Reviewer's report

Title: Learning with case-based worked examples: Comparing the effects of additionally providing self-explanations and making or studying concept maps on physiotherapy intervention knowledge

Version: 1 Date: 30 September 2014

Reviewer: Ralf Schmidmaier

Reviewer's report:

The authors present a well written report on a laboratory experiment with 91 physiotherapy students in an electronic learning environment. The title summarizes the study correctly but is in my opinion only an aggregation of the key words and is not really understandable for the reader. This is good for literature search, but makes it difficult to structure the reading of the article. I prefer to describe the results in the title, not the method, but opinions may differ concerning this point.

The abstract is well written and presents all necessary information.

The introduction gives a good overview about the previous work of the authors and provides the definitions of the used terms in the manuscript. It tries to explain the operationalization of the study, but neglects to some extent the complexity of the problems (e.g. meaningful learning or problem solving) and avoids mentioning alternatives. The whole story about clinical reasoning is much simplified. The idea of the authors was to combine different instructional methods – one after the other – to find the optimal sequence to foster clinical reasoning maximally. Why scaffolding and reflection and why not other strategies? I assume that these methods fit well to the used instructional method of case-based worked examples. Case based worked examples are an established method to foster clinical reasoning, but there remain many open questions regarding the optimal use – no doubts about this. The authors state that it is unclear how to optimize the acquisition of problem solving skills. What do they mean? Problem solving skills in general? Or rather procedural knowledge in the special field of electrophysical intervention in physiotherapy? Do the authors want to optimize a special course in physiotherapy or do they want to gain knowledge about more general principles of problem solving? And especially in the field of electrophysical physiotherapy we do not know whether the chosen methods are suitable only for novices – like in the study – or also for advanced learners or physiotherapists who lack specific knowledge in elecrophysical therapy. I think it is important to discuss these points and to stress the goal of the presented study.

The authors state that worked/completion example pairs “may” be an effective strategy for improving physiotherapy knowledge in novice learners and they cite the available evidence. However, is this really proven? However, we have to assume that it is because this question is not addressed in the presented study
and this variable was kept stable. Based on this the authors want combine this combination with other strategies like self-explanation or concept-mapping to promote more meaningful learning … of procedural knowledge? … of problem solving skills? … of factual knowledge? Meaningful learning in this context means cognitive skills that allow solving new clinical problems – a kind of transfer performance. The authors assume that especially self-explanation would be a potent method to foster (near) transfer. In contrast they assume that concept mapping focuses on conceptual knowledge with less strong effects on transfer performance.

There is a comprehensive review about concept mapping which leads the reader a little apart from the main focus of the study, as concept mapping is a well known method in the literature.

The dependent and independent variables are pointed out in the last section of the introduction, but the reason for choosing conceptual knowledge, near transfer and cognitive load as outcome parameters for better clinical reasoning in a special field is not easily to understand.

The authors clearly show their broad experience in the field and their founded knowledge about the scientific problems and the necessary methods in the introduction. However, I suggest an additional section between meaningful learning and objectives to summarize the rationale, to describe the lack of knowledge, to reason the choice of methods used for operationalization and assessment and also to explain what the limits are and what cannot be addressed by the study in this complex field in clinical reasoning and problem solving.

In the methods section the authors very nicely describe this complex laboratory study. They try to keep it readable on the one hand, but comprehensive on the other hand. I suggest putting the whole material in a supplemental section, not only one example for each. It would be much easier for the reader (who is interested in the details) to understand the complex interactions between the interventions and the assessments. Conceptual knowledge was assessed by six multiple choice questions. Only 2 questions are presented. These two questions do not fulfil the criteria for good quality MCQs as described in the literature (long statements, cues, several statements within one answer, combinations of answers …). Additionally, I am wondering whether 6 (!) questions of uncertain quality provide reliable results. What are the test statistics for this assessment, please present! Furthermore, I am not sure whether it really assesses conceptual knowledge, many of the given examples are simple textbook facts. Also here, please present the whole test. Problem solving skills were assessed by short case scenarios called transfer test. The authors should use a straight nomenclature, what they really mean, they mix transfer test and problem solving throughout the whole manuscript including the table. They should provide the test statistics and the correct solution of the scenario and the rules how the 20 points were distributed. A main difference between the conceptual knowledge test and transfer test is that one is MCQ and the other is open ended question. Retrieval of knowledge is therefore completely different. As far as I can interpret the content and the knowledge dimension of the conceptual test and the transfer test
it is almost the same and both could have been assessed by the same type of question (either open ended or MCQ). Only the difference in retrieval of knowledge (active vs. passive) may explain the differences of the study. I suggest being very careful in the interpretation of the results and generalization of the obtained results in terms of conceptual knowledge, problem solving skill and transfer performance. It would have been interesting to change the sequence of meaningful learning methods to find out, why self explanation was so useful. It can be assumed that self explanation is most potent at the beginning of the session with subsequent studying units.

Results: the authors present theirs results in a very well manner, scientifically correct. I am not surprised by the fact that the concept map study group outperformed in the rather factual knowledge based test as they were confronted with the most conceptual facts during the study. They spent more time on facts studying than the other groups that were prompted to organize knowledge. Of note, there was no increase of knowledge between pre-test and post-test in the latter two. I am also not surprised that the self explanation group outperformed in “problem solving”, because the open ended prompt in the self explanation task is quite similar to the open ended questions in the problem solving tests (“to treat a patient with any pain related problem” vs. “most appropriate intervention”). Unfortunately the study has not included a control group (no fostering of meaningful learning). Is studying concept maps superior to control? Furthermore, the study focuses on very short term effects (within the same session without distractor). Meaningful learning would mean that near transfer (or far transfer) cases could be solved in a long term manner. Therefore, this aspect of the design of the study seems to be crucial for the interpretation of the results. Furthermore, facing the fact of content specificity of knowledge and clinical reasoning, the question whether similar results are obtainable in completely different content domains is not addressed.

Again I have a problem in reading the first section of the discussion as transfer and problem solving are mixed up. Please use a uniform nomenclature to make the manuscript better understandable. To some extent the study design includes repeated testing (e.g. self explanation and completion cases) and repeated studying (concept map study group). These issues should be brought into consideration.

In summary

This is a quite large, prospective, well controlled, randomized trial regarding an important topic in medical education

The manuscript is well written and the data are presented in a usual scientific manner

The study design is well described with clear dependent and independent variables and interventions

Interventions are clearly described and well done

Operationalization and nomenclature are not stringent. This should be revised. Knowledge gap and rationale should be very clearly stated.
The assessments are rather weak, so interpretation should be careful. Limitations of the assessment should be honestly and clearly described in the introduction, in the methods section and especially in the discussion. The perfect assessment of problem solving skills is difficult, so alternatives should be discussed and it should be clearly stated that only a (small) piece was assessed in this study.

Interpretation of the results should be more descriptive, especially in the results section, in the abstract and title. Generalizations should be clearly named as hypotheses. The limitations of the study should be discussed more intensively.

As the topic is important, the study is large and well done I recommend publication. However, the mentioned aspects with nomenclature, operationalization and data interpretation need to be addressed before publication (major revision).

**Level of interest:** An article of importance in its field

**Quality of written English:** Acceptable

**Statistical review:** Yes, and I have assessed the statistics in my report.

**Declaration of competing interests:**

I declare that I have no competing interests