Teaching and Learning RESEARCH BRIEFING

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Vicarious learning and case-based teaching:

developing health science students' clinical reasoning skills

Developing expertise in clinical reasoning and diagnosis poses an enormous challenge to health science students. In a three-phase project, we identified the difficulties that health science students in initial training have with clinical reasoning, designed and implemented an online vicarious learning system to address those difficulties, and evaluated the outcomes in terms of learners' experiences, diagnostic skill development and use of professional language.

- Diagnostic accuracy involves the generation of true hypotheses, the ability to rule out alternative hypotheses and consider negative evidence, and the use of professional vocabulary. → Expertise consists of subject specific knowledge as well as more general problem-solving skills. Applying both is an enormous cognitive challenge to students.

- Students working with other students frequently communicate their lack of confidence and indicate when they are 'stuck' or lack knowledge. The discourse of expert tutors operates on a different level and tends to focus on subject knowledge and diagnostic strategy. → Students reassure each other that they are not alone in their difficulties. Observing dialogue vicariously achieves the same learning outcomes as direct participation.

- Stimulated discussions between pairs of students and students and tutors to generate dialogues were useful for students who observed or overheard them 'vicariously'. → Video clips are a rich corpus of reusable learning content. Topics in this project cover subject information, clinical reasoning strategies, and expressions of hesitancy and uncertainty that reassure the learner.

- The majority of students felt that observational learning is an efficient way for them to learn, allowed them to learn more professional ways of talking about clinical concepts, and gave them more time to reflect than traditional teaching. → Vicarious learning is effective across a range of different learning outcomes – cognitive, strategic, affective, social-emotional

The research

This project blended technology-enhanced learning, case-based teaching and vicarious learning - learning by observing the learning of others - in developing the clinical reasoning expertise of health science students.

The project consisted of three phases. In phase 1 we used authentic clinical tasks to identify the difficulties that students face in learning to reason clinically. The objective was to identify the difficulties that students have with clinical (diagnostic) reasoning, defining difficulty as 'an inability to apply formal knowledge in a clinical setting'. We identified a large range of such difficulties and characterised them in three categories, relating to various forms of knowledge, to academic self-esteem and to linguistic terms. This allowed us to develop cognitive/educational models of clinical reasoning. This work informed the phase 2 activities.

In phase 2, we developed innovative methodologies for producing vicarious learning (VL) resources, and produced a large corpus of VL resources specifically designed to target the issues identified in phase 1. They were richly indexed in a structured database for online re-use by learners.

In phase 3 we evaluated learning outcomes for students in terms of skills, professional language use and learners' experiences.

Vicarious learning

Vicarious learning is the notion that people can learn through being given access to the learning experiences of others. Instances include masterclasses in music, the 'Gardeners' Question Time' radio programme, 'crit sessions' in architecture, and the process of clinical teachers going through cases with students. In these situations, one student is the focus of tutorial attention, but the others benefit from observing the interaction. Vicarious learning is a topic of growing interest among educators.

This project aimed to investigate this concept within students' learning of complex clinical reasoning skills. The students involved were undergraduate or masters levels students on the speech and language sciences course at Newcastle University and its counterpart at Sheffield University. The project used a previously developed web-based database of clients with communication disorders, called PATSy, the Patient Assessment Training System (www.patsy.ac.uk). The project sought to extend the system to offer web-based tutorial video clips to assist the students in their learning.

The nature of clinical reasoning

Seventeen pairs of speech and language therapy (SLT) students at the two universities were videoed as they completed a one-hour online assessment of 'virtual patients' that they had not seen before. They used the PATSy TEL system, which is used by 80 per cent of UK SLT teaching departments. One pair of experienced speech and language therapists, who were not part of the project team, also completed an assessment of one of these cases under the same conditions, a previously unseen case selected as one of three pre-selected cases.

Two of the cases had acquired language disorders, aphasia following a stroke, and the other was a developmental case of a child with language difficulties. These pre-selected cases all exhibited a degree of complexity in their clinical presentation. For example, their behavioral profile might be consistent with a number of possible diagnoses of their underlying impairment. Participants were asked to come to a consensus decision and produce a set of statements that described key impairments shown by the case, and if possible, an overall diagnostic category. Very rich data were collected. The students' online interactions with PATSy were recorded with digital computer screen capture of all on-screen activity within PATSy web pages, as well as the notes made by the students. Video of the student pairs engaged in dialogue during collaborative diagnostic reasoning was also recorded.

A conceptual framework was developed that characterises clinical reasoning as a complex skill comprising domain-specific knowledge and general reasoning skills. A model of the process of clinical reasoning skill development was also produced (see figure 1).

Developing effective, reusable VL resources

In Phase 2 of the project, we designed vicarious learning resources to address the students' difficulties identified in Phase 1. Findings from Phase 1 showed that students often have difficulty designing appropriate test administration strategies, particularly with issues such as being systematic and giving equal weight to negative as well as affirming results.

The VL resources were 179 videoclips of educational dialogues between students, or between students and tutors. They were subsequently made available for further learners to observe and learn from by being placed online. Figure 2 shows VL-PATSy.

To make the videoclips, we used a method from second-language teaching called task-directed discussion (TDD) as a means of facilitating dialogue. A TDD is a discrete language activity with a set goal and is a device for generating reusable educational discussion where spontaneous discussion is infrequent and where capturing naturally occurring dialogue is difficult and uncontrollable. For example, a TDD may stimulate discussion by posing the following scenario: 'You have a quantity of evidence in the form of test results - you do not have time to look at all the results - describe a strategy or set of criteria you might use to select the most relevant tests.' TDDs are structured discussions which may lead to a resolution of reasoning or conceptual difficulties.

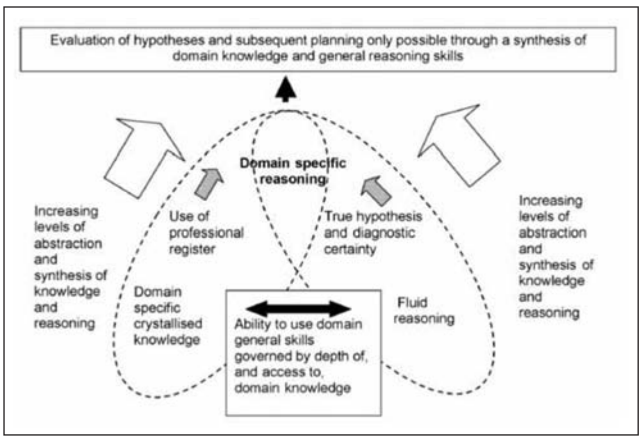
Various types of TDD were used to generate discussions. Another example of a TDD addressing a difficulty in formulating hypotheses might be: 'You notice that a client's speech is difficult to understand on a video. What might be some tentative differential diagnoses and what assessments would you carry out to investigate this further?' Other types of domain-specific TDD addressed topics such as knowledge of language tests, models of normal language production and language pathologies.

Other TDD tasks focussed on the use of professional terminology, for example: 'Read the following description of a client's communication difficulties and then rephrase it in professional terminology'.

Some of the TDDs required the pair of students to use an interactive computer-based tree diagram developed as part of the project (figure 3). In this example, the students are selecting what particular cognitive subsystems are involved when a patient undergoes a particular language test.

The 179 videoclips were all edited, tagged and richly annotated in terms of criteria such as what aspect of clinical reasoning they addressed, whether the participants reached a conclusion, or their duration. This meant that each became a reusable vicarious learning resource. They were then incorporated into a structured database which became an extension of the PATSy 'virtual patient' system and which is now called VL-PATSy. Students may browse VL resources at any point as they work through a case. In another mode of use, the learner's interaction with

Figure 1: Model of clinical reasoning development in health science students



PATSy results in students being offered dialogues by the system itself. VL-PATSy watches the learner's interactions with PATSy and intervenes where necessary. For example, if a student administers an unusual and inappropriate sequence of language tests to a virtual patient on PATSy, the system actively offers VL video clips on relevant topics, perhaps in this case 'hypothesis testing'. Clips with content tags such as 'a student and tutor discuss how understanding what a test does helps with planning a test strategy' and 'a student and tutor discuss confirming and disconfirming a hypothesis' might be offered.

Research Findings

Models and frameworks of clinical reasoning

A framework of clinical reasoning and a model of students' diagnostic expertise development were developed from phase 1 findings. The findings also identified a wide range of teaching and learning issues that the VL resources of Phase 2 could target.

VL resource development methodologies

The TDD methodology used by teachers of second languages was refined and extended by the use of interactive diagrams which we term 'mediating representations'. This proved a very effective way of producing reusable dialogues which were useful for students to subsequently view and learn from.

Major implications

The phase 1 findings strongly suggest that clinical reasoning education should be more informed by findings on the nature of clinical reasoning from cognitive, affective and linguistic perspectives.

Health science students of speech and language therapy face an enormous challenge when learning to reason clinically. Accurate diagnoses require domain-specific knowledge of language and cognition in non-impaired people, of language disorders, of tests of language and what they measure, as well as more generic strategic skills (generating hypotheses, devising efficient test sequences to 'home-in' on a diagnosis, judicious switching from broad to narrow types of test, etc), and knowledge of how to communicate with each other and with practising clinician colleagues using professional language. Each facet needs to be addressed in training, with emphasis on their integration to develop expertise.

Vicarious learning offers considerable scope for modelling all of these skills. The VL resources should be available on demand, when needed by the student. VL offers the additional advantage that students are reassured by seeing other students experiencing the same difficulties as themselves, and by being exposed to other students' discussions of difficult topics. They also gain from observing discussions of the same topics by experienced clinician educators who model professional language use, a process called empathic identification.

Phase 2 findings suggest that educationally effective, re-usable learning dialogues must be designed and facilitated, and do not just happen. Natural dialogue between students or between students and tutors is too poorly focussed for effective re-use. Our findings confirm the potential of task-directed dialogue 'games' as an effective methodology for generating educationally effective, reusable vicarious learning resources. We extended the TDD methodology through the use of graphical representations as used in knowledge engineering. These methods can also be applied to other case-based domains such as law, general medicine and architecture.

In technology-enhanced learning contexts, VL can be personalised by allowing students to decide when to retrieve and view a dialogue or to allow the system to detect their impasses and suggest relevant clips to view, which we term mixed initiative learning.

In Phase 3, learners' experience data indicates that students benefit from VL in their clinical training in skill acquisition, from exposure to good models of professional language use and in their academic self-esteem and self-confidence.

Learning outcomes:

PATSy/VL Patsy usage

Over a 10-week evaluation period involving 68 student participants at Sheffield and Newcastle Universities, each learner interacted on average with nine PATSy virtual cases. Each learner spontaneously browsed an average of 18.1 vicarious learning video clips. In addition they were offered an average of 11.6 clips by VL-PATSy when it detected clinical reasoning issues.

Learner experiences

In a learner experience survey, students provided with VL clips of students in dialogue with tutors responded significantly more favourably to the statement 'PATSy helps me become better at deciding which test to do first with a patient' than did students given access to VL clips in which one student was in dialogue with another student. Both groups were positive, but those exposed to student-student dialogue were less positive than the students exposed to student-tutor VL clips. Compared to traditional forms of teaching and learning, students felt that vicarious learning 'helped them reflect' 'somewhat more' (55 per cent), and 'much more' (7 per cent).

The survey also covered learners' experiences of VL-PATSy. The question: 'Was it useful when the system suggested clips for you to watch?" produced mixed responses overall: very useful 9 per cent, useful 27 per cent, somewhat useful 29 per cent, not sure 20 per cent, and not at all useful 15 per cent. More positive were the answers to the proposition: 'Compared to traditional forms of teaching and learning, learning by observing others helped me reflect,' at somewhat less 2 per cent, about the same amount 36 per cent, somewhat more 55 per cent, and much more 7per cent.

In other response, 'Clips in which the discussion did not lead to firm conclusions or results are not useful to me to learn from' produced the response: strongly disagree 1.8 per cent, disagree 41.8 per cent, neutral 24 per cent, agree 22 per cent, and strongly agree 11 per cent.

The question 'I would have learned more if I had been a participant in the discussions, rather than just an observer' also produced equivocal responses: strongly disagree, 2 per cent, disagree 28 per cent, neutral 26 per cent and agree 43 per cent. Finally the proposal that 'Being an observer of (rather than a participant in) a discussion gives you more time to reflect and think about what's being said' produced responses: disagree 2 per cent, neutral 18 per cent, agree 73 per cent and strongly agree 7 per cent. The phase 3 evaluation yielded extensive rich data and analyses are ongoing. We are particularly interested in assessing the extent to which vicarious learning develops students' use of professional language.

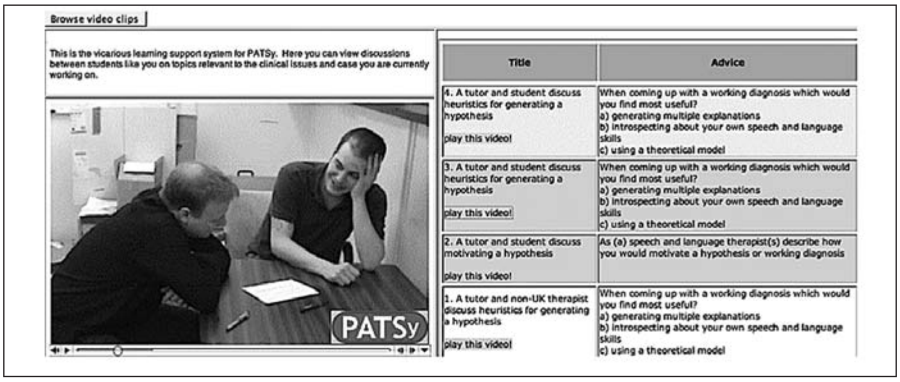


Figure 2: VL-PATSy browse mode interface. Panel on right provides a scrollable list of VL video clips available to the student, together with a description of the clinical reasoning topics that each addresses. Darker-coloured items have already been viewed by the learner. A VL dialogue videoclip still is shown on the left.

Further information

Publications include:

Cox, R. & Lum, C. (2004) Case-based teaching & clinical reasoning: Seeing how students think with PATSy. In Brumfitt, S. (Ed.) Innovations in professional education for Speech and Language Therapists, Whurr.

Cox, R. & Pang, J. (2007) Vicarious learning and (virtual) case-based teaching in health science education. In P. Kokol, V. Podgorelec, D. Micetic-Turk, M. Zorman & M. Verlic (Eds) Proceedings of the 20th IEEE International Symposium on Computer-Based Medical Systems, Los Alamitos, CA: IEEE Computer Society, 657-662.

Cox, R. & Pang, J. (2007) VL-PATSy: Facilitating vicarious learning via intelligent resource provision. In R. Luckin, K. Koedinger & J. Greer (Eds) Artificial Intelligence in Education:Building technology rich learning contexts that work.

Hoben, K., Varley, R. & Cox, R. (2007) The clinical reasoning skills of Speech & Language Therapy students. International Journal of Language and Communication Disorders, 42, 123-135.

Howarth, B., Morris, J., & Cox, R. (2007) Student-centred discussion as an on-line vicarious learning resource for educators in speech and language therapy. European Association for Research in Learning and Instruction (EARLI) Conference, SIG 7: Learning and Instruction with Computers, Budapest, Sep.

The warrant

The findings presented in this briefing are based on a three-phase program of research involving over 100 undergraduate and post-graduate students in two University health science departments, plus several expert clinician educators. In the three project phases the research intensively exploited educational technologies not just for teaching and learning support and interactive multimedia content delivery, but also for rich research data capture. Learner-technology interactions were captured in real time at the level of mouse movements and screen navigation. Synchronised video of the computer screen and the participants, with audio, were also collected

Clinicians gave expert assessments of students' performance. Several expert clinician educators also performed the same tasks as students, allowing comparisons between experts and novices. Issues in students' clinical learning were based on studies conducted in authentic assessment contexts, for example the diagnosis from scratch of language disorders in difficult and previously unseen adult and child cases by pairs of students whose discussions were recorded and analysed in detail. This allowed us to target a range of areas of difficulty for students – strategic, cognitive, linguistic, knowledge-based and social and emotional, including academic self-esteem and confidence.

We devised innovative task-directed discussion methodologies for producing educational dialogue on this wide range of learning issues, including discussions involving interactive tree-diagram representations of clinical knowledge.

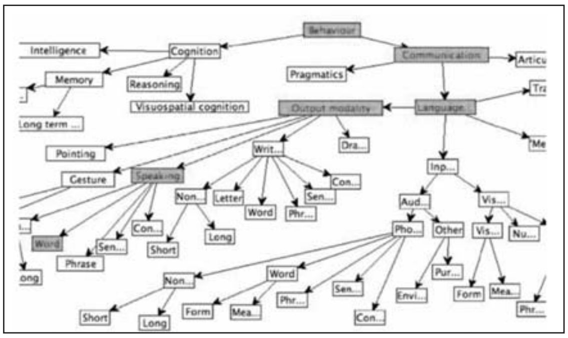


Figure 3: interactive online tree diagram. Part of the interactive online diagram of cognitive subsystems.

Project website:

http://www.vicarious.ac.uk

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Teaching and Learning
Research Programme

TLRP involves some 90 research teams with contributions from England, Northern Ireland, Scotland and Wales. Work began in 2000 and the Technology Enhanced Learning phase will continue to 2012.

Learning: TLRP's overarching aim is to improve outcomes for learners of all ages in teaching and learning contexts across the UK.

Outcomes: TLRP studies a broad range of learning outcomes, including the acquisition of skill, understanding, knowledge and qualifications and the development of attitudes, values and identities relevant to a learning society.

Lifecourse: TLRP supports projects and related activities at many ages and stages in education, training and lifelong learning.

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Expertise: TLRP works to enhance capacity for all forms of research on teaching and learning, and for research informed policy and practice.

Improvement: TLRP develops the knowledge base on teaching and learning and policy and practice in the UK.

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