Article

e-learning and digital media

E-Learning and Digital Media
0(0) 1–11

DOI: 10.1177/2042753015571839
ldm.sagepub.com

Still to learn from vicarious learning

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Abstract
The term 'vicarious learning' was introduced in the 1960s by Bandura, who demonstrated how learning can occur through observing the behaviour of others. Such social learning is effective without the need for the observer to experience feedback directly. More than twenty years later a series of studies on vicarious learning was undertaken in the context of technology-enhanced learning in mass higher education. These studies employed the idea in a rather narrower sense, defining it as learning through observing others in the *act of learning*, focusing in particular on the kind of conceptual learning that is typical in higher education and is best observed in tutorial settings. The key proposal was that multimedia recorded versions of tutorial dialogues could be chosen for their effectiveness in revealing the way concepts are grasped, questions posed and problems solved, from the perspective of real learners rather than from that imagined by teachers. These recorded dialogues could be linked to the primary subject matter and, it was hoped, would constitute a powerful resource for new students who would otherwise not have the opportunity to benefit from a teaching method which, if restricted to the original participants, simply does not scale. This paper reviews the subsequent research that has continued to explore this idea. Overall, the potential importance of vicarious learning in various kinds of subject matter has been confirmed. Research on vicarious learning continues to resonate with fundamental issues of the design of higher education in a digital world.

Keywords
Digital, higher education, online, reusable resources, social learning, tutorial dialogues, vicarious learning

Introduction

There exists a particular method for enhancing learning that seems ideal for exploitation by modern technology in educational settings. It is based on sound pedagogy and there is now nearly twenty years of evidence from experimental and laboratory -based research to confirm its effectiveness. Its most telling advantage is that it offers a highly cost-effective solution to

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the problem that in higher education (HE) generally it is no longer possible to offer students individual attention at the level they might require. This method offers students at least some of the benefits of small-group or even one-to-one tutorials. Strangely, the approach remains almost entirely absent from mainstream HE.

There are actually at least two broad methods that fit the above description. The first of these involves the historic dream of educational technology: to automate learning and teaching by programming a computer to act as an always available and infinitely patient personal tutor. Intelligent tutoring systems (ITS) have occupied an important niche in artificial intelligence (AI) research and there are now many examples of success, where students have shown real learning gains, in some cases rivalling the effectiveness of a human tutor (VanLehn, 2011). Unfortunately ITS also face at least two serious obstacles to their wider introduction into mainstream HE (Muldner et al., 2014). One is the cost of their development; the other is that they are limited in the range of their application to highly proceduralized and formal domains, such as mathematics or physics.

It is the second broad approach that is the subject of this paper. It involves learning by observing others learn and it is generally referred to as *vicarious learning* (VL).

The term 'vicarious learning' was introduced in the 1960s by Bandura (see, for example, Bandura et al., 1963) who demonstrated how learning can occur through observing the behaviour of others and by noting the consequences of that behaviour for those being observed. Such social learning is effective without the need for the observer to experience feedback directly. Bandura's introduction of the idea – vicarious reinforcement – was based on now-classic studies in which children were seen to imitate the aggressive behaviour modelled by adults as they assaulted *Bobo* dolls. In fact, the concept of learning through imitation had been discussed from more or less the beginnings of learning theory in the early twentieth century (see Gholson et al., 2010). However, the subsequent reintroduction of the term 'vicarious learning' in learning research in the 1990s involved a narrower meaning, depicting learning through observing others specifically in the act of learning – rather than referring to observational or imitative learning more generally. Furthermore, the research was now conducted in the specific context in technology-enhanced HE and the kind of learning studied was mainly conceptual rather than behavioural.

The need for dialogue

In the mid-1990s a number of researchers (e.g. Mayes and Neilson, 1995) started to focus on the question of how technology could be designed to put tutor–student discussion back at the centre of the individual student's experience, where that discussion focuses on the student's developing comprehension. This was a reaction to what was seen as a trend in HE towards testing comprehension solely in the performance of assessment tasks, rather than through feedback in dialogue in which a student is encouraged to develop self-explanation. At that time of rapid expansion of HE it seemed clear that the main component being lost from the student experience was indeed tutorial dialogue. In a number of papers (Mayes and Neilson, 1995; Mayes and Fowler, 1999; McKendree et al., 1998), attention was turned to ways in which technology could help to alleviate or even reverse this trend.

The starting point for this research involved the description (Mayes and Fowler, 1999) of a principled way of distinguishing three different ways of using technology – called, in the terminology of the day, 'courseware'. Each type of technology was mapped onto a particular kind of learning. Thus, one kind of technology was mapped to *conceptualization*, in which the learner explores content – subject matter – and attempts to relate the new material to what is already known. This is served by what was called *primary* courseware, the familiar stuff of content – multimedia, web sites, documents, simulation, even virtual reality. In contrast, *secondary* courseware was defined as the set of tools which learners use to operate on this primary material, and the products of these operations. These might be applications with which students compose multimedia essays, or problem solving environments, or self-assessment tools. Essentially, secondary courseware supports learning by doing, and maps onto the learning stage of *construction*, named thus to emphasize constructivist assumptions about the need to situate learning in meaningful, task-based activity, including the co-creation of content.

So what kind of technology would support the kind of learning that is achieved through discussion between learners and tutors? The key problem can be stated as follows. How can technology be exploited so that the benefits of dialogue be achieved in a 'smart' way, through offering students the essence – the enhancement of understanding – without the costs of increased access to human tutors? The view of tutorial dialogue that was targeted by the imagined *tertiary* courseware, as well as the asking and answering of questions, also included challenge and argument, the exchange of views, summoning of evidence, refinement of categories, suggesting links. At that time there were no examples of ITS that employed conversational dialogues of this kind (Graesser et al., 2001).

By the mid-1990s it was becoming clear that HE dialogue would increasingly take place online. The question was raised: is it possible to capture online dialogue and somehow reuse it for the benefit of learners who had not had the opportunity to participate directly? Thus, in attempting to answer this question, the modern work on VL was initiated in a series of studies by Lee and Mayes and their collaborators in Scotland (Cox et al., 1999; Mayes et al., 2001; McKendree et al., 1998).

An early inspiration was offered by Ackerman and Malone's (1990) *Answer Garden* which provides for the development of databases of commonly asked questions that grow 'organically' as new questions arise. A previously unanswered question would be directed to the appropriate expert who enters it, along with the answer, into the database. However, in exploring how readily such a database could be constructed for real courses, the researchers discovered that even in a comparatively technical subject (computers in education) questions that were aimed at clarification of concepts were surprisingly infrequent and some students were very reluctant to ask questions at all. When questions were asked they tended to be restricted to a shallow factual level. An important conclusion from these trials was the difficulty of eliciting natural dialogue that had any of the characteristics that were judged to be suitable for reuse (Lee et al., 1998).

Underpinning this research effort was an expectation that learners not only *can* learn by observing other learners, but also will actively want to do so. But why should a learner find recorded tutorials or peer discussions any more engaging than conventional subject matter? The assumption is that the VL material will offer a learners' perspective on the subject matter, notoriously difficult for subject experts to achieve (Chi et al., 2001), and that observing other learners at much the same level of understanding will engage the observers in a way that simply accessing conventional subject matter could not achieve. If the observed dialogues also offer a model of how to ask questions and attempt self-explanations, then so much the better.

Experimenting with vicarious learning

Having established that dialogue of an appropriate kind is hard to capture spontaneously the researchers devised a way to facilitate its production (Mayes et al., 2001). Before embarking on this, however, it was necessary to establish that vicarious dialogues really can help to promote learning. If they have no particular advantages over conventional content in the form of the usual expository materials, then it would seem hardly worth the effort of capturing and storing such resources.

An initial study was designed to compare primary expositions – text and worksheets – to versions annotated with captured dialogue (Cox et al., 1999). In a course on 'Human Communication' students had difficulty with the problem of learning formal techniques for analysing English sentences. In particular they found it hard to construct syntax-trees revealing the grammar of sentences. A computer-based tool was developed to assist the students in creating and editing these diagrams. Employing this in the basic learning task, recordings of an expert monologue were compared with those of a student–tutor dialogue. In the monologue case, a tutor constructed a diagram while explaining the activity for the benefit of students. This was presented as a movie of the manipulation of the computer tool, together with a transcript of the tutor's commentary. In the dialogue case, a novice student constructed the diagram, with appropriate assistance from the tutor. There was also a condition in which students were presented with animated diagrams accompanied by transcripts of the recorded monologue. There was no clear difference between students given the dialogues and those given the 'direct instruction' monologues, but both of these produced significantly better results than conditions where students were given only animations of the diagrams or only text materials. It was therefore concluded that these dialogic recordings are indeed effective for learning.

Before the new interest in vicarious *learning* there had been research that looked at differences between direct participation in a task and simple observation of it being performed. This strand of work was initiated by the studies of Schober and Clark (1989) in which pairs of participants communicated about a task that involved sequencing figures correctly. Simply overhearing the dialogue, rather than participating directly, resulted in poorer performance, leading Schober and Clark to conclude that the direct participants had an advantage by being able jointly to construct a common ground of comprehension. In fact, Lee (2010) has pointed out that in these experiments the 'overhearers' were actually rather good at understanding the dialogues, especially when they heard them from the start. Using a similar task, Fox Tree and Mayer (2008) demonstrated that it was the number of 'perspectives' contained in an overheard discourse that was important, rather than whether it was a monologue or dialogue. The extent to which an overhearer is able to adopt common ground with the direct participants is crucial in these comprehension tasks, but this is likely to be the outcome of a complex interaction involving many variables which define how the various participants relate to each other. Thus, as Lee (2010) has argued, the alignment of the cognitive processes of vicarious and direct comprehenders is likely to be determined by a socially grounded process, the identification of one learner with another being essentially empathic.

Chi et al. (2009) reported what was essentially a replication of the Schober and Clark (1989) study on overhearers. Here, though, the overhearers were required to be active, by self-explaining aloud while overhearing a tutor/tutee interaction on how to assemble a portion of a radio kit. In this condition the overhearers did just as well as the original tutees.

Chi et al. suggested that the difficulty experienced by overhearers was more to do with their passive listening per se rather than the lack of direct interaction with a tutor.

It was next decided to find a way of generating suitable dialogue, rather than trying to capture it spontaneously (Dineen et al., 1999). A series of structured activities was designed, called *Task Directed Discussions* (TDDs). These were tasks that actually required learners to engage in meaningful structured discussion, based on approaches used in second language learning. Using these, learners are engaged task by task in deeper thinking about the to-be-learned concepts, simply through participation in structured discussion. TDDs are essentially constructivist tasks in which the learners' developing understanding of the subject domain is made visible. Altogether, eleven TDDs were devised, with varying manipulations of the concepts required through discussion with a peer learner. Each task focused the learners' attention on an explicit and shared set of concepts that had been derived from the course content. To give one example: in the *Defining Terms TDD* one student attempts to describe a concept well enough for another to identify the concept through further questioning.

The video clips of these discussions were indexed into a multimedia database which linked to the primary content. Using this system a study was then undertaken in which students took part in a 10-hour learning experiment (Mayes et al., 2001). The task was to learn and understand enough of the subject matter to achieve a post-test criterion score. Two groups were matched on prior knowledge, stated media preferences and attitude toward discussion. One group saw the primary learning material only; the other had additional access to the database of TDD-derived discussions. There was no requirement in the latter condition actually to use this resource. The assumption was that subjects would only attempt to retrieve those examples of discourse from the database that would help them in the interpretation and understanding of the course content. Each media clip in the tertiary courseware could be retrieved by topic, the kind of TDD or the medium. Eventually, the students were divided into groups and, in order to improve their performance, then participated in an online discussion of the material. The data revealed good evidence for a VL effect. Those students who chose to spend most time observing discussions subsequently structured their own free discussions in ways that resembled what they had observed. Moreover, these participants then showed real learning gains.

Similar results were reported by Craig et al. (2000) who demonstrated that students can acquire the cognitive skills necessary for effective learning by observing a dialogue between an animated virtual tutor and a virtual tutee which involved deep questions. The vicarious learners then asked more deep questions and learned more. Driscoll et al. (2003) were able to demonstrate that this vicarious effect of observing deep questions emerged when the questioning occurred in a dialogue, rather than when the questions simply represented advance organizers in a monologue.

In a further use of the TDD approach, Cox and Pang (2007) report on VL in the context of educating speech and language therapists with *PATSy*, a system for providing virtual patients, including case histories, video interviews and test results. A range of TDDs was developed for this context and the resulting dialogues between peer students or students and tutors were offered at key points in the diagnostic reasoning process. Again, the approach was effective (Lee, 2010) though it is acknowledged that generating dialogues through TDDs is much less cost-effective than exploiting dialogues occurring spontaneously. However, as Lee argues, we have as yet no general method for identifying dialogue episodes that are likely to make effective VL resources, not least because the potential value of a dialogue will often be particular to an individual learner. A natural possibility, then, is to invite learners themselves to identify effective dialogues, an approach developed by Rabold et al. (2008) in a system called *YouTute*. A web-based interface allowed students to edit streamed tutorials by tagging, annotating and sharing with other students. This approach has been especially well received by students as a revision aid. In effect, the identification of suitable dialogues becomes here a form of social networking learning activity, as well as a kind of crowd-sourcing for effective VL material.

Enhancing the impact of vicarious learning from dialogues

In an attempt to understand how VL can be best employed, several studies have explored observation of tutorial dialogues with various manipulations of the vicarious activity. Rummel and Spada (2005), for example, showed how vicarious learners will benefit from various kinds of prompting during observing, particularly prompts to self-explain. Gholson and Craig (2006) have reviewed the evidence on prompting, concluding that, for vicarious learners just as for the original participants, self-explaining and deep questioning are key to learning. Their review concludes that prompting can be effectively automated but it is not clear how effectively when learners are aware that the prompts are being generated by a computer.

Chi et al. (2008) have investigated VL in an interestingly different variation, by setting the vicarious learners a collaborative task. In their study pairs of students, required to learn how to solve a physics problem, together viewed recordings of another student being tutored in the same problems. The students doing the observing learned just as effectively as the tutees being tutored individually. Working and observing in pairs was better than just observing alone, and observing a dialogue was better than just working together from a textbook. Chi et al. attribute the effect to the interactivity with a peer, encouraging each other to become constructive observers. They state: 'In essence, collaboratively observing combines the benefit of tutoring with the benefit of collaborating'. The same result was reported by Craig et al. (2009), where the advantage for collaborative observing was seen to lie in long-term retention and transfer measures, and by Muldner et al. (2011), where the result was replicated in conceptual learning. The latter study again showed an advantage for observing in pairs, rather than alone, and confirmed that this was more effective, at least for some question types, when observing dialogues rather than just viewing a 'talking head' monologue.

The importance of what is observed

The more we learn about tutorial dialogues, the more important it seems to become that they are carried out skilfully (Chi et al., 2001). In fact, the detailed protocol analysis conducted by Chi et al. (2008) revealed that tutoring is effective when tutees are independently or collaboratively constructing knowledge with a tutor, but not when the tutor independently tries to convey knowledge directly. Similarly, Muller et al. (2007) demonstrated that students who viewed a tutorial in which 'alternative' conceptions of physics were exposed and then resolved, learned significantly better than those who merely received the subject matter in conventional expository style. All this is very compatible with the literature on the importance of encouraging self-explanation (Chi et al., 1989) and the finding that learning from tutorials is improved when tutor explanations are actually suppressed (Chi et al., 2001). In their 2011 review of tutoring, Graesser et al. (2011) suggest that it is too sweeping a generalization to conclude that human tutors are generally insensitive to their students' knowledge states, but their sensitivity is to the micro-level, rather than the macro. VanLehn's (2006) distinction is between the 'inner loop' (covering individual steps or expectations within a problem) and the 'outer loop' (the selection of problems, judgements of mastery, more global aspects of tutorial interactions). The evidence suggests that tutors are generally poor at outer loop judgements.

It follows, as we understand more about what makes a tutorial effective for the participants that VL also will depend on the nature of the tutorial dialogues being observed. In the context of most of the examples reviewed here, effectiveness of learning equates to depth of understanding. The key is likely to be the encouragement provided by the observed dialogue to use constructivist thinking, whether that encouragement stems from interacting directly with a peer, or by observing a tutorial (or a structured discussion between peers, as in TDDs) in which knowledge building dialogues occur. Chi (2009) has attempted to untangle the differences between the overt processes of active, constructive and interactive learning. The distinctions are quite close to the taxonomy of learning described by Mayes and Fowler (1999). Active learning is essentially 'attending': encoding new information, activating and filling in gaps in existing knowledge. Being constructive involves integrating new knowledge with old – creating new understanding by repairing and enhancing what was previously understood. Being interactive involves constructive activity with the advantage of a partner's contribution and feedback in the building of a shared understanding. From this analysis Chi (2009) put forward a testable hypothesis, that in overt learning active is better than passive, constructive is better than active, and interactive is better than constructive. Support for the hypothesis was found in the existing literature involving many different learning tasks, including the range of activities performed in the observing tutoring experiments.

Mayes 2001, Mayes et al. (2001) and Fowler and Mayes (1999) have speculated that the potential effectiveness of observing dialogues will depend on the strength of the psychological identification that the new learner can develop for the original participants, and on the extent to which the dialogue is considered relevant to the achievement of the learner's own goals. This perspective invites an analysis of the effect at a social level, connecting with current understanding of the social dimension in scaffolding (e.g. Pea, 2004). Indeed, Lee (2010) has suggested that the additional advantage that comes from collaborative VL may be due to the way it can enhance the empathic engagement with the original learner. It also raises the idea that much VL will occur spontaneously and informally through internet-based social networking.

Why is the approach still unexploited in practice?

Let us now turn to the main justification for the kind of research effort described above – its application in practice. It is hard to be definitive but it seems that if there are any compelling examples of VL from tutorial dialogues being applied in real practice, at any level of education, then they have not reached the educational development literature. This is puzzling, not least because the approach seems to offer at least a partial solution to the most basic problem that faces mass HE – the need for individual students to experience dialogue about their understanding of their subject.

There are several possible reasons why an approach such as the one described here should fail to emerge from the laboratory. First, there is a generic resistance to technological innovation in HE, especially where the opportunity cost – in leadership and time – is high. Ellis and Goodyear (2010) describe universities as ecosystems, in which conceptions of learning will play a key role in determining how they adapt. Thus, an appreciation of the implications of constructivist pedagogy must be paramount. In the case in question, however, there is an additional barrier: the research still seems incomplete, particularly with regard to how to identify tutorial dialogues that are appropriate for a particular student in a particular subject at a particular level. The existing research can be seen as having provided proof of concept, but without more evidence about larger-scale application of the idea in real courses, or widening the scope beyond HE, it remains insufficiently well evaluated to unlock the investment required for the exemplars to be fully developed and implemented. The approach taken by the *YouTute* system (Rabold et al., 2008), where the learners themselves identify suitable dialogues, is very promising but, again, has encountered barriers to evaluation on the scale required.

Since the modern work on VL began in the mid-90 s we see emerging from the global phenomenon that is social networking a characteristic behaviour perhaps best understood at a cultural level. This can be described as an eagerness to share experiences (through 'like', 'follow', 'friend', etc.) that stands somewhat in contrast to the norm of individual learning that still characterizes HE. Indeed, it seems plausible to argue that the main barrier to the introduction of technology-supported VL is more to do with norms concerning the visibility and sharing of student work than it is about a reluctance to adopt digital pedagogies. The current norm in HE is to treat individual feedback as confidential. However, if expectations were established from the start of students' HE experience that records of their interactions, as well as feedback on assignments, would be available to their peers, and to future students, then we might create a climate of sharing in which technology enhanced VL could flourish. It ought not to be beyond our capacity to design safeguards that would protect individuals from any negative consequences from such a change. Conceivably, an opt-out approach to the sharing of feedback could be introduced as a first step. This might also help to create the conditions for a new approach to feedback practice in general, challenging what Molloy and Boud (2014) have called the 'feedback ritual' and favouring a shift towards regarding feedback as a continuous system of engaged learning, rather than as discrete episodes of assessing performance. Observing the feedback to others would become a natural component of such a change in culture.

Currently, an ideal window of opportunity exists to explore the impact of changing expectations about sharing feedback. This can be found in the wave of development in *Massive Open Online Courses* (MOOCs) which has opened opportunities for new norms and affordances to evolve rapidly with regard to feedback practice. In many existing MOOCs individual feedback is achieved through some form of machine marking. In many others, however, in domains that do not readily offer automated feedback, what are termed as open-ended assignments are the focus of a significant current research effort aimed at improving the reliability and validity of peer assessment (see, for example, Piech et al., 2013). Nevertheless, one would predict that the comparatively low expectations about individual feedback in MOOCs ought to lead to an appreciation of the chance to benefit from feedback to others. It will be surprising indeed if vicarious learning approaches of the kind described in this paper do not find a place in the developing MOOC ecosystems.

Finally, it is worth considering whether our approach to the introduction of technology in the enhancement of learning might now be misaligned with the way web tools are adopted in general use. It may be that, before experimenting with the design of new technological solutions to support VL, we might more profitably look at how aspects of VL have emerged spontaneously in online practice. Perhaps our developmental efforts should be targeted more deliberately at ways of raising the awareness and curiosity of students about how existing and emerging tools can already enhance their formal learning. New methods of using social tools for learning could be regarded as emergent properties, to be tuned in use rather than designed from scratch. Once learners fully appreciate the value to be gained by improving understanding through the dialogues of others, then they might be empowered to evolve their own methods of achieving this. Thus, we arrive at a potentially key conclusion about VL, that it poses fundamentally an attitudinal or even cultural challenge for education, rather than a technical one.

Funding

This review received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

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