Combining worked-example and completion strategies in a digital learning environment to foster intervention knowledge

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Background: Worked-examples have been used to foster medical and physiotherapy students’ clinical reasoning skills. This study investigated whether combining worked-examples with completion examples could foster clinical reasoning in intervention selection.

Summary of Work: Sixty-two second-year physiotherapy students were randomized in two groups. They solved a pre-test consisting of two authentic clinical cases, each with three questions pertaining to physiotherapeutic intervention selection. Then, they studied two pairs of worked-examples/completion examples in a digital learning environment. Worked-examples presented the written-out clinical reasoning and selection of the optimal physiotherapeutic intervention for a patient with physical impairment. Completion examples were worked-examples in which, at the end, students had to either write out the optimal intervention themselves (experimental group) or select it mentally (control group). All students solved a post-test in the same format as the pre-test.

Summary of Results: Performance on the pre-test was not significantly different between the experimental (mean±SD: 10.8±3.6) and the control (10.1±3.2) groups. Performance on the post-test was higher (P = .045) in the experimental group (14.0 ±4.2) than in the control group (11.5±5.3). The mental effort invested while solving the post-test in the experi-mental group (5.7±1.5) was lower (P = .037) than in the control group (6.5±1.2).

Discussion and Conclusions: Students who completed the examples in writing invested less mental effort on the post-test and outperformed those who answered mentally. Worked example/completion example pairs can foster intervention selection skills in physiotherapy students.

Take-home messages: Combining worked example and completion strategies can foster intervention selection skills.

Does medical education improve the reasoning and decision-making skills of students?

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Background: Errors in medical decision-making are extremely costly for society. Kohn et al. (2000) reported that medical errors were the eighth leading cause of death. Typical biases can be reduced by offering medical students training in reasoning and decision making skills (Hershberger et al., 1994). What is less clear is whether traditional undergraduate medical education in itself might lead to a reduction in these biases.

Summary of Work: A battery of psychometric assessments was used to investigate the following determinants of reasoning and decision-making skills, numeracy, mathematical anxiety, probabilistic reasoning ability, cognitive reflection, and abstract conditional reasoning. Participants were first (n=166) and third year (n=234) medical students. A comparison group of first year psychology students (n=160) participated in the study.

Summary of Results: Medical students had higher numeracy levels, displayed lower levels of mathematical anxiety and showed better probabilistic reasoning performance than psychology students. This suggests that medical students are generally highly confident and competent in dealing with numbers. Third year medical students outperformed the other groups in cognitive reflection and conditional reasoning. Cognitive reflection tasks assess the ability to avoid typical fallacies in reasoning, conditional reasoning problems are additionally related to the ability to reason about unfamiliar and abstract materials. Medical students’ course performance was moderately related to their probabilistic and conditional reasoning skills.

Discussion and Conclusions: Medical education may contribute to the development of abstract reasoning skills and the ability to avoid decision-making biases. These attributes are central to the enhancement of patient safety. The findings indicate that cognitive reflection and conditional reasoning skills improve as medical students progress. Further work is required to determine if this is a direct result of undergraduate medical training.

Take-home messages: Cognitive reflection and conditional reasoning improves as medical students progress through the undergraduate programme.
313 (21743)
Teaching Clinical Reasoning by Making Expert Thinking Visible and Accessible for Students: An Action Research Project with Clinical Educators

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Background: Clinical reasoning is fundamental to all forms of professional health practice, but it is also difficult to teach and learn because it is complex, tacit, and effectively invisible for students. One pedagogical approach to assist educators to teaching clinical reasoning is to make expert clinical thinking visible and then accessible to students. The process of making educators’ expert thinking steps visible and accessible has been researched and previously applied in school settings. It encourages teachers to reflect on the most salient features of the reasoning process and it assists students to access this complex thinking.

Summary of Work: Using action research methodology, 21 allied health and 5 medical educators trialed this teaching approach with their students in clinical teaching settings. This involved identifying their own expert thinking steps in discussion groups; using these steps to develop thinking routines for their students, then evaluating and reporting the impact of this approach on their students’ learning.

Summary of Results: Participating educators found they began to focus more on their students’ understanding and level of reasoning, and they also became more aware of their own teaching styles.

Discussion and Conclusions: Our findings suggest that the making thinking visible approach has potential to act as a scaffold to assist health educators to articulate their own expert reasoning and for students to then access and use to guide their own clinical reasoning.

Take-home messages: Educators can learn to improve their clinical reasoning teaching by making their own thinking visible and then accessible to students.

314 (20633)
Why we do not need a dual systems assumption to explain and teach clinical reasoning

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Background: Recently, “dual process” theories of reasoning and decision making have made their way into the field of medical education, in particular clinical reasoning. These theories assume the operation of two systems in the mind, one rapid, unconscious, and intuitive (System 1), and the other one slow, conscious, effortful, and rule-based (System 2).

Summary of Work: This study critically reviews the implications of the distinction between System 1 and System 2, both from a more fundamental (philosophical) and a practical (research and education) angle.

Summary of Results: It will be demonstrated that from a philosophical point of view, dividing the human mind into two systems that each can make decisions leads to a fallacy. There are also practical problems: the distinction obfuscates, rather than clarifies, the way novice and expert clinicians solve diagnostic problems. In this respect, it does not make a difference whether the two systems are perceived to work in parallel or whether it is assumed that they can interact, if the details of this interaction are not specified. In addition, the dual process view is counterproductive in that it does not generate research that yields useful information about how clinical reasoning can best be taught.

Discussion and Conclusions: Mapping features of clinical reasoning on an underlying cognitive continuum will be more helpful in providing guidelines for research and teaching than a dual process perspective.

Take-home messages: To understand clinical reasoning, more thought should be given to how novices and experts approach diagnostic tasks and by what criteria the accuracy of a diagnosis should be judged.
A Multi-step Examination of Analytic Ability in an Internal Medicine Clerkship

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**Background:** The general problem of clinical reasoning was dissected for students as a step-wise, task-specified examination of analytic steps in a free response, written format, in order to measure the progress of clerkship year students in their diagnostic reasoning skills.

**Summary of Work:** In this open-book examination students wrote responses for three cases presented in video format, each with a common internal medicine problem. In Step One students listed their responses to "What else would you ask this patient?" In Step Two students wrote a “complete problem list”, listing “major” and “minor” problems (five minutes). In Step Three students were each given the correct, full problem list, and wrote an analysis and plan for “problem number one”. Sub-scores for Step One were classified as “Descriptive” and “Differentiating”; for Step Two subscores included “Concrete” and “Semantic” expression of problems. Step Three sub-scores included correct “Diagnoses” listed, “Support of Conclusions”, “Conclusion”, labeling a diagnosis as "definite", "probable", etc ” and an explicit “Dominant reason” justifying conclusions.

**Summary of Results:** 960 students in their 12-week internal medicine clerkship from six consecutive classes of medical students were included. Intracase reliability for steps was 0.6 to 0.8, and reliability across cases was 0.7 to 0.8. Scores increased within each academic year. There were modest significant correlations between students’ scores with workplace assessments in patient care responsibility.

**Discussion and Conclusions:** A free-response, written examination can be targeted to specific analytic steps in the process of diagnostic reasoning.

**Take-home messages:** Progress in students’ cognitive processes may be better understood as specific analytic tasks than as conclusive reasoning.

Combining bimodal presentation schemes and buzz groups improves clinical reasoning and learning at morning report. A randomized, controlled study

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**Background:** The morning report offers opportunities for intensive work-based learning. In this controlled study, we measured learning processes and outcomes associated with report of paediatric emergency room patients.

**Summary of Work:** Twelve experts and 12 non-experts were randomized to four groups and discussed the same two paediatric emergency room patients. The cases were always verbally presented and according to a factorial design groups differed in their use of written cases (verbal only vs. multimodal) and the use of buzz groups (with vs. without buzz groups). The verbal interactions were analysed for clinical reasoning processes. Perceptions of learning and judgment of learning were reported in a questionnaire. Diagnostic accuracy was assessed by a 20-item multiple choice test.

**Summary of Results:** An interaction effect of bimodal presentation and buzz groups increased the odds ratio that clinical reasoning would occur in the discussion of cases by a factor of 1.90 (p = 0.013), indicating superior reasoning for buzz groups working with bimodal materials. For specialists, a positive effect of bimodal presentation was found on perceptions of learning (p < 0.05), and for residents, a positive effect of buzz groups was found on judgment of learning (p < 0.005). A positive effect of bimodal presentation on diagnostic accuracy was noted in the specialists (p < 0.05).

**Discussion and Conclusions:** This study shows that combined bimodal presentation and buzz group discussion of emergency cases at morning report may improve participants' clinical reasoning and learning.

**Take-home messages:** Combined bimodal presentation and discussion in buzz groups of cases improves clinicians' learning.