The effect of self-assessment in reciprocal learning with task cards on the quality of CPR

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Abstract: This study investigated the effect of self-assessment with and without motor activity on the quality of CPR in reciprocal learning with task cards. Gender differences in learning outcomes were analysed as well. Eighty-six university students (39 women and 47 men) were randomised in pairs into three groups: cognitive self-assessment, cognitive-motor self-assessment, and a control. Student pairs had to learn Basic Life Support (BLS) in 20 min with task cards. Cardiopulmonary Resuscitation (CPR) performance was measured before (baseline), immediately after (intervention) and 2 weeks later (retention). Results at intervention and retention showed no beneficial effects of self-assessment on the quality of CPR. Self-assessment with motor activity did not differ significantly from merely cognitive self-assessment. At retention, males ventilated significantly less volume than females. Within the limitations of this study, it can be concluded that implementing self-assessment in reciprocal learning with task cards does not lead to better CPR performance in the present target group.

Key words: Education; resuscitation; cardiopulmonary resuscitation; training; instructional model.

Reciprocal peer tutoring is a teaching strategy in which students work in pairs to maximise their own and each others’ learning. As one learner is doing (doer), the other learner (observer) provides instructions and specific feedback to the doer (1). This format has been extensively studied in general education (2) and was found to enhance students’ social and cognitive learning (3). Literature suggests that the positive effects of this teaching strategy are due to the increased provision of instruction, the opportunity to respond, and the provision of specific feedback (4). In physical education, peer tutoring structures have been investigated in different-aged target groups (5, 6). In general, these studies demonstrated increased student responses (7), and increased percentages of correct student performances (8). While the doer is learning by doing, the observer is learning by observing, analysing, and giving performance-related feedback (1, 9). Consequently, academic gains occur for doers and observers (10). Concerning skill-level, it has been shown that low-skilled as well as high-skilled students benefit from peer tutoring (8).

Previous research demonstrated that a 20 min reciprocal learning setting with task cards is a promising strategy to teach Basic Life Support (BLS) and Cardiopulmonary Resuscitation (CPR). Furthermore, study outcomes point out that the retention of BLS skills increases when doer and observer exactly know what to do (i.e., how to cooperate and how to use the task cards) and when to switch roles (11). While one learner is performing BLS (the doer), the other learner (observer) provides instructions and feedback based on the information on the task cards. These task cards contain all the necessary information to learn BLS, and combine a picture of the BLS skill with written instruction about how to perform the skill. Hence, it was stated that reciprocal learning with task cards is an effective, time-efficient and less instructor-intensive strategy to teach BLS (11). This study aims at the further enhancement of this learning setting by adding self-assessment, and investigating its impact on the quality of CPR.

Self-assessment is believed to be an important technique in helping students to take responsibility for learning, encouraging independence in learning and self-motivation (12). It is initiated and driven by the individual learner and is used for ongoing improvement (13). In general education, self-assessment was found positive on learners’ mathematic skills (14). In the science domain, self-assessment conducted throughout a six month unit improved students’ achievement (15). In the
psychomotor domain, self-assessment research has focused largely on teachers’ perceptions and practice, rather than the impact of self-assessment on student learning (16). Recently however, Marzano stated that students should become key participants in their learning process by tracking their own progress (17). This implies the integration of self- and peer-assessment procedures during the learning process. For learning psychomotor tasks like BLS, the question arises whether this self-assessment should be only cognitive, or cognitive with accompanying motor activity.

In this study, self-assessment was implemented in a 20 min reciprocal learning setting for acquiring BLS with task cards. Self-assessment was considered as an autonomous activity where learners look back and reflect after an experience or practice in order to analyse the passed event and to discriminate essential aspects. Two experimental self-assessment groups and a control were implemented. The experimental settings differed in the nature of self-assessment: only cognitive or cognitive with additional motor activity. In the control group, no self-assessment was implemented. The following research questions were addressed in this study: (a) What is the effect of self-assessment on the quality of CPR performance?; (b) Is there a difference between merely cognitive self-assessment and cognitive self-assessment combined with motor activity?; and (c) Are there gender effects in the quality of CPR performance?

MATERIALS AND METHODS

Sample and student grouping

Eighty-eight students in Kinesiology were recruited from the University of Leuven, Belgium. Students were told that they would receive BLS training, but not in which way it would be taught. All participants had given their informed consent for participation in this study. Based on previous research indicating that the most appropriate pairing technique for peer learning is self-selection (1, 9), students were allowed to choose a partner they preferred to work with and marked their relationship individually with 1 (unknown person), 2 (acquaintance), 3 (friend), or 4 (bosom friend). Before the start of the experiment, students filled in a questionnaire to determine whether they had received previous BLS or CPR training.

Student pairs were randomly assigned to the cognitive self-assessment, cognitive-motor self-assessment, or control group prior to the start of the experiment.

Description of the study

Baseline BLS performance was assessed individually. Students received standardised instructions on a laptop computer. On the computer screen they could read the following: “You are asked to help a man who has just collapsed in this room. The manikin in this room represents this man. You have 2 minutes to help the man to the best of your abilities. I will answer questions concerning the victim’s condition but I will not tell you what to do”. A mobile phone was present next to the victim. Student’s actions were evaluated as baseline assessment.

After baseline assessment students joined their preferred partner for intervention and were given 20 minutes to learn BLS by means of task cards. Student pairs received standardised instructions about the experimental protocol, according to their experimental group. In the control group, students were asked to work in a doer-observer relationship. The function of the observer was defined as “with the task cards in one’s hands instructing the doer what to do and giving continuous feedback concerning the correctness of his/her actions”. This feedback also comprised feedback related to the quality of chest compressions and ventilations, based on output from the Skillreporter software that was projected on a white screen during the 20 min intervention. The function of the doer was defined as “following the instructions and taking into account the feedback given by the observer”. Every five minutes students had to switch roles when prompted by the researcher. In the cognitive and cognitive-motor group, students also worked together in the same doer-observer relationship, and also switched roles every five minutes. However, every last minute before the switching of roles the observer asked a standardised question to the doer. This question was printed on an A4 sheet. In the cognitive group this questions was as follows: “Repeat aloud the BLS sequence you have learned by now. Discuss which steps you already perform correctly and which deserve more attention”. During this minute, the doer was not allowed to perform any motor actions related to BLS and CPR. In the cognitive-motor group, the standardised question was as follows: “Repeat aloud and perform the BLS sequence you have learned by now. Discuss which steps you already perform correctly and which deserve more attention". In
both the cognitive and cognitive-motor condition, the observer was not allowed to provide hints or feedback to the doer during this minute of self-assessment. In addition, the doer could not consult the task cards during self-assessment. At all other times during intervention, the task cards were continuously available and served as the only source of information for learning BLS. During all BLS assessments, Skillreporter software was not projected and consequently not visible for students. After 20 minutes intervention time BLS skills were individually assessed. Retention testing occurred two weeks following intervention. Participants were asked not to involve in BLS activities meanwhile. The entire research procedure was supervised by two researchers, in order to validate the study design. Both researchers were experienced in reciprocal peer tutoring and were trained to execute the study protocol in a standardised way.

BLS task cards

Eleven task cards were developed to learn BLS. Their content was developed according to the ERC 2005 guidelines (18) and comprised the instruction of nine BLS items: safe approach, check responsiveness by shaking gently and shouting loudly, shout for help, open airway, check for breathing, call 112, perform thirty chest compressions, perform two ventilations and continue the 30-2 sequence. The performance of chest compressions and ventilations was both instructed on two task cards because of the complexity of these skills. All task cards had an A4 format and combined a picture of the BLS skill with written instruction about how to perform the skill.

Assessment and statistical methods

All BLS assessments were individually completed on a Laerdal AED Resusci Anne manikin connected to a laptop running the Laerdal PC-Skill Reporting system version 2.0 (Laerdal Medical, Vilvoorde, Belgium). This software recorded the following CPR variables: total number of compressions, average compression depth, average compression frequency, hand position, chest compressions without errors, duty cycle, total number of ventilations, average ventilation volume, ventilation flow rate, and ventilations without errors. At baseline, participants were given 2 minutes to act to the best of their abilities. At intervention and retention, assessment was stopped after participants performed three compression-ventilation cycles. Continuous CPR variables were analysed using two-way analysis of variance (ANOVA) with group and gender as independent variables. For all CPR variables analysed with ANOVA, Levene’s test demonstrated homogeneity of variances between groups at baseline, intervention and retention. Scheffé’s test was conducted for post hoc analysis. For all statistical testings a $P$ value less than .05 was considered statistically significant.

RESULTS

In total, 88 university students in Kinesiology were recruited to participate in this study. Two students, both males, were excluded because they reported to have received BLS and/or CPR training before. Eighty-six students were randomised into three groups: $n = 26$ (13 women and 13 men) for
the cognitive self-assessment group, \( n = 30 \) (14 women and 16 men) for the cognitive-motor self-assessment group, and \( n = 30 \) (12 women and 18 men) for the control. Mean age for all participants was 20.3 years, with a standard deviation of 0.5 and a range between 19.8 and 22.3. Analysis of variance (ANOVA) indicated no significant differences in the quality of relationship between partners across the three groups, \( F(2, 83) = 1.68, P = .19 \). In all three conditions partners had similar relationships, with means ranging between 3.2 and 3.8.

**CPR variables at baseline and intervention**

Data for mean CPR variables at baseline and intervention are presented in Table I.

At baseline, no significant differences in CPR performance were found between groups and gender. At intervention, significant differences between groups were found for the average chest compression depth \( (P < .01) \), the percentage of correct chest compressions, \( (P < .01) \), and the average amount of total rescue breaths performed \( (P = .02) \). Post hoc Scheffé analysis revealed that the average chest compression depth was deeper in the control group compared to both experimental groups \( (P = .04) \). Both experimental groups achieved and average depth of 38 mm, which is below the required range of 40-50 according to the 2005 ERC guidelines. The control group achieved 44 mm, which is satisfying. Also for the percentage of correct chest compressions, the control group performed significantly better than both other groups \( (P < .01) \). Students in the control group performed 63% of all chest compressions without errors, whereas students in the experimental groups hardly achieve 30%. Finally, Scheffé found that the average amount of performed rescue breaths in the control group was higher compared to the cognitive-motor group \( (P = .02) \). Concerning gender, ANOVA revealed no significant differences.

Furthermore, the average total amount of compressions performed achieved ERC guidelines in all groups. Chest compression rates were rather excessive, as well as the average ventilation volumes. The percentages of compressions with correct hand placement are high and satisfying. Duty cycles are about 45% in all three groups, which is close to the required 50%. Rescue breath flow rates achieve ERC 2005 standards. The percentage of correct rescue breaths was low.

**CPR variables at retention**

At retention, a significant gender effect was found for the average rescue breath volume \( (P = .02) \). Results show that boys ventilate significantly less (635 ml) than girls (831 ml). No significant group effects were found. Average means for the total compressions performed, chest compression depth, and total rescue breaths performed achieved or closely approached ERC 2005 standards. Chest compression rates were again excessive, as well as the rescue breath volumes. The latter, however, was

<table>
<thead>
<tr>
<th><strong>Table I</strong></th>
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<tbody>
<tr>
<td>Comparison of mean CPR variables and standard deviations at baseline and after three compression ventilation cycles at intervention testing in the Cognitive (COG), Cognitive-Motor (COG-MOT), and control (CON) group. The ( F ) and ( P ) values presented are calculated on between groups intervention scores</td>
</tr>
<tr>
<td>Guideline targets</td>
</tr>
<tr>
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</tr>
<tr>
<td>Total compressions performed</td>
</tr>
<tr>
<td>Chest compression rate (min(^{-1}))</td>
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<tr>
<td>Chest compression depth (mm)</td>
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<tr>
<td>Chest compressions with correct hand placement (%)</td>
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<td>Correct chest compressions (%)</td>
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<td>Duty cycle (%)</td>
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<td>Total RB performed</td>
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<td>RB volume (ml)</td>
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<td>RB flow rate (ml/s)</td>
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<tr>
<td>Correct RB (%)</td>
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</table>

* RB = Rescue breaths.
satisfactory in the cognitive-motor group. The percentages of chest compressions with correct hand placement were still quite high in all groups, in contrast to the percentages of chest compressions without errors. Duty cycles averaged around 43-44%. Also, the percentage of correct rescue breaths remained low.

**DISCUSSION**

This study aimed at investigating the effect of adding self-assessment to a reciprocal learning setting for acquiring BLS with task cards. More specifically, the effect on CPR outcomes was analysed. Results from this study showed that at both intervention and retention, none of the analysed CPR variables was significantly better performed in one of the self-assessment groups compared to the control. Contrarily, at intervention students from the control group outperformed students in the experimental groups on several CPR variables. At retention however, these significant differences disappeared. At first one might conclude that self-assessment has an immediate, detrimental effect on learning which fades over time. However, one could also assume that the effect of self-assessment needs some time to yield results. This could explain why the significant differences disappeared between groups at retention, indicating that the self-assessment groups caught up with the control over a 2-week period. Maybe the experimental groups would even outperform the control if the retention testing interval would be extended. Further research is needed to investigate this statement. Also, a comparison between the percentages of correct chest compressions at intervention and retention in the three groups indicated a more stable performance in the self-assessment groups. Whereas the control group drops about 20%, the cognitive-motor group only drops 3%. Remarkably, the cognitive group gains 10%. This is a clinically relevant finding, certainly because the definition of a correct chest compression depends on the accuracy of three variables, namely hand position, compression frequency, and compression depth. In trying to explain why the self-assessment groups didn’t perform better than the control at intervention, we need to discuss the issue of interaction. During the self-assessment procedures, there was no interaction between learners. The observer was not allowed to give feedback to the doer, even if the latter made mistakes. In addition, the absence of interaction (i.e., feedback) could be detrimental for learning from a social constructivist perspective on learning. According to this theoretical framework, teaching and learning are highly social activities. Interactions with teachers, peers and learning materials like task cards influence the cognitive and affective development of learners (19). It is stated that when learners perform intellectual activities, they dynamically interact with the learning environment which could support improved performance. In the present study, every learner in a self-

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**Table II**

Comparison of mean CPR variables after three compression : ventilation cycles at retention testing in the Cognitive (COG), Cognitive-Motor (COG-MOT), and control (CON) group

<table>
<thead>
<tr>
<th>Guideline targets</th>
<th>Retention testing means</th>
<th>Group</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>COG</td>
<td>COG-MOT</td>
<td>CON</td>
</tr>
<tr>
<td>Total compressions performed</td>
<td>90</td>
<td>91 (6)</td>
<td>87 (6)</td>
</tr>
<tr>
<td>Chest compression rate (min⁻¹)</td>
<td>100</td>
<td>132 (24)</td>
<td>117 (18)</td>
</tr>
<tr>
<td>Chest compression depth (mm)</td>
<td>40-50</td>
<td>41 (7)</td>
<td>38 (11)</td>
</tr>
<tr>
<td>Chest compressions with correct hand placement (%)</td>
<td>N/A</td>
<td>77 (38)</td>
<td>77 (33)</td>
</tr>
<tr>
<td>Correct chest compressions (%)</td>
<td>N/A</td>
<td>44 (38)</td>
<td>24 (36)</td>
</tr>
<tr>
<td>Duty cycle (%)</td>
<td>50</td>
<td>44 (7)</td>
<td>43 (9)</td>
</tr>
<tr>
<td>Total RB performed</td>
<td>6</td>
<td>6 (2)</td>
<td>5 (2)</td>
</tr>
<tr>
<td>RB volume (ml)</td>
<td>500-600</td>
<td>782 (370)</td>
<td>616 (416)</td>
</tr>
<tr>
<td>RB flow rate (ml/s)</td>
<td>500-600</td>
<td>885 (526)</td>
<td>566 (417)</td>
</tr>
<tr>
<td>Correct RB (%)</td>
<td>N/A</td>
<td>8 (16)</td>
<td>11 (16)</td>
</tr>
</tbody>
</table>

* RB = Rescue breaths.
The assessment group was not able to interact with a peer and the task cards for a total of two minutes. This makes a total of 10% of the total learning time (i.e., 20 minutes). When you consider the individual time as a doer (i.e., 10 minutes), 2 minutes of self-assessment even means 20%. The absence of feedback during self-assessment could have caused the significant differences in favour of the control group, where students were free to interact during the total amount of 20 minutes. Future research could therefore investigate the effect of adding peer assessment, which requires interaction, to the present learning setting.

Second, the fact that self-assessment was not able to enhance CPR outcomes might lie in the absence of pretraining in this matter. Research from Dearmley and Meddings addressing the impact of self-assessment on learning among student health care practitioners indicated that students do not always possess effective self-assessment skills (20). As a result, it was stated that self-assessment is a skill that must be taught and practiced to become refined and beneficial. In this study, students did not receive any training in the self-assessment procedure. Also, the process of self-assessment was not analyzed or adjusted. Assuming that pretraining in self-assessment is indispensable to provoke positive learning effects, future research could investigate its impact on the quality of CPR in reciprocal learning. Within the limitations of the present study, it can be concluded that adding self-assessment, whether cognitive or cognitive with additional motor activity, does not enhance CPR performance in reciprocal learning with task cards. Consequently, outcomes from this study do not confirm previous research demonstrating the positive effect of self-assessment (14, 15).

A second research question addressed the effect of cognitive self-assessment with additional motor activity compared to merely cognitive self-assessment on CPR outcomes. For none of the analysed CPR skills, significant differences were found between the two self-assessment groups. This suggests that cognitive self-assessment and cognitive-motor self-assessment are equal. Some proof for this statement can be found in the area of surgery. For learning basic surgical skills, it was found that physical practice followed by mental rehearsal was equal to additional practice (21). This mental rehearsal is related to the cognitive self-assessment procedure in this study, which included the following assignment: ‘Repeat aloud what you have learned by now’. A difference lies in the fact that students had to express themselves verbally in this study, which is not the same as merely mentally rehearsing the past practice session. It seems that for acquiring psychomotor tasks like CPR in reciprocal learning, cognitive self-assessment and cognitive self-assessment with additional motor activity generate equal outcomes.

Finally, this study addressed gender effects in CPR performance. The only gender effect was found for the average ventilation volume at intervention. It was found that boys ventilate significantly less than girls (635 ml compared to 831 ml). This suggests that girls tend to overinflated, and thus perform qualitatively less good rescue breaths than boys. This finding is in line with previous research in peer tutoring, where it was found that boys achieved better performances than girls (8, 22). However, it is noteworthy that research about gender effects in peer tutoring for learning psychomotor tasks is still in an early stage. Further research is needed to provide deeper insight in this topic.

This study, with its limitations mentioned above, demonstrated that adding self-assessment to a 20 min reciprocal learning setting with task cards does not enhance the quality of CPR performance. At intervention, the quality of some CPR variables was even better in the group where no self-assessment was implemented. At retention however, these differences disappeared. Also, no significant differences were found between the group performing cognitive self-assessment, and the group performing cognitive self-assessment with motor activity. At intervention, the rescue breath volume of boys was significantly less than girls. No other gender effects were found.

References