Analysing Problem Structuring in a Collaborative Explanation Dialogue to Capture Conceptual Change

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Abstract

In medical law education, discussion of real-world cases is frequently used to complement conventional lecture-based learning. However, it is currently unclear how to evaluate whether a discussion does promote the desired understanding of medical law concepts. We report an analysis of conceptual change in dialogues between medical students as they attempted to explain the verdicts in several negligence cases. The analysis relies on a generic cognitive model of conceptual change through problem structuring which indicates how conceptualisations will manifest themselves in dialogues. Our approach offers a basis for developing a framework for evaluating conceptual change in collaborative case based learning. We present arguments for its heuristic value and potential trajectories for further development.

Keywords: medical law education, collaborative learning, conceptual change; dialogue analysis.

Introduction

Collaborative learning with cases (CLC) is a valued method in medical education and training. For example, the cases appearing in this paper are of medical negligence lawsuits and are typical of cases used in the professional training of clinicians. Characteristically, CLC uses problems embedded in a represented context to drive active learning through a process of joint exploration, explanation and solution construction. In spite of the belief in its practical value, the processes through which CLC engenders learning are poorly understood, limiting efforts to develop the method and exploit it. In fact, it is even unclear what the learning outcomes of CLC are, even in the hands of the best practitioners. In this paper we examine the conceptual change evident in the joint construction of an explanation of a case. We treat learning as knowledge structuring and together with models of conceptual change this provides the theoretical background for the evaluation of learning.

Our analysis of the discussions will rely on earlier work on identifying conceptual change by examining how learners conceptualise examples, problems and cases. Previous research has investigated conceptual change in a collaborative learning situation (i.e. not specifically case based). Roschelle’s (1992) influential study on a dyad solving a physics problem relied on the learners’ description of the specific features of the problem situation to identify mechanisms of collaborative learning. In that study, learning was described as the construction of a deep-featured situation at an intermediate abstraction of the literal features of the problem, a description that is an approximation of an expert’s description. Duit et al. (1988) analyse learners’ verbal and non-verbal contributions in a dialogue on a physics concept to trace the development of novel conceptualisations and gain understanding of learning from the trajectory towards those conceptualisations. They show the fragility of insights, the difficulties of peers to accept novel conceptualisation, and speculate that affective and social factors may play a significant role in the advent of this form of learning. These and other studies (e.g. Chan, Burtis & Bereiter, 1997; Tao, 1999) exploit the opportunity to analyse data collected in a group learning situation – mostly verbal but occasionally non-verbal – at a micro level to investigate the effects of knowledge and information on the construction of novel conceptualisations, and the processing of that knowledge and information. Underlying this approach is the assumption that in a group situation, knowledge and processes on knowledge are externalised and become inspectable for analysis.

An important assumption of our own study is that the group of learners can be treated as a single cognitive system that constructs a joint explanation for the case in the sense of a virtualised representation, but that the domain knowledge which each individual possesses is distinct and is modified differentially by the joint explanation. The micro-analysis of dialogues allows therefore insight into the construction process, and into the generic mechanisms of conceptual change.

The study presented in this paper analyses a set of dialogues between undergraduate students as they construct explanations for the medical law cases. The study was conducted in parallel with the students’ curriculum focussing on legal, ethical and practical aspects of becoming a medical professional, within which the students attended conventional lectures on the relevant domain knowledge on medical law. In the study, the students were
given access to a summary of the lecture content to assist their interpretation of the case. The cases are thus a first opportunity to apply abstract conceptual knowledge to concrete situations, and learning is analysed in terms of conceptualising the concrete situations according to the taught knowledge.

**Elements of a Cognitive Model of Conceptual Change**

Conceptual change is a key phenomenon in much learning activity. Early descriptions of it in Gestalt psychology show how people come to recognise the solution of a problem through a re-representation of the situation with which they are confronted and the finding of relations between the separate aspects of that situation. Structural knowledge abstracted in this way may constitute new general knowledge to be used in isomorphic situations, or the structuring process may entail the instantiation of existing general knowledge.

Within this notion of conceptual change, two theoretical commitments are made. First, conceptual change involves the recognition of a high-level structure in the problem situation: conceptual change has occurred when the problem solver is able to see the point of the problem (e.g. Gick & Holyoak, 1980; Hammond, Seifert & Gray, 1991) and is able to relate the concrete elements of the situation into a coherent whole. Second, seeing the structure of the problem situation conditions the interpretation of its separate concrete aspects. The labelling of edges/corners in the reorganisation afforded by a Necker cube serves as a simple analogy to illustrate the interpretation of problem aspects. More generally, the structuring of a problem situation assigns a role to its concrete aspect. In real world problem situations, some aspects will be more or less relevant, and some irrelevant for the problem situation. Accordingly, structuring such a situation may include additionally assigning more or less relevance to concrete aspects.

This view of conceptual change can be well exploited to identify learning: whether a problem has been solved should be evident in how people interpret or classify it, in how they interpret the concrete aspects and in how important they deem these aspects to be for the solution. These forms of evidence constitute the basis of the analysis presented in the paper, and their use will be illustrated after the presentation of the cases and the domain of study.

As described above, the studies were conducted in parallel with the participants (undergraduate students) being taught the principles of medical law through conventional lectures. Our notion of conceptual change must be understood within this educational setting: the requirement to rely on an expert conceptual system taught instructionally means that the students will have to overcome initial lay interpretations and substitute them with that conceptual system. The expert conceptual system is rather unfamiliar to the students and the cases themselves constitute difficult situations even for experts. Constructing the correct conceptualisation is hence a considerable learning achievement in its own right.

**The Cases and the Domain of Study**

Medical law is mostly concerned with two concepts: negligence and liability. A case of negligence can be made if a duty of care has existed in a doctor-patient relationship, and if a physicians’ action or lack of action is implicated in some harm of the person in her care (i.e., there has been a breach of the duty). A case of liability can only be made if it can be established beyond reasonable doubt that a physician’s negligence has *sine qua non* caused the harm. For example, in the case of a clinical intervention that has led to the harm of a patient, a case of liability can only be made if the harm would not have occurred if the intervention had not been carried out.

The cases given for discussion were particularly difficult because in all the situations a physician failed to take action. Causality is clearly difficult to identify from a lack of action. The difficulties the cases present, as well as their interpretations in the courts and in subsequent appeal rulings, will be illustrated in the following cases descriptions.

Three cases were chosen as study material, though we will rely on discussions of only two cases to illustrate our analysis approach. The two cases are the Vadera case and the Chester case.

The Vadera case concerns a young woman who was prescribed the contraceptive pill by her GP (General Practitioner), subsequently developed stroke-like symptoms and then suffered a near-fatal stroke that left her partly paralysed. At the time of the original prescription, the GP had measured Mrs. Vadera’s blood pressure and discounted a high reading as anomalous, rather than as an indication of hypertension. The contraceptive pill can sometimes increase blood pressure and is not recommended for women who have hypertension. The patient claimed that she had seen the GP again after stroke-like symptoms appeared, but the GP disputed this visit. The judgment about negligence and liability therefore turns on the question of whether the GP has prescribed the contraceptive pill to a hypertensive patient.

The Chester case concerns a patient who agreed to undergo surgery to relieve her persistent back pain, but the surgeon did not adequately warn her about the risks of the procedure. There was a low risk that the procedure would worsen the back pain. The surgeon considered the procedure to be the best option for Mrs. Chester; he also was aware that she had an aversion to surgery. The operation left Mrs. Chester with sensory and motor impairment. The judgment about negligence and liability in this case turns on the question of whether Mrs. Chester would have refused the surgical procedure if she had had more knowledge about the risks.

As is evident from these summaries, the judgments on the cases rest on answering a single core question. To reiterate, in the Vadera case, the core question is “has the GP prescribed the pill to a hypertensive patient”, and in the Chester case “has the lack of knowledge about the risks of
the operation affected the patient’s decision to undergo it”. Posing these core questions was key to correctly explaining the cases; identifying whether they have been posed by the students is the aim of the analysis.

The Analyses
Capturing the core ‘point’ of the case. In this section, it will be illustrated how conceptualisations of the cases have been inferred from students’ contributions. First, though, a summary of learning is given. The evaluation of learning relied on our interpretation of the students’ contribution, and specifically, we sought contributions that indicated that the case had been conceptualised correctly. The assessment of the correctness of a conceptualisation provides a mixed picture; in most discussions, the learners had substantial difficulties in identifying the core question of the Vadera case (and more often than not failed to identify it clearly and explicitly), while three groups conceptualised correctly the Chester case. However, two of these groups did so at the very beginning of the discussion, thus learning defined as conceptual change is not evident in the discussions.

The Analyses

Evidencing Conceptual Change
The notion of structuring and its associated notion of the assignment of a role and relevance to individual elements of the case should be the basis for capturing conceptualisations of cases and changes in conceptualisation over the course of a discussion. We instantiated this generic view of the processing of cases as an instrument for our study as follows.

Identifying the participants’ conceptualisation of the case as a whole is based on assaying contributions to the dialogue which assert or imply the core question. These contributions include observations, explanations and questions. Also justifications of verdicts can be used to infer a conceptualisation. Verdicts themselves, due to their simple binary variation (guilty or not guilty) are not very useful for this purpose. There are clearer, but rarer indicators of conceptualisation, such as keywords, key phrases and tell-tale signs (cf. Chi, 1997). Examples of these are: “the problem here is”, “the crux of the problem is”, “this case is about” or “the main question is”. Indicators of the interpretation and specifically the assignment of a role and relevance to individual aspects may also include keywords, but such interpretations are often clearly evident in contributions. When presenting the analysis, the method to identify aspects’ interpretation will become clearer.

The study

Participants, Study Procedure and Learning Environment
The study was conducted in an Internet-based computer-supported learning environment. The environment implemented basic hypertext architecture, a chat facility for quasi-synchronous communication, and a display window. The set of hyperlinks permitted the navigation of the learning material (background knowledge and the cases); when clicking on a hyperlink a case or the background knowledge was displayed in the displayed window. 11 students of a 1st year undergraduate class of a medical school participated in the study. They were paid 10£ for their participation. They were grouped into 4 groups (3 groups of 3 students, 1 group of 2 students). They used desktop computers located in different rooms. The cases consisted of a narrative description of the events and the verdict decided by the court. To give the students some guidance on how to approach the understanding of the cases, some justification of the courts’ verdicts was also included.

The procedure was as follows: first students were asked to read through the background material, a single page summarising the concepts of negligence and liability. Then they were asked to discuss the cases in sequence (each for twenty minutes) and to produce a joint explanation of the reported verdict.

Figure 1 shows a statement on the Chester case demonstrating the correct relating between Mrs. Chester’s knowledge about the risk of the operation and her disposition towards the operation. The contribution rests on the correct structuring of the case’s aspects: it expresses the causal relation between the knowledge about the risks and the decision Mrs. Chester may have made had she known more about them, upon which indeed the judgment in the Chester case rests.

Figure 1. A statement (in group 2) expressing the correct conceptualisation of the Chester case.

A similarly correct conceptualisation is shown in figures 2 and 3, albeit expressed as a question and an explanation.

Figure 2. A question (in group 3) expressing the correct conceptualisation of the Chester case.
so, the verdict is basically based on the fact that the judge did not believe that she would have changed her mind had she been given alternative advice.

Figure 3. An explanation (in group 4) expressing the correct conceptualisation of the Chester case.

As mentioned, keywords and key phrases are valuable indicators of a student’s attempt to conceptualise the whole case. Figure 4 shows an example of a message with the keyword ‘crux’. We rely on this keyword to infer the students’ attempt to identify the core problem of the Vadera case. The utterances expresses the conceptualisation of the Vadera case as a whole: the student identifies the aspect of the ‘second meeting’ as the core upon which the judgement rests. He thus assigns strong relevance to this aspect, an aspect that indeed does not have any relevance in the case (it cannot be known whether the second meeting took place). The utterance indicates hence the incorrect conceptualisation of the Vadera case.

I think that the crux here is whether the second meeting took place.

Figure 4. A contribution (in group 2) containing the keyword ‘crux’. This conceptualisation of the Vadera case is incorrect.

Interpreting Aspects. The second analysis targets the interpretation of the aspects (facts) of the cases. While the aim of the analysis is also to infer the conceptualisation of the case, the aspect analysis, in contrast to the analysis of justification, explanations, questions, etc., infers that conceptualisation from the role the individual aspects play in the question on the defendants’ guilt. For example, the Chester case is decided on the patient’s decision rather than on the extent of the warning. That is, the courts must not consider whether the absence of a more extensive warning is by itself a negligent action, but rather whether that absence has affected the patient’s decision. The judgement hence rests on the causal relation between the extent of the warning and the patient’s decision. Likewise, the Vadera case is not decided merely on the absence of a further measuring of the patient’s blood pressure, but rather on the question of whether the high blood pressure should have been diagnosed as a dangerous symptom of a sustained tendency for hypertension. As is clear from these descriptions, understanding the case means placing the aspects/facts into relations and understanding their role in an eventual verdict.

In addition to a role, aspects have also different relevance in the structure of the case. For example, in the Chester case, the patient’s decision has more relevance than the extent of the warning. Some aspects have no relevance at all. For example, the second visit to her GP Mrs. Vadera claims to have taken place is irrelevant for the judgement of the case. Mrs. Chester’s aversion to surgery does also have no relevance for a judgment.

We report now a few contributions that illustrate how aspects are interpreted. In figure 5, student H incorrectly interprets the lack of adequate warning as the main reason for a negligent verdict. D’s contribution in figure 4, above, is also an indication that the irrelevance of an aspect is not understood.

I get the impression he did not warn her properly so he is negligent.

Figure 5. A contribution (in group 4) showing the incorrect interpretation of an aspect (the extent of the warning) of the Vadera case. The aspect is incorrectly deemed to be of central relevance for the judgement.

Figure 6 shows a contribution focussing on the diagnosis Mrs. Vadera’s GP made after the first BP reading. The interpretation is only partially correct: indeed, student J correctly identifies the diagnosis made on the first BP reading on Mrs. Vadera as the central aspect of the case, but does not ask the question whether this reading can be taken as evidence for sustained hypertension.

I think the case is more to do with should he have picked up on the high blood pressure as something more important than what he thought.

Figure 6. A contribution (in group 4) interpreting an aspect of the Vadera case partially correctly. The centrality of the aspect is recognised, but its causal relation to the harm is not mentioned.

Figure 7 shows the correct interpretation of an aspect of the Chester case: student D correctly identified Mrs. Chester’s decision as the central aspect of the case (rather than the extent of the warning), and further shows how that this aspect will be the one focussed upon in the courts. Specifically, the courts’ decision will rest on accepting Mrs. Chester’s claim that she would have refused the surgery if properly warned.

She can’t claim she would have refused surgery to try and alleviate it.

Figure 7. The correct interpretation of the ‘decision’ aspect of the Chester case (group 2).

Correspondences between the analyses. We will now illustrate the heuristic value for separating the analysis of conceptualisations of the whole case from the analysis of the interpretation of aspects. Intuitively, both the difficulty of the material and the background knowledge, on the one hand, and the group setting on the other should lead to a relatively slow and only gradual appropriation of an insight.
offered by one of the group members. That is, even if one student is able to understand the case and maybe even identify the core question, the effect of a contribution expressing that insight on her peers will certainly not be immediate. In addition, it may even be the case that the student proposing a correct conceptualisation does not interpret the individual aspects according to that conceptualisation. The following figures (contributions of group 3 to the discussion on the Chester case) illustrate the divergence between novel conceptualisations and the interpretations of individual aspects according to that conceptualisation, and the lack of appropriation of a novel (and correct) conceptualisation by one of the group members.

Figure 8 shows an early (incorrect) understanding of the Chester case. Student E proposes (implicitly) a ‘guilty’ verdict on the basis that the surgeon has failed to fully inform Mrs. Chester. The contributions of student C (figure 9) and S (figure 10) show that they agree with this early verdict in principle.

Figure 8. An early incorrect conceptualisation on the Chester case. The student asserts that the judgment should focus exclusively on the failure to inform the patient. This aspect is relevant only if related to the patient’s decision.

Figure 9. Contribution of student C, amending student E’s (figure 8) early verdict, but not altering it in principle.

Figure 10. Student S’s contribution affirms E’s early verdict (figure 8) and underlying conceptualisation

Later in the discussion, student S proposes an entirely new conceptualisation of the case, this time the correct one (figure 11). However, despite the identification of the causal structure of the case, individual aspects (such as Mrs. Chester’s aversion to surgery) remain interpreted outside the new structure (figure 12).

Indeed, within the new structure, Mrs. Chester’s aversion to surgery becomes irrelevant, and S’ mentioning of that aspect after her insight is an indication that role and relevance of that aspect is not yet understood.

The following figures show that student S’ new conceptualisation is adopted by C but not by E. Student E continues indeed to maintain that a verdict should rest on the failure to inform the patient, rather than the patients’ decision (figure 13).

Student C, in contrast, adopts S’ conceptualisation (figure 11) and reformulates it as a question (figure 14). It would be only a small step from this contribution towards the identification of the core question of the case.

Figure 11. Student S’s novel and correct conceptualisation of the Chester case. The contribution represent a radical restructuring of the case, and positions the aspects in the correct causal relation (knowledge → decision).

Figure 12. Student S’s contribution containing a reference to an aspect of the case (aversion to surgery). The aspect is irrelevant within the conceptualisation proposed by the same student earlier (figure 11). Its mentioning is evidence that the novel conceptualisation has not yet led to the re-interpretation of all aspects.

Figure 13. This contribution shows student E’s persistence on her earlier (incorrect) conceptualisation of the case (see figure 8).

Figure 14. Student C’s reformulation of S’s conceptualisation (figure 11).
The selected extracts of this discussion show that (1) novel conceptualisation may not lead to an immediate complete restructuring of the case (in contrast to perceptual restructurings) in the individual proposing the new conceptualisation, and (2) the adoption is structural in that a conceptualisation may be reformulated and expressed in a different dialogical move.

The learning goal of the discussion sessions go beyond the mere correct conceptualisation of the case: it would be desirable if the students would be able to reason as a judge reasons about the cases: a judge’s reasoning focuses on answering the core question of the case. None of the contributions shows that these core questions are explicitly posed. Rather, though questions are sometimes posed, the students fail to understand that it is such questions that decide the case. Correct conceptualisations are expressed as statements, explanations, etc., but the students fail to transform these statements into the core question. Further, the analysis also shows that the students have a tendency to speculate about absent facts or to imagine alternative scenarios (what should have occurred, what could have occurred). Also this tendency shows a failure to reason legalistically about the cases. Court cases are decided on available facts (and all these facts were reported in the case descriptions), and in the absence of some concrete facts a court may decide that a verdict cannot be reached.

The absence of legalistic reasoning may account for the divergence between the interpretation of the cases and the interpretation of individual aspects. Once the core question of a case is identified, the role and relevance of the aspects ‘fall into place’, at it were, i.e. it becomes immediately apparent which facts are essential and irrelevant for a judgment. A judge’s reasoning delivers a verdict supported by the facts, rather than providing a complete and coherent interpretation of the case.

**Discussion**

Analyses of conceptual change have provided researchers with insight into the trajectories of learning of complex domains or difficult problems (e.g. Duit et al., 1988). The micro-analytical approach permits to identify separately the several features (e.g. the type of interactions, the problem space constructed by the students, the material and the task) of learning experiences on actual learning progress, and investigate the interaction between these factors.

The paper proposed a view of conceptual change that may serve as the basis for the development of a more extensive analytical framework enabling educators and researchers to identify conceptual change. We have illustrated the application of our view of conceptual change on data collected in real-world learning settings, and have shown that our approach is applicable.

The approach enables us to identify the locus of the appearance of novel conceptualisations in the dialogue as well as the various transformations a conceptualisation undergoes throughout a discussion. We regard this identification as the first step towards micro-analytical studies that focus on the learning trajectories of individual students, the effect of insights on peers and the conditions under which novel conceptualisations are appropriated by peers.

A possible limit of our approach is the requirement that the learning material permits a clear distinction between deep structural features and concrete aspects. Cases and problems may be seen as the ideal form of learning material amenable to this form of analysis.

The approach demonstrated in this paper is especially useful in combination with dialogue analyses, such as a classification of contributions into dialogue moves or argumentation moves. Ontologically, a cognitive and a dialogue analysis are in contrast: whereas a cognitive analysis attempts to identify the deep structure of a contribution and thus disregards its surface expression, a dialogue analysis’ claims about learning rests on exactly those surface aspects. However, a cognitive analysis contributes to a dialogue analysis by being able to show when learning occurs thus enabling the identification of correlations with dynamic aspect of a dialogue.

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**References**


