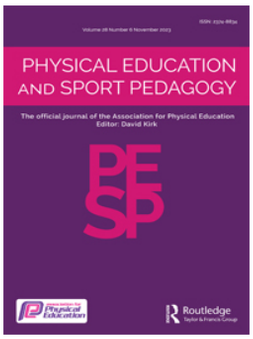

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The effect of specialized content knowledge in reciprocal peer learning in a university content class

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ABSTRACT

Background: Teaching strategies using peers to influence student-learning outcomes are commonly used in physical education. Reciprocal peer learning is a teaching strategy where students work in pairs as tutor and tutee. Effective peer tutoring requires knowledge about the critical elements for correct performance (i.e. common content knowledge, CCK) and knowing how to detect and address common errors (i.e. specialized content knowledge, SCK). Research on training students for their task as tutor to increase peer learning effectiveness is limited.

Purpose and research question: This study documents an online approach to prepare students for their role as tutor during reciprocal peer learning. Also, it investigates the effect of online CCK + SCK-training versus online CCK-only training on (a) skill performance by tutees and error detection by tutors during peer learning; and (b) individual skill performance at a 1-week retention test.

Methods: Seventy-seven undergraduate students (25 female, 52 male) were randomly assigned to an online CCK + SCK ($n = 37$) or CCK-only ($n = 40$) training for learning Basic Life Support (BLS) as part of their curriculum. All participants learned online the correct procedure for BLS according to international guidelines (i.e. CCK). In the CCK + SCK condition, students additionally learned online to detect and correct four common errors related to chest compression. Following the online training all students learned BLS using reciprocal peer learning with manikins. For each student pair skill performance during practice by tutees was reported using digital manikins and error detection by tutors was collected using systematic observation of video recordings. One week following practice (i.e. retention), BLS-performance was assessed individually using a validated protocol.

Findings: During peer learning, SCK-trained tutees performed less unique errors (Mdn = 2 vs. 1, $p < .05$) and SCK-trained tutors detected a higher proportion of unique errors (Mdn 100% vs. 0%, $p < .05$) compared to CCK-only trained students. At retention, SCK-trained students outperformed the CCK-group for chest compressions with adequate rate (Mdn 91% vs. 69% $p < .05$) and complete release (Mdn 81% vs. 35% $p < .05$).

Conclusions: Teaching undergraduate students online to detect and correct errors positively impacted the quality of practice during peer learning and the performance at retention.

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Introduction

Teaching strategies using peers to support psychomotor learning are often used in higher education (Madou and Iserbyt 2020; Madou and Iserbyt 2018; Iserbyt 2015; Dervent et al. 2020; Ward et al. 2018) and in physical education in schools (Ward and Lee 2005; Jenkinson, Naughton, and Benson 2014). Reciprocal peer teaching is a peer-assisted learning strategy where students are paired and alternate between the roles of tutor and tutee to maximize each other's learning. This strategy has been described as a central instructional model for school-based physical education (Metzler 2017; Mosston and Ashworth 2008) and has been researched in elementary (Iserbyt et al. 2017), secondary (Iserbyt and Madou 2022; Madou et al. 2023) and higher education (Madou and Iserbyt 2020). During peer teaching, the tutee performs the task while the tutor engages in instructional interactions that occur during and after the tutee's learning trials (e.g. offering immediate and on-going feedback, identifying the source of mistakes, providing good learning ques for the next attempt) (Metzler 2017; Mosston and Ashworth 2008). For peer teaching to be most effective Metzler suggests preparing and training students for what he calls 'their role as teacher-of-the-moment' (Metzler 2017, 300).

Tutor training

To date, research investigating the benefits of training tutors to increase the effectiveness of peer teaching is limited. A study by Legrain, D'Arripe-Longueville, and Gernigon (2003) examined the effect of a tutor training program for novice college students in a French boxing setting. In this study, tutors were taught to identify correct and incorrect performance and to formulate appropriate advice. Results showed that trained tutors identified errors more precisely, gave more appropriate feedback, and improved their own performance better compared to untrained tutors (Legrain, D'Arripe-Longueville, and Gernigon 2003). A study by Madou and Iserbyt (2020) reported that providing online training prior to using reciprocal peer teaching for learning Basic Life Support with undergraduate students was effective compared to other research with similar test populations using peer teaching without tutor training (Madou and Iserbyt 2020). Reviews on peer learning in secondary school physical education show that in most studies some training was provided to tutors. However, the training varied in quantity, quality, content, and duration (Jenkinson, Naughton, and Benson 2014; Ward and Lee 2005) and in some cases details on the training were not reported at all (Ward and Lee 2005). For decades, peer teaching programs have stressed the importance for teachers to prepare and train students in requisite skills for peer teaching (Legrain, D'Arripe-Longueville, and Gernigon 2003; Johnson and Johnson 1989). These skills involved knowing the criteria for correct performance, observing performance, comparing performance against criteria, drawing conclusions, and communicating results (Mosston and Ashworth 2008). Metzler also stated that tutors must be able to identify the source of mistakes and provide good learning ques for the next attempt (Metzler 2017). Consequently, a teacher's decision to implement a peer teaching strategy is inevitably linked with: (a) tutors needing appropriate knowledge to assume their role, (b) the teacher's responsibility to provide them with this knowledge, (c) the instructional decision on how to provide students with this knowledge. In this study with undergraduate students, we examined a blended learning approach using online learning to prepare students for their teaching roles during in-class reciprocal peer teaching. In particular, we use online instruction prior to face-to-face physical education, referred to as 'flipped learning' (Østerlie et al. 2023; Sargent and Casey 2020). Online instruction can offer efficient and effective ways to promote student learning and has increasingly been used in higher education as a pedagogical strategy (Dumford and Miller 2018). The use of online instruction to prepare undergraduate students for peer teaching has to our knowledge only been reported by Madou and Iserbyt (2020) who reported it was effective for learning Basic Life Support in higher education.

Content knowledge for tutors

To be an effective tutor during peer teaching students require content knowledge on the subject they are teaching. This finding is supported by studies that have investigated the role of tutors with higher knowledge or ability level compared to their peers which report positive effects on learning outcomes of tutees (Madou and Iserbyt 2018; D'Arripe-Longueville et al. 2002). Recent developments in content knowledge research with pre- and in-service teachers (Ward and Ayvazo 2016; Dervent et al. 2022; Kim et al. 2018) offer a framework to investigate the knowledge students need for peer teaching. Different types of content knowledge have been defined (Loewenberg Ball, Hoover Thames, and Phelps 2008) and operationalized for teaching physical education (Ward 2009). Common Content Knowledge (CCK) refers to the knowledge needed to perform an activity (e.g. knowing the adequate depth for chest compression during basic life support). Specialized content knowledge (SCK) refers to knowledge unique to teaching such as knowledge of common errors students make and how to correct them (e.g. knowing that students who are learning basic life support often flex their elbows during chest compressions leading to insufficient depth which can be solved by straightening the arms). Although this framework originates from research with teachers it seems valuable during peer teaching because tutors are expected to discriminate between correct and incorrect performances in order to provide feedback and determine the next step in instruction. This teaching ability has been defined in physical education literature as 'skill analysis' (Ward et al. 2021). For skill analysis both CCK and SCK matter. CCK allows to identify critical elements in a movement. Also, it serves as the foundational knowledge to inform feedback for students (Ward et al. 2021). SCK is used to anticipate errors and to select instructions to improve performance (Ward et al. 2021). Research with teachers shows that a lack of CCK and SCK limits their ability to adapt instruction to the needs of students (Kim et al. 2018; Iserbyt et al. 2017). Moreover, improving content knowledge with teachers, in particular SCK, leads to more effective teaching and learning (Kim et al. 2018; Iserbyt et al. 2017; Madou et al. 2023). As tutors in a peer teaching setting become responsible for correcting errors and providing feedback during their partners' learning trials (Metzler 2017), they also require CCK and SCK. Consequently, training students in CCK and SCK prior to peer teaching might benefit their tutoring behavior and in turn their performance. This study implemented online CCK and SCK training for students prior to a reciprocal peer teaching setting for learning Basic Life Support (BLS).

Basic life support

BLS refers to a sequence of actions bystanders should perform when a person suffers from out-of-hospital cardiac arrest to maximize chances for survival (Perkins et al. 2021). It contains checks for safety, consciousness, and breathing, a call for specialized help and the performance of cardiopulmonary resuscitation (Perkins et al. 2021). International organizations such as the European Resuscitation Council emphasize the importance of implementing BLS in educational settings from preschool to university level (Greif et al. 2021). Reciprocal peer teaching has proven to be an effective instructional model to teach BLS with limited face-to-face time (i.e. one lesson of 50 min) in higher education (Iserbyt, Elen, and Behets 2009; Madou and Iserbyt 2020; Iserbyt et al. 2014; Iserbyt 2015) and in secondary education physical education (Iserbyt and Madou 2022; Madou et al. 2023; Beck et al. 2015).

Purpose of the study

The purpose of this study was to improve reciprocal peer teaching for BLS with undergraduate students by investigating the effect of a tutor training intervention. This work is important because survival rates in case of out-of-hospital cardiac arrest are reported to depend on the educational efficiency of BLS education (Søreide et al. 2013). Annually, the incidence of out-of-hospital cardiac

arrest in Europe is between 67 and 170 per 100,000 inhabitants (Perkins et al. 2021). Research shows that the performance of bystander BLS is an important predictor of outcome as the survival to hospital discharge rate among patients in whom BLS was started by a bystander is twice as high as when BLS was started by emergency medical services (Gräsner et al. 2020). Because of the public health concerns regarding bystander BLS, learning to perform BLS is a part of the required curriculum of Flanders' secondary education as it is in many other countries. As such it is also a part of the university curriculum for the training of physical education teachers and coaches.

We investigated the effect of an online CCK + SCK training versus an online CCK-only training on (a) the quality of chest compressions by tutees and the frequency of error detection and correction by tutors during reciprocal peer teaching; and (b) students' quality of chest compressions at a 1-week retention test. This study is grounded in a behavior analytic framework where the dependent variables are observable and measurable and where the focus is on socially significant behaviors (Cooper, Heron, and Heward 2020) The independent variable in this study was grounded on literature from SCK and CCK and focused on behaviors from tutors and tutees (Kim et al. 2018; Iserbyt et al. 2017; Madou et al. 2023). In line with research conducted in schools (Kim et al. 2018; Iserbyt et al. 2017; Madou et al. 2023) we hypothesized that within CCK + SCK-trained dyads tutors would show higher frequencies of error detection and correction, and consequently tutees would show less chest compression errors compared to students from CCK-only trained dyads. Also, we hypothesized that students from the CCK + SCK condition would show less chest compression errors compared to the control group at the individual retention test.

Materials and methods

Participants and setting

Participants in this study were 77 (25 female, 52 male, age: M = 20) undergraduate students in a Movement Sciences programme at a university in Belgium. Informed consent was received from all participants and the study was approved by the author's institutional review board (identification number G-20212991). All students were enrolled in a university content course on swimming and lifesaving. Data for this study were collected during the covid-19 pandemic. Consequently, European guidelines for BLS were adapted to a compression-only version of cardiopulmonary resuscitation (Nolan et al. 2020). All participants completed an online training prior to attending one face-to-face lesson aiming to learn to perform BLS according to international guidelines. All classes were led by the same teacher (female, age 37). The teacher had extensive background in teaching (i.e. 14 years of teaching experience), was a certified BLS-instructor and had experience in using the reciprocal peer teaching model. She was blinded to the research questions and the randomization. Also, the teacher was not involved in the delivery of online training prior to face-to-face lessons or the pairing of students for reciprocal peer teaching.

Study design

This study was a randomized controlled trial. After providing informed consent participants were randomly assigned to an online CCK or CCK + SCK tutor training using an online randomization tool (www.randomizer.org). This study was grounded in a behavioral perspective, which means that observable behaviors were a primary interest. The dependent variables were the quality of chest compression practice and the occurrence of error detection in week 2 of the study, and the individual BLS performance of students at a retention test in week 3 of the study.

Week 1: Online content knowledge training

Based on their assigned condition participants received one of two online training modules (CCK vs. CCK + SCK). The online content knowledge training was the independent variable in this study.

All online training modules were developed and delivered by a member of the research team using the university's online learning management system. Two content experts, certified in BLS, reviewed the training modules to assess content and face validity. Training modules consisted of instructional videoclips with accompanying quizzes to increase and check learning (Spanjers et al. 2015). All participants were asked to complete their assigned online training outside of class time and score 100% on all accompanying quizzes. To complete this task students were given unlimited attempts for the duration of one week leading up to a face-to-face lesson where they practiced BLS using the reciprocal peer teaching model.

Participants from the CCK-only condition received an online training on how to perform BLS according to international guidelines. The training contained a two-minute instructional videoclip showing an expert performing the procedure correctly followed by 10 quiz questions (e.g. students were asked what the correct chest compression depth was according to the guidelines for which 'five to six cm' was the correct answer). The quiz result was presented to students after completing the final question in the test. On average, this online training took about 10 min to complete.

Participants from the CCK + SCK condition received an identical online training as the CCK-condition and were additionally taught to detect and correct four clinically important and common errors students make while performing chest compressions. The following errors were selected based on their clinical relevance towards survival (Olasveengen et al. 2021) and previous research on SCK in the domain of BLS (Iserbyt et al. 2017): (1) inadequate chest compression rate; (2) inadequate compression depth; (3) incomplete release of the chest between compressions; and (4) incorrect hand placement during compressions. To improve error detection participants from the CCK + SCK condition assessed ten 30-second videoclips of chest compressions for the occurrence of any of the selected errors using multiple choice questions. Videoclips were filmed from a point of view similar to that of tutors during peer teaching and showed a person performing erroneous chest compressions. Following this error detection training a final videoclip was shown along with four questions on how to correct the selected errors (e.g. when your partner performs compressions with inadequate depth, tell him/her to straighten the arms and bring the shoulders above the victim). On average, this CCK + SCK training took about 20 min to complete.

Week 2: Reciprocal peer teaching

During a structured face-to-face lesson students learned to perform BLS using reciprocal peer teaching. The duration of the lesson was 45 min and class size was typically 24 students. Each class contained an equal number of students from each condition (for which the teacher was blinded). Students were not allowed to choose their partner but were paired with a student from the same research condition by a member of the research team. Consequently, each class consisted of an equal number of student pairs from each condition (e.g. six CCK student pairs and six CCK + SCK pairs). Each student pair received one ResusciAnne manikin (© Laerdal) to practice BLS and one iPad. All student pairs were filmed separately for the duration of the lesson. Each lesson was taught by the same teacher who explained the instructional model and the expected behavior of tutors and tutees at the beginning of the lesson using a standardized instruction. Previous research on teaching BLS in a similar setting showed that providing clear guidance on role switching and role definition during peer teaching leads to students spending more time-on-task and giving instructions (Iserbyt 2015). Students assuming the role of tutor were instructed to hold the iPad in their hands during peer teaching, observe their tutee, and provide feedback. The iPad served as an instructional CCK-aid as tutors could use it to consult a videoclip of a correct BLS-procedure. Also, this iPad recorded all verbal interactions between learners in the dyad during practice. Students assuming the role of tutee were instructed to kneel beside the manikin to practice BLS. All manikins were equipped with sensors and were connected to separate tablet computers collecting data on chest compression quality during practice (i.e. chest compression depth, release, and rate). The manikin-generated data were used only for research purposes (see data collection) and were not available for students. The remaining time of the lesson was organized using the reciprocal

peer teaching model. Students were cued by the teacher every five minutes to switch roles. During practice the teacher supervised and was available for questions.

Week 3: Assessment

One week following the face-to-face lesson all students' BLS-performance was assessed individually and unannounced using a validated protocol (Whitfield, Newcombe, and Woollard 2003).

Data collection

The first week of the study the completion of the online learning modules was tracked using the university's learning management system. Completion of online learning and quiz-scores were checked prior to the face-to-face lesson. All students completed their training.

During reciprocal learning in week two multiple data-streams were captured for each student pair allowing to create a coding clip for data analysis for each dyad. Coding clips combined the following data: (a) video recording of the dyad during practice; (b) audio-recording of the tutor's iPad; (c) data visualization of the manikins' sensors for chest compression quality. In addition, audio-cues with six-second intervals were added for the entire duration of the clip to support systematic observation. Each coding clip was analyzed in a three-step procedure. First, all intervals in which chest compressions were performed were identified. A six-second interval was considered a 'practice interval' when at least one chest compression occurred. Second, each practice interval was coded for the occurrence of each of the four selected errors using partial interval recording. The occurrence of inadequate hand position was assessed by two trained observers. Observers were trained to assess correct hand position for chest compressions during a one-hour workshop combining live assessment of compressions using specialized equipment (© Laerdal QCPR connected to Simpad Plus) and the assessment of videos designed for the purpose of observer training. Inter-observer reliability for correct hand position during practice was 94% based on 33% of the total sample as recommended in behavioral research (Cooper, Heron, and Heward 2020). The occurrence of inadequate chest compression rate, depth, or release during a practice interval was assessed based on the manikin software. Third, for all practice intervals in which the tutee performed an error it was coded whether the tutor verbally detected the error and whether the error was corrected.

In the third and final week of this study all students were assessed individually and unannounced for BLS performance. All assessments were performed using a full-body digital manikin connected to a tablet computer (© Laerdal QCPR connected to Simpad Plus) and were videoed separately. The software for error detection was set to the international guidelines for high-quality chest compressions during BLS (Olasveengen et al. 2021). This means that compressions should be performed in the middle of the chest (i.e. lower half of the sternum), at a rate of 100–120 compressions per minute with a depth of 5–6 cm, while avoiding to lean on the chest between compressions (Olasveengen et al. 2021). Overall BLS performance was assessed using a covid-adapted scoring system based on the Cardiff protocol (Whitfield, Newcombe, and Woollard 2003) combining data collected by the manikin with expert observations. Observers were two trained experts certified in BLS and blinded to the research conditions. Inter observer reliability related to the BLS assessment was 94% based on 33% of the sample. The following variables were collected with expert observation: safety check; check responsiveness; call 112; cover mouth and nose of victim due to the covid pandemic; continuing chest compressions. The following variables were retained by the manikin software: compressions with correct hand placement; compressions with adequate depth; compressions with complete release; compressions with adequate rate. BLS-scores combined the variables observed by the experts with the variables retained by the software using a Cardiff-based scale. BLS scores could range between 12 and 39 points and were converted to percentages for clarity.

Dependent variables

For each student, the dependent variables during peer teaching as a tutee were: (1) the total number of chest compression practice intervals during the learning episode; (2) the number of practice intervals without errors; (3) for each of the selected errors the number of practice intervals they occurred; (4) the number of unique errors a student demonstrated across all practice intervals with zero being the lowest possible score and four being the highest (i.e. all errors were demonstrated at least once).

For each student, the dependent variables during peer teaching as a tutor were: (1) the number of unique errors that were detected during the learning episode as measured by verbal behavior; (2) the number of unique errors that were corrected.

For each student, the dependent variables at the retention test were: (1) Overall BLS performance score; (2) percentage of compressions with correct hand placement; (3) percentage of compressions with adequate depth; (4) percentage of compressions with complete release; (5) percentage of compressions with adequate rate.

Data analysis

Statistics were performed using IBM SPSS (version 22.0). Shapiro–Wilk testing showed that dependent variables were not normally distributed (W = 0.90 - 0.96, $p < 0.05$). Accordingly, Mann–Whitney U testing was used to compare conditions for all dependent measures. Medians and interquartile range (IQR) were reported for the dependent variables. A $p < .05$ was considered significant.

Results

Tutee and tutor behavior

During reciprocal peer teaching tutees from the CCK + SCK group showed significantly less practice intervals with incomplete chest compression release ($Mdn = 0$) compared to the tutees from the CCK-only condition ($Mdn = 9$, $p < .05$). Also, tutees from the CCK + SCK group performed significantly less unique errors ($Mdn = 1$) during practice compared to the CCK-only group ($Mdn = 2$ $p < .05$). Tutors from the CCK + SCK group detected ($Mdn = 100\%$) and corrected ($Mdn = 50\%$) a significantly higher proportion of unique errors compared to tutors from the CCK-only group (detected $Mdn = 0\%$ $p < .05$; corrected $Mdn = 0\%$ $p < .05$). A comparison of tutor and tutee behavior between CCK + SCK trained students and CCK-only trained students during reciprocal peer teaching is presented in Table 1.

BLS retention test

At retention, results showed that students who completed the CCK + SCK training achieved a significantly higher percentage of fully released compressions ($Mdn = 88\%$ vs. Mdn 30% $p < .01$) and a higher percentage of chest compressions with adequate rate compared to students who completed the CCK-only training ($Mdn = 92\%$ vs. $Mdn = 69\%$ $p < .05$) (see Table 2). Overall median BLS performance was 89% for the CCK + SCK group and 85% for the CCK-only group.

Discussion

The first purpose of this study was to investigate the effect of an online CCK + SCK training versus an online CCK-only training on the quality of chest compressions by tutees and error detection and correction by tutors during reciprocal peer teaching. Students from both conditions showed no difference in the total amount of practice intervals indicating that both groups spent the same

Table 1. Mann–Whitney *U* comparison between CCK-only and CCK + SCK trained students during chest compression practice.

	CCK Median (IQR)	CCK + SCK Median (IQR)	Z	*P*	Data origin E: Expert S: Software
Tutee behavior: Skill performance					
Observed practice intervals total (*n*)	55 (41)	52 (42)	−0.53	.960	E + S
Observed practice intervals without errors (*n*)	10 (24)	24 (32)	−1.94	.052	E + S
Observed practice intervals with errors					
Performing incorrect hand placement (*n*)	0 (0)	0 (0)	−1.13	.259	E
Performing insufficient compression depth (*n*)	0 (0)	0 (0)	−1.4	.174	S
Performing incomplete release (*n*)	9 (43)	0 (2)	−0.73	.000*	S
Performing inadequate compression rate (*n*)	31 (32)	29 (33)	−0.73	.482	S
Unique errors performed during entire practice (*n*)	2 (1)	1 (1)	−2.624	.009*	E + S
Tutor behavior: Skill analysis					
Unique errors detected as tutor (%)	0 (100)	100 (100)	−2.503	.012*	E + S
Unique errors corrected as tutor (%)	0 (50)	50 (100)	−2.017	.044*	E

Note: IQR = Interquartile range.
*$p < .05$.

proportion of lesson time practicing chest compressions. Results confirm our hypotheses that CCK + SCK trained tutors detect higher proportions of errors in their tutees. Including SCK in online tutor training improved the tutors' ability to detect clinically important errors and to provide congruent feedback to improve tutee's performance. CCK + SCK-trained tutees showed more practice intervals without errors, particularly in terms of adequate compression release, compared to the CCK-only group. These results confirm our hypotheses that tutees from the CCK + SCK group practiced with higher chest compression quality during peer teaching compared to the CCK-only group. The finding that CCK + SCK trained tutors were better able to detect errors and provide feedback might have positively impacted the quality of chest compressions by their tutees. However, results show this is not the only reason. The finding that CCK + SCK-trained tutees performed less 'unique' errors during practice is indicative for better chest compression performance regardless of tutor interactions. In other words, CCK + SCK-trained students might have made fewer errors because they had learned to detect and correct common errors prior to practicing chest compressions on a manikin.

The second purpose of this study was to investigate the effect of online CCK + SCK training versus online CCK-only training on chest compression quality during an individual and unannounced retention test for all participants. At the retention test, CCK + SCK trained students significantly outperformed the CCK-only condition for chest compression rate and chest compression release which are both clinically important markers of high-quality chest compressions (Olasveengen et al. 2021). These results confirm our hypotheses and indicate that including SCK in an online tutor training before using the reciprocal peer teaching model produces not only an immediate

Table 2. Comparison between CCK-only trained students and CCK + SCK trained students for chest compression quality at an unannounced and individual assessment one week following reciprocal peer learning. Conditions were compared using Mann–Whitney U testing.

	CCK group Median (IQR)	CCK + SCK group Median (IQR)	Z	*P*
Compressions with correct hand placement (%)	100 (2)	100 (0)	−1.063	.288
Compressions with sufficient depth (%)	45 (70)	38 (65)	−1.007	.281
Compressions with complete release (%)	35 (69)	81 (58)	−2.807	.005*
Compressions with adequate rate (%)	69 (83)	91 (47)	−2.71	.030*

Note: IQR = Interquartile Range.
*$p < .05$.

positive effect on peer teaching behavior, but also a significant positive effect on learning outcomes at a retention test. In this regard the results align with literature on improving teacher SCK (Kim et al. 2018; Iserbyt et al. 2017; Madou et al. 2023) which also report improved learning outcomes with students.

Building on previous research with in-service teachers (Madou et al. 2023) this study documented an approach using online training to prepare students for their roles as tutor and tutee during reciprocal peer teaching. Many of the advantages of using online instruction align with the goals of tutor training. For example, using online learning with video clips and quiz questions to train error detection and correction allows for individual, high-paced practice with immediate feedback. The decision to use online instruction is endorsed by the European Resuscitation Council as Greif et al. (2021) stated that the use of online learning can save valuable time for hands-on practice (Greif et al. 2021). This finding becomes increasingly relevant in case of limited resources (e.g. limited access to practice manikins). Also, online instructions for BLS can aid the standardization of content in and between curricula (Thorne et al. 2015) adding to the quality of population level BLS-education. A study by Madou and Iserbyt (2020) showed that implementing an online CCK-training prior to a 50-minute face-to-face session using reciprocal peer teaching was an effective strategy to teach BLS to university students (Madou and Iserbyt 2020). The use of online SCK-training preparing tutors to detect and correct errors during peer teaching, has to our knowledge not been reported for BLS in higher education. Therefore, this study extends literature on content knowledge by investigating the effect of CCK and SCK training with a population who are not teachers. Future research could investigate the effect of CCK and SCK for reciprocal peer teaching in schools. Also, this work extends literature on (instruction for) skill analysis (Ward et al. 2021). Previous work on skill analysis with teachers might be relevant for tutor training as the content is identical for tutors and teachers. Instruction for skill analysis with teachers typically consists of four training phases: observation, diagnosis, prescription, and application (Ward et al. 2021). It is remarkable that the use of videoclips has been reported for all phases (Ward et al. 2021) as it might indicate that the use of online training can be an effective tool to train teachers (and tutors) for their role. This finding is in line with the results of this study.

Limitations and strengths

A limitation of this study is the BLS procedure. Due to the covid-19 pandemic, an adjusted version of BLS-guidelines had to be used prohibiting comparison of chest-compression quality of this study with previous reports of similar interventions. Strengths in this study were the detailed and objective data collection on skill performance and skill analysis during peer teaching. Tutor interactions were collected using systematic observation of separate video and audio tracks for all student pairs. Data on tutee performance were collected using data streams from sensors in digital practice manikins and systematic observation of all student pairs. Also, at the retention test chest compression quality was measured using digital manikins.

Conclusions

Overall, the online SCK-training positively impacted the quality of practice by tutees, the incidence of error detection and correction by peer tutors and the performance at a retention test. Online training preparing students for learning motor skills using the reciprocal peer teaching model should focus on CCK and SCK.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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