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ASSESSMENT

Effect of Pairing by Ability on Performance, Physical Activity, and Time-on-Task During Reciprocal Peer Teaching in Swimming

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Abstract

This study investigated the effect of pairing by ability in peer teaching on swimming performance, physical activity, and time-on-task. During a 4-lesson unit in front crawl swimming, 113 (36 female, 77 male) university students in Kinesiology were randomized over gender-homogeneous same-ability (low with low and high with high) and mixed-ability (high with low) dyads. Swimming performance was assessed before and after the four lessons. Physical activity and time-on-task was coded based on video recordings of all lessons through the System of Observing Fitness Instruction Time (SOFIT). Although not significant, results showed higher swimming improvement in mixed-ability dyads, especially for low-ability swimmers. Overall, students spent 37% of lesson time in moderate-to-vigorous physical activity and were on task 82% of the time. Further research should focus on the effect of pairing by ability during longer units of instruction and investigate peers' verbal interactions.

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The need to address a wide variety of learning outcomes in physical education (PE) requires the employment of different types of instruction (Gurvitch & Metzler, 2013). According to Metzler (2011), peer teaching is one of eight instructional models used in PE together with direct instruction, Personalized System of Instruction, cooperative learning, Sport Education, inquiry teaching, Tactical Games, and Teaching Personal and Social Responsibility (TPSR). An instructional model provides teachers with a blueprint on what teaching and learning will look like and what outcomes to expect. While models such as peer teaching could emphasize psychomotor learning more, others such as TPSR focus more on social outcomes. Each instructional model has clear benchmarks that serve as non-negotiable features of the model, such as the element of working in pairs as tutor and tutee during peer teaching (Metzler, 2011).

In PE, a large body of literature demonstrates the effectiveness of peer teaching to influence a wide range of learning outcomes (for reviews, see Byra, 2006; Lafont, Rivière, Darnis, & Legrain, 2016; Ward & Lee, 2005). Research outcomes in PE are consistent with those from general education (Walberg, 1990), and regardless of study methodology, they show significant psychomotor learning in students of varying age levels and abilities (Ward & Lee, 2005). The reciprocal style of teaching is a specific form of peer teaching in which learners are paired and exchange roles of doer (i.e., tutee) and helper (i.e., tutor) during instruction (Mosston & Ashworth, 2008). While the doer is performing the task, the helper is observing and providing performance-related feedback, often supported by task cards (Iserbyt & Byra, 2013b). Task cards are instructional tools that often include doer and helper names, directions for behavior, and space for recording student performance (Byra, 2004). In addition, task cards can also focus on the psychomotor skill that needs to be learned, combining a picture of the skill with written instructions about how to perform the skill (Iserbyt & Byra, 2013b). While task cards to record the partner's performance are helpful to hold students accountable for learning (Dyson, 2002), task cards presenting the skill through pictures and written instructions facilitate performance and the provision of feedback (Iserbyt, Elen, & Behets, 2010).

Despite well-established evidence for the effectiveness of using peers to effect student learning, some questions regarding how best

to group students remain unanswered. Ward and Lee (2005) and Lafont et al. (2016) mention the mediating effect of pairing by ability on learning outcomes. In gymnastics, a better learning effect and retention was found in mixed-ability compared to same-ability dyads for learning a somersault (d'Arripe-Longueville, Fleurance, & Winnykamen, 1995). In high school, breaststroke swimming males benefited more from highly skilled tutors, whereas females benefited from high- and average-skilled tutors (d'Arripe-Longueville, Gernigon, & Huet, 2002a). In both studies, tutors were not trained prior to the peer-teaching episode. Legrain, d'Arripe-Longueville, and Gernigon (2003) described the training of university peer tutors to identify common errors that novices would make and how to formulate appropriate advice in a French boxing setting. Compared with untrained tutors, trained tutors exhibited more coaching behavior and demonstrated greater learning.

Although it is generally accepted that tutor training leads to improved outcomes (Ensergueix & Lafont, 2011), research has shown that peer teaching is also particularly effective when the learning environment is deliberately organized and peers have access to instructional materials. Acknowledging that merely putting students together is not sufficient to provoke learning (Lafont et al., 2016), Dyson (2002) argued that clearly defining roles of doer and helper is an element that improves learning through enhanced interaction between peers. Together with instructions on role switching, defining roles as doer and helper and having access to instructional tools such as task cards or tablet computers have been shown to improve performance in peer teaching regardless of purposeful pairing by skill level or prior tutor training (Iserbyt & Byra, 2013a; Iserbyt et al., 2010). Without some form of structure in the learning environment and instructional support, it is generally accepted that mixed-ability dyads, where students of different skill levels work together, demonstrate higher learning because of the expert–novice relationship in those dyads. High-ability learners learn from explaining the content, while low-ability learners learn from the proximity of quality demonstrations and feedback (King, 1998; Wilkinson & Fung, 2002).

In the United States, the Institute of Medicine (IOM, 2013) stated that PE lessons should engage students in moderate-to-vigorous physical activity (MVPA) at least 50% of the time. This benchmark

is often not reached in PE, especially through the direct instruction model (Roberts & Fairclough, 2011). Harvey, Smith, Fairclough, Savory, and Kerr (2015) found that a games-based approach achieved higher PA levels compared with direct instruction. With an increased emphasis on models-based instruction, research investigating the physical activity (PA) levels in those models is warranted. To date, literature investigating PA levels during peer teaching is nonexistent. One could argue that average PA will be lower through peer teaching compared with a direct instruction approach because learners divide the available time between practicing (i.e., higher level of PA) and helping (i.e., lower level of PA). Using the variable of trials performed, studies have shown that peer learning can increase students' total amount of trials and the percentage of correct trials (Crouch, Ward, & Patrick, 1997; Ward, 1993). However, an increase in the amount of trials does not necessarily mean performance will increase. Ward, Smith, Makasci, and Crouch (1998) found that although elementary students' opportunity to respond increased during peer learning, average-skilled students increased their number of correct trials, whereas low-skilled students did not. Only when partners were given the responsibility to provide their partner with verbal performance-related feedback did the performance of low- and high-skilled students increase. Cardon, Verstraete, De Clercq, and De Bourdeaudhuij (2004) found that average MVPA levels were higher in elementary swimming classes compared with nonswimming classes (52% vs. 40%). During swimming classes, an average 40% of time was spent standing. However, 41% of all swimming classes did not reach the recommended 50% MVPA. To date, it is unknown how PA levels during peer teaching in swimming differ as a function of pairing by ability.

From an ecological perspective, class life contains a set of three interrelated systems (instructional, managerial, and student social) in which changes in one system affect the other systems (Hastie & Siedentop, 1999). Although order and academic work have been put forward as the most significant systems (Doyle, 1986), the student social system cannot be underestimated. When students are misbehaving, the teacher will most likely suspend the instructional system to restore order (i.e., managerial system). According to Allen (1986), students have two major goals during lessons: socializing and passing

the course. Some instructional models have the potential to align the student social system with the managerial and instructional system. Carlson and Hastie (1997) found the student social system crucial for the accomplishment of managerial and instructional tasks during a Sport Education unit. In Sport Education, similar to peer teaching, working with peers is considered an attractive element for achieving lesson objectives. Following this ecological perspective, researchers have investigated the student social system on the level of on-task behavior and verbal exchanges. Brock and Hastie (2016) found that although verbal exchanges were higher during a Sport Education unit in homogeneous skill teams compared with heterogeneous skill teams, exchanges were mostly on task. During a peer-teaching unit in tennis, Iserbyt Madou, Vergauwen, and Behets (2011) paired middle school students in dyads as coaches and players. Results showed that student players remained on task more than 90% of the time, whereas their coaches were on task 80% of the time. On-task behavior was defined as executing the expected behavior at a certain time and place. To date, no research has investigated how on-task behavior differs as a function of pairing by ability during peer teaching.

This study sought to investigate the effect of pairing by ability during a 4-day reciprocal peer-teaching unit with university students in Kinesiology on (1) front crawl swimming performance, (2) MVPA levels, and (3) time-on-task. It was hypothesized that mixed-ability pairing would lead to higher performance improvement and low-ability learners would benefit the most from this configuration. It was also hypothesized that MVPA and time-on-task would be higher for individuals in mixed-ability pairings. Student roles as doer and helper were clearly defined, and task cards were used as instructional tools so that helpers could provide the doer with performance-related feedback.

Method

Subjects

One-hundred twenty-one (38 females, 83 males) university students in Kinesiology participated in this study. Students had an average age of 19 years (range 18–21). Students participated in four 50-min lessons in front crawl swimming where the reciprocal style of teaching was applied. This course was included in the yearly PE

curriculum. All lessons were taught by the same teacher (female, 48 years of age), who was familiar with the reciprocal style of teaching and had over 25 years of teaching experience in swimming. Students had no previous experience in the reciprocal style of teaching at the university level. Only dyads attending all tests and lessons were withheld for analysis, leading to a dropout of 8 and leaving 113 participants for analysis

Experimental Groups and Procedures

At the start of this study, all 121 students, constituting two female (n = 17 and 21, respectively) and three male (n = 28, n = 26, and n = 29, respectively) classes, participated in a two-part assessment as a pretest. The first part consisted of a 50-m sprint test where all subjects swam the 50-m front crawl as fast as possible. During this assessment, the sprint time and the number of strokes to complete 50 m were measured. In the second part of the assessment, students swam 25 m technically to the best of their abilities while being filmed with multiple underwater cameras. All assessments were conducted under similar conditions. Both parts of the assessment started with a competition race dive, and each subject swam alone in one lane of a 25-m swimming pool.

Based on sprint time, all students were classified as either low-skilled (up to 50th percentile) or high-skilled (up to 100th percentile). This categorization was used to create similar-ability dyads (low with low and high with high) and mixed-ability dyads (high with low; see Figure 1). The gap in percentiles between students in mixed-ability dyads was at least 50%. For low- and high-ability dyads, partners representing percentiles that were the closest to each other formed a dyad. Since the individual student was the subject of analysis, four categories of individuals were defined, namely, low-skilled students paired with either a low- or high-skilled partner, and high-skilled students paired with either a high- or low-skilled student.

Next, a four-lesson intervention was conducted. In the first lesson, students analyzed the underwater video footage of their own performance together with their assigned partner. To complete the analysis, students had access to sports performance analysis software (Dartfish v7). This assignment was designed to help students identify technical errors to work on during the next swimming lessons.

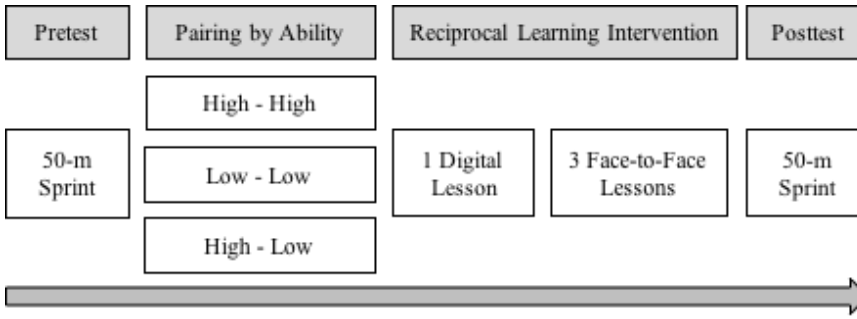

Figure 1. Study overview.

Students could finish the assignment at any preferred time prior to the second lesson. Upon completion of the online assignment, students attended three face-to-face lessons of 50 min, during which they practiced their front crawl performance through the reciprocal style of teaching. The lessons took place once a week in the 25-m university swimming pool. Students worked with the same partner throughout the four-lesson unit.

Reciprocal Style of Teaching

During the swimming lessons, the roles of doer and helper were explained and modeled by the teacher, but the students were responsible for selecting and executing exercises. The high level of autonomy persisted throughout all lessons. A set of task cards containing exercises to address common technical errors was available during practice to support this process. Task cards contained a picture of the skill, written instructions about how to perform the skill technically correct, and potential errors. Nine task cards including a total of 19 technical elements were provided for student practice. The teacher was responsible for implementing the reciprocal style of teaching during practice but was not allowed to give feedback about the swimming performance of the students. She was responsible for correctly implementing the reciprocal peer-teaching model and communicated solely with the helper. Students decided when to switch roles of doer and helper. All lessons in the swimming pool were videotaped, and students wore unique colored swim caps for identification purposes on video. Lessons were single-gendered, meaning that boys were always paired with boys, and girls were

always paired with girls. After the four-lesson intervention, a second assessment was organized where all subjects retook the 50-m front crawl sprint test. Swimming time and number of strokes used to swim 50 m were determined (see Figure 1). Lessons were supervised by the first author of this study for fidelity purposes. No incompatibilities with the reciprocal style of teaching were noted.

Dependent Variables

Performance. For all students, 50-meter sprint time and number of strokes used were measured during pretest and posttest. All tests were videotaped. Based on this footage, a trained assistant counted the number of strokes. A finger entering the water was counted as one stroke. Based on previous research (Barden & Kell, 2009; Toussaint & Beek, 1992), it was assumed that longer stroke lengths in swimming are largely responsible for higher velocities. High-ability swimmers separate themselves from low-ability swimmers, needing fewer strokes to cover the same distance (Toussaint & Beek, 1992; Barden & Kell, 2009). To account for exponentially increasing water resistance at higher velocities and diminishing improvement potential for improving swimming times, the variable of sprint time was converted to an individual performance score using the formula (Belgian Record/Sprint Time)^3 × 1000 = Individual Performance Score. This conversion formula has been used in other research (Iserbyt, Ward, & Martens, 2015).

Physical activity and time-on-task. A subset of 44 students (16 female, 28 male) were randomly selected for assessment of PA levels and time-on-task based on video recordings. The System of Observing Fitness Instruction Time (SOFIT) was used for coding PA levels based on momentary time sampling with 10-s intervals (McKenzie, Sallis, & Nader, 1991). The following categories were used: (1) Lying Down, (2) Sitting, (3) Standing, (4) Walking, (5) Swimming. The sum of Categories 4 and 5 was labeled as MVPA. Similarly, the 10-s observe/record interval was used for coding on-task behavior through momentary time sampling. Doers were coded as on task when they were swimming, listening to the helper, returned to their starting position in the swimming pool to switch roles, or engaged in a combination of the previous. Helpers were coded as on task when they were observing their partner, communicating with their partner, reading the task cards aloud or silently, returned to their

starting position to switch roles, or engaged in a combination of the previous. Data on PA levels and time-on-task were collected during all three reciprocal peer-learning lessons in the swimming pool.

Observer Training

Two observers were trained to code PA levels and time-on-task from video recordings. Prior to coding the study videos, they memorized the coding categories and practiced coding with a sample video. Reliability was calculated for 22% (i.e., 10 of 44 students) of the sample, which is higher than the recommended 12% (McKenzie, 2015). Reliability as measured with Cohen's kappa averaged 0.91 for PA and time-on-task.

Results

Performance

The average sprint time at pretest was 39 s (range 28–64) with a standard deviation of 7 s. At posttest, the average sprint time was 39 s (range 27–58) with a standard deviation of 7 s. After sprint times were converted to individual performance scores, no significant differences were found between groups. The results suggest a higher improvement for low-ability students paired with high-ability students (see Figure 2). At posttest, low-ability students paired with a high-ability partner swam on average 1.2 s (i.e., 10 performance score points) faster than they did at pretest.

The average number of strokes to cover 50 m at pretest was 50 (range 28–73) with a standard deviation of 9. At posttest, the average number of strokes was 49 (range 32–73) with a standard deviation of 9). No significant differences were found between groups. Significant positive correlations were found between number of strokes and sprint time, at pretest ($r = .65$, $p < .01$) and posttest ($r = .69$, $p < .01$).

Physical Activity

PA output based on momentary time sampling was converted to percentages of the total number of observed intervals per subject. No significant differences were found between groups. Descriptive statistics show that low-ability students paired with high-ability students spent the highest amount of time swimming (22%).

Homogeneous high-ability dyads spent the least amount of time swimming (15%; see Figure 3). MVPA levels showed no meaningful differences between groups with an overall average of 37% (range 36–38), although students in mixed-ability dyads had higher PA levels.

Time-on-Task

Time-on-task output based on momentary time sampling was converted to percentages of the total number of observed intervals per subject. No significant differences were found between groups, and overall time-on-task was 82%. Descriptive statistics show that mixed-ability dyads spent the highest amount of time on task, with low-ability students spending 83.6% and high-ability students spending 83.8% of time on task. Homogeneous high-ability dyads spent the lowest amount of time on task (78.5 %; see Figure 4).

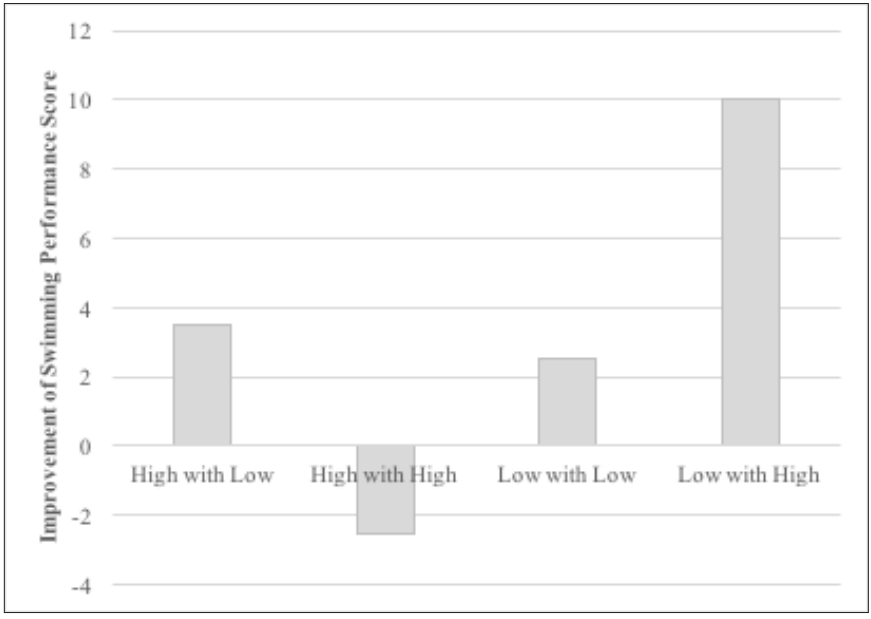

Figure 2. Average improvement from pretest to posttest in performance score of low- and high-ability students as a function of their partner's ability level. All performance scores were calculated using the formula (Belgian Record/Sprint Time)^3 × 1000.

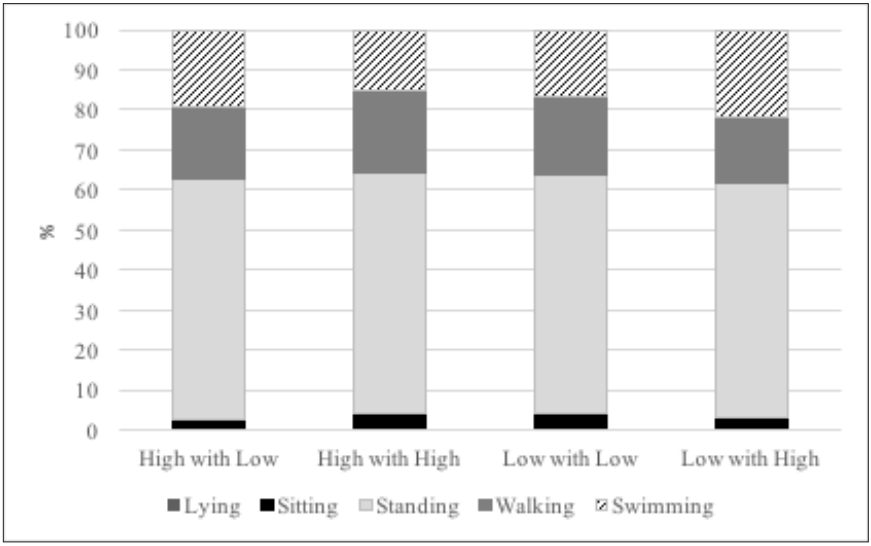

Figure 3. Average physical activity levels of low- and high-ability students as a function of their partner's ability level.

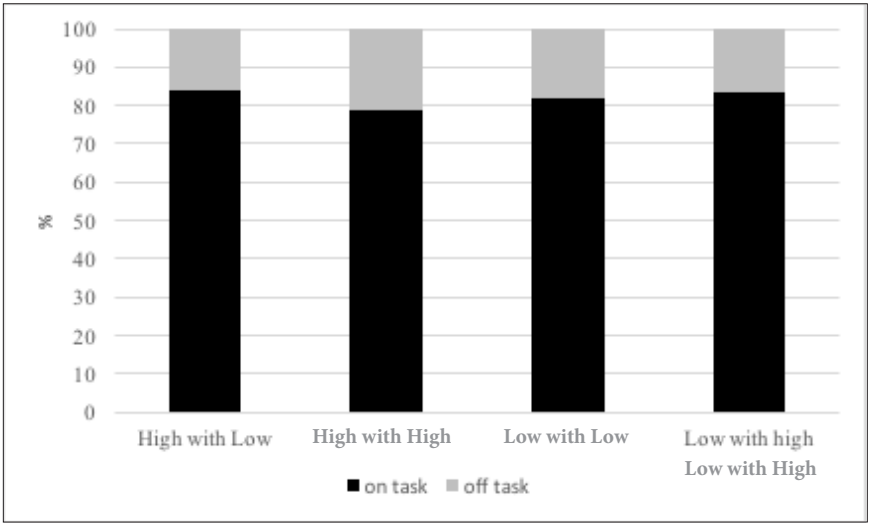

Figure 4. Average time-on-task of low- and high-ability students as a function of their partner's ability level.

Discussion

This study investigated the effect of pairing by ability on swimming performance, PA, and time-on-task. Overall, swimming performance did not improve from pre to post on the level of sprint time and number of strokes needed to cover 50 m. The limited duration of the intervention and the fact that all participants had already received one swimming lesson per week during a full semester (i.e., ceiling effect) as part of their curriculum might explain this finding.

Previous work in high school swimming has shown no learning effect, even after a 10-day unit (Iserbyt et al., 2015). Although not significant, analysis of swimming performance by ability level showed that low-ability learners paired with high-ability learners improved their swim time from pre to post, whereas other students did not. These results fit the hypotheses that for improvement in performance, low-ability learners benefit most from working together with a more skilled peer. This result also fits the contention that when the learning environment is highly organized in terms of role definition, role switching, and access to instructional tools, the effect of pairing by ability on learning is reduced.

Previous work by d'Arripe-Longueville et al. (2002b) with same-sex dyads revealed a significant difference in swimming performance after an 8-min peer-teaching episode. In that study, however, the peer-teaching episode was not reciprocal in nature. In this study, a low-ability student was identified as scoring below the 50th percentile, whereas a high-ability student scored above the 50th percentile. This classification still implicates a wide ability range (i.e., percentile 55 vs. 95) and might be fine-tuned through the addition of the category "average-ability," as was the case in the study by Legrain et al. (2003). Although they hypothesized that average-skilled tutors would lead to greater learning in low-ability learners compared with high-skilled learners because of the presence of a "zone of proximal development," the contrary was the case since high-skilled learners also experienced significant learning.

The present study only used the categories low- and high-skilled and thus the results are limited in that way. A positive correlation was found between sprint time and the amount of strokes needed to cover 50 m. These findings confirm research on this topic (Toussaint & Beek, 1992). Number of strokes is a simple and objectively

measurable variable that learners and teachers can use to evaluate swimming technique. They can use it to provide swimmers with insight into their own ability, to set clear and observable goals, and to map progress. Previous research in the field of sport pedagogy already focused on a reduction of strokes needed to cover 50 m as a learning outcome (Iserbyt et al., 2015). Although a four-lesson unit represents an average learning period in secondary schools in Flanders and thus is ecologically valid, longer interventions will be necessary for more insights into performance improvement to be gained.

For PA, no significant differences were found regarding MVPA between groups, with an overall average of 37% of lesson time spent in MVPA. Descriptive statistics show that the time spent swimming during reciprocal learning was higher for mixed-ability dyads compared with same-ability dyads. Within mixed-ability dyads, low-ability learners spent more time swimming than high-ability learners. This difference in time spent swimming could partly be explained by the fact that high-ability learners need less time to swim 25 m compared with low-ability learners. Also, perhaps high-ability learners reduced their own practice time in favor of their low-ability partners so that they could improve. Research investigating levels of PA during Flemish swimming lessons in elementary PE showed that learners spent around 50% of their time standing or walking (Cardon et al., 2004). In an English study, learners were active for just 9% of swimming lesson time (Warburton & Woods, 1996). Earlier research showed that "swimming more laps" does not always lead to superior swimming performances (Iserbyt et al., 2015). More important, data show relatively similar PA levels for all learners regardless of ability level. This is important since a large body of evidence demonstrates that low-ability children, adolescents, and adults have lower activity levels, whether expressed in terms of MVPA, trials performed, opportunity to respond, or motor appropriate behavior (for a review, see van der Mars, 2006).

Students in this study were on average on task 82% of the time, which is consistent with previous findings (Iserbyt et al., 2011) during classwide peer tutoring in tennis where doers and helpers were on task 90% and 80% of the time, respectively. This result supports the claim that an instructional model such as reciprocal peer

teaching aligns the student social system with the managerial and instructional system, regardless of student ability level. Given learners in this study stayed on task most of the time during reciprocal learning, this instructional model may prove its value in swimming education by engaging nonactive swimmers in the learning process.

Conclusion

Although not significant, results from this study suggest that in gender-homogeneous groups, mixed-ability pairing is to be favored in a structured reciprocal peer-teaching setting with task cards. Low-ability learners seem to improve most when paired with high-ability learners during reciprocal peer teaching. These learners also spent the most time swimming and on task. High-ability learners on the other hand improved their performance the least when paired with other high-ability learners. They also spent the lowest amount of time swimming and were least on task in such configuration. Overall, students did not improve their swimming performance after a 4-day lesson unit in swimming. Given the wide range in ability of participants, similar results in secondary education would be expected, although a higher need for the teacher to guard the process of high-quality interactions seems probable. In this study, all dyads were single gendered. Research has shown that heterogeneous or homogeneous grouping regarding gender has little effect on learning (Ernst & Byra, 1998). In general, reciprocal learning lends itself well as an instructional model in swimming classes because nonswimmers can stay largely involved in the lesson content.

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