed. Students had the opportunity to start level 0 one week before its due date as soon as they completed the demographic survey and consent form.

The main sessions included participants performing four total sessions over two weeks. In sessions one and three, students learned how to perform the SP (level 1) and BT (level 3) by watching an instructional video. Students were asked, at the end of each instructional video, which was approximately five minutes long, to provide in short answer form at least two key elements about each skill; this was done to ensure they had watched the video and to help students process the critical features of each skill. See Figure 2 for an overview of levels 1 and 2.

Figure 10

Overview of Levels 1 and 2: Spin Putt



Note. TF = Teacher Feedback; SA = Self-Assessment; VCS = Visual Cue Sheet.

Additionally, all main sessions included a video feedback practice section which required students to record and submit three videos of five throws of that session's focused skill to Flip; sessions one and two focused on the SP, and sessions three and four focused on the BT. Flip has many of the desired features of other video feedback mobile apps: record, play, pause, stop, scrub (allows students to move back and forth on their video quickly), trim, and playback speed (the Flip app allows for .75, 1.0, 1.25, 1.50, and 2.00 speed). Furthermore, Flip has a mobile app and a web-based version allowing students to access it on a mobile device or desktop.

Before starting each video feedback practice session, students were asked to watch the expert model video twice before recording their first five throws; this is the same expert model video used in the pretest. After watching the expert model video, students were given a cue focus to help guide their performance. For example, when students completed SP video feedback practice sessions, they were instructed to *focus on a target throwing the disc as flat and as accurately as possible,* and when they completed

BT video feedback practice sessions, are instructed to *focus on a target throwing the disc as far and as accurately as possible*. Then, after each round of five throws (throws 1-5, 6-10, and throws 11-15), students were instructed to *watch your video and fix any errors you noticed*. Furthermore, students were instructed to watch their video feedback at least once and reminded that they could rewind, fast-forward, or re-watch their video as many times as they wanted. Within this step, all groups were instructed for the first viewing to be watched at 0.75 speed; this method of having students watch their videos in slow motion is standard in other video feedback research (Barzouka et al., 2015; Kretschmann, 2017; Souissi et al., 2021). Finally, students were allowed to watch the expert video demonstration as often as they wanted before recording the next set of five throws.

Students in the VCS group were given access to a document (that they could print out or access digitally) to help them analyze their video feedback during each session. The VCS for each skill included pictures with written cues overlaid on the pictures representing the most critical aspects of each skill (see Appendix B and D). Additionally, each VCS had two directional prompts reminding students to *(1) watch the recorded video of the previous five trials and compare the technique with this sheet and the expert model as often as desired and (2) correct the detected errors when performing the next five throws.* The design and use of each VCS are similar to Kok et al. (2020) and Souissi et al. (2021).

After every five throws, students in the SA group identified one throw in their previous five trials that they thought was their best performance to self-assess. Students in the SA group utilized a visual checklist that they could print off or access digitally to help guide their assessment. This SA checklist asked students to assess five critical elements for either the SP or the BT by having them record *yes* or *no* for each present critical element (see Appendix A and C). Students recorded their results of each round of SA in that level's Google Form. This SA sheet is designed similarly to other video feedback research (O'Loughlin et al., 2013) and practitioner advice (Beseler & Plumb, 2019). Students not in the SA or VCS groups were given delayed TF on the last five throws of each learning session. This feedback was delayed from the primary researcher within 48 hours of submitting it to Flip as a private comment in Google Classroom. This timeframe represented the best-case scenario for OLPE teachers.

Level 5, the posttest, and level 6, the retention test, had students record a video of their SP disc golf performance (5 throws) and a video of their BT performance (5 throws), with the same procedures in the pretest measurements. After recording level 5's posttest measurements, students completed a three-question exit survey in Qualtrics (see Appendix E). This exit survey asked if students practiced disc golf skills during the study that were not required; if they utilized any additional video feedback sessions on their own; what device they primarily used to watch their video feedback; and what their interest in learning disc golf is (post-study). Level 6 was scheduled to release seven days after students completed their posttest measurements.

A pilot study was conducted with participants from another university in which participants completed a modified version of the intended disc golf unit. Results from this pilot study led to including more instructions on how to record themselves in the recording quiz assignment (#002) and include fidelity checks in Google Forms before students went to Flip. Additionally, the Flip app was reorganized so students could not work ahead in future sessions without going to Google Classroom first; some students could record their video practice without first watching the instructional video. The last change was including more communication on what to do for each level. This increased information was put on each Google Classroom news post for each level, including tips and suggestions for common technical errors. Additionally, these news posts included short (~1-2 minutes) screencast videos from the primary investigator outlining what participants needed to complete for this level.

All data shared with the primary investigator was stored on a password-secured computer. In addition, video recordings collected using Flip were also password protected, and students could not see other participants' videos.

Participants and Setting

Power analysis using G*power reveled that with an estimated moderate effect size, a minimum of 50 participants would be needed (alpha=.05, power = .80, and effect size = 0.50). Three teachers from two universities volunteered four intact classes and students to participate in this study. One class was a university online health-related fitness course, and three were face-to-face PETE classes that transitioned their class online for the study. Instead of meeting face-to-face, students were given normally scheduled class time to complete the online disc golf unit; they were not required to come into class. Additionally, all students received class credit for completing the unit—the online disc golf unit was not extra credit.

Table 2

Participants Per Class

	Class 1 (*n=24*)	Class 2 (*n=17*)	Class 3 (*n=9*)	Class 4 (*n=21*)

Provided consent-only finished posttest	1 (4.17)	3 (17.65)	0	6 (28.57)
Provided consent-finished retention test	19 (79.17)	9 (52.94)	5 (55.56)	0
Provided consent-did not finish any test measurements	4 (16.67)	4 (23.53)	4 (44.46)	5 (23.81)
Did not provide consent	0	1 (5.88)	0	10 (47.62)

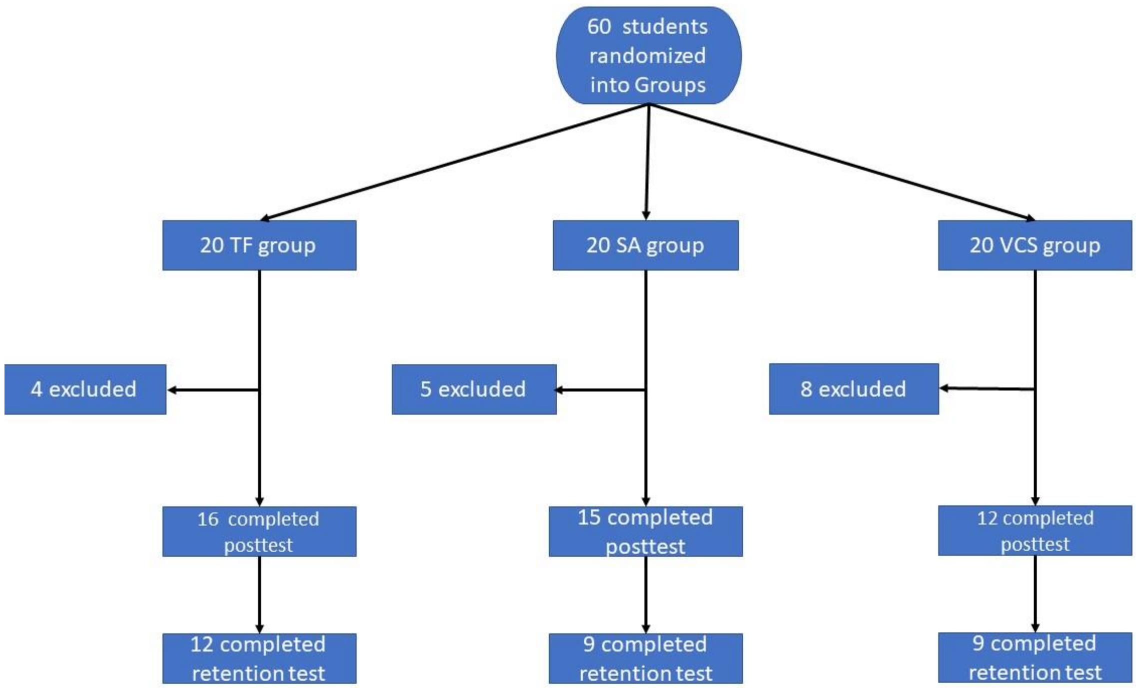
Note: Parenthesis is used to represent percentages.

Table 3 represents the overview of the participation rate of all four classes. Classes 1 and 2 started the disc golf unit roughly at the same time at the end of March 2023; class 3 started two weeks after classes 1 and 2, and class 4 started two weeks after class 3 started. Class 4 could not complete the retention test because the disc golf unit was scheduled at the semester's end.

Of the 60 participants that provided consent, six never finished any pretest measurements, and 11 never finished any posttest measurements (see Figure 3 for a flowchart of participant completion). Of the 43 participants that completed a posttest measure, two did not complete their SP posttest, and three did not complete their BT posttest. However, participants that completed a retention test measure completed both SP and BT measurements. All participants were thanked and debriefed on the purpose of the study and what group they were in within two weeks after completing all data collection.

Figure 6

Flowchart of Participant Completion



Note. TF = Teacher Feedback; SA = Self-Assessment; VCS = Visual Cue Sheet.

Table 4 reports the descriptive characteristics of participants included for analysis for each group. Most participants have never played disc golf before (*n = 30*); however, 11 participants have played disc golf before this study, with nine having played at least two rounds of disc golf in the last year; five participants have at least played disc golf in physical education before; and no participants or their family members have played on a disc golf team in middle school, high school or college. In addition, participants rated themselves as moderately interested in learning disc golf (M = 43.72, $SD = 27.87$), self-efficacy of their SP ability as being not arcuate at all (M = 19.37, SD = 23.60), and their BT just as being slightly accurate (M = 23.23, SD = 26.58).

Table 3

Descriptive Characteristics of Each Group

Variable	TF (n = 16)	SA (n = 15)	VCS (n = 12)	Total (N = 43)
Race				
Caucasian/White	10 (62.5%)	11 (73.3%)	8 (66.7%)	29 (67.4%)
African American	5 (31.3%)	3 (25.0%)	3 (25.0%)	11 (25.6%)
Hispanic	0 (0%)	1 (6.7%)	0 (0%)	1 (2.3%)
Bi- or multi-racial	1 (6.3%)	0 (0%)	1 (8.3%)	2 (4.7%)
Gender				
Male	12 (75.0%)	9 (60.0%)	9 (75.0%)	30 (69.8%)
Female	4 (25.0%)	6 (40.0%)	3 (25.0%)	13 (30.2%)
Major				
PETE Major	9 (56.3%)	10 (66.7%)	8 (66.7%)	27 (62.8%)
Non-PETE Major	7 (43.8%)	5 (33.3%)	4 (33.3%)	16 (37.2%)
Never DG before [a]	12 (75.0%)	11 (73.3%)	7 (58.3%)	30 (69.8%)
Played DG in PE [a]	1 (6.3%)	2 (13.3%)	2 (16.7%)	5 (11.6%)
Plays DG with friends or family for fun [a]	3 (18.8%)	3 (20.0%)	5 (41.7%)	11 (25.6%)
Played at least two rounds last year	2 (12.5%)	3 (20.0%)	4 (33.3%)	9 (20.93%)
Age	21.63 (2.13)	21.67 (3.87)	22.83 (3.35)	21.98 (3.14)
Interest in learning disc golf	40.00 (30.15)	36.00 (21.32)	58.33 (28.45)	43.72 (27.87)
Spin putt SE	16.63 (18.64)	14.80 (19.01)	28.75 (32.52)	19.37 (23.60)
Backhand throw SE	21.25 (24.13)	19.27 (22.84)	30.83 (33.90)	23.23 (26.58)

Note: Parenthesis represents standard deviations for parametric variables and percentages for non-parametric variables. TF = Teacher Feedback; SA = Self-Assessment; DG = Disc Golf; VCS = Visual Cue Sheet; PETE = Physical Education Teacher Education; SE = Self-efficacy.

[a] Reflects the number and percentage of participants who answers "yes" to the question

Data Analysis Plan

This section will review how each research question was answered, providing how the data was collected and analyzed. See Table 5 for a summary of the data analysis plan. All analyses were done with SPSS version 28 (2021). All levels of significance are set with an alpha level of .05.

Table 4

Summary of Data Collection and Method of Analysis

Research Question	Item Collected	When it is collected	How is it assessed	Analysis
1	SP Pretest	Level 0	SP Rubric	Descriptive statistics; 3x2 RM ANOVA
	BT Pretest	Level 0	BT Rubric	
	SP Posttest	Level 5	SP Rubric	
	BT Posttest	Level 5	BT Rubric	
2	SP SA score	Levels 1 & 2	SP SA Rubric	Descriptive statistics; Pearson-R
	BT SA score	Levels 3 & 4	BT SA Rubric	
3	Gender	Level 0	Demo Survey	Descriptive statistics; moderation/mediation analysis;
	Prior experience	Level 0	Demo Survey	
	SP SE	Level 0	Demo Survey	
	BT SE	Level 0	Demo Survey	
	Age	Level 0	Demo Survey	
	Major	Level 0	Demo Survey	
	Interest Pre	Level 0	Demo Survey	
	Interest Post	Level 5	Exit Survey	
4	SP Retention	Level 6	SP Rubric	Descriptive statistics; 3x3 RM ANOVA,
	BT Retention	Level 6	BT Rubric	

Note. SE = Self-Efficacy; SP = Spin Putt; BT = Backhand Throw; RM = Repeated Measures; SA = Self-Assessment; ANOVA = Analysis of Variance.

Research Questions 1 and 4

SP pre, post, and retention measurements were assessed with the SP rubric (Appendix F), including assessing all five throws students make during each measurement. One point was awarded for each of the five present criteria, representing the most critical elements for a mature pattern based on content provided by Educational Disc Golf Experience (EDGE, 2013). These criteria included (1) Inline stance, throwing hand's foot is forward, point to target with back foot behind front almost or directly in line with the front foot; before curling disc into the chest, point throwing arm towards the target (2) Weight shifts back and arm curls into the chest/waist and then shifted out; the reach in is not past their back hip (3) hand leads disc as arms reach out keeping disc cocked as the arm reaches past the body with wrist snap on release (4) arm reaches straight out (not all wrist) below head but above chest on follow-through with thumb in 12'o clock position and making sure your palm is not facing the target (5) the disc should have a flat/straight release with keeping back leg behind hip (may kick up to help counterbalance). The best score a student can get is 25 points on each measurement.

Similarly, the BT rubric (Appendix G) utilized the same setup as the SP rubric. However, it is assessed with its own five criteria, representing the critical elements for a mature pattern based on content provided by EDGE (2013). These criteria included (1) pointing the non-throwing shoulder at the target before reaching back with feet at least wider than shoulder width on the brace, (2) straight arm reach back just below shoulder height (across chest and past back hip); their back should be pointed toward the target when they reach back fully (3) student drives elbow forward (almost make 90-degree angle) keeping it close to their body as hips rotate to uncoil the back as weight shifts from back foot to front foot, (4) throwing motion of disc moves in a relatively straight line with wrist snaps on release and disc is flicked to basket or target, and (5) follow through level and around the body with the release of the disc with a straight arm at shoulder height; back leg will rotate forward with shoulder squaring to target. The best score a student can get is 25 points on each measurement.

Some participants had trials that could not be fully observed, e.g., poor camera placement or not recording all five trials. Therefore, SP and BT scores were analyzed as percentages instead of raw scores. Participants with missing trial criteria at either the pretest or posttest mark for SP were 13 participants and eight participants for BT; As long as participants had at least 70% of all observable trials for all criteria, they were included for analysis. Due to this exclusion, one participant has been excluded from SP and BT analysis. While some individuals had missing trial data at the retention test, none were excluded from the analysis.

To answer research question one, a 3 (group condition) x 2 (pretest and posttest) analysis of variance (ANOVA) was conducted on each disc golf skill. Similarly, a 3 (group condition) x 3 (pre, post, and retention test) ANOVA was conducted on each disc golf skill to answer research question four. In addition, post hoc pairwise comparison with a Bonferroni correction was conducted on each repeated measure test (3x2 and 3x3).

Research Question 2

Overall SP SA and BT SA accuracy were obtained by comparing the SA group's Google Form SA data from levels 1-4 and assessing their technique for the selected throw they self-assessed. Combined SP SA accuracy collected during sessions 1 and 2 utilized the SP SA rubric (Appendix H), and combined BT SA accuracy collected during sessions 3 and 4 utilized the BT SA rubric (Appendix I). These two rubrics use the same criteria to assess student performance as the SP and BT rubrics but compare them to the student's SA Google Form data to award one point for each correct SA. In each SA session, students can receive 15 points and 30 points for a combined SA score for each disc golf skill. Pearson product-moment correlations were calculated on all SA accuracy measures to answer research question 2.

Research Question 3

Non-parametric variables from the demographic survey (gender, prior disc golf experience, and major) were used as moderating variables to examine the relationship between SP and BT pretest and posttest scores. In addition, continuous variables from the demographic survey (age, SP self-efficacy, BT self-efficacy, and interest in learning how to play disc golf) and the exit survey (interest in learning how to play disc golf) were used as mediating variables to examine differences between pretest and posttest scores for the SP and BT.

Reliability Checks

Inter-observer agreement (IOA) was established for all disc golf skills (SP and BT) at all three-time measurements (pre, post, and retention) between the primary researcher and an independent observer. Two steps were taken to establish IOA for each disc golf skill. First, the primary researcher explained each critical element for each skill and the rubric sheets to be used. Next, the independent observer asked questions until they fully understood each skills criterion and how to score each rubric. Then, the primary researcher and observer coded and analyzed five videos to practice coding. During this step, the primary researcher explained what to look at until the observer fully understood how to code the data. After the independent observer showed a clear understanding of how to code each skill, the observer analyzed randomly selected 20% of all videos collected, and the results were compared with the results of the primary researcher. An 85% IOA was set as the benchmark; if 85% was not achieved, the primary researcher and the independent observer would compare disagreements until their scores reached above 85%.

The results of the IOA are reported in Table 6. IOA was conducted on 24.35% of all videos, 23.81% of pretest (20 total videos), 23.81% of posttest (20 total videos), and 26.6% of retention (16 total videos) scores.

Table 5

Inter-Observer Agreement for Disc Golf Measurements

Skill	Pre	Post	Retention	Total
Spin putt	91.25%	88.75%	90.00%	89.85%
Backhand Throw	90.91%	88..04%	95.00%	91.35%

CHAPTER IV: RESULTS

This chapter will report the results of each research question to address the purpose of the research study. The first section addresses if participants' performance is affected differently by the form of video feedback guidance they receive from pre to posttest (research question 1). The second section addresses if there is a relationship between participants' self-assessment (SA) accuracy and their performance (research question 2). The third section examines factors influencing differences from pre to posttest (research question 3). The last section addresses if participants' performance is affected differently by the form of pedagogical guidance they receive from pre to post to the retention test (research question 4). Furthermore, a summary of the results is presented at the end of each section.

Research Question 1

What form of pedagogical guidance is the most effective in improving online students' disc golf motor performance from pretest to posttest?

Research question 1 examined whether group differences existed between spin putt (SP) and backhand throw (BT) technique scores from pre to posttest. Table 7 reports the mean pretest and posttest recorded for each group's SP and BT techniques percentages.

Table 7

Mean Scores of Disc Golf Scores (%) At the Pretest and Posttest for Each Group

Group	Spin Putt			Backhand Throw		
	n	Pre	Post	*n*	Pre	post
TF	16	55.65 (21.65)	80.31(14.07)	16	55.29 (21.77)	70.79 (23.51)
SA	14	63.89 (13.87)	82.43 (13.36)	14	50.77 (22.09)	69.40 (22.78)
VCS	11	64.40 (23.35)	82.08 (7.58)	10	55.13 (22.67)	76.86 (17.52)

Note: Standard deviations are presented in parenthesis. TF = Teacher Feedback; SA = Self-Assessment; VCS = Visual Cue Sheet; PETE = Physical education teacher education.

The mean technique scores for each group at the pretest and posttest measurements for each skill are represented in Figures 4 and 5.

Figure 4

Group Changes in Spin Putt Technique From Pre to Posttest

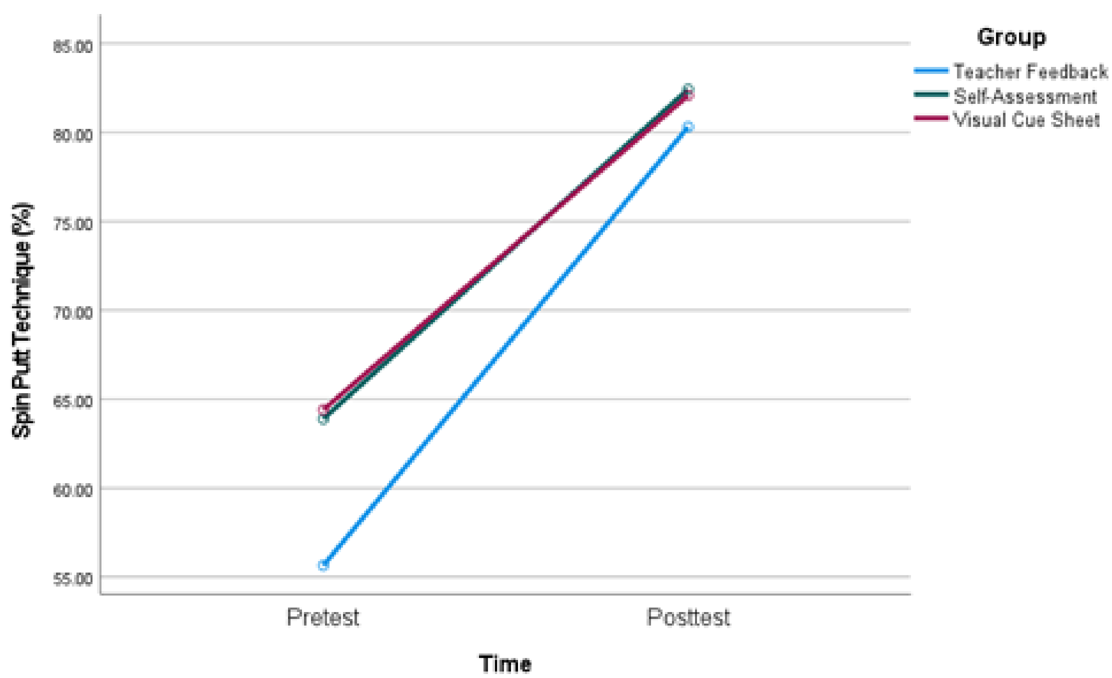
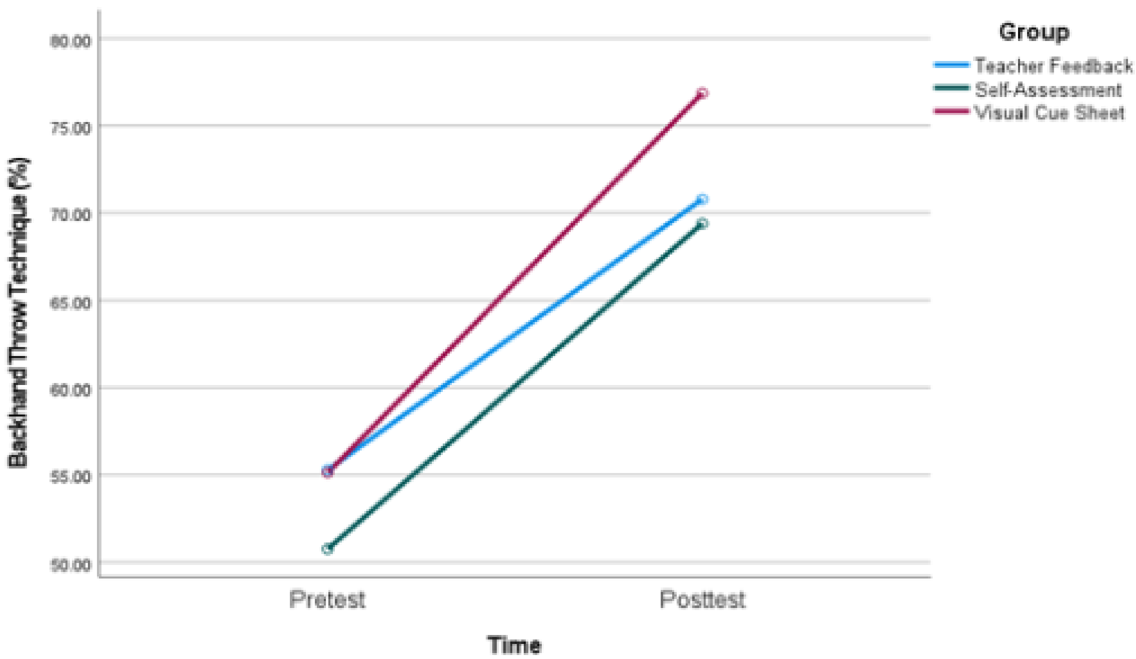


Figure 5

Group Changes in Backhand Throw Technique From Pre to Posttest



Changes in Spin Putt Technique

Hypothesis 1a: *A significant difference exists in SP performance from the pretest to the posttest in the SA group.*

Hypothesis 1b: *A significant difference exists in SP performance from the pretest to the posttest in the visual cue sheet (VCS) group.*

A 3x2 way factorial analysis of variance (ANOVA) was conducted to compare the main effects of participants' group condition and a repeated measure and the interaction effect between participants' group condition and a repeated measure has on SP technique scores. Laevne's equality of error variances could be assumed for SP technique measurements (pretest, $p = .63;$ posttest, $p = .10$)

There was a significant main effect for time on participants' SP technique scores, $F(2,38) = 58.52$, $p < .001$, $\eta p^2 = 0.61$. In addition, post hoc pairwise comparison using Bonferroni correction showed a significant increase from the pretest to posttest for the teacher feedback (TF) group (*M = 24.66, p < .001)* SA group (*M = 18.54 p < .001*), and the VCS group (*M = 17.69 p < .01*). Hypothesis 1a and 1b is accepted.

Hypothesis 1c: *There will be a significant difference between the SA group and the VCS group in SP performance from the pretest to the posttest when compared to the TF group.*

There was a non-significant main effect for group, $F(2,38) = 0.59$, $p = .56$, $\eta p^2 = .03$, and interaction between group and time, $F(2,38) = 0.74$, $p = .48$, $\eta p^2 = .04$, for participants' SP technique scores. Hypothesis 1c is rejected.

Changes in Backhand Throw Technique

Hypothesis 1d: *A significant difference exists in BT performance from the pretest to the posttest in the SA group.*

Hypothesis 1e: *A significant difference exists in BT performance from the pretest to the posttest in the VCS group*

A 3x2 way factorial analysis of variance (ANOVA) was conducted to compare the main effects of participants' group condition and a repeated measure (pretest and posttest) and the interaction effect between participants' group condition and a repeated measure has on BT performance technique scores. Laevne's equality of error variances could be assumed for the BT technique measurements (pretest, *p = .72; p*osttest, *p = .34*).

There was a significant main effect for time on participants' BT technique scores, $F(2,37) = 28.65$, $p < .001$, $\eta p^2 = .44$. Post hoc pairwise comparison using Bonferroni correction showed a significant increase from pretest to posttest for the TF group (*M = 15.50, p = .01),* SA group (*M = 18.63 p < .01*), and the VCS group (*M = 21.73 p < .01*). Hypothesis 1d and 1e is accepted.

Hypothesis 1f: *A significant difference exists between the SA group and the VCS group in BT performance from the pretest to the posttest when compared to the TF group.*

There was a non-significant main effect for group, $F(2,37) = 0.28$, p = .78, $\eta p^2 = .02$, and interaction between group and time, $F(2,37) = 0.26$, p = .77, $\eta p^2 = .01$, for participants' BT technique scores. Hypothesis 1f is rejected.

Research Question 1 Summary

Participants improved their mean percentage in SP and BT techniques after practicing in all groups (see Figures 6 and 7). However, different methods of video feedback guidance did not produce significant differences. Therefore, research question 1 is partially supported.

Figure 6

Spin Putt Scores as A Function of Group and Time

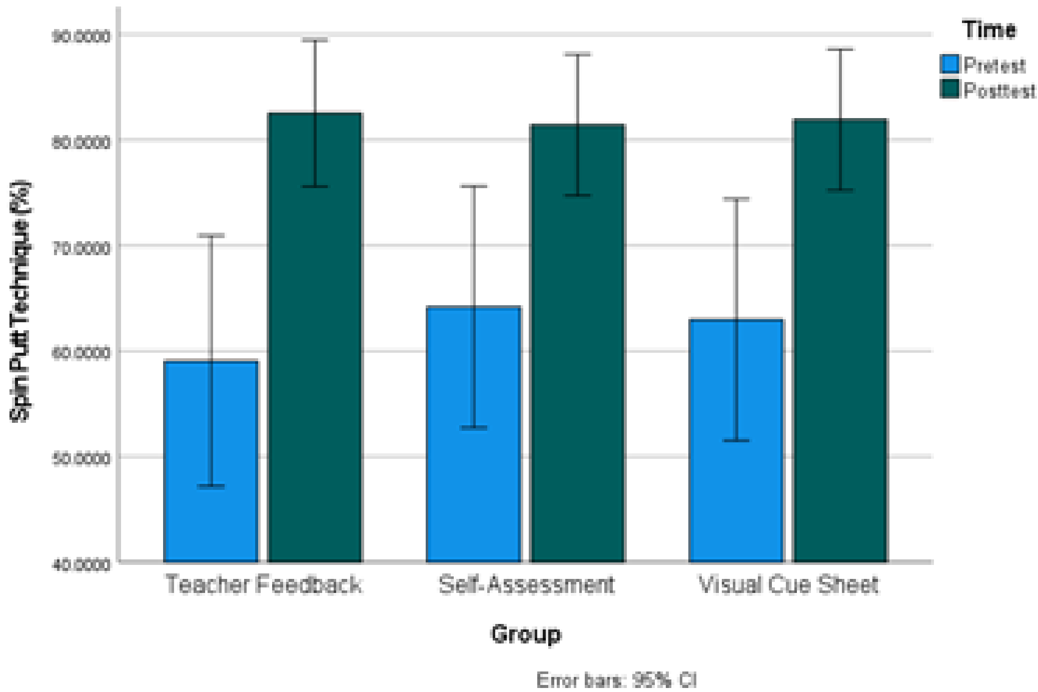
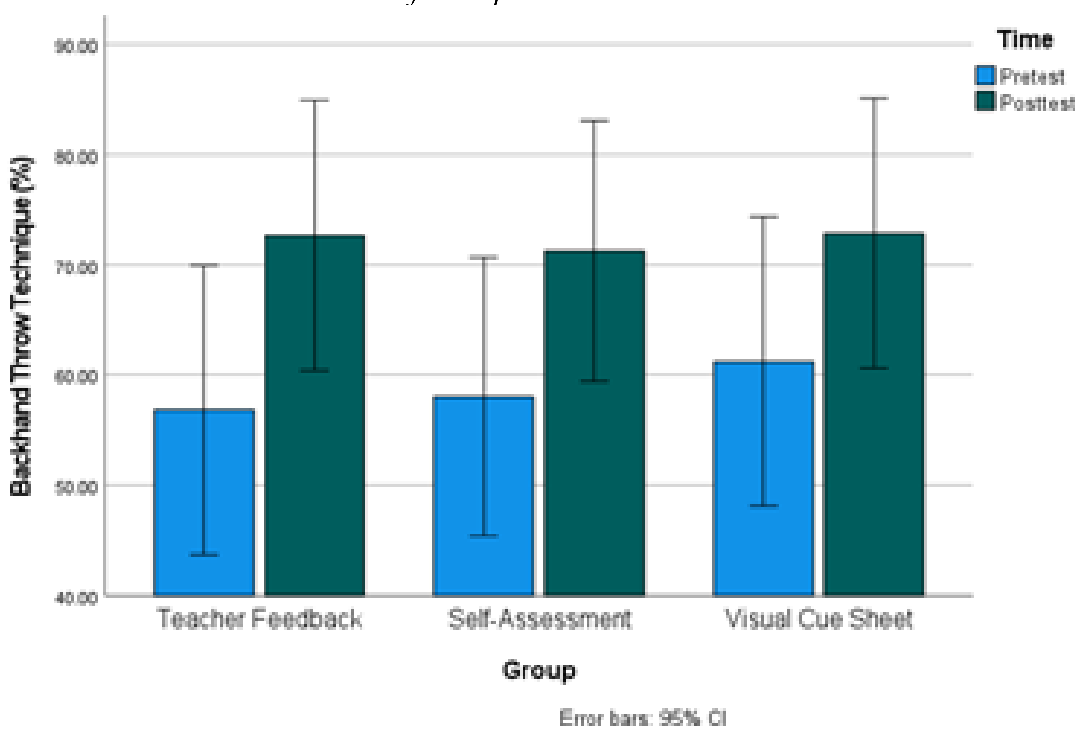


Figure 7

Backhand Scores as A Function of Group and Time



Research Question 2

Is there a relationship between participants' SA accuracy and their disc golf performance?

Research question 2 examined if there was a relationship between participants' SA accuracy to their SP and BT technique posttest scores. Table 8 reports the mean SA accuracy for SP and BT techniques over each session.

Table 8

Mean Self-Assessment Accuracy at Each Practice Session

Skill		Session 1		Session 2	
	n	Mean	SD	Mean	SD
Spin Putt	14	62.24%	22.56	69.70%	26.00
Backhand Throw	12	70.91%	22.03	81.21%	13.99

Self-Assessment Accuracy

Hypothesis 2a: *A significant relationship exists between participant's SP SA accuracy and their posttest SP scores*

Participants' SA accuracy percentages for SP sessions one and two were combined to make an overall SP SA variable (*n = 14, M = 66.67. SD = 18.34*). SP SA accuracy for session one has a relatively normal distribution with a slightly positive skew of 0.35 and a platykurtic kurtosis value of -1.15. SP SA accuracy for session two has a relatively normal distribution with a slightly negative skew of -0.93 and a leptokurtic kurtosis value of 1.32. Combined SP SA accuracy has a normal distribution with a slightly positive skew of 0.06 and a slightly platykurtic kurtosis value of -0.58.

Pearson correlations between combined SP SA accuracy and SP posttest technique scores have a strong positive relationship (*r* = .83, $p < .001$), indicating that their SP posttest scores increase as participants' combined SP SA accuracy increases. Therefore, hypothesis 2a is accepted.

Hypothesis 2b: *A significant relationship exists between participant's BT SA accuracy and their posttest BT scores*

Participants' SA accuracy percentages for BT sessions one and two were combined to make an overall BT SA variable (*n = 12, M = 76.18, SD = 16.90*). BT SA accuracy for session one has a normal distribution with a slightly positive skew of 0.21 and a slightly platykurtic kurtosis value of -0.55. BT SA accuracy for session two has a relatively normal distribution with a negative skew of -1.27 and a leptokurtic kurtosis value of 1.74. Combined BT SA accuracy has a normal distribution with a slightly negative skew of -0.05 and a slightly platykurtic kurtosis value of -0.52.

Pearson correlations between combined BT SA accuracy and SP posttest technique scores have a moderately positive relationship (*r* = .79, $p < .01$), indicating that as participants' combined BT SA accuracy increases, their BT posttest scores increase. Therefore, hypothesis 2b is accepted.

Research Question 2 Summary

Participants improved their SA accuracy from sessions one to two for both the SP and BT. In addition, participants' combined SA accuracy for both the SP and BT significantly correlated to the SP and BT, respectively; based on these results, research question 2 is supported in this study.

Research Question 3

To what extent are participants' disc golf motor performance influenced by moderating factors?

Gender

Multiple regression analysis was conducted to analyze if gender moderates the interaction between SP pretest and posttest scores. There was a statistically significant main effect of a participant's SP pretest score and their gender has on their SP posttest scores, $F(3,37) = 6.44, p < .01$. However, gender does not moderate the relationship between SP pretest and posttest scores ($B = 0.07, SE = 0.18, p = .69$).

A multiple regression analysis was conducted to analyze if gender moderates the interaction between BT pretest and posttest scores. There was a statistically significant main effect of a participant's BT pretest score and their gender has on their BT posttest scores, $F(3,37) = 5.14, p < .01$. However, gender does not moderate the relationship between BT pretest and posttest scores ($B = 0.51, SE = 0.32, p = .12$).

Age

A series of regression analyses were conducted to determine whether participants' age mediated their SP pretest and posttest scores. The results show that SP pretest scores have a significant direct effect ($b = 0.35, p < .01$) on SP posttest scores. However, SP pretest scores do not significantly predict age ($b = 0.001, p = .97$). This indicates the relationship between participants' SP technique pretest and posttest scores are not mediated by their age, $b = .02$, 95% CI [-0.02, 0.07].

A series of regression analyses were conducted to see if participants' age mediated their BT pretest to posttest scores. The results show that BT pretest scores have a significant direct effect (*b = 0.47, p < .01*) on BT posttest scores. However, BT pretest scores do not significantly predict age (*b = -0.02, p = .35*). This indicates the relationship between participants' BT pretest and posttest scores is not mediated by their age, *b* = .02, 95% CI [-0.02, 0.07].

Self-Efficacy

A series of regression analyses were conducted to see if participants' self-rated scores of their SP ability (also called SP self-efficacy) mediated their SP pretest to posttest scores. The results show that SP pretest scores have a significant direct effect (*b = 0.32, p < .001*) on SP posttest scores. However, SP pretest scores do not significantly predict participants' SP self-efficacy (*b = 0.30, p = .11*). This indicates the relationship between participants' SP pretest and posttest scores is not mediated by their SP self-efficacy, *b* = .02, 95% CI [-0.02, 0.07].

A series of regression analyses were conducted to see if participants' self-rated scores of their BT ability (also called BT self-efficacy) mediated their BT pretest to posttest scores. The results show that BT pretest scores have a significant direct effect (*b = 0.38, p = .01*) on BT posttest scores. Furthermore, BT pretest scores significantly predict participants' BT self-efficacy (*b = 0.42, p = .02*). However, the effect of participants' BT self-efficacy on BT posttest scores was non-significant (*b = 0.20, p = .11*). This indicates the relationship between participants BT pretest and posttest scores are not mediated by their BT self-efficacy, *b* = .08, 95% CI [-0.01, 0.23].

Interest in learning Disc Golf

A series of regression analyses were conducted to see if participants' interest in learning disc golf at the start of the unit mediated an individual's SP pretest to posttest scores. The results show that SP pretest scores have a significant direct effect (*b = 0.30, p < .001*) on SP posttest scores. However, SP pretest scores do not significantly predict participants' interest in learning disc golf at the start of the study (*b = 0.38, p = .08).* This indicates the relationship between participants' SP pretest and posttest scores is not mediated by participants' interest in learning disc golf at the start of the study, *b* = .05, 95% CI [-0.01, 0.14].

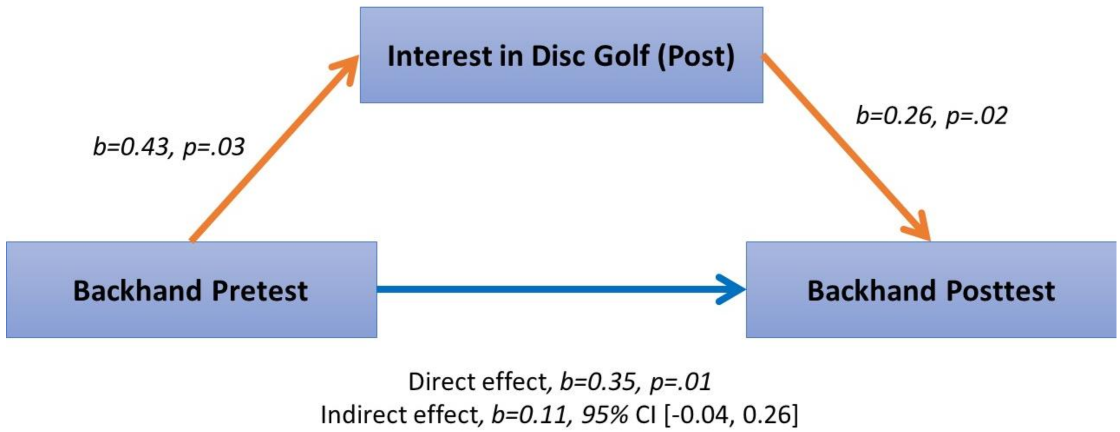
A series of regression analyses were conducted to see if participants' interest in learning disc golf post-study completion mediated individuals' SP pretest to posttest scores. The results show that SP pretest scores have a significant direct effect (*b = 0.30, p < .01*) on SP posttest scores. In addition, SP pretest scores significantly predicted participants' interest in learning disc golf post study completion (*b = 0.68, p < .01*). However, the effect of participants' interest in learning disc golf post-study completion on SP posttest scores was non-significant (*b = 0.07, p = .28*). This indicates the relationship between participants' SP pretest and posttest scores is not mediated by participants' interest in learning disc golf at the end of the study, *b* = .05, 95% CI [-0.05, 0.16].

A series of regression analyses were carried out to see if participants' interest in learning disc golf at the start of the study mediated individuals' BT pretest to posttest scores. The results show that BT pretest scores have a significant direct effect (*b = 0.39, p = .01*) on BT posttest scores. In addition, BT pretest scores significantly predict participants' interest in learning disc golf at the start of the study (*b = 0.48, p = .01*). However, the effect of participants' interest in learning disc golf at the start of the study on BT posttest scores was non-significant (*b = 0.14, p = .23*). This indicates the relationship between participants BT pretest and posttest scores are not mediated by participants interest to learn disc golf, *b* = .07, 95% CI [-0.08, 0.24].

A series of regression analyses were conducted to determine if participants' interest in learning disc golf post-study completion mediated individuals' BT pretest to posttest scores. The results show that BT pretest scores have a significant direct effect ($b = 0.35$, $p = .01$) on BT posttest scores. In addition, BT pretest scores significantly predict participants' interest in learning disc golf post-study completion ($b = 0.43$, $p = .03$). The effect of participants' interest in learning disc golf post-study completion on BT posttest scores ($b = 0.26$, $p = .02$) indicates the more interest they have to learn disc golf post study completion, the higher their BT posttest score is. There was a significant indirect effect of participants' BT pretest on posttest scores through their interest in learning disc golf post-study completion, $b = 0.11$, 95% CI [-0.04, 0.26]. The total effect that BT pretest scores have on BT posttest scores is $b = 0.47$ ($p < .01$). The mediation analysis indicates that the higher participants' BT pretest scores are, the higher their interest in learning disc golf post-study completion is; the higher their interest to learn disc golf post study completion is, the higher their BT posttest scores are (see Figure 8).

Figure 8

Mediated Relationship of Backhand Throw Scores by Interest in Disc Golf Post-Study



Prior and Current Disc Golf Experience

Hypothesis 3a: *A significant interaction effect exists between individuals with more disc golf experience on their pre to posttest on both SP and BT.*

A multiple regression analysis was conducted to analyze if participants' past experiences (played in PE or with family or friends) moderate the interaction between SP pretest and posttest scores. There was a statistical main effect of participants' SP pretest score and their past experiences has on their SP posttest scores, $F(3,37) = 7.32, p < .01$. However, past experiences do not moderate the relationship between SP pretest and posttest scores ($B = -0.09, SE = 0.16, p = .56$).

A multiple regression analysis was conducted to analyze if participants' past experiences moderate the interaction between BT pretest and posttest scores. There was a statistically significant main effect of a participant's BT pretest score and their past experiences has on their BT posttest scores, $F(3,35) = 4.70, p < .01$. However, past experiences do not moderate the relationship between BT pretest and posttest scores ($B = -0.16, SE = 0.28, p = .55$). Hypothesis 3a is rejected.

Hypothesis 3b: *A significant interaction effect exists between individuals with a higher number of times they have played disc golf in the last year on their pre to posttest on both SP and BT.*

A multiple regression analysis was conducted to determine if participants who played at least two rounds of disc golf in the last year (current playing habits) moderate the interaction between SP pretest and posttest scores. There was a statistically significant main effect of a participant's SP pretest score and current playing habits has on their SP posttest scores, $F(3,36) = 6.77, p < .01$. However, current playing habits do not moderate the relationship between SP pretest and posttest scores ($B = 0.03, SE = 0.19, p = .85$).

A multiple regression analysis was conducted to analyze if current playing habits moderate the interaction between BT pretest and posttest scores. There was a statistically significant main effect of a participant's BT pretest score and current playing habits has on their BT posttest scores, $F(3,37) = 4.56, p < .01$. However, current playing habits do not moderate the relationship between BT pretest and posttest scores ($B = -0.12, SE = 0.32, p = .71$). Hypothesis 3b is rejected.

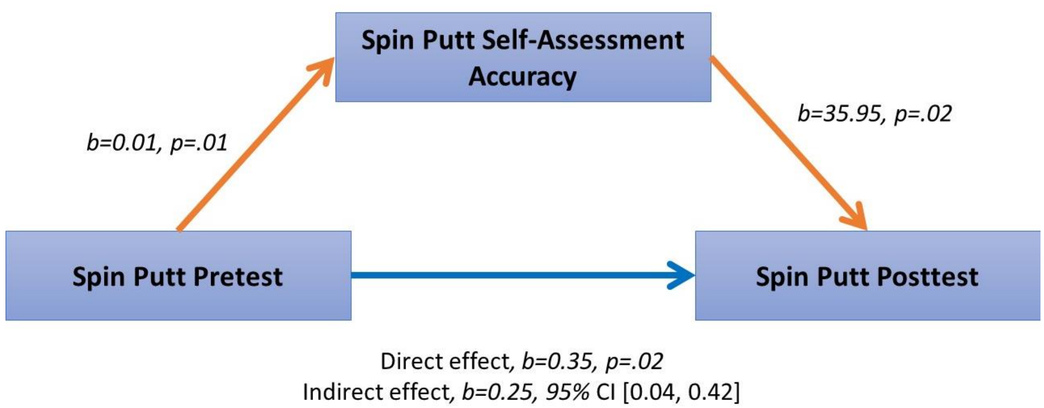
Self-Assessment

Hypothesis 3c*: A significant interaction effect exists between individuals with a higher SA score on their pre to posttest on both SP and BT.*

A series of regression analyses were conducted to determine if SP SA accuracy mediated participants' SP pretest to posttest scores. The results show that SP pretest scores have a statistically significant direct effect ($b = 0.35, p = .02$) on SP posttest scores, indicating that the higher a participant's SP pretest score, the higher their posttest scores are likely. Participants' SP SA accuracy mediates this relationship with a direct effect of SP pretest scores on SP SA accuracy (*b = 0.01, p = .01*), which indicates that the higher participants' SP pretest scores are, the higher their SA accuracy is. The effect of SP SA accuracy on SP posttest scores (*b = 35.95, p = .02*) indicates that the more accurate participants self-assess their spin punt ability, the higher their SP posttest scores are. There was a significant indirect effect of participants' SP pretest on posttest scores through their SP SA accuracy, *b* = .25, 95% CI [0.04, 0.42]; the total effect of the SP pretest on SP posttest is 0.60 ($p < .001$). The mediation analysis indicates that the higher participants' SP pretest scores are, the more accurate their SA accuracy is, and the more accurate their SA scores, the higher their SP posttest scores are (see Figure 9)

Figure 9

Mediated Relationship of Spin Putt Scores by Spin Putt Self-Assessment Accuracy



A series of regression analyses were conducted to see if BT SA accuracy mediated participants' BT pretest to posttest scores. The results show that BT pretest scores have a non-significant direct effect (*b = 0.30, p = .09*) on BT posttest scores. As a result, the results indicate that the relationship between participants' BT pretest and posttest scores is not mediated by BT SA accuracy, *b* = .21, 95% CI [-0.14, 0.49]. Therefore, hypothesis 3c is partially accepted.

Major

Hypothesis 3d: *Physical Education Teacher Educator (PETE) students will have significantly higher overall SA accuracy than all other participants.*

Table 9 represents the overall SA accuracy between PETE and non-PETE majors for their SP and BT SA accuracy.

Table 9

Mean Self-Assessment Accuracy for PETE and non-PETE Majors

Major	Spin Putt			Backhand Throw		
	n	Mean	SD	*n*	Mean	SD
Non-PETE	4	59.17%	16.42	3	73.78%	26.00
PETE	10	69.67%	19.00	9	75.96%	13.99

Note. PETE = physical education teacher education.

An independent-samples t-test was conducted to compare SP SA accuracy for non-PETE majors and PETE Majors. On average, PETE majors' SP SA accuracy was higher than non-PETE majors by 10.50%. Equal variance could be assumed because Levene's test of variances was not significant (*p = .52*). However, this difference, 10.50, 95% CI [-13.20, 34.20], was not statistically significant, t(12) = 0.97, p = .35.

An independent-samples t-test was conducted to compare BT SA accuracy for non-PETE majors and PETE Majors. On average, PETE majors' BT SA accuracy was higher than non-PETE majors by 2.18%. Equal variance could be assumed because Levene's test of variances was not significant (*p = .34*). However, this difference, 2.18, 95% CI [-23.19, 27.569], was not statistically significant, t(10) = 0.19, p = .85. Hypothesis 3d is rejected.

Hypothesis 3e: *PETE students will have a significantly higher motor performance score on their spin put posttest than non-PETE students*

Table 10 represents the mean SP technique scores between PETE and non-PETE majors at the pretest, posttest, and gain scores.

Table 10

Mean Spin Putt Technique Scores (%) By Majors and Time

Major		Spin Putt		
	n	Pre	Post	Gain
Non-PETE	14	52.90 (20.49)	77.95 (11.49)	25.05 (18.28)
PETE	27	64.90 (20.12)	83.35 (12.27)	18.45 (15.66)

Note. Standard deviations are presented in parentheses. PETE = physical education teacher education.

An independent-samples t-test was conducted to compare SP posttest scores for non-PETE majors and PETE Majors. On average, PETE majors' SP posttest scores were higher than non-PETE majors by a magnitude of 5.40. Equal variance could be assumed because Levene's test of variances was not significant ($p = .99$). This difference, 5.40, 95% CI [-2.60, 13.41], was not statistically significant, t(39) = 1.37, p = .18.

Furthermore, an independent samples t-test was conducted to compare the SP technique gain score from the pretest to the posttest for non-PETE majors and PETE Majors. On average, non-PETE majors improved their SP technique scores more than PETE majors by a magnitude of 6.60. Equal variance could be assumed because Levene's test of variances was not significant (*p = .26*). This difference, 6.60, 95% CI [-4.44, 17.64], was not statistically significant, t(39) = 1.37, p = .23.

A multiple regression analysis was conducted to analyze if participants' major moderated the interaction between SP pretest and posttest scores. There was a statistically significant main effect of SP pretest score and participants' major has on their SP posttest scores, $F(3,37) = 6.64$, $p < .01$. However, participants' major does not moderate the relationship between SP pretest and posttest scores ($B = 0.13$, $SE = 0.17$, $p = .44$). Hypothesis 3e is rejected.

Hypothesis 3f: *PETE students will have a significantly higher motor performance score on their BT posttest than non-PETE students*

Table 11 represents the mean BT technique scores between PETE and non-PETE majors at the pretest, posttest, and gain scores.

Table 11

Mean Backhand Throw Technique Scores (%) By Major and Time

Major		Backhand Throw		
	n	Pre	Post	Gain
Non-PETE	16	45.75 (16.51)	65.11 (20.93)	21.79 (12.34)
PETE	26	57.05 (24.81)	75.44 (21.44)	16.19 (24.66)

Note. Standard deviations are presented in parentheses. PETE = physical education teacher education.

An independent-samples t-test was conducted to compare BT posttest scores for non-PETE majors and PETE Majors. On average, PETE majors' BT posttest scores were higher than non-PETE majors by a magnitude of 10.33. Equal variance could be assumed because Levene's test of variances was not significant (*p = .99*). This difference, 10.33, (95% CI [-3.94, 24.60]), was not statistically significant, t(38) = 1.47, p = .15.

Furthermore, an independent samples t-test was conducted to compare the BT technique gain score from the pretest to the posttest for non-PETE majors and PETE Majors. On average, non-PETE majors improved their BT technique scores more than non-PETE majors by a magnitude of 5.60. Equal variance could be assumed because Levene's test of variances was not significant (*p = .14*). This difference, 5.60, (95% CI [-8.67, 19.87]), was not statistically significant, t(38) = 0.90, p = .43.

A multiple regression analysis was conducted to analyze if participants' major (PETE or Non-PETE) moderates the interaction between BT pretest and posttest scores. There was a statistically significant main effect of BT pretest score and participants' major has on BT putt posttest scores, $F(3,36) = 6.33, p < .01$. However, participants' major does not moderate the relationship between BT pretest and posttest scores ($B = -.70., SE = 0.35, p = .051$). Hypothesis 3f is rejected.

Research Question 3 Summary

Overall, participants' SP and BT posttest performance was not moderated by their gender, age, individual self-efficacy for each skill, their interest in learning disc golf before the start of the unit, their past disc golf experiences, if they have played at least two rounds of disc golf in the last year, and their major. However, their interest in learning disc golf post-study completion significantly mediated their BT posttest scores, indicating that an increase in interest in learning disc golf after the study led to an increase in their BT posttest scores. Additionally, SP posttest scores were mediated by participants' SP SA accuracy, indicating a causal effect of increased SP SA accuracy on their SP posttest scores. Furthermore, overall SA accuracy did not differ between PETE and non-PETE majors.

Research Question 4

What form of pedagogical guidance is the most effective in improving online students' disc golf motor performance from pre to post to retention tests?

Research question 4 examined whether group differences existed in SP and BT technique scores from pre to post to retention tests. Tables 12 and 13 report each group's mean pretest, posttest, and retention test recorded SP and BT technique percentages.

Table 12

Mean Spin Putt Scores at The Pretest, Posttest, and Retention Tests for Each Group

Group	Spin Putt			
	n	Pre	Post	Retention
TF	12	57.42 (19.39)	80.47 (15.40)	77.78 (18.90)
SA	9	71.61 (17.83)	87.56 (13.03)	79.46 (18.46)
VCS	9	64.44 (23.64)	82.10 (8.41)	87.70 (15.64)

Note: Standard deviations are presented in parenthesis. TF = Teacher Feedback; SA = Self-Assessment; VCS = Visual Cue Sheet.

Table 13

Mean Backhand Throw Scores at Pretest, Posttest, and Retention Tests For Each Group

Group	Backhand Throw			
	n	Pre	Post	Retention
TF	12	52.73 (19.90)	67.56 (23.25)	59.77 (23.50)
SA	9	52.13 (25.02)	74.81 (14.53)	70.61 (18.89)
VCS	9	57.26 (22.96)	80.21 (14.80)	77.49 (19.21)

Note: Standard deviations are presented in parenthesis. TF = Teacher Feedback; SA = Self-Assessment; VCS = Visual Cue Sheet.

The mean technique scores for participants' SP and BT for each group at each time measurement (pretest, posttest, and retention test) are represented in Figures 10 and 11.

Figure 10

Spin Putt Scores From Pre to Post to Retention Test in Groups by Each Skill

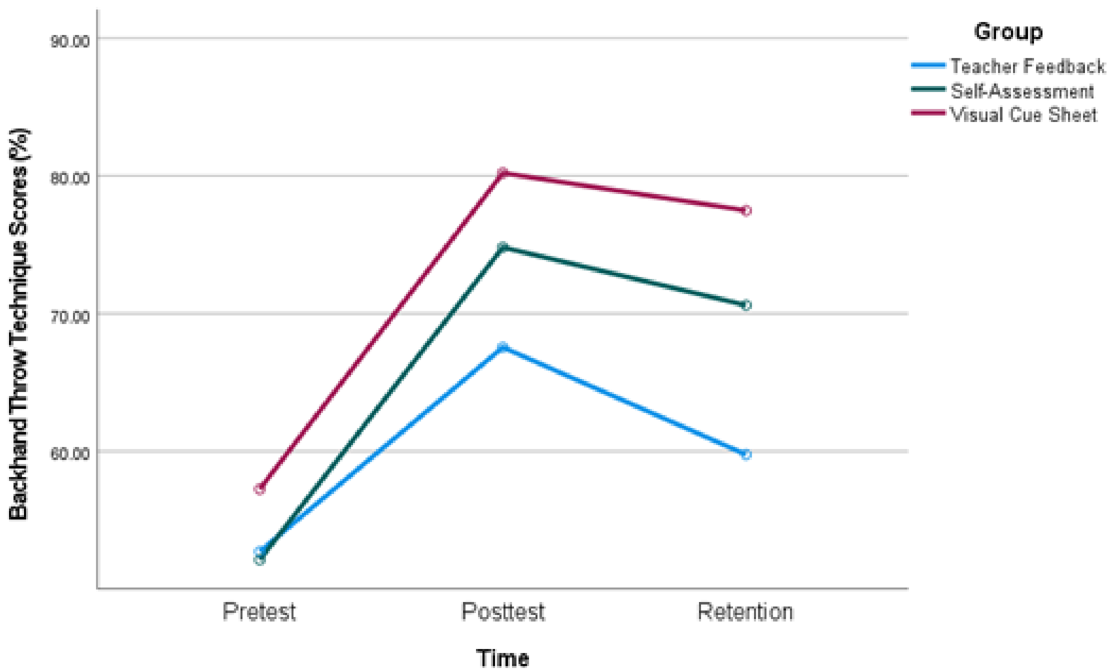
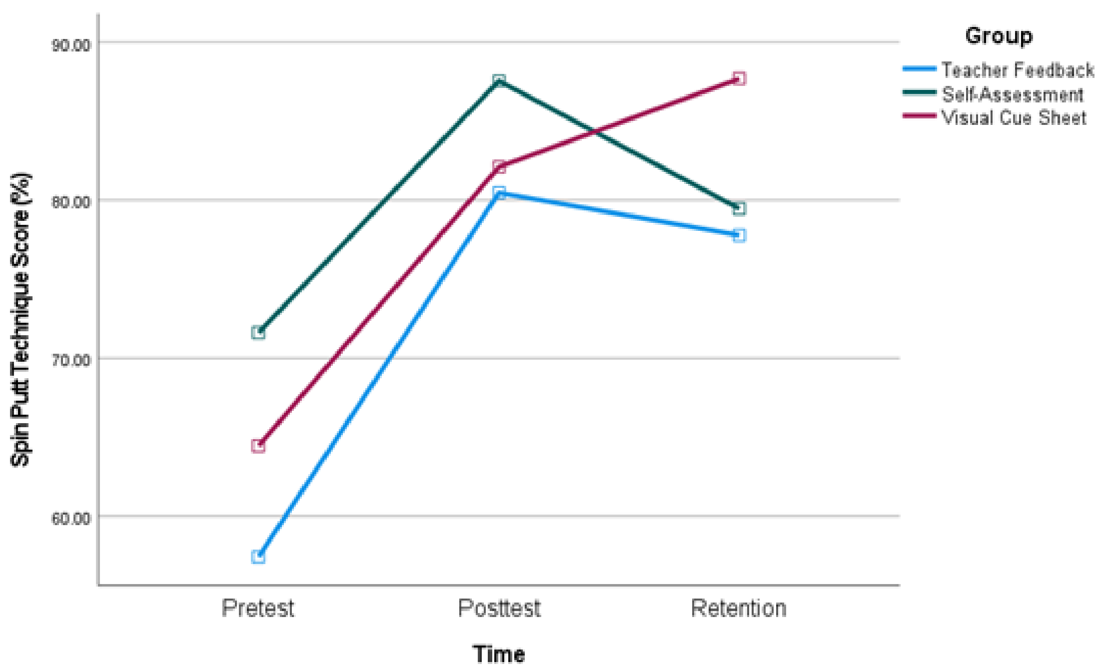


Figure 11

Backhand Throw Scores From Pre to Post to Retention Test in Groups by Each Skill



A 3x3 way factorial analysis of variance (ANOVA) was conducted to compare the main effects of participants' group condition (TF, SA, and VCS) and a repeated measure (pretest, posttest, and retention test) and the interaction effect between participants group condition and a repeated measure has on their SP and BT performance technique.

Mauchly's test indicated that the assumption of sphericity was not violated for SP technique scores ($p = .16$). However, for BT technique scores, Mauchly's test indicated that the assumption of sphericity was violated ($p = .01$); therefore greenhouse-Geisser corrected tests are reported. Additionally, Laevne's equality of error variances could be assumed for SP technique measurements (pretest, $p = .48$; posttest, $p = .06$; retention test, $p = .60$) and BT technique measurements (pretest, $p = .60$; posttest, $p = .05$; retention test, *p = .61*); and the covariance matrices between groups were assumed to be equal (*p = .09*).

Hypothesis 4a: *There will be a significant main effect for time on participants' SP and BT techniques with significant differences from pretest to posttest and pretest to retention test.*

There was a significant main effect for time on participants' SP technique scores, $F(2,54) = 23.85$, $p < .001$, $\eta p^2 = .47$, and BT scores, $F(1.83,39.58) = 15.87$, $p < .001$, $\eta p^2 = .37$. A post hoc pairwise comparison using Bonferroni correction showed a significant increase from the pretest to the posttest for participants' SP technique (*M = 18.87, p < .001*) and BT technique (*M = 20.20, p < .001*); this increase was also observed from pretest to retention for SP technique (*M = 17.19, p < .001*) and BT technique (*M = 15.25, p = .01*); non-significant differences from posttest to retention test was observed for SP technique (*M = -1.73, p = .99*) and BT technique (*M = -4.91, p = .14*). Hypothesis 4a is accepted.

Hypothesis 4b: *There will be a significant time difference for the SA and VCS groups in their SP and BT techniques from pretest to posttest and pretest to retention test.*

There was a non-significant main effect for group condition on participants' SP technique scores, $F(2,27) = 0.89$, $p = .42$, $\eta p^2 = .06$, and BT scores, $F(2,27) = 1.19$, $p = .32$, $\eta p^2 = .08$. For SP technique scores, a post hoc pairwise comparison using Bonferroni correction showed a significant increase from pretest to posttest for the TF group (*M = 23.06, p < .001*), SA group (*M = 15.95, p = .02*), and the VCS group (*M = 17.66, p = .01*); this increase was also observed from pretest to retention for the TF group (*M = 20.36, p < .01*), the VCS group (*M = 23.27, p < .01*), and a non-significant increase for the SA group (*M = 7.87, p = .65*). For posttest to retention test, non-significant differences were observed for the TF group (*M = -2.69, p = .99*), SA group (*M = -8.09, p = .31*), and VCS group (*M = 5.60, p = .76*).

For BT technique scores, a post hoc pairwise comparison using Bonferroni correction showed a significant increase from pretest to posttest for the SA group (*M = 22.69, p = .02*), VCS group (*M = 22.95, p = .02*), and a non-significant increase for the TF group (*M = 14.83, p = .10*). A significant increase was also observed from pretest to retention test for the VCS group (*M = 20.23, p = .047*). A non-significant increase for the TF group (*M = 7.04, p = .93*) and SA group (*M = 18.49, p = .08*). For the posttest to retention test, non-significant differences were observed for the TF group (*M = -7.79, p = .13*), SA group (*M = -4.20, p = .99*), and VCS group (*M = -2.72, p = .99*). Hypothesis 4b is partially accepted.

Hypothesis 4c: *There will be a significant interaction effect with group differences at the posttest and retention test for either the SA or the VCS groups for participants' SP and BT techniques*

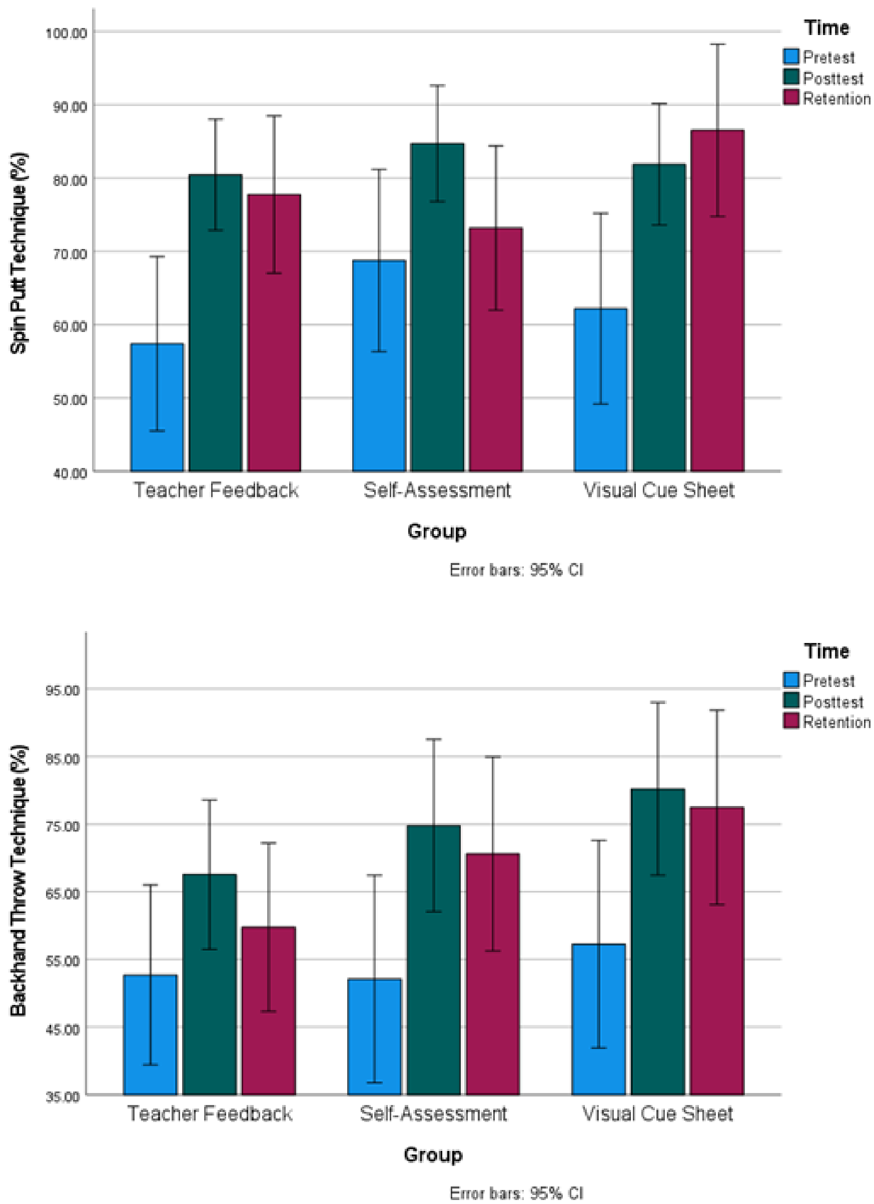
The one-way ANOVA showed no significant differences for SP technique $F(2,27) = 1.62$, p = .30, $\eta^2 = .09$, and BT technique $F(2,27) = 0.15$, p = .87, $\eta^2 = .01$ at the pretest. There was a non-significant interaction between group and time for participants' SP technique, $F(4,52) = 1.33$, p = .27, $\eta p^2 = .09$, and BT scores, $F(2.93, 39.58) = .68$, p = .57, $\eta^2 = .05$. Hypothesis 4c is rejected.

Research Question 4 Summary

Participants improved their mean percentage in SP and BT techniques after practicing in all groups (see Figure 12).

Figure 12

Spin Putt and Backhand Performance Scores as A Function of Group and Time



No significant differences in SP and BT techniques were found at the pretest between groups. Regarding the difference in SP and BT techniques from the pretest to the posttest, participants in all three groups showed improvement. However, there was no significant difference in this improvement between groups at the posttest for both SP and

BT techniques. Nevertheless, the SA and VCS groups were the only groups to show a significant increase in BT technique scores at the posttest; all three groups showed a significant increase in SP technique at the posttest.

Only the TF and VCS groups improved significantly from the pretest to the retention test for SP technique scores. Additionally, only the VCS significantly differed from the pretest to the retention test for participants' BT technique. Therefore, research question 4 is partially supported.

CHAPTER V: DISCUSSION

This study aims to identify which form of pedagogical guidance with video feedback is the most effective in an online environment by examining differences in participants' disc golf skills. This chapter discusses findings from the research, the implications pertinent to the current literature limitations of the study, and recommendations for future research.

Comparison of Performance

In this section, changes in participant disc golf technique are examined. This section is organized by participant improvements regardless of group condition, group improvements, and group differences. This section addresses changes from the pretest to the posttest (research question 1) and changes during the pre, post, and retention tests (research question 4). The six hypotheses supporting research question one were:

- A significant difference exists in spin putt (SP) performance from the pretest to the posttest in the self-assessment (SA) group (*Hypothesis 1a)*.
- A significant difference exists in SP performance from the pretest to the posttest in the visual cue sheet (VCS) group (*Hypothesis 1b)*.
- A significant difference exists between the SA group and the VCS group in SP performance from the pretest to the posttest when compared to the delayed teacher feedback (TF) group (*Hypothesis 1c)*.
- A significant difference exists in backhand throw (BT) performance from the pretest to the posttest in the SA group (*Hypothesis 1d)*.
- A significant difference exists in BT performance from the pretest to the posttest in the VCS group (*Hypothesis 1e)*.

- A significant difference exists between the SA group and the VCS group in BT performance from the pretest to the posttest when compared to the teacher feedback group (*Hypothesis 1f)*.

Three hypotheses supporting research question four were:

- A significant main effect exists for time on participants' SP and BT techniques with significant differences from pretest to posttest and pretest to retention test. (*Hypothesis 4a)*.
- A significant time difference exists for the SA and VCS groups in their SP and BT techniques from pretest to posttest and pretest to retention test. (*Hypothesis 4b)*.
- A significant interaction effect exists with group differences at the posttest and retention test for either the SA or the VCS groups for participants' SP and BT techniques (*Hypothesis 4c)*.

Improvements Over Time

Hypothesis 4a suggested that all participants would have significant differences in SP and BT technique scores from the pretest to the posttest and from the pretest to the retention test. On average, participants significantly improved their SP and BT techniques at both the post and retention tests compared to their pretest scores. The findings support similar results from previous studies (Kretschmann, 2017; Kok et al., 2020; Madou & Cottyn, 2015; Nowels & Hewit, 2018; Palao et al., 2015; Potdevin et al., 2018; Puklavec et al., 2021; Souissi et al., 2021) exploring the relationship between video feedback and the improvement of various motor skills.

While many elements contribute to students learning a motor skill (Rink, 2020), practice is considered the most critical factor (Haibach et al., 2017). All three groups in this study received a four-session disc golf unit consisting of two sessions of three sets of five throws with video feedback for each disc golf skill; the participants in all conditions received the same amount of practice time to improve their disk golf skills. Therefore, it is not surprising that, on average, participants improved from the pretest to the posttest and from the pretest to the retention test for both disc golf skills.

As Kretschmann (2017) alluded, motor learning can be enhanced with video feedback in unconventional learning environments (i.e., swimming pools). It is not surprising that Daum and Buscher (2018) recommend that online physical education (OLPE) teachers adopt the use of video feedback into their curriculum. However, without a control group that did not use video feedback while practicing, it is unclear how much participants in this study benefited solely from using video feedback. Participants in this study could have been overwhelmed with the new technology, as reported similarly to secondary OLPE students (Karp & Woods, 2003). However, just like Kooiman et al. (2016) demonstrated the benefits of using new technology (exergaming) with secondary OLPE students, this study participants, on average, benefitted from using practice sessions with video feedback. The result of this study should reduce concerns from physical education teacher education (PETE) professors (Daum & Woods, 2015) on the ability of OLPE to address psychomotor learning.

Group Improvement Over Time

Hypotheses 1a, 1b, 1d, 1e, and 4b suggests that the SA and the VCS groups would significantly improve their two-disc golf skills from pretest to posttest and pretest to retention test. This premise was valid only for the VCS group as the SA group did not show a significant difference in both disc golf skills from the pretest to the retention test—the SA group did have significant differences in the posttest measurement for both disc golf skills. Furthermore, the TF group did not show a statistically significant improvement in their BT at either the post or retention test. The findings in the VCS group are similar to other studies (Kok et al., 2020; Souissi et al., 2021) that found significant group improvement at both the post and retention tests. Additionally, Souissi et al.'s (2021) VCS was designed and implemented similarly to this study; VCS contained all of the critical elements of the focus skill instead of only focusing on one element in each practice session (Kok et al., 2020). Furthermore, the VCS group in the current study was the only group to show improved SP technique after the posttest; however, it did not significantly increase ($M = 5.60, p = .76$).

While the SA group significantly improved both disc golf skills at the posttest measurement, this improvement was not significant at the retention test for both skills. This finding is in contrast to past studies (Nowels & Hewit, 2018; O'Loughlin et al., 2013; Potdevin et al., 2018) that found video feedback with SA guidance to be beneficial to motor learning; however, these studies did not include a retention test. These studies implementing SA guidance also utilized teacher feedback in traditional face-to-face settings. It could be that SA in-the-moment guidance is less valuable without being pared with verbal feedback or some other in-the-moment guidance. It could be that face-to-face students can pry the answer out of the teacher or peers when they are supposed to be self-assessing—unlike asynchronous OLPE students that might feel like they are on an island waiting for delayed feedback from their teacher.

The SA group evaluated five critical elements of each disc golf skill in this study. This amount to assess at one time could have been overwhelming for them to focus on; it could have been more beneficial to only assess one critical element like Potdevin et al. (2018) did. Novice learners will typically benefit from fewer elements while they watch their videos, as they lack the needed attentional focus (Haibach et al., 2017; Obrusnikova & Rattigan, 2016). The five critical elements still could have all been addressed but split up into smaller chunks during each session or only assess one element during each set of five throws.

Additionally, students in the SA group in this study only judged one trial during each set of five throws, and it could have been more beneficial to have students evaluate all trials (O'Loughlin et al., 2013). If this were used, it would have helped ensure that students watched their entire video feedback, not just one trial. Keeping students accountable for watching instructor-made video feedback is a common concern with many higher education teachers (Ketchum et al., 2020). Lowenthal's (2022) study highlights this concern, which found that online students tend to watch less than half of all video announcements, even though they report that they watched all the videos. As Bahuyla and Kay (2022) speculated, video feedback is more effective with smaller chunks of time that are no more than four minutes long. Even though in this study, the student-created video feedback that the SA group had to watch was less than a minute for each set, they did have to spend more time creating each set of video feedback to watch. This process of creating their video feedback, finding their best throw to self-assess, and reporting their judgment on five critical elements might have been too time-consuming for students in this study.

A possible reason for the lack of significance at the SP retention test may be due to the SA group having the highest SP pretest score (*M = 71.61*) of any group. While this difference at the pretest was not significantly different from the rest of the groups, their room for significant growth was limited. Furthermore, the SA group was approaching significance at the BT retention test (*M = 18.49, p = .08*). Additionally, the small SA group size (*n = 9*) may have limited the effect of finding significant differences in this group.

While the delayed TF group significantly improved their SP technique scores at both the posttest and retention test, this was not true for their BT technique scores. This finding in the BT supports past studies (Madou & Cottyn, 2015; Rucci & Tomporowski, 2010; Souissi et al., 2021) that found video feedback without some sort of in-the-moment guidance may not be beneficial to motor learning. Furthermore, the TF group received positive and negative feedback on all critical elements, and it may be more helpful to give corrective feedback on just a few of the most important elements (Puklavec et al., 2021). Additionally, there is no way to confirm if participants in the TF group read their feedback in Google Classroom.

One way to address this is to include open-ended or specific questions encouraging students to respond to the given TF. Similarly, teachers could require students to respond with questions about their performance based on the TF. While students could respond to these prompts with a private comment in Google Classroom, they could also respond via e-mail or text messaging. Delaying students' grades until a response is made can help motivate students to respond.

Typically, video feedback is more effective for students when paired with some version of in-the-moment guidance (Han et al., 2022; Mödinger et al., 2021; Zhou et al., 2021). Surprisingly, the delayed TF group in this study significantly improved and retained their SP technique. This result could be explained by the fact that when the TF students reviewed the delayed feedback, they reengaged with the content. This opportunity might have allowed for a desirable amount of struggle to remember what was learned during the previous session (Agarwal et al., 2013). This delayed feedback might have also motivated students to rewatch their video feedback to help process the teacher's comments on their performance. What may explain the significant findings in the TF group may have more to do with their group having the lowest SP technique score at the pretest ($M = 57.42$), which was 14.19 percentage points lower than the SA group's pretest scores.

Group Differences

Hypotheses 1c, 1f, and 4c suggested that the SA and the VCS groups would show significant differences in their disc golf skills at the posttest and retention test compared to the TF group. However, no significant group differences were identified for either disc golf skills at the posttest or retention test. This finding is similar to Kok et al. (2020), which found no group differences at post and retention tests for students learning the shot put in a face-to-face physical education setting. Madou and Cottyn (2015) also found no significant group differences in post and retention tests for PETE students learning two gymnastics skills. However, this lack of group difference in Madou and Cottyn's (2015) study could be explained because they did not provide any form of in-the-moment guidance—unlike Kok et al. (2020) that provided in-the-moment guidance in the form of a VCS.

Unlike the results in this study, most other research utilizing video feedback has shown significant group differences in face-to-face settings (Casey & Jones, 2011; Kretschmann, 2017; Nowels & Hewit, 2018; Potdevin et al., 2018; Puklavec et al., 2021; Yu et al., 2020). However, these studies' significant group differences are only to groups that did not utilize video feedback compared to those that did, and none included a retention test. Until recently (Kok et al., 2020; Palao et al., 2015; Puklavec et al., 2021; Souissi et al., 2021; Souissi et al., 2022), different forms of video feedback implementation is hardly investigated.

Additionally, this study's lack of significant group differences differs from past research that utilized a VCS in an online environment (Souissi et al., 2021; Souissi et al., 2022). However, in Souissi et al.'s 2021 study, the significant group differences were only for those who did not use video feedback during their practice sessions. Furthermore, in Souissi et al.'s 2022 study, the VCS group also got delayed peer feedback and could have had an additional benefit that our participants did not get. Not achieving the desired sample size can also explain the lack of significant group differences. Power analysis revealed that a sample size of 50 participants was needed to see a moderate effect. While 71 participants were recruited to participate, only 43 students were included for analysis, and of those 43, only 30 completed the retention test. A larger sample or greater group differences are needed to see significant results. However, a smaller sample size of 35 was enough to find significant group differences in past research (Souissi et al., 2021; Souissi et al., 2022). However, these studies had 144 practice trials compared to the current study's use of 30 trials.

Unlike the results from this study, previous research in OLPE settings has shown significant group differences (Hager et al., 2012; Lim et al., 2008; McNamara et al., 2008; Sidman et al., 2014). However, these differences are only compared between online and face-to-face students. Regardless, these group differences in OLPE settings indicate that face-to-face students do better than their online counterparts in improving their fitness ability. However, students enrolled in hybrid OLPE courses show no differences from their face-to-face counterparts when improving their fitness ability (Brewer, 2001; Futrell, 2009; McNamara et al., 2008). In this study, a little over 85% of the students included for analysis could be considered hybrid OLPE students since they were in face-to-face classes that transitioned to an online environment and back to the face-to-face after the study's completion. These students could have benefited similarly to other hybrid OLPE courses, which explains why no significant group differences were found in this study.

A few studies have examined group differences within an OLPE course (Goad et al., 2021; Mosier, 2010). Goad et al. (2021) indicated that freshmen struggle more in an OLPE course. Similarly, Mosier (2010) indicated that 12th-grade students were about 60% likely to complete their OLPE course compared to grades 6-11, who were all under 50%. While most students in this study were enrolled in upper-division classes, one class was lower division general education OLPE wellness class. There is likely a higher number of freshmen in that course, which could explain why only about 30% of the students in that class completed the study. Another reason for the lack of group differences found in this study could be that the students that did not complete the study (about 40% of the original 71 students) struggled to improve their disc golf skills and did not have the necessary skills to persist. Significant group differences might have been easier to identify if these students completed the study.

Relationship Between Self-Assessment and Performance

Research question two examined the relationship between SA accuracy and disc golf performance. Two hypotheses supporting this research question were:

- A significant relationship exists between participants' SP SA accuracy and their posttest SP scores (*Hypothesis 2a)*.
- A significant relationship exists between participants' BT SA accuracy and their posttest BT scores (*Hypothesis 2b)*.

It was hypothesized that there would be a significant relationship between SA accuracy and disc golf performance. Participants' SP SA accuracy significantly correlated to their SP posttest score ($r = .83, p < .001$). Additionally, participants' BT SA accuracy significantly correlated to their SP posttest score ($r = .79, p < .01$). The findings support similar results from previous studies (Hastie et al., 2012; Nowels & Hewit, 2018; O'Loughlin et al., 2013; Potdevin et al., 2018) that explored the relationship between video feedback and improved SA ability.

While past research (Hastie et al., 2012; Nowels & Hewit, 2018; Potdevin et al., 2018) examined how video feedback can improve an individual's SA ability, results from this study can only be applied to the SA group. While the TF and VCS groups might have improved their SA ability, this data was not collected. Additionally, results from this study indicate that participants' SA accuracy improved from each session, which is similar to the findings of Potdevin et al. (2018), which saw students' SA accuracy increase over five sessions.

While not reported in this study, students in the SA group both overestimated and underestimated their abilities. Typically, students tend to overestimate their ability, and video feedback helps students become more accurate with their assessments (Hastie et al., 2012; Nowels & Hewit, 2018). However, it is unclear if students improved SA accuracy was due to their performance improving and thus aligning with their initial inflated SA. Conversely, it could be that video feedback with SA guidance helped students make more accurate judgments regardless of their improved performance, thus explaining the significant relationship between SA and performance. Without a control group not utilizing video feedback, it is unclear what elements are causing the strong relationship between performance and SA accuracy.

Review of Factors That Impact Performance

Research question three examined the factors that help explain differences in motor performance. Six hypotheses supporting this research question were:

- A significant interaction effect exists between individuals with more disc golf experience on their pre to posttest on both SP and BT *(Hypothesis 3a)*.
- A significant interaction effect exists between individuals with a higher number of times they have played disc golf in the last year on their pre to posttest on both SP and BT. *(Hypothesis 3b)*.
- A significant interaction effect exists between individuals with a higher SA score on their pre to posttest on both SP and BT *(Hypothesis 3c)*.

- PETE students will have significantly higher overall SA accuracy than all other participants *(Hypothesis 3d).*
- PETE students will have a significantly higher motor performance score on their spin put posttest than non-PETE students *(Hypothesis 3e).*
- PETE students will have a significantly higher motor performance score on their BT posttest than non-PETE students *(Hypothesis 3f).*

Similar to previous meta-analyses on the use of video feedback (Han et al., 2022; Mödinger et al., 2021; Rhoads et al., 2014; Zhou et al., 2021), the current study did not find participant characteristics of age, gender, self-efficacy for each disc golf skill, their interest in learning disc golf before the start of the unit, their past disc golf experiences, if they have played at least two rounds of disc golf in the last year, or their major (Non-PETE or PETE) to be significantly different in their SP and BT pretest to posttest scores. Furthermore, non-significant differences in age and gender align with the findings in students in a college online health-related fitness (Goad, Jones, et al., 2021).

This study revealed that disc golf posttest scores were mediated between interest in learning disc golf post-study completion and SP SA accuracy. Previous research has demonstrated that video feedback can help increase motivation to learn various motor skills (Legrain et al., 2015; O'Loughlin et al., 2013; Potdevin et al., 2018; Roure et al., 2019). Similarly, in the present study, the relationship between BT pretest and posttest results was mediated by participants with more interest in learning disc golf after they completed the disc golf unit. This result is similar to Legrain et al. (2015), which found that motivation posttest scores mediated middle school-age physical education students' motor performance using video feedback during a six-week gymnastics unit. However, this result from Legrain et al.'s (2015) is somewhat surprising since participants did not get any in-the-moment verbal feedback (either from peers or teachers), which can be essential for video feedback having a positive effect on motivation (Roure et al., 2019; San et al., 2022).

In this study, the relationship between SP pretest and posttest scores was mediated by participants' SP SA accuracy. This result provides evidence that competency in SA and motor skill ability can be developed simultaneously in a short period of time, which is similar to the findings of Potdevin et al. (2018). Additionally, utilizing SA guidance with video feedback helped improve students' amotivation while learning the handstand (Potdevin et al., 2018). With this in mind, developing skill performance and error analysis, an essential ability for future physical education teachers, may not be connected to each other (Tsuda et al., 2019; Ward et al., 2018). That is to say, improving one's skill performance does not improve their ability to analyze and fix errors in that skill—both have to be intentionally taught (Hastie, 2021). However, SA accuracy did not significantly differ between PETE (SP-SA= 69.67%; BT-SA=75.96%) and non-PETE majors (SP-SA= 59.17%; BT-SA=73.78%) in this study. In other words, participants in this study were able to improve their SA accuracy regardless of their major. PETE professors should consider intentionally developing their student's error analysis ability (Ward et al., 2021) and not assume that improving their performance will help improve their corresponding error analysis.

Implications

The following section will examine how this study contributes to the existing literature in three main ways: (a) improved motor performance in an online setting, (b) video feedback with in-the-moment guidance, (c) utilizing video feedback in OLPE, and (d) designing and implementing an OLPE unit.

Improved Motor Performance in an Online Setting

Many researchers (Daum & Buschner, 2018; Daum, Goad, Mosier, et al., 2021; Mohnsen, 2012; Mosier, 2012) have called for evidence-based practices demonstrating effective teaching practices that lead to psychomotor learning in OLPE. The results of this study help support recent findings (Souissi et al., 2021 Souissi et al., 2022) that students can learn in online environments. While the results of this study are not conclusive on which form of in-the-moment video feedback guidance is superior, it did demonstrate that video feedback can help improve motor performance in an online setting. While Souissi et al. (2021) showed motor gains in an online setting, their environment did not represent an OLPE context. For instance, Souissi et al.'s (2021) participants volunteered and did not receive a grade. This study is different because all participants' involvement was required as part of regular class work while working in an online environment. Additionally, this study was not conducted during the Covid-19 pandemic (Souissi et al., 2021 Souissi et al., 2022) as the face-to-face students were not forced into being online and only participated in this disc golf section online.

A few studies (Brewer, 2001; Futrell, 2009; Hager et al., 2012; McNamara et al., 2008) have examined changes in psychomotor performance in an OLPE setting. However, these studies have only examined differences in fitness outcomes. The results of this study help demonstrate that OLPE does not have to be primarily fitness-focused, which dominates the organization of many OLPE courses (Cox et al., 2019; Daum & Buschner, 2012, 2018; Goad, Jones, et al., 2021). SHAPE America’s (2018) *Guidelines* *for K-12 OLPE* indicate that OLPE courses should address all national or state standards. This appropriate practice would mean that OLPE courses must instruct psychomotor skills and not only focus on improving fitness and wellness. Despite the focus on teaching motor skills in OLPE, Daum and Buschner (2018) declared, "Until research can address the feasibility of teaching motor skills online, including best practices, OLPE should be primarily a fitness-focused curriculum" (p. 331). The results of this study are the first step in creating an evidence-based practice that motor skills can be taught online. OLPE teachers should be more comfortable that their students can learn psychomotor skills by using video feedback.

Video Feedback with In-The-Moment Guidance

Video feedback is less effective in improving motor learning without providing some guidance to students (Han et al., 2022; Mödinger et al., 2021; Zhou et al., 2021). Typically, this guidance is given in-the-moment and comes from a teacher or peer's verbal feedback (Palao et al., 2015; San et al., 2022) , utilizing a VCS (Kok et al., 2020; Souissi et al., 2021), or self-assessing (Nowels & Hewit, 2018; O'Loughlin et al., 2013; Potdevin et al., 2018). The results of this study support the notion that video feedback is more valuable with in-the-moment guidance. The delayed TF group did not significantly improve their BT at any time measurements. Additionally, there were more significant performance gains in the two in-the-moment guidance groups; the VCS group significantly improved their SP and BT at all time measurements; While the SA group did not show significant differences in the retention test for both disc golf skills, they did show significant differences in the posttest measurements for both disc golf skills.

Furthermore, this study provides two methods to adapt in-the-moment guidance in an OLPE setting; VCS and SA. While some studies have utilized a VCS in an online environment (Souissi et al., 2021, Souissi et al., 2022), these participants were not enrolled in a physical education course—they were forced to utilize the online medium because of the Covid-19 pandemic. Additionally, this is the first study to utilize video feedback with SA guidance in an online environment, and the method used in this study could be replicated for practitioners to use. However, it might be beneficial to explore different forms of SA guidance. This study utilized having students assess all five critical elements of each focus skill, and it could be more beneficial to only have students evaluate one element at a time (Potdevin et al., 2018) or focus on making one evaluative judgment on the entire skill (Nowels & Hewit, 2018). Regardless, practitioners should be encouraged to utilize SA guidance in online environments.

While the two forms of in-the-moment guidance were used in online environments, they could easily be adapted to face-to-face settings. These guidance methods, SA and VCS, are helpful to implement because they do not require as much of the teacher's in-the-moment time as other methods. They require more time on the front end to create the SA and VCS documents. Therefore, PETE programs should consider training their students to create these documents to familiarize them with implementing non-teacher-in-the-moment video feedback guidance. Furthermore, including this training will help PETE majors have methods that work in face-to-face and online environments. This training would also align with recent recommendations for PETE programs to develop practices that prepare future teachers to work in OLPE (Murtagh et al., 2023)

Utilizing Video Feedback in Online Physical Education

Video feedback is one of the most common suggestions for OLPE teachers to utilize to help promote psychomotor learning (Daum, 2020; Goad et al., 2019; Jenny et al., 2020; Killian et al., 2021; Mohnsen, 2012; SHAPE America, 2018). While the video feedback method can be an effective teaching strategy for motor skill learning in face-to-face classes (Han et al., 2022; Mödinger et al., 2021; Rhoads et al., 2014), it lacks the same empirical backing in OLPE settings. Therefore, the results of this study provide evidence for the effective use of video feedback in online environments. In particular, OLPE teachers should consider using video feedback with VCS guidance in their curriculum.

Most secondary OLPE programs tend to implement a fitness-focused curriculum (Daum & Buschner, 2012; Harris & Metzler, 2019; Mercier et al., 2021; Mosier & Lynn, 2012), with some programs not including any motor skill development (Daum & Buschner, 2012; Mercier et al., 2021). At the beginning of the Covid-19 pandemic, many K-12 PE teachers struggled to adapt their face-to-face curriculum to online instruction (Centeio et al., 2021). Some teachers mentioned that their biggest struggle was finding effective methods to provide in-the-moment feedback to their students (Foye & Grenier, 2021). With this in mind, physical education teachers currently utilizing video feedback in their face-to-face classes should feel more confident using this technique in an online setting as a result of this study. Additionally, physical education teachers that have not utilized video feedback before can utilize the method used in this study.

In this study, the Flip app was primarily used as a way to facilitate video feedback. Still, this method also allowed for verifying participants' engagement in motor learning tasks. Keeping students accountable for learning is one of the main concerns of OLPE teachers (Centeio et al., 2021; Daum & Buschner, 2012; Daum & Woods, 2015; Foye & Grenier, 2021). Usually, this concern is about OLPE teachers not trusting the validity of self-report data (Daum, Goad, Mosier, et al., 2021; Ransdell et al., 2008). To alleviate some of these concerns, OLPE teachers could use the Flip app to collect assessment data, which will help keep students accountable. This study helps give OLPE teachers a method to hold students accountable for motor skill practice while giving them a tool to provide in-the-moment feedback.

Designing and Implementing an Online Physical Education Unit

This study utilized many recommended best practices in OLPE course design (see Appendix K). SHAPE America's *Guidelines for K–12 OLPE* (SHAPE America, 2018) outline four categories that should be included in any OLPE course: curriculum, learning environment and instructional strategies, student prerequisites, and assessment. This section will address the various best practices in OLPE course design and how it was addressed in this study.

Curriculum

Many practitioners recommended that the OLPE curriculum should be based on state and national standards (Buschner, 2006; Crosby, 2018; Daum, 2020; Daum & Buschner, 2012; Daum & Woods, 2015; Daum, Goad, Killian, et al., 2021; Jenny et al., 2020; Mohnsen, 2012; Ransdell et al., 2008; Waller & Schempp, 2022). This study focused on improving two disc golf skills, SP and BT techniques, allowing national grade-level outcomes S1.M18.7-8 and S1.H1.L1 to be addressed (SHAPE America, 2014). Additionally, the BT is used in other invasion game sports (i.e., Ultimate) and thus would help address grade-level outcome S1.M18.6 (SHAPE America, 2014). Students in the TF group that implemented their corrective feedback would have addressed grade-level outcome S4.M3.6 (SHAPE America, 2014).

Another aspect of quality curriculum design is that it should be assessed and revised on a regular schedule (Crosby, 2018; Daum, Goad, Mosier, et al., 2021; Jenny et al., 2020; Mohnsen, 2012). While this recommendation typically involves reviewing the course every two to three years (SHAPE America, 2018), the implementation of a pilot study in this project allowed for revisions to be made for smoother implementation. The last curriculum recommendation is that teachers include a student orientation module (Beard & Konukman, 2020; Crosby, 2018; Jenny et al., 2020; Killian et al., 2021; Mohnsen, 2012). In this study, level 0 was a way to orient students to the disc golf unit. Students had to confirm their practice area and equipment and practice how to record. These assignments in level 0 also let students familiarize themselves with the technology they would use (i.e., Flip and Google Forms), which benefited the teacher in helping identify what students might struggle with learning online.

Learning Environment and Instructional Strategies

This study addressed various elements of appropriate practices related to learning environments and instruction (SHAPE America, 2018). The first recommended best practice is to have a plan to prepare their online learning environment (Beard & Konukman, 2020; Brooks et al., 2020; Cox & Kulinna, 2022; Killian et al., 2021; Waller & Schempp, 2022). To accomplish this recommendation, Waller and Schempp (2022) suggest that OLPE teachers "think through the process of a student entering your online gymnasium… step into the student's shoes" (p. 45). Following this advice, the primary researcher made a student account before the study's implementation and experienced how students will experience the various activities. This step allowed for a better understanding of how students see and experience content to ensure that quality design was being implemented. To this point, a tip and help section was added to the bottom of every Google Classroom news post. Additionally, assignments in Google Classroom were given a number (i.e., #001) to make it easier to refer to students.

When preparing the online environment, it is also recommended that OLPE teachers should also balance the amount of screen time (Cox & Kulinna, 2022; Daum, Goad, et al., 2021; Jenny et al., 2020; Killian, Daum, et al., 2021; SHAPE America, 2018). In this study, students could complete all learning tasks outside; however, all tasks required some screen time. It is also recommended to have a plan for parent and social interaction when preparing for the online environment (Beard & Konukman, 2020; Daum, 2020; Jenny et al., 2020; Killian, Daum, et al., 2021; SHAPE America, 2018; Waller & Schempp, 2022; SHAPE America, 2018). While these two elements were not explicitly addressed, as participants were asked not to complete levels with other students in their class and were asked to record by themselves, some recruited friends and parents to help them record their performances.

Another best practice related to the learning environment is having and maintaining clear expectations (Beard & Konukman, 2020; Crosby, 2018; Cox & Kulinna, 2022; Harris & Metzsler, 2019; Moisser & Lynn, 2012; SHAPE America, 2018; Waller & Schempp, 2022). This study addressed this best practice by including a pacing guide that included what students needed to complete each week. Additionally, the initial welcome post included instructions on contacting the teacher (private comments or e-mail), and every level was accompanied by a Google Classroom news post outlining the expectations of what they needed to complete. Any expectations can be rendered meaningless if teachers are not continually reinforcing them. To accomplish this, the primary researcher would send private comments encouraging them to complete their missing work when students feel behind the pacing guide. If students turned in work incomplete, the primary researcher would remind students that they needed to go back and correct it; e.g., some students submitted their Google Form that they completed even though they did not have any videos submitted in Flip. Unfortunately, using Google Classroom in this study meant all participants had a different learning management system to check than what they used at their university (D2L and Canvas). It would have been more desirable to select tools that integrate into the current learning management system so students only have one platform to check their status in the class.

Another best practice related to learning environment and instruction strategies is having a communication plan (Beard & Konukman, 2020; Brooks et al., 2020; Daum, Goad, et al., 2021; J.A. Jackson, 2000; Jenny et al., 2020; Killian, Daum, et al., 2021; Mosier, 2010; SHAPE America, 2018; Waller & Schempp, 2022; Williams, 2013). This plan will help maintain a positive learning environment and help reinforce expectations. In this study, the first aspect of the communication plan was having a welcome post, which included a personalized screencast video from the primary researcher on how to navigate Google Classroom and what students should do first. The plan also allowed students to ask questions as private comments in Google Classroom or e-mails. There were multiple check-ins with students in the form of news posts explaining the various levels students needed to complete. Each news post included a screencast video where students could see the teacher, which could help create a personal connection. To help streamline any communication plan, Brooks et al. (2020) recommend utilizing the learning management system feature to automate student messages; Google Classroom's feature to schedule news posts and assignments in advance was used to accomplish this. At the end of the unit, a Google Classroom news post was sent to students thanking them for completing the unit and instructing them to return any discs they checked out. The last part of the communication plan included e-mails thanking students for participating once the study was over.

Within any communication plan, it is recommended that OLPE teachers plan to give prompt and quality feedback (Beard & Konukman, 2020; Cox & Kulinna, 2022; Crosby, 2018; Waller & Schempp, 2022). This feedback was accomplished in a variety of ways in this study. First, video feedback practice sessions were used for students to help get feedback without the teacher's guidance. Any private comments or e-mails students submitted were also responded to within 24 hours. Furthermore, using Google Forms allowed for prompt feedback when completing the Equipment Check (#001) and Recording Quiz (#002) by the auto-grade feature. Additionally, the Google Forms branching function, used on every Google Form assignment, gave students feedback if they got fidelity check questions wrong by making them go back to a previous section in the Google Form to review before re-taking the fidelity check. Students in the TF group got prompt 48-hour feedback on their performance. To help give this timely feedback and follow advice from practitioners (Beard & Konukman, 2020; Waller & Schempp, 2022), a bank of common statements was created and used to copy and paste feedback into Google Classroom.

The last recommended best practice related to the learning environment is that OLPE teachers should utilize a variety of instructional methods (Beard & Konukman, 2020; Crosby, 2018; Jenny et al., 2020; SHAPE America, 2018; Waller & Schempp, 2022). In this study, this was done by utilizing video for instruction and providing students autonomy. In levels 1 and 3, students watched instructional videos on each skill and included a recommended practice of including reflection questions to help ensure students were interacting with the video (Daum, Goad, Killian, et al., 2021; Ransdell et al., 2008; Waller & Schempp, 2022). Additionally, these instructional videos followed the best practice advice of keeping video less than five minutes (Foye & Grenier, 2021; Centeio et al., 2021) and only covering one skill at a time (Daum, Goad, Killian, et al., 2021). Another form of video instruction used in this study was utilizing an expert model video that was less than 1 minute long for students to watch before practicing their first set of five throws. This design follows Waller and Schempp's (2022) recommendation of short demonstration videos followed immediately with an application task.

The students in this study had autonomy in various ways to help give them an individualized learning experience. First, students picked when they completed each level; some worked ahead, others were on pace, and others were behind schedule and caught up. Additionally, autonomy was provided by students deciding where they got to practice; this included going to a disc golf course, gymnasium, parks, parking lots, apartment balconies, backyards, and various open spaces. While some students practiced in the same location for each session, others mixed and matched where they practiced. Autonomy could have been enhanced in this study by lettings students pick which skill they practiced first and letting students self-regulate when they wanted TF (Kok et al., 2020).

Student Prerequisites

SHAPE America (2018) recommended two appropriate practices related to student prerequisites; set criteria for who is eligible and conduct a readiness questionnaire. While these criteria were not included in this study, there are important elements to consider. Like the teachers in this study, OLPE teachers have limited input on who enrolls in their classes. However, a plan to identify students who do not have the perquisites skills should be used to identify what students may struggle with in online learning. In this study, a survey instrument could have been used during Level 0 to help accomplish this. The 71.66% posttest completion rate (43/60) might have been higher if this had been used. To this end, SHAPE America (2018) and Jenny et al. (2020) recommend using any of the following readiness assessments: Online Course Readiness Quiz (UoArk); Online Readiness Self-Assessment (Stanislaus State); Online Learning Readiness Questionnaire (PSU). Loyola University New Orleans Online Learning Readiness.

Assessment

The last appropriate best practice that OLPE teachers should consider revolves around assessments. Many recommend that students submit still images or videos of motor skills for the teacher to assess and give feedback (Mohnsen, 2012; Jenny et al., 2020; SHAPE America, 2018). In this study, the Flip app was used for students to submit their motor performance for evaluation. Additionally, the SA group formally evaluated their performance during practice sessions. While all groups might have been selfanalyzing their skill, there is a chance they never watched their video. At least the SA group had to watch one throw after each set.

The Flip app was also used to help verify student's physical activity, which is a recommended assessment best practice (Daum, 2020; Goad et al., 2019; Jenny et al., 2020; Killian, Daum, et al., 2021; Mohnsen, 2012; Ransdell et al., 2008; SHAPE America, 2018) In this study, physical activity was verified by having students submit three sets of videos in Flip for each practice sessions (levels 1-4). This verification method might have been enhanced if following Killan et al.'s (2021) advice of using this video data to make goals for future practice sessions or reflect on their progress.

Overall this study used various recommended best practices related to assessment, learning environment, instruction, and curriculum. OLPE teachers should consider adapting these best practices to their unique teaching context. A more extensive list of best practices can be found in Appendix K.

Limitations

The following are four main limitations of the study:

1. Participants learned online, but most participants were not online students. All classes, except for one, transitioned their face-to-face class to online for this study. The results of this study may not be generalizable to OLPE contexts. Furthermore, the results of this study should only be generalizable to college-age participants.
2. Results only indicate differences in disc golf technique; participants may or may not be improving their distance and accuracy.

3. This study had no way to control disc golf practice outside of the research design. With 20.93% of participants playing at least two rounds of disc golf in the last year, there is a good chance that some participants got additional practice.
4. While 30 trials in each disc golf skill were enough for the VCS group to show significant improvement at the post and retention test, this was not the case for the TF and SA groups.

Future Research

The following recommendations are made in order to obtain a better understanding of how the use video feedback in OLPE settings:

1. When using video feedback in face-to-face physical education classes, peer feedback is a common method of providing in-the-moment guidance (Kok et al., 2020; Palao et al., 2015; San et al., 2022). Recently, the use of video feedback with in-the-moment VCS guidance was paired with delayed peer feedback, which was beneficial to middle school-age children learning the snatch technique in an online environment (Souissi et al., 2022). However, these participants do not represent an OLPE environment. Thus, using delayed peer feedback with video feedback in OLPE settings would be beneficial to explore.
2. Examine the effect of the use of video feedback on other learning domains. This study only examined psychomotor performance, which may positively affect cognitive and affective domains, as found in other video feedback research (Kok et al., 2020; Souissi et al., 2022; San et al., 2022).

3. Many video analysis apps are recommended and used by researchers that may be more beneficial than the use of Flip; e.g., OnForm (Estrada-Oliver & Mercado-Gual, 2022), CoachMyVideo (Goad et al., 2019), Video Catch (Koekoek et al., 2018) Move Improve (San et al., 2022). However, many of these video analysis apps have downfalls with their use in OLPE; e.g., cost, only accessible on Apple mobile devices, or no web-passed platform. Regardless, utilizing different video analysis apps with video feedback in OLPE settings should be explored.
4. Investigate other forms of in-the-moment guidance. For instance, providing a list of common errors and a VCS might be beneficial. Providing this list could also help with improved results in the SA group.
5. While this study only had students utilize video feedback for two sessions per skill practiced, this process can still be cumbersome for students. Therefore, it would be advantageous to see how a mixed design of video feedback practice sessions with other practice tasks affects motor performance. For example, teachers might always provide a VCS for in-the-moment guidance but could pair it with various self-assessing tasks, such as having students take screenshots and highlighting or narrating errors and correct form.
6. Apply video feedback to multiple content areas and grade ranges. Doing so would allow the results to be more generalizable and to find content and student-specific strategies. In particular, replicating the current study

in secondary OLPE settings would be beneficial to accomplishing this goal.

7. Look at how the effects of the adoption of using video feedback throughout a whole year. Learning how to utilize video feedback online effectively was a challenge for many participants in this study. Ideally, this technique would be adopted with multiple content areas through a whole semester or year of instruction, allowing students to become more efficient with each subsequent use. The repeated use of video feedback throughout multiple content areas in an OLPE curriculum should be investigated to better understand its long-term benefits and pitfalls.

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Appendix A:

Spin Putt Self-Assessment Checklist

Directions: After each round of throws select one throw to self-assess. Record which throws you are self-assessing for each round and then mark (✓or X) if you are completing each of the stages

Record your self-assessment trials 1-5 in round 1 (R1), trials 6-10 in round 2 (R2), and trials 11-15 in Round 3 (R3)

Which throw are you assessing in each round; put 1 if you are assessing your first throw put 3 if you are assessing your third throw in each round:

R1________ R2________ R3________

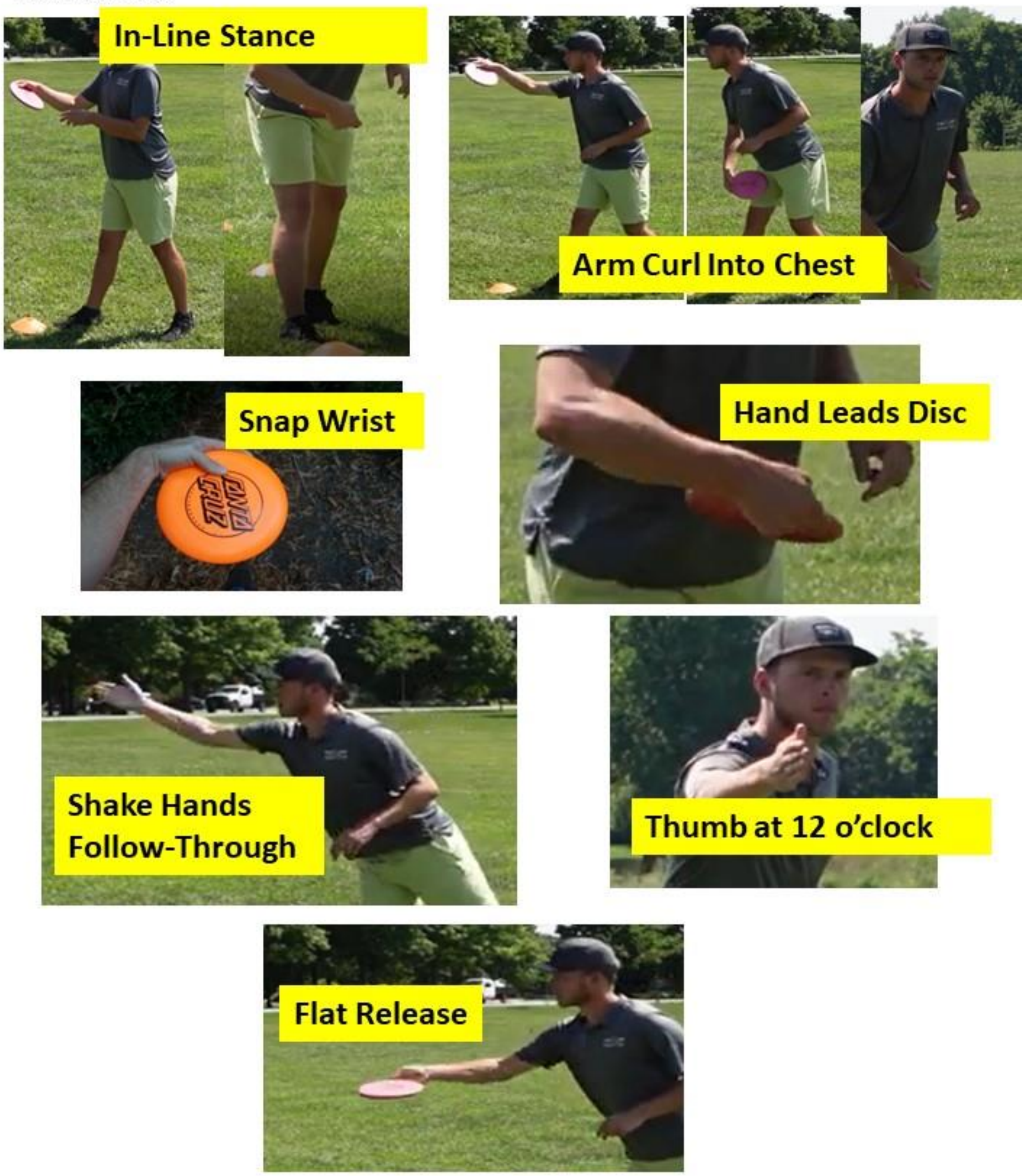
Step	**Illustration**	**Score**		
		R1	**R2**	**R3**
In-line Stance • Throwing hand's foot is forward, pointed to target • Back foot behind front almost or directly in line with front foot				
Arm Curl into chest • Weight shifts back and arm curls into chest and then out				
Wrist Snap • Hand leads disc as arms reaches out keeping disc cocked • Wrist snaps on release and disc is flicked to basket/target				
Shake Hands • Arm reaches out on follow through • Thumb in 12 o'clock position. • Make sure your palm is not facing the target				
Flat Release • As your release the disc you should have a flat release				

Appendix B:

Spin Putt Visual Cue Chart

Spin Putt Cue Chart

DIRECTIONS: (1) Watch the recorded video of the previous 5 trials and compare the spin putt technique with that of the expert model as often as desired **(2)** Correct the detected errors when performing the next five throws.



Appendix C:

Backhand Throw Self-Assessment Checklist

Directions: After each round of throws select one throw to self-assess. Record which throws you are self-assessing for each round and then mark (✓or X) if you are completing each of the stages

Record your self-assessment trials 1-5 in round 1 (R1), trials 7-10 in round 2 (R2), and trials 11-15 in Round 3 (R3)

Which throw are you assessing in each round; put 1 if you are assessing your first throw put 3 if you are assessing your third throw in each round:

R1________ R2________ R3________

Step	**Illustration**	**Score**		
		R1	**R2**	**R3**
Point Shoulder • Throwing shoulder should be pointed at target before reaching back.				
Reach Back • Reach back <u>just</u> below shoulder height				
Elbow Leads • Drive elbow forward close to your body • Hips should rotate to uncoil the back				
Wrist Snap • Wrist snaps on release and disc is flicked to basket/target				
Finish level • Follow-through around the body • Keep throwing arm level as you finish				

Appendix D:

Backhand Throw Visual Cue Chart

Backhand Throw Cue Chart

DIRECTIONS: (1) Watch the recorded video of the previous 5 trials and compare the backhand throw technique with that of the expert model as often as desired **(2)** Correct the detected errors when performing the next five throws.

Appendix E

Exit Survey

1. Did you practice any disc golf skills in addition to what was required?
    a. If yes, describe how many throws of each skill you practiced.
        i. Backhand_________# of throws
        ii. Spin Putt _________# of throws
        iii. Describe any additional practice you did: (Open ended)
2. Did you utilize video self-assessment in addition to the required four times?
    a. If yes
        i. How many times?
        ii. How many throws would you say you video taped yourself to self-analyze?
        iii. Which skills did you use video self-assessment on? (Spin putt, Backhand, or both)
3. What device did you mostly use to watch your videos on?
    a. Smartphone
    b. Tablet
    c. Laptop
    d. Other

Appendix F:

Spin Putt Rubric

Spin Putt Rubric

Observer: ____________ Student ID Number: _____ Session (Pre/Post/Ret): ______

Directions: Evaluate each trial of the spin putt using the scale below. If the element is present put a 1 in that box and a 0 if it is not present. If you cannot assess the element because of poor video quality or camera angle then place an X in the box. The max score anyone can get for 5 trials is 25 points.

0 = Element not present
1 = Element is present
X = Unable to assess

Step	**Score**					**TOTAL**
	T1	**T2**	**T3**	**T4**	**T5**	
In-line Stance and Point Disc • Throwing hand's foot is forward, pointed to target • Back foot behind front almost or directly in line with the front foot • Before curling the disc into the chest, point the throwing arm towards the target						
Arm Curl into chest and weight shift • Weight shifts back and arm curls into the chest/waist and then weight shifted forward from back foot to front foot; rocking motion forward • Not popping straight up • The reach in is not past their back hip						
Wrist Snap • Hand leads disc as arms reaches out keeping disc cocked • Wrist snaps on release and disc is flicked to basket/target						
Shake Hands • Arm reaches out on follow through (not all wrist) • Reach is below the head but above chest • Thumb in 12 o'clock position. • Make sure your palm is not facing the target						
Flat Release with counterbalance • The disc should have a flat/straight release • Keep back leg behind hip (may kick up to help counterbalance)						

TOTAL___________

Appendix G:

Backhand Throw Rubric

Backhand Throw Rubric

Observer: ____________ Student ID: ____________ Session (Pre/Post/Ret): _______

Directions: Evaluate each trial of the Backhand Throw using the scale below. If the element is present put a 1 in that box and a 0 if it is not present. If you cannot assess the element because of poor video quality or camera angle then place an X in the box. The max score anyone can get for 5 trials is 50 points.

0 = Element not present
1 = Element is present
X = Unable to assess

Step	**Score**					**TOTAL**
	T1	**T2**	**T3**	**T4**	**T5**	
Point Shoulder on Brace • Throwing shoulder should be pointed at target before reaching back. • Feet at least wider than shoulder width on brace						
Straight Arm Reach Back • Arm Reach's across their chest; past back hip • Arm should be *mostly* straight • Just below or at *shoulder height* • Their back should be pointed toward the target when they reach back fully						
Elbow Leads with Hip Rotation • Drive elbow forward close to your body • Should almost make 90-degree angle • Hips should rotate to uncoil the back • Weight shifts from back foot to front foot						
Straight whip-like motion • Throwing motion of disc moves in *relatively* straight line • Wrist snaps on release and disc is flicked to basket/target						
Finish level • Release of disc is with a straight arm and shoulder height • Follow-through around the body; • Shoulders will square to target • Back leg will rotate forward • Follow-through around the body						

TOTAL____________

Appendix H:

Spin Putt Self-Assessment Rubric

Observer: ___________ Student ID Number: _____ Session: ______

Directions: Evaluate the same trial that the student identifies for each round of self-assessment. Place a checkmark (✓or X) for each criterion that was present for each trial. If a criterion was not present leave it blank. Put the students score next to the corresponding column. Each set of five criteria award one point for each criterion that the students self-assessed that aligns with the evaluator. Add up the total at the bottom. The max a student can get would be 15 points.

Step	**Trial #___**	**Students Score**	**Trial #___**	**Students Score**	**Trial #___**	**Students Score**	**TOTAL**
In-line Stance • Throwing hand's foot is forward, pointed to target • Back foot behind front almost or directly in line with front foot							
Arm Curl into chest • Weight shifts back and arm curls into chest and then out							
Wrist Snap • Hand leads disc as arms reaches out keeping disc cocked • Wrist snaps on release and disc is flicked to basket/target							
Shake Hands • Arm reaches out on follow through • Thumb in 12 o'clock position. • Make sure your palm is not facing the target							
Flat Release • As your release the disc you should have a flat release							

TOTAL___________

Appendix I:

Backhand Throw Self-Assessment Rubric

Observer: ____________ Student ID Number: _____ Session: ______

Directions: Evaluate the same trial that the student identifies for each round of self-assessment. Place a checkmark (✓or X) for each criterion that were present for each trial. If a criterion was not present leave it blank. Put the student's score next to the corresponding column. Each set of five criteria award one point for each criterion that the students self-assessed that aligns with the evaluator. Add up the total at the bottom. The max a student can get would be 15 points.

Step	**Trial #___**	**Students Score**	**Trial #___**	**Students Score**	**Trial #___**	**Students Score**	**TOTAL**
Point Shoulder • Non-throwing shoulder should be pointed at target before reaching back.							
Reach Back • Reach back just below shoulder height							
Elbow Leads • Drive elbow forward close to your body • Hips should rotate to uncoil the back							
Wrist Snap • Wrist snaps on release and disc is flicked to basket/target							
Finish level • Follow-through around the body							

TOTAL____________

Appendix J:

Demographic Survey

1. Age:____
2. Gender:
    a. Male
    b. Female
    c. Preferer not to answer
3. Race
    a. African American
    b. Latino or Hispanic
    c. Caucasian
    d. Asian
    e. Native American
    f. Native Hawaiian or Pacific Islander
    g. Bi- or multi-Racial
    h. Prefer not to say
4. What is your Major? Include any Concentration or degree emphasis:_______________
5. What are your disc golf experiences? (Check all that apply)
    a. I have not played disc golf outside of PE
    b. I have played on a disc golf team in middle school, high school, or college,
    c. I have played disc golf with my friends or family for fun
    d. I have a family member who plays on a disc golf team (competitive or recreational)
    e. I have played disc golf in PE
6. In the last year, how many times have you played at least one round of disc golf:____
7. How interested are you in learning disc golf?*
8. Self-Assess each of the following disc golf skills**
    a. Spin Putt
    b. Backhand Throw

*Participants rate their answer on a numerical slider scale from 0-100 from not interested at all to extremely interested

**Participants rate their answer for each skill on a numerical slider scale from 0-100 from not accurate at all to extremely accurate

Appendix K:

Extended Literature Review

History and Policies of K-12 Online Physical Education

Florida Virtual School (FLVS) started in 1997 and added its first OLPE class focused on personal fitness in 1999 (J.A. Jackson, 2000). A doctoral student from Florida State University developed the curriculum and piloted the first offering of the course with 38 students. By 2004, there were 6,314 students enrolled in OLPE courses at FLVS (Ware, 2005). While OLPE at FLVS was up and running during this time, widespread recognition of this new trend was not known until 2006. That year, The National Association for Sport and Physical Education (NASPE) published the *2006 Shape of the Nation Report*, which found that 12 states allowed physical education credits to be earned online. The subsequent reports showed more states officially allowing credits in physical education to be earned online; by 2010, 22 states offered OLPE for credit; by 2012, 30 states offered it; and by 2016, 31 states offered OLPE for credit (NASPE, 2010; 2012, Society of Health and Physical Educators [SHAPE] America, 2016[1]). Unfortunately, within each report, only about half of the states require teachers to be certified in physical education to teach OLPE. However, this trend could be changing; in 2016, 80% (25 of the 31) of the states now have policies requiring OLPE to be taught by a certified teacher in physical education.

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[1] In 2013, NASPE was replaced by SHAPE America

Before the *2006 Shape of the Nation Report*, awareness of K-12 OLPE only existed in news articles praising or criticizing this new learning trend (e.g., Dolezalek, 2003). With the popularity of K-12 OLPE on the rise, and as a response to NASPE's *2006 Shape of the Nation Report*, in 2007, NASPE published the *Initial Guidelines for OLPE*. This document addressed many of the pros and cons of K-12 OLPE that scholars debated at the time (Buschner, 2006; Wiseman et al., 2006) and provided a checklist for stakeholders to use to evaluate OLPE programs. NASPE also stated that due to the lack of current research, K-12 OLPE should only be delivered to high school students and utilize the hybrid model, which combines face-to-face (F2F) instruction and virtual learning days. While these guidelines were intended to be *initial*, they were not updated until 2018 (SHAPE America). In this guidance document, SHAPE America maintained that OLPE was not suited for elementary students but added that not just hybrid but fully OLPE courses were a viable alternative to F2F instruction. While the initial guidance document (NASPE, 2007) appeared indifferent about online learning by stating, "OLPE is neither inherently good nor bad" (p. 1), the updated document was definitive in its stance on what role OLPE should play. First, it identified that OLPE should never be used to replace F2F teachers and should not be used as a way for credit recovery for students who fail F2F physical education.

Additionally, the updated guidance document was clear that OLPE was only viable if it had a standards-based curriculum, followed appropriate practices, and was instructed by a certified teacher in physical education. In order to help aid teachers and administrators, the updated guidance provided specific examples of appropriate and inappropriate practices and practical recommendations for each guideline—something that Harris and Metzler (2019) noted was missing from the initial guidance. Additionally, this document provided a list of concrete ways each of the *National Standards for K-12 Physical Education* (SHAPE America, 2014) could be addressed in OLPE as well as providing a list of digital tools and exemplar lessons.

Besides SHAPE America, several other national organizations have established standards and guidelines for online learning and teaching that have impacted OLPE. These include publications from Southern Regional Education Board (SREB, 2006), National Education Association (NEA, 2006), International Association for K-12 Online Learning (iNACOL, 2011), the International Society for Technology in Education (ISTE, 2008), and Quality Matters (QM, 2010). Adelstein and Barbour (2018) reported that Florida, Ohio, Texas, Michigan, and California have all adopted iNACOL's *National Standards for Quality Online Courses*. Also, FLVS partnered with QM to help create their standards, which FLVS (2020) still uses today to build and evaluate their courses. NASPE's 2007 *Initial Guidelines for OLPE* were molded from SREB's (2006) guidance document. While the impact of these policies on OLPE teachers and courses is unclear, Mohnsen (2012) did recommend iNACOL's standards to be used when designing and teaching an OLPE course.

Other policies and factors may have contributed to the rise of K-12 OLPE before the pandemic. By February 2020, 12 states had policies or guidance allowing schools to use eLearning days (DLC, 2020). These eLearning days—also known as virtual learning days, cyber days, or online learning days—are primarily used to maintain the required amount of instruction that is lost due to weather, natural disasters, or widespread illness. While eLearning days would not affect OLPE teachers, more and more traditional physical education teachers are being asked to teach their content online. Additionally, many states require the completion of any online high school course to graduate (Rice & Skelcher, 2018; Schwirzke et al., 2018). A relatively newer trend is the rise of full-time online schools (Schwirzke et al., 2018). Virtual schools, like FLVS, are designed as a supplement for students to take online courses while still attending F2F classes; full-time online schools, also called cyber schools, are designed for students to take all the courses online. In 2020, these cyber schools only represented 1% of all K-12 students, with no states above 4% of its total enrollment (DLC, 2020). Cyber schools and virtual schools typically deliver their content asynchronously—However, DLC (2020) noted that synchronous/live methods of instruction are starting to become less uncommon.

Best Practices in K-12 Online Physical Education

Besides SHAPE America publishing the *Guidelines for K–12 OLPE* (SHAPE America, 2018), physical education teachers had little practical advice to lean on when they transitioned to virtual instruction—especially since the advice that did exist was meant for students and teachers who chose the online environment. Subsequently, there has been a large volume of practitioner articles published geared toward providing best practices for K-12 OLPE (Beard & Konukman, 2020; Brooks et al., 2020; Cox & Kulinna, 2022; Daum, Goad, Killian, et al., 2021; Goad, Killian, et al., 2021; Killian et al., 2021; Waller & Schempp, 2022).

Most of these new recommendations help provide a clearer picture of how to implement best practices in K-12 OLPE. While most of these recommendations are based on research in other online content areas or higher education, very few of the recommendations are based on research in K-12 OLPE—even though there has been an uptick of new research being published in the field of K-12 OLPE (e.g., Foye, 2022). Reviewing all the new and old recommendations and the implications of the latest research in K-12 OLPE could be beneficial. With all this in mind, this section will synthesize best practices in K-12 OLPE.

This section is organized around the four best practice categories in SHAPE America's *Guidelines for K–12 OLPE* (SHAPE America, 2018). The four categories include curriculum, learning environment and instructional strategies, student prerequisites, and assessment. This format is meant to help organize and guide the implementation of each recommendation. This section will utilize the most recent practitioner articles, as well as additional advice that is geared towards K-12 OLPE (Goad et al., 2019; Jenny et al., 2020; Mohnsen, 2012; Ransdell et al., 2008; SHAPE America, 2018) to synthesize and understand what practitioners recommend as best practices for K-12 OLPE. Unless noted, all practitioner recommendations were intended for implementation in K-12 OLPE. Additionally, when appropriate, research on K-12 OLPE will be referenced to help support best practice recommendations. Table 2-1 includes an overview of the number of best practices made by SHAPE America (2018) and the number of best practices presented in this section.

Table 2-6

Number of Appropriate Practices in K-12 OLPE

Component	SHAPE America (2018)	Updated # of Best Practices
Curriculum	2	3
Learning Environment and Instructional Strategies	6	10
Student prerequisites	2	2

Assessment	2	4

Curriculum

SHAPE America (2018) recommended two appropriate practices related to the curriculum, and one new recommendation will be presented (see Table 2-2). SHAPE America's (2018) first recommendation is that the curriculum should be based on the national physical education standards. This recommendation is supported overwhelmingly by other practitioners and research (Buschner, 2006; Crosby, 2018; Daum, 2020; Daum & Buschner, 2012; Daum & Woods, 2015; Daum, Goad, Killian, et al., 2021; Jenny et al., 2020; Mohnsen, 2012; Ransdell et al., 2008; Waller & Schempp, 2022). These recommendations include addressing state physical education standards and national technology standards (i.e., ISTE). Overall it is considered best practice if programs are based on physical education standards.

Table 7-2

Overview of Curriculum Best Practices in K-12 OLPE

Recommendation
Based on physical education national and state standards
Include a student orientation module
The curriculum is assessed and revised on a regular schedule

The second suggestion made by SHAPE America (2018) is curriculum be assessed and revised on a regular schedule. To this end, SHAPE America recommended reviewing courses every two to three years and basing changes on course satisfaction from completers and non-completers. Other practitioners and research support this recommendation (Crosby, 2018; Daum, Goad, Mosier, et al., 2021; Jenny et al., 2020; Mohnsen, 2012). Crosby (2018) indicated that OLPE course information and design elements could be outdated quickly, which learners equate to content being old and irrelevant to them. Daum, Goad, Mosier, et al. (2021) recommended that the revision process follow Florida Virtual School's (FLVS) lead, which involves an external reviewer (i.e., Quality Matters) collecting data every year and curriculum revisions made every three years by an OLPE expert. Additionally, Crosby (2018) recommended that evaluation pieces should go at the end of each unit instead of waiting till the end of the course. This evaluation would allow students to give more accurate and specific feedback that teachers can use immediately. When making more extensive course assessments and revisions, it is recommended to use rubrics, standards, and guidelines for online instruction to evaluate programs (Daum, Goad, Mosier, et al., 2021; Jenny et al., 2020; Mohnsen, 2012). To this end, SHAPE America's (2018) guidelines can be used for OLPE programs—however, it does not appear that any programs utilize this document to assess themselves. The most used and recommended evaluation tools come from the Online Learning Consortium, International Association for K-12 Learning (iNACOL), and Quality Matters—which are even recommended to use in SHAPE America's (2018) guidance document. While these evaluation tools may not be content-specific, they are supported by research and are continually updated. While many of these evaluation tools offer free resources, all require a fee to gain full access to the tool—which FLVS is willing to pay for (Mossier & Lynn, 2012). Quality Matters appears to be the most recommended and used evaluation tool for OLPE (Daum, Goad, Mosier, et al., 2021;

FLVS, 2020; Jenny et al., 2020; Mossier & Lynn, 2012), while iNACOL appears to be the second most (Jenny et al., 2020; Mohnsen, 2012).

The last best practice recommendation related to curriculum, which is not included in SHAPE America's (2018) guidelines, is including a student orientation module (Beard & Konukman, 2020; Crosby, 2018; Jenny et al., 2020; Killian et al., 2021; Mohnsen, 2012). This orientation module should be included before any coursework to help orient the learner for what is to be expected. Some items that are recommended to be covered in this module include a video overview explaining major assignments (Jenny et al., 2020); video tutorials on how to use specific apps (Killian et al., 2021); and tutorials that teach students how to use e-mail and the learning management systems notifications (Beard & Konukman, 2020). This recommendation comes with the importance of setting clear learning expectations, which many practitioners recommend (Beard & Konukman, 2020; Cox & Kulinna, 2022). This recommendation of including a student orientation module in the curriculum helps set up a thriving learning environment, which will be explored in the next section.

Learning Environment and Instructional Strategies

SHAPE America (2018) recommended six appropriate practices related to the learning environment and instruction strategies, and four additional strategies will be presented (see Table 2-3). These 10 recommended best practices or organized into six groups; these include (a) prepping the online environment, (b) promoting parent involvement, (c) setting and maintaining expectations, (d) having a clear communication plan, (e) promoting synchronous interaction, and (f) utilize a variety of instructional methods.

Table 2-8

Overview of Environment and Instructional Strategies Best Practices in K-12 OLPE

Recommendation
Have a plan for preparing the online environment
Balance the amount of screen time
Promote parent involvement
If possible, supplement asynchronous with synchronous instruction
Expectations—setting and maintaining them
Have a communication plan and policy in place
Give prompt and quality feedback
Having a plan for social interaction
Utilize a variety of instructional methods
Providing individualized learning activities

Prepping the Online Environment. The first best practice that K-12 OLPE teachers should consider is having a plan to prepare their online learning environment (Beard & Konukman, 2020; Brooks et al., 2020; Cox & Kulinna, 2022; Killian et al., 2021; Waller & Schempp, 2022). Teachers should think about what the online environment now allows them to do that they could not do in their regular gymnasium. To do this, Waller and Schempp (2022) suggested that OLPE teachers "think through the process of a student entering your online gymnasium… step into the student's shoes" (p. 45). Additionally, Killian et al. (2021) suggested that this environment allows for new topics that cannot be traditionally covered. Cox and Kulinna (2022) suggested that OLPE teachers "try new things that you might not attempt in a face-to-face setting" (p. 93). For example, teachers can allow students to engage in service-learning activities, such as teaching motor skills they are learning to a local community center or church group (Beard & Konukman, 2020). Waller and Schempp (2022) also suggested making a flowchart of how students progress through the *online gymnasium*. This flowchart can be shared with students, but this practice is meant to help teachers understand how students are experiencing content. When teachers review how they have set up this environment for their students, it is also essential to ensure that learning activities are safe and not too complex (Brooks et al., 2020).

Using an online gymnasium also means that educators must balance the screen time students get. If there are too many learning tools or they are not easy to use, then students may retreat in the learning process (Cox & Kulinna, 2022). To help address this, many practitioners recommend scheduling physical activity outside (Daum, Goad, Killian, et al., 2021; Jenny et al., 2020; Killian et al., 2021; SHAPE America, 2018). Other suggestions include having students physically active inside their homes (e.g., walking up and down stairs) and evaluating local play spaces (Killian et al., 2021, SHAPE America, 2018). Other suggestions for preparing a positive learning environment include offering office hours (Killian et al., 2021) and including a place to ask the professor discussion board where students can ask questions they have at any time (Jenny et al., 2020). While students might e-mail their questions to the instructor, creating an online discussion board that all students can see and respond to might allow other students to help answer common questions about the class (Killian et al., 2021).

Promote Parent Involvement. While setting up the online environment, many practitioners recommend that K-12 OLPE teachers find ways to promote parent involvement (Daum, Goad, Killian, et al., 2021; Jenny et al., 2020; SHAPE America, 2018). This involvement could involve having an assignment where students interview parents' physical activity preferences and patterns (Jenny et al., 2020; SHAPE America, 2018) or designing homework to include an option for family physical activity (Daum, Goad, Killian, et al., 2021). In addition, parents can help supplement the valuable in-the-moment feedback that happens in F2F gymnasiums by giving instructions to parents. For example, "Students, during this next activity you will be practicing your static balance. Parents and guardians, look for your child to have a slight bend in their knees and arms out" (Daum, Goad, Killian, et al., 2021, p. 9). It is important to remember that parents play an essential role in their children's education, especially when enrolling in online courses. Parent involvement in some Secondary OLPE courses has led to healthier and more active home life (Williams, 2013).

Set and Maintain Expectations. Another best practice related to the learning environment is having and maintaining clear expectations (Beard & Konukman, 2020; Cox & Kulinna, 2022). Courses should have an overview of what will be covered and an introduction to what is expected from the students (Crosby, 2018). As mentioned earlier, this could be done by including an introduction module within the curriculum. However, before this module starts, students should be greeted with a welcome e-mail and message in the course's learning management system as soon as they enter the online classroom (Jenny et al., 2020). These messages would help set the initial expectations that students should have moving forward. While there are many items to include in these initial expectations, practitioners suggested that they should include appropriate communication with peers and the teachers, online etiquette for any synchronous lessons (i.e., what to wear or if the camera should be on or not), how to contact the teacher, and what students can expect from the instructor (SHAPE America, 2018; Waller & Schempp, 2022). Knowing what students can expect from the teacher (e.g., how quickly they will get feedback on assignments) can help keep the teacher accountable for maintaining a positive learning environment.

Any expectations can be rendered meaningless if teachers are not continually reinforcing them. While many K-12 OLPE programs provide their students with a pacing guide or an overview of assignments sheet (Harris & Metzsler, 2019; Moisser & Lynn, 2012), OLPE teachers can help maintain expectations by communicating a weekly checklist or list of goals to students (Beard & Konukman, 2020; Waller & Schempp, 2022). Including module check-ins or exit slips may be valuable to help maintain or adjust expectations (Daum, Goad, Killian, et al., 2021; Killian et al., 2021). These check-ins would be an informal survey (ungraded) that allows students to let the teacher know if the expectations are too hard or too easy and make any adjustments. Additionally, these check-ins could let teachers know what resources or concerns students have. Including this process allows the effective K-12 OLPE teacher to not wait until the end of the course to make any changes. Preparing the online environment for students and setting and maintaining clear expectations are worthwhile considerations for the K-12 OLPE teacher to consider.

Have a Clear Communication Plan. The next suggested best practice for K-12 OLPE teachers is having a communication plan or policy in place (Brooks et al., 2020; Daum, Goad, Killian, et al., 2021; J.A. Jackson, 2000; Jenny et al., 2020; SHAPE America, 2018; Waller & Schempp, 2022). This plan will help maintain a positive learning environment and help reinforce expectations. This communication plan will most likely include previously suggested practices, e.g., having a welcome e-mail/post and posting a weekly checklist or goals. Florida Virtual School's communication plan requires all teachers to call students within the first week of class and expect teachers to respond to concerns within 24 hours (J. A. Jackson, 2000; Mosier, 2010). Waller and Schempp (2022) recommend that teachers check in weekly with videos to help students have a personal connection with the teacher. To create a personal connection, Waller and Schempp (2022) recommend utilizing Bitmoji (similar to posting a picture of the teacher) or infusing current sports news and events into instructional videos and presentations. This communication plan should also include one-on-one communication with students weekly and parents monthly (Daum, Goad, Killian, et al., 2021; Jenny et al., 2020; SHAPE America, 2018; Waller & Schempp, 2022). Many professionals recommended supplementing weekly check-ins with synchronous methods (SHAPE America, 2018; Waller & Schempp, 2022), such as texting, videoconferencing, making phone calls, and Killian et al. (2021) even recommend making house visits. However, it might be more feasible and just as valuable to visit with groups of students when making F2F visits (J.A. Jackson, 2000). Finding methods for efficient communication is essential for OLPE teachers to utilize. Some OLPE teachers found it most efficient to e-mail struggling students and follow up with a phone call if improvement did not happen (Williams, 2013). Additionally, Brooks et al. (2020) recommended utilizing the learning management system feature to automate student messages to save teachers time. These messages can be set up to inform students when they forget to submit an assignment, have not logged in for a certain amount of days, or remind students that they have an upcoming due date.

The last part of having a communication plan in place is making sure that OLPE teachers plan to give prompt and quality feedback (Beard & Konukman, 2020; Cox & Kulinna, 2022; Crosby, 2018; Waller & Schempp, 2022). This feedback should be given in various contexts (i.e., individual, small groups, public forums) and mediums (i.e., verbal, written, video) and be individualized for each student. To accomplish this, teachers can use quiz software (e.g., Kahoot, Quizzizz, Google Forms) that allows students to immediately receive feedback as well as create banks of common statements that teachers can cut and paste (Beard & Konukman, 2020; Waller & Schempp, 2022). Furthermore, some quiz software allows for differentiated feedback that allows teachers to put a review link or extension activity depending if they got the question right or wrong (Beard & Konukman, 2020). Additionally, some K-12 teachers successfully gave feedback while utilizing synchronous video conferencing (Foye, 2022).

In other content areas, teacher video feedback in online learning is considered more effective than written feedback (Bahula & Kay, 2022). Video feedback can help create meaningful connections between teacher and student in the online environment. Bahula and Kay (2022) advocate that teachers give individualized screencast video feedback on assignments. The most common suggestion for providing feedback in OLPE is utilizing video feedback with self-assessment (Daum, 2020; Goad et al., 2019; Jenny et al., 2020; Killian et al., 2021; Mohnsen, 2012; SHAPE America, 2018). While this suggestion is recommended for students to use offline without the teacher, it could still be used to communicate assignment feedback.

Promote Synchronous Interaction. These communication plan recommendations also involve another suggested best practice; that OLPE teachers should supplement asynchronous with synchronous communication and instruction (Daum, Goad, Killian, et al., 2021; Ransdell et al., 2008; SHAPE America, 2018; Waller & Schempp, 2022; Yu & Ha, 2021). Before the pandemic, this suggestion was only meant to supplement communication. Before the pandemic, some OLPE programs and practitioners recommended using synchronous instruction—however, this was all done F2F at the beginning of the course (Harris & Metzler, 2019; Ransdell et al., 2008). During the initial transition to online learning in 2020, many traditional physical education teachers found success in supplementing their instruction with synchronous content delivery (Centeio et al., 2021).

Additionally, Killian et al. (2021) recommended using online live instruction to help students learn how to use specific digital apps (i.e., Flip) so they are more prepared to use them asynchronously. This strategy could also be applied to teaching students how to assess their fitness independently (Ransdell et al., 2008). Some teachers successfully blended synchronous and asynchronous lessons simultaneously (Foye, 2022). To accomplish this meld of delivery styles, students received a synchronous lesson on Zoom. Then students would practice or be physically active asynchronously, and then students would come back synchronously to debrief. These synchronous methods can be optional (e.g., make your office hours an open Zoom meeting) or required depending on the teacher's school district's policy. Daum (2020) recommended not letting asynchronous discussion boards be the only form of social interaction.

With this in mind, this brings up another best practice that K-12 OLPE teachers need to consider: having a plan for social interaction (Beard & Konukman, 2020; Waller & Schempp, 2022). While synchronous instruction may not be an option for every teacher, there are various ways to intentionally create social engagement and learning opportunities. Most of the following suggestions could be adopted for synchronous or asynchronous methods. Killian et al. (2021) suggested that OLPE teachers have students collaborate with "goal groups" (p. 15) with similar physical activity preferences. Additionally, students can do group projects where they meet with other students using video conferencing software or work on an individual section of a group project (Beard & Konukman, 2020). Another example of a group project is having students create an obstacle course that uses equipment all group members have at their homes (Waller & Schempp, 2022). In addition, SHAPE America (2018) recommended finding meetup groups in their neighborhood to participate in physical activity. Finally, many practitioners recommend including peer feedback in any social interaction plan (Beard & Konukman, 2020; Jenny et al., 2020; SHAPE America, 2018; Waller & Schempp, 2022). While peer feedback groups can reinforce learning, they can also help encourage meaningful peer interaction—especially if used synchronously. One specific example of utilizing synchronous methods is using social media to help students create a story of their physical activity journey (Daum, 2020). Another way to create synchronous social interaction is by having students post online introductions (Jenny et al., 2020; Waller & Schempp, 2022). Besides having students post on a discussion board, students can introduce themselves using video. Another creative way students can introduce themselves is by creating a custom sports training card with their name, picture, personal interest, and favorite physical activity (Waller & Schempp, 2022). It may be necessary for teachers to have a variety of ways to promote social interaction.

Utilize a Variety of Instructional Methods. The last suggested best practice for this subsection is that K-12 OLPE teachers should utilize a variety of instructional methods (Beard & Konukman, 2020; Crosby, 2018; Jenny et al., 2020; SHAPE America, 2018; Waller & Schempp, 2022). These include utilizing lectures, discussions, videos, guest speakers (i.e., student or teacher interview an expert), hands-on practice opportunities, audio recordings, and readings. Additionally, these methods can include snippets from TV shows, recorded interviews, social media, YouTube clips, music, news articles, podcast segments, and allowing time for reflection. Waller and Schempp (2022) recommend limiting the lecture format and not utilizing any method longer than 10 minutes.

Possible due to the visual nature of physical education, the most recommended mode of instruction is utilizing video (Daum, Goad, Killian, et al.,2021; Mohnsen, 2012; SHAPE America, 2018; Waller & Schempp, 2022). Daum, Goad, Killian, et al. (2021) recommended keeping the video less than five minutes, having quality video production (sound, camera angle, video resolution), and covering only two concepts or one for younger students. Similarly, Waller and Schempp (2022) recommended two to four-minute demonstration videos followed immediately with an application task. During the pandemic, many teachers found that students would only watch videos that were five minutes or less (Foye & Grenier, 2021; Centeio et al., 2021). Other suggestions for using video instruction consist of: including videos that have the teacher instructing, just as they would be doing in a F2F class—standing and using gestures; looking into the camera; practicing what teachers are going to present before recording; supplementing teacher-made videos with YouTube (Daum, Goad, Killian, et al., 2021 recommended using Viewpure.com to take off adds); using interactive video clips that require participants to respond to what they are watching (Daum, Goad, Killian, et al., 2021; Ransdell et al., 2008; Waller & Schempp, 2022). Daum, Goad, Killian, et al. (2021) recommended the tool EdPuzzle to get students to interact with the video. Using any method will require teachers to consider what is best for their students.

With this in mind, many practitioners recommended providing individualized learning activities (Beard & Konukman, 2020; Jenny et al., 2020; Killian et al., 2021; Mohnsen, 2012; SHAPE America, 2018; Waller & Schempp, 2022). This individualization can be achieved by letting students choose a custom learning path helps promote them being independent thinkers and autonomous learners. Beard & Konukman (2020) give the example of letting students watch a Ted Talk or read an article that covers the same content; students learn the same material but pick which learning path works best for them. This individualization could also mean letting students work at the best pace for them (Mosier, 2010). While teachers can let students choose which pace and method they want to learn, many practitioners advocate for letting students choose how they participate in physical activity (Jenny et al., 2020; Killian et al., 2021; SHAPE America, 2018; Waller & Schempp, 2022). However, some students can get lost without any structure and thus may need a physical activity option grid that addresses each health-related fitness component (Jenny et al., 2020; SHAPE America, 2018). Similarly, teachers can provide a list of appropriate websites (for whatever assignment) so students do not get stuck in the weeds (Beard & Konukman, 2020). This suggestion helps students not waste their time but still gives them some control over their learning. Other examples of providing a custom learning path include: creating a fitness plan to address student-made fitness goals (Beard & Konukman, 2020; Mohnsen, 2012; SHAPE America, 2018; Waller & Schempp, 2022); letting students create their own game or practice plan that focuses on specific skill or concept (Mohnsen, 2012; Waller & Schempp, 2022); and including assignments that allow for reflection (Crosby, 2018; Beard & Konukman, 2020; Killian et al., 2021; SHAPE America 2018; Waller & Schempp, 2022). Many practitioners recommend that students keep a training log that students reflect on their feelings toward physical activity (Daum, 2020; Jenny et al., 2020; SHAPE America, 2018). In a similar fashion, students can keep a photo or video journal of physical activity (Jenny et al., 2020; Killian et al., 2021; Waller & Schempp, 2022). These examples can help K-12 OLPE teachers apply various instructional methods that promote individualized learning and instruction.

Student Prerequisites

SHAPE America (2018) recommended two appropriate practices related to student prerequisites (see Table 2-4). The first recommendation is that “OLPE only be at the secondary level to students who have demonstrated competency in prior grade-level outcomes, especially in the psychomotor domain” (SHAPE America, 2018, p.8). While this might be considered best practice, this has not stopped elementary OLPE programs from existing (e.g., Carone Learning, 2022; CMCSS, n.d.). Possible to address this trend, recently, there has been an increase in practical advice for elementary OLPE (Daum, Goad, Killian, et al., 2021).

Table 2-9

Overview of Student Prerequisites Best Practices in K-12 OLPE

Recommendation
1. Set criteria for who is eligible for K-12 OLPE
2. Conduct a self-assessment/readiness questionnaire

The second suggestion made by SHAPE America (2018) is to ensure that students have the perquisites skills to succeed in OLPE. Teachers may not be able to set the criteria for enrollment (i.e., GPA), but they can help identify students who may not be ready for online instruction. To this end, SHAPE America (2018) and Jenny et al. (2020) recommend using any of the following readiness assessments: Online Course Readiness Quiz (UoArk); Online Readiness Self-Assessment (Stanislaus State); Online Learning Readiness Questionnaire (PSU). Loyola University New Orleans Online Learning Readiness. While these questionnaires are geared toward university students, they could be adopted for K-12 OLPE to help identify struggling students. Teachers may need to provide more assistance to students who are enrolled in their first online course, are fully online, or receive free or reduced lunch (Mosier, 2010)

Predicting student success can help teachers identify what students may need more of their attention (Ransdell et al., 2008). Goad, Jones, et al. (2021) developed a screening tool for university OLPE students to help identify potential non-completers. While this tool would need to be adopted for K-12 OLPE students, it should also include an inventory of the required technology devices and the quality of internet access (Crosby, 2018). Additionally, teachers may benefit from having students, and parents sign a physical activity readiness questionnaire (Jenny et al., 2020). Like F2F teachers OLPE have limited input on who enrolls in their classes. However, having a plan to identify students who do not have the perquisites skills and may struggle in online learning should be used.

Assessment

Practitioners recommend three primary assessment best practices (see Table 2-5). First, and similar to having a variety of instructional practices, K-12 OLPE teachers should utilize diverse assessment practices (Crosby, 2018; Daum, 2020; SHAPE America, 2018; Waller & Schempp, 2022). These assessment practices should include various formative and summative assessments throughout the curriculum to address each state or national standard (SHAPE America, 2018). Teachers will have to utilize a variety of technology tools to help facilitate their assessment practices, such as discussion boards, video, video conferencing, web authoring software (e.g., Google Pages), presentation software (e.g., PowerPoint), Wiki, concept mapping software (e.g., MindMeister), drawing software (e.g., Sketchup and Kid Pix), online quiz software, spreadsheets. Additionally, assessments should vary weekly, and students should not do the same assignment every week (Waller & Schempp, 2022).

Table 2-10

Overview of Assessment Best Practices in K-12 OLPE

Recommendation
1. Utilize a variety of assessment methods that target all state and national physical education standards

2. Utilize images and videos of motor skills for the teacher to assess and give feedback on
3. Verify students' physical activity

The second suggested best practice is utilizing video and images to assess psychomotor skills. While teaching psychomotor skills online may be difficult, it is still essential to assess them. The most common suggestion for accomplishing this is having students submit still images or videos of motor skills for the teacher to assess and give feedback (Mohnsen, 2012; Jenny et al., 2020; SHAPE America, 2018). These videos can also be utilized for peer and self-assessment, which many practitioners recommended using video-analysis apps (Daum, 2020; Goad et al., 2019; Jenny et al., 2020; Killian et al., 2021; SHAPE America, 2018). Additionally, SHAPE America (2018) provided the following advice to help teachers be creative with their psychomotor assessment practices: "Demonstrates does not necessarily mean physically; depending on the specific learning objectives, students can demonstrate the performance of a skill, comprehension of a topic on a written assessment, or enjoyment of physical activity through a discussion with peers" (p. 10).

The last suggested best practice is that K-12 OLPE teachers should verify students' physical activity. Many recommended utilizing wearable devices that track fitness and activity (Daum, 2020; Goad et al., 2019; Jenny et al., 2020; Killian et al., 2021; Mohnsen, 2012; Ransdell et al., 2008; SHAPE America, 2018). This recommendation was given because concerns about self-reported data, like activity logs, were seen as unreliable—even if the log was verified with a parent's signature. (e.g., Ransdell et al., 2008). However, Killian et al. (2021) recommended not focusing much of a student's grade or time on surveillance methods (e.g., heart rate monitors) and fitness logs. It is not that teachers should not use them but instead encourage students to use the data to make goals and changes to their lifestyles.

Overall this section presented a variety of best practices that K-12 OLPE teachers can consider using. These best practices were not meant to be an exhaustive list but the ones most referenced in the literature. Any teacher will have to adapt to their unique teaching context.