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The Influence of Metacognitive Prompting on Students' Performance in a Motor Skills Test in Physical Education

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Abstract. This study investigated the hypothesis that students' performance in physical education can be improved, if question prompts are used to activate students' metacognitive processes. 241 students, thirteen years old, participated in this study. The students had to face a problem-solving situation: how to effectively perform five attempts in volleyball service in order to achieve the highest score. They had to perform two trials with 5 attempts each and AAHPERD motor skills test was used in order to assess students' performance. During the second trial, all students were given a semi-structured written interview prompting them to activate their high-order thinking. Firstly, paired t-test was used in order to examine differences between the two trials and there were statistically significant differences. Performance scores of the final trial were higher compared to the scores of the first trial. Secondly, a repeated measures analysis showed that there were not statistically significant differences between boys and girls. The results imply that metacognitive prompting has significant influence on students' performance.

Keywords: metacognitive prompting, performance, volleyball service.

1. Introduction

As educators, we have the obligation to pay more attention to the important role of metacognitive strategies which can improve student's performance and reasoning. An important goal for all of us is to create a learning environment that enables pupils to reflect on their own understanding, to become skilful learners and aware of their own processes, as it is very productive to know how to learn or merely to be metacognitively trained (Lin, Schwartz and Hatano, 2005).

Schools' failure is that many students do not think on a reflective level without guidance, so it is the responsibility of the teacher to support them to increase their capacities (Smith et al., 2007). Student's own supervision, self-evaluation process and regulation of their own learning are crucial elements for each individual to learn how to learn in order to be autonomous and productive learner (Schraw, 2002).

Studies have shown that experts in the psychomotor domain use self-regulation strategies like planning and monitoring more effectively than non experts in high strategy sports like tennis and volleyball as well as in low strategy sports like diving (Huber, 1997; McPherson, 1994). Martini, Wall and Shore (2004) who examined a think-aloud protocol to compare the active use of metacognition in children during a psychomotor task, found out that children with developmental coordination disorder didn't verbalize metacognitive concepts as average or high skill children did.

On the other hand, Lidor (2004) found out that the application of appropriate strategies can promote student's metacognitive behavior in physical education classes. Specifically, she investigated the effectiveness of learning strategies on performance accuracy of free throws in basketball. She noticed that the group which applied the strategies: readying, imaging, focusing attention, executing, and evaluating and the nonawareness group that activated thought processes before the throwing act, achieved higher level of accuracy of performance than the awareness group which was directed to feel their movements and the control group.

Nevertheless, few studies have explored metacognition in psychomotor domain, there are many studies that examined ways to improve metacognitive behaviour in other subjects (Bielaczyc et al., 1995; Conner,

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2007; Davis and Linn, 2000; Ge and Land, 2003; King,1991; Koechlin and Zwann, 2007; Lan, 1996; Leow, and Morgan-Short, 2004; Nuckle et al., 2009; Schraw, 1998; Zohar and Peled, 2008). Many of them claim that metacognitive prompting is a promising way that could promote the use of self-regulation strategies, such as selecting and monitoring strategy, evaluating process and outcomes and revising ideas in order to perform effectively (Garofalo and Lester, 1985).

Conner (2007) who used cues and prompts in a final-year high school biology class in order to broaden students' thinking about bioethical issues associated with cancer found that planning for and using cues in units of work helped students to become more responsible for their own learning, something very beneficial for learners. Such a technique of scaffolding provides an opportunity for the students to be independent critical thinkers as they can think carefully about their activities, making use of planning, monitoring and reflection, rather than focusing on smaller goals (Davis et al, 2000).

Schwonke, Hauser, Nuckles and Renkl (2006) who investigated the effectiveness of cognitive and metacognitive prompts in a computer-based environment in order to support the writing of learning protocols revealed that the quality of the learning protocols and the learning outcomes improved significantly by fostering the acquisition of declarative knowledge and deep understanding.

Studies have shown that metacognitive prompts help students stay on task, keep track of their effort and progress (Koechlin and Zwaan, 2007), and are related to more efficient problem solving in mathematics (Hoffman and Spatariu, 2008). Whereas Davis (2003) who tried to examine ways of prompting students for reflection in physical science topics, by comparing generic (stop and think) and directed prompts (hints about what to think about) found that generic prompts helped students with some autonomy to develop significantly more coherent understandings than the others who received directed prompts.

Nevertheless many studies have revealed that metacognitive prompting enhances the understanding of science, there aren't studies about the influence of metacognitive prompts in psychomotor domain. So, our research investigates the effectiveness of metacognitive questions prompts on problem solving in volleyball service. Whether metacognitive prompts help students to be better performers, as researchers claim that students should be able to plan, perform and evaluate movement (Curtner-Smith et al., 2001).

2. Methodology

2.1. Participants

Two hundred and thirty six students (121 boys, 115 girls), aged 13 years old (7^{th} grade) participated in this study. All students were novices in volleyball skills. Students participated voluntarily. There was permission from the school authorities and inform consent was first signed by their parents in order to participate in the study.

2.2. Measures

The AAHPERD (1984-Appendix A) motor skills test for volleyball service was used for the assessment of pupils' performance. Students had to execute 5 consecutive services in a volleyball court. They scored different points (from 1 to 4) depending on the marked area of the opposite court that the ball was landing. For example, if the student's volleyball service was landing in the area near the baseline of the opposite volleyball court he/she was taking 4 points. On the left and the right side of the court he/she could take 3 points, 2 points if the ball was landind in the area between the net and the baseline and finally 1 point if his/her service was in the area near the net. The maximum possible score that a student could earn by executing the 5 services was 20 and the minimum was 0, if they failed in all of their attempts.

2.3. Procedure

Pupils had to consider in which ways they would execute five attempts in volleyball service in order to achieve the highest score which was 20 points. Firstly they had to execute the first trial. In this trial students were directed to pay attention to the shooting act, to feel the movements. A five minute break was given between trials.

Afterwards they had to execute the second trial and each time they performed a volleyball service they had to complete a semi-structured written interview (metacognitive prompting), in order to investigate if the metacognitive prompts helped them to execute better than the first time. The semi-structured written interview that was given to them had five categories of open and closed questions. These questions were designed according to the recent literature for enhancing metacognitive activity (Davis, 2003; Davis & al,

2000; King, 1991) with adaptations to the specific test.

The steps of the research design are:

i) at first, students had to execute the first trial (five volleyball services)
ii) secondly, learners were asked to respond to the questions of the first two categories of metacognitive activity (problem analysis and planning),
iii) afterwards they had to execute the first of the five services in volleyball (second trial),
iv) after the first execution they had to respond to the other three categories of metacognitive activity (monitoring, evaluating, reflecting).

So for each execution of the second trial they had to complete the same written interview.

More specifically, before their first 5-service of the second trial, they had to complete the two categories of the written interview (Appendix B): i) analysis of the problem (e.g. which factors will you control in order to accomplish your goal?) and ii) planning (e.g Do you have a performance design in order to accomplish your goal?). After the completion of the first service execution they had to complete the other three categories of the written interview: iii) monitoring (e.g. Stop and check if your service was accurate. 'Stop and think' about your performance. Does it help you and why?), iv) evaluating (e.g. Was your plan accurate?) and v) reflecting (e.g. what will you do next time if you have to perform a service?), prompting them to activate their reflective thinking. The same procedure occurred in each volleyball service of the second trial.

So a systematic ***analysis of the problem*** completed firstly by the students in which they determined which variables had a causal effect on volleyball services in order to design their performances and secondly they constructed their prior knowledge in an active guided way (e.g. what they had learned and what they remembered about it), thinking carefully how they could execute the service in order to gain a good score. Students were then asked to execute the services of the second trial.

Afterwards the students had to monitor each performance (e.g. whether he/she was right or wrong), to justify it and evaluate the outcome of their efforts in order to ensure themselves that their goal had been met. Following, they had to think and determine what needs could be done (modification strategies, changes in technique etc) to be assured that their goal will be met next time.

3. Results

Paired t-tests were used to assess differences between pre-test and post-test measures. A level of 0.05 was used for determining significance for the statistical analysis. The results of the data analysis indicated a statistically significant difference between the pre-test and post-test, because the second trial's scores were significantly higher than the first trial ($t_{(237)} = -2.99$, $p < .005$). The students indeed performed better in the second trial (M=3.55±3.41) maybe due to the metacognitive question prompts which guided them to assess themselves, think about their failed executions, modifying their strategy and performance in order to gain more points than they did at the first trial (M=3.07±3.17). Finally repeated measures analysis revealed there were not statistically significant differences between boys and girls

4. Conclusions

This study examined the influence of question prompts in students' performance in volleyball service. The results from data analysis revealed that metacognitive prompting had significant influence on students' performance because the students' scores in the second trial were significantly higher than the first. Students claimed that the metacognitive prompted questions encouraged them to reflect on their reasoning strategies, while monitoring and evaluating the performance of each service for the second trial. Every time they stopped and were thinking about their executions, they had the opportunity to plan the next execution, modify their strategies in order to apply the most appropriate of them and improve their performances.

The students in the present study had the opportunity to think before, during and after the problem solution, so they engaged in monitoring which helped them to explain what they did wrong and where the difficulty occurred. Additionally, the metacognitive prompts led them to more accurate evaluation of their newly created knowledge by controlling carefully variables, that influenced their performance, like technique, or the implementation of appropriate strategies for more accurate performances e.g the position of their body or the hit of the ball with their hand, the concentration etc, in order to gain a high score. For these reasons maybe the second trial performance in services was better than the first, because the metacognitive prompting activated the students' reflective thinking and so they executed better next time.

Metacognitive prompting in our research stimulated pupils' awareness of task features and supported

them to think about their goals and their progress guiding them to walk through the activity step-by-step. So they went beyond their prior knowledge and reorganized their performance design by making their thinking explicit which led them to more coherent understanding and higher score.

Our findings are consistent with the notions from other researchers who claim that metacognitive prompting increases problem-solving performance and efficiency through activation of reflection and strategy knowledge (King, 1992; Davis et al, 2000; Lin and Lehman's 1999). And that students' reflection in response to these prompts plays a crucial role in their progress (Chen et al., 2009; Lin and Lehman's 1999; Hatton and Smith 1995) as they become more strategic, autonomous and productive.

According to our findings, metacognitive prompting helped boys and girls to the same degree. This is because a large percentage of boys and girls in physical education have poor metacognitive knowledge of task, person and strategy variables (Luke and Hardy, 1999) and so they demonstrated the same progress after the prompting guide.

So we can conclude that metacognitive prompting has a positive effect not only in intellectual activities but in physical activities too. This is very important because students must learn how to plan, perform and evaluate their movement (Curtner-Smith et al., 2001) in order to engage in the same activities for their entire life.

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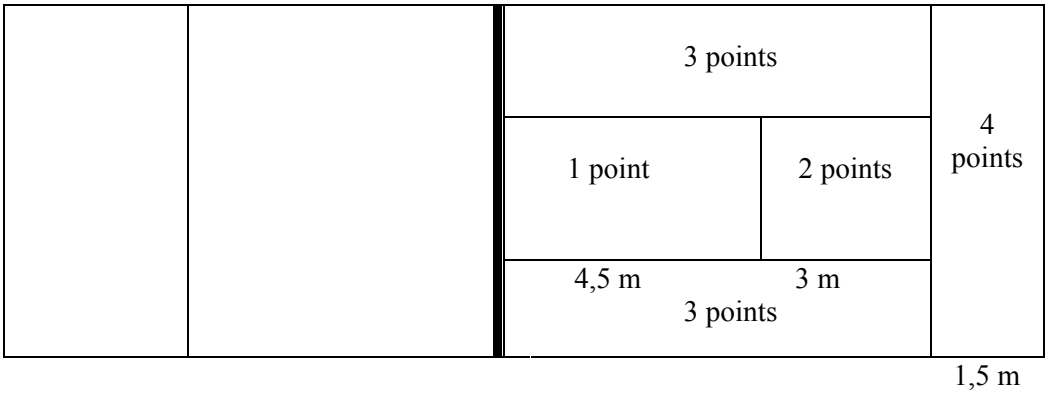
Appendix A

AAPHERD motor skills test



Volleyball court

Appendix B

Semi-structured written interview

Analysis of the problem:

What is the goal of the problem solving situation?

Which factors will you control in order to accomplish your goal?

Planning:

Do you have a performance design in order to accomplish your goal?

According to all that you have been taught, what should you do and in which order so as to send the ball to a specific place in order to achieve your goal?

Service execution…Good luck

Monitoring:

Did you check if you accomplished your goal?

yes no

Stop and check if your service was accurate. 'Stop and think' about your performance. Does it help you and why?

Evaluation:

Was your plan accurate?

1 2 3 4 5 6 7

Can you explain why your service doesn't land at the desired place on the court?

Reflection:

What will you do next time if you have to perform a service?

What would you try to correct in your performances in order to send the ball at the desired places on the court?