



THE UNIVERSITY *of* EDINBURGH

Edinburgh Research Explorer

Distributed Learning and Isolated Testing

Citation for published version:

Fawns, T & O'Shea, C 2018, Distributed Learning and Isolated Testing: Tensions in Traditional Assessment Practices. in M Baji, NB Dohn, M de Laat, P Jandri & T Ryberg (eds), *Proceedings of the 11th International Conference on Networked Learning 2018*. pp. 132-139.
<http://www.networkedlearningconference.org.uk/abstracts/papers/fawns_11.pdf>

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Publisher's PDF, also known as Version of record

Published In:

Proceedings of the 11th International Conference on Networked Learning 2018

General rights

Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact openaccess@ed.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.



Distributed learning and isolated testing: tensions in traditional assessment practices

Tim Fawns

Edinburgh Medical School, University of Edinburgh, tfawns@ed.ac.uk

Clara O'Shea

Moray House School of Education, University of Edinburgh, Clara.O'Shea@ed.ac.uk

Abstract

Traditional assessment in higher education often measures performance in controlled conditions, isolating students from the people and many of the resources they have interacted with in the process of learning. While a desire to maximise reliability and standardise the measurement of ability is understandable, there is a danger that such practices privilege internal, individual and abstract forms of knowledge at the expense of contextualised, collective and adaptive practices. Most university graduates will need to be effective networked learners, using social and material resources to adapt to changing and complex workplace settings and, increasingly, digital networks. If we accept that assessment is an important driver of learning, then it follows that assessments in which students are able to make use of available resources and networks, may afford a more appropriate preparation for future employment, particularly in light of an increasing need to adapt to technological change.

In this paper, we draw on ideas from distributed cognition, in which processes of thinking are shared across people, tools and objects, to question traditional assessment practices. To ground our discussion, we present findings from a thematic analysis of blog posts of MSc Clinical Education students (made up of clinical educators from a variety of nationalities and disciplines) about the process of learning a novel motor skill. While these students tended to consider mastery of the skill to involve the ability to perform it without the help of people or supporting resources (instructions, images, video demonstrations, etc.), our analysis shows that there was often no clear boundary between supported and unsupported performance and that a requirement to reduce dependency on supportive networks and materials could be a barrier to development. Further, the acknowledgement by many students that learning and performance are contextual leads us to the conclusion that, while reducing reliance on resources may help to stabilise some forms of knowledge, it may also reduce opportunities to develop effective practices and the adaptive capacity to integrate into complex social and technological environments. In conclusion, we call for the development of assessments in which students are not only allowed but encouraged to make effective use of networks, technologies, environments and artefacts in ways that test both understanding and the ability to operate as components of distributed systems.

Keywords

Assessment; distributed cognition; situated learning;

Introduction

In higher education, students of many disciplines have traditionally been assessed in standardised environments that are isolated from both the social (e.g. peers and tutors) and material (e.g. textbooks and computers) resources that they have made use of in their learning. The underlying rationale is not so much that using these resources would make assessment too easy (since it's possible to design complex open-book examinations, for example) but that by isolating students from external support, assessment results are due to the student's internalised knowledge and skills. In this way, measurement of a student's ability should be standardised and reliable (Boud, 1995; Knight, 2002). Of course, reliable measurement is only helpful if it reflects the sort of performance that we want to know about (Boud, 1995). As we will see, processes of learning are largely made up of contextualised interactions with people, artefacts, environments, and technologies and, upon graduation, such interactions are a crucial aspect of successful employment. Therefore, the extent to which reliable measurement of the performance of students in isolation of these elements represents their actual capabilities to

do the kinds of work they will be required to do as professionals is, for us, questionable (see also Govaerts & van der Vleuten, 2013; Rethans et al., 2002 for related arguments in medical education).

The field of networked learning highlights this tension between notions of isolated, independent ability and contextualised, connected and, often, collaborative practice. In an early “E-Quality in e-learning Manifesto,” the E-Quality Network (2002) called for networked learning research and practice to place “as much emphasis on learning processes and learning to learn as on subject knowledge”. Such attention to networked learning processes can surface the direct and indirect role of digital technology in promoting connections between people and resources (Goodyear, 2004), both locally and remotely. Goodyear and colleagues noted that the simple “use of online materials is not a sufficient characteristic to define networked learning” and that “human-human interaction is an essential part of networked learning” (p. 1). For those authors, networked learning is only meaningful in terms of co-operation, collaboration, dialogue, and participation. It is appropriate, then, that over time, as Parchoma (2016) pointed out, there has been a shift in the focus of scholarship of networked learning from online resources to activity. For us, networked learning provides a starting point to which theoretical perspectives can be applied, one where the focus on the activity of networked learning must, crucially, include both social and material resources. In addition, we argue that networked connections can be explicit and direct (i.e. through conscious and concurrent interaction) or they can be implicit and indirect, informing learners’ thinking through previous or potential connections. As such, the boundary between networked and non-networked learning is blurred, permeable and the possibilities of the network can be present even when a learner’s connections to it are not currently manifest.

Before diving too deeply into our questioning of isolated assessment practices in relation to the networked reality of student learning and professional practice, we want to make the case for thinking about how all forms of learning - networked or otherwise - involve connections and interactions between people and things. To begin with, a number of important theories of learning highlight the role of social interaction and engagement with one’s social environment. Vygotsky (1978) positioned social interaction as crucial to cognitive development, introducing the influential concept of the zone of proximal development, through which one’s ability to solve problems and, thereby, develop understanding, is extended by the support of more capable others. Similarly Brown, Collins and Duguid’s (1989) notion of ‘cognitive apprenticeships’ highlighted the contextual and collaborative construction of knowledge. Lave (1988) also emphasised the situated nature of learning, culture and activity and then, with Wenger (Lave & Wenger, 1999) the role of ‘legitimate peripheral participation’ for novices becoming acquainted with the ways of thinking and practising of their community. While the material environment may be implicit in these works, a clear account of the role of the material in learning is often elided. Papert and Harel (1991) argued for the importance of actively manipulating materials in constructing meaning – focusing on playfulness and the social aspect of making – but did not account for how different elements of the material contribute to learning.

One framework that can help us to capture the importance of both social and material interactions in learning and knowledge is distributed cognition. This perspective considers processes of thinking as shared across a distributed system that includes people, tools and objects (Sutton, 2009), where the cognitive properties of the system cannot be reduced to the properties of individual components (Hutchins, 1995). In other words, working with other people, technology or artefacts does not just affect thinking, it is literally part of thinking. However, there are certain caveats that we feel are important for the use of distributed cognition as a theoretical lens for examining assessment practices. In line with the shift in the focus of networked learning scholarship from resource to activity (Parchoma, 2016) mentioned above, we caution against simplistic conceptions of distributed cognition, where knowledge is still thought of as predefined, packageable, and merely “offloaded” from people to the environment (e.g. Nestojko, Finley, & Roediger, 2013). Similarly, we wish to avoid thinking of distributed systems in terms of a small number of interacting elements, viewed independently of their context and the other social and material resources that contribute to the emergent dynamics of the situations in which they interact. Instead, we consider learning activity to be distributed, not only across people and tools, but across settings, such as home, classroom, workplace and digital networks. Further, distributed cognition should not be thought of in terms of information processing, where outputs of cognition are valued to the neglect of the activity and experiences of the constitutive elements and how these influence the development of the system over time (Johri, 2011). Instead, it matters exactly how activity is distributed between people, tools, environments and institutions, and it matters how distributed activity is informed by both immediate (health, mood, comfort, etc.) and wider (social, cultural, technological, economic, etc.) contexts.

From this perspective, tools, people and environments are profound and natural elements of our cognitive systems (Clark, 2003), and digital networks, for example, do not just connect different entities but facilitate the

very production and performance of thinking and learning across the network. In contrast, traditional assessment practices value individual, internal knowledge, separated from the contexts and social and material interactions through which students learn (Hounsell et al., 2007). For us, the purpose of defining thinking and learning as distributed is primarily methodological, in that it allows us to see differently what is important in learning and, therefore, assessment. Yet, even without taking a distributed perspective, the works of Lave and Wenger (1991) and others (cited above) suggest that methods such as closed book examinations, abstract multiple choice questions and penalties for “collusion” all point to a valuing of independent knowing above contextualised, culturally-specific and networked knowledge. In traditional assessment, each individual student should be able to produce evidence of a set of pre-defined concepts and skills that are presumed to be transferable from one situation or setting to another (Brown et al., 1989). An approach that considers knowledge as produced through social and material interactions views knowledge differently—as contingent on the specific context and distributed activity within that situation. Further, the contribution of distributed cognition to this discussion is that assessment should take into account the ability of students to participate in and contribute to the overall effectiveness of networks and systems, rather than simply focusing on notions of individual and isolated competence.

As teachers and researchers, our specialised fields of digital and clinical education have provided us with rich and diverse stimuli for considering the tension, described above, between distributed learning processes and traditional assessment. Digital education’s focus on technology in learning has helped us to understand that it is, as Kranzberg (1986, p. 545) proposed, “neither good nor bad; nor is it neutral” but that, instead, there is a kind of “continuous reciprocal causation” where person and technology are “both continuously affecting and simultaneously being affected by activity” in the other (Clark, 2008, p. 24). Clinical education’s focus on a highly practical and multidisciplinary domain offers opportunities for investigating ways that learning and performance are distributed across people, environments, technologies and artefacts. Consider, for example, what is required for a graduate of medical school to function effectively as a junior doctor in a hospital ward. Effective performance requires more than abstract knowledge about anatomy, pharmacology, communication, and so forth; more than the ability to perform a set of standardised skills; and more than acquiring cultural practices and the identity of a member of the relevant community of practice (Wenger, 1998). Effective performance also involves ongoing processes of integration into, and adaptation of, distributed systems that include shifting combinations of different kinds of doctors, nurses and healthcare staff, patients, instruments, paperwork, environments, etc. It involves developing practices that complement those already in place (Sutton, 2010) and that work in the specific situations that the graduates find themselves in.

In this paper, we raise questions about the appropriateness of traditional assessment practices by presenting learning and performance not as internal processes of individuals but as distributed activities. To aid us in this discussion, we will use excerpts from a study, conducted between 2015 and 2017, to shed light on some of the ideas discussed above. It involved two cohorts of first year students of the MSc Clinical Education at the University of Edinburgh. Students of this programme are clinical educators from a variety of disciplines (medicine, nursing, dentistry, veterinary and other allied healthcare professionals) and a variety of locations within United Kingdom, Europe, USA, Australia, Asia and Africa. The programme is delivered online via video tutorials, discussion boards and blogs. At the start of the programme, students were asked to learn an unfamiliar motor skill such as juggling three balls, performing a magic trick, drawing a horse, tying a complex knot or mastering an origami shape. The activity was designed to help students remember the kinds of challenges they faced in developing their expertise as clinicians, reflect on their assumptions and beliefs around performance, learning and knowledge, and help them identify with the perspectives of their own students. While learning their skills, our students were asked to blog about the barriers, challenges and approaches to learning, and to read and comment on the blogs of their fellow students. 31 students (12 from cohort 1, 19 from cohort 2) consented to having their blogs thematically analysed. Full details of the methods, findings and conclusions are yet to be published. What follows is a discussion of selective insights and excerpts (anonymised, with pseudonyms) from the study, chosen for their potential to exemplify, augment and challenge the propositions outlined above.

Social learning

It was clear that, for our students, learning a motor skill was not an individual, isolated process. While their learning was scaffolded through activities of reflecting on and discussing their progress through blogs visible to their tutors and peers, our students' accounts also contained evidence of learning through interactions with family, colleagues, and even strangers (e.g. producers of YouTube video tutorials). There were different kinds of connections with people and with wider learning networks, and these affected the possibilities for dialogue around approaches, challenges, feedback and reassurance. For example, YouTube videos were often discussed

as very effective guides, but they could also lead to dead ends, distraction, and conceptual blocks, because it was not possible to ask questions or elaborate on what was being shown. Kevin, commenting on another student's blog, illustrated a limitation of video demonstrations that could respond to his needs.

The last time I used youtube to facilitate my learning was to learn to aspirate a swollen joint (not having done one before). It looked SUPER EASY at first, but was obviously an absolute shamble in reality. Eventually did it though! (Kevin)

Experienced demonstrators or instructors often had an important role to play, either in being responsive, supportive and nurturing, or by constructively increasing the pressure to perform while creating an environment that helped rather than hindered learning.

This makes me consider the role of an educator, how vital it is to see vulnerability in a learner and to actively help them overcome their issues. (Jane)

Indeed, the products of learning were not just the learned motor skills, but the collaborative partnerships and networks that came into being through the distributed production of knowledge. Through their blogs, students performed different, supportive roles for each other that could be sustained beyond this specific learning activity to other courses within the MSc and, in some cases, into their professional practice. In other cases, the activity prompted students to connect with people outside of the programme. Consider the following example, where Rebecca wrote about how her daughter helped her to make sense of her external resources.

Patently my 10 year old talks me through the steps she is performing to create the [origami] box. At first using simple instructions but then she explains how these relate to the terminology in the book. (Rebecca)

Through this interchange, Rebecca's daughter's specialised knowledge of the techniques and the language of origami became available to Rebecca beyond this instance of learning and into future origami work. This learning partnership, or any of the ongoing learning relationships established through the blog and the programme in general, might be considered a valuable product of Rebecca's learning, yet such a notion would be strongly at odds with competitive, individual assessment practices prevalent in higher education (Boud, 1995). This challenge is evident when we consider something that is fundamental to the work our students will go on to do as graduates, yet is underappreciated within our assessment regimes: working as part of a team. In teamwork, people with different knowledge, practical and theoretical expertise, and different agendas need to contribute to different tasks (Fenwick, Nerland, & Jensen, 2012; Nyström, Dahlberg, Hult, & Dahlgren, 2016). The challenge of taking this into account within higher education assessment practices was highlighted in our previous work on group assessment in an online MSc in Digital Education (O'Shea & Fawns, 2014). We found that students struggled to understand the value of individual contributions to a collaborative document, perhaps because the contribution of a given group member was interdependent with the contributions of others and because important contributions may not have been clearly visible in terms of time spent or words on a page (e.g. where an idea enhanced the thinking of other group members). Nonetheless, participants of the present study consistently discussed the crucial role of other people, even in seemingly individual learning pursuits.

Scaffolding, dependency and progress monitoring

While our participants were aware of how materials and technologies supported and then became embedded in their performance, many of the blog posts suggested that being able to perform a skill without guides, tutors or other kinds of supporting resources was necessary to demonstrate competence or mastery. For example, Chloe viewed her progress in learning to make an origami box in relation to her reliance on online instructions.

Today I created 2 more boxes both on first attempt but I am trying to reduce my dependency on the instructions. I can get as far as step 8 and then a tricky little fold throws me off both times. (Chloe)

As a point of contrast, there were also indications that insistence on being able to perform a skill in isolation of resources could be inappropriate. For example, Gordon wrote that a

... task sometimes just calls for team work and knowing when you need help along with having the ability to ask someone for it... (Gordon).

Not using external resources and other people could lead to “a lot of wasted time and effort” (Gordon) and may be a hindrance to performance and, potentially, learning.

Being able to work independent is great, but being too headstrong could sometimes be a hinder [sic] for good and effective solutions. (Amy).

Therefore, the appropriate use of supporting resources and drawing on social networks was also seen as a component of proficiency in terms of both learning and performance. The concept of scaffolding has been used in educational discourse to convey how teachers and others can support development by extending a student's capacity to solve problems, before gradually reducing support and encouraging independent learning. For Vygotsky (1978), this kind of social support enables a zone of proximal development, which he defined, in the context of a child's learning, as the “distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers.” (p. 86). Where Vygotsky focused on the support that could be derived from being situated in rich, social contexts, Brown and colleagues' (1989) emphasised both the social and the material in making learning environments supportive and meaningful.

The self-assessment of many of our students tended to be around the consistent performance of a skill without needing to refer to external resources (e.g. attempting to draw a horse “from memory” or “trying to reduce dependency on the instructions” when constructing origami). It seems that from our students' perspective, both social and material scaffolding needed to gradually be removed to achieve proficiency or what Vygotsky characterised as *independent problem solving*. Carolyn gave an example of this process of de-scaffolding in relation to attempting to make an origami box without reference to an online video demonstration.

Day 2 (Thurs) – had a practice minus the video and managed to still be able to do it. (Carolyn).

However, the next day, she realised that she was still reliant on the support of video instruction.

Unfortunately, it turned out that I had completely forgotten how to do it and had to revert to watching the video again. (Carolyn)

In Vygotsky's (1978) terms, we might say that Carolyn's *actual developmental level*, or competence, was, in relation to this task, unstable or not “fully matured” (p. 86). However, Vygotsky proposed that “the actual developmental level characterizes mental development retrospectively, while the zone of proximal development characterizes mental development prospectively” (pp. 86-87). In other words, Carolyn's scaffolded performance (i.e. with the aid of the video) might have represented what was achievable for her in practice, given appropriate opportunities. While there may be value in assessing isolated students in controlled environments, particularly if this helps us to understand something about the stability or resilience of the relevant knowledge, it is important to acknowledge the limitations of this kind of assessment. Rethans et al. (2002) have argued that the relationship between context-independent competence and context-dependent performance is complicated, and one cannot reliably predict the other. Govaerts and van der Vleuten (2013) went further, arguing that we should question the validity of objective notions of competence, since performance can only be interpreted in situ. While reducing the support or scaffolding that underpins student performance may tell us something about the stability or maturity of certain capacities, socially and materially supported kinds of knowledge may be more indicative of potential. This is important since, according to increasingly influential ideals of sustainable assessment, we want to evaluate students' capacity for future learning and performance (Boud & Soler, 2016).

One solution might be to complement traditional forms of assessment, where performance is measured in heavily constrained conditions and without taking context into account, with forms of assessment that factor in the student's ability to make appropriate and critical use of available resources. One might also question whether the total withdrawal of external support is necessary, given the distributed nature of performance in real world settings (e.g. Sutton, 2010; Hutchins, 1995). Indeed, the belief that mastery required transforming “knowledge in the world” into “knowledge in the head” raises questions about where the line might be drawn. For example, drawing a horse still required pen and paper; juggling still required appropriate objects for throwing and catching (e.g. juggling balls) and a suitable environment; rock climbing still required a scalable wall. The suitability of these materials affected the complexity of performance and might, therefore, be considered a form of scaffolding. Nonetheless, our students seemed to consider the support provided by easy-to-use resources that were directly operated on as part of the performance (e.g. the paper, the juggling balls, the wall) to be

qualitatively different from that provided by non-essential resources (e.g. a photo of a horse or a video demonstration of juggling).

Knowledge as contextualised, dynamic and emergent

We are not surprised that our participants valued being able to perform in the absence of social or material support. We have already indicated that traditional assessment culture is likely to promote this view. Ramsden (2003) and others have noted the motivational influence of assessment on student learning, and this has resulted in students becoming used to practising under examination conditions. Further, being able to perform independently of external resources may have important implications for the confidence that students themselves and others have in their ability. Returning to the example of the medical graduate working in a hospital ward, there is likely to be a limit to the amount of information that can be looked up during clinical practice (e.g. via a smartphone, textbook or by asking a colleague), without creating perceptions of incompetence. An important question for the present argument, then, is whether this is primarily a cultural issue—in that we have been socialised as to what we should expect from competent doctors—or whether this perception is based on a functional need for doctors to know things without looking them up. Does it matter, from a distributed cognition perspective, *how* a doctor knows what to do, or does it only matter *that* the overall system (doctor *and* colleagues *and* technology *and* environment) knows what to do? One argument is that apparently internalised knowledge might constitute a safety net that enables evaluation of external sources. Another is that meaningfully synthesising different information (e.g. from textbooks, patient histories, tests, etc.), involves making sense of the relations between relevant elements, something that does not seem possible if all elements must be externally accessed whenever they are thought about.

However, some distributed cognition scholars (e.g. Sutton, 2010) would argue that no knowledge is independent of external resources or that, at the very least, the boundary between internal and external cognitive elements is unclear. “Looked up” information is never independent of what we already know, just as what we already know is never independent of our experience of our present environment (Sutton, 2010). Consider Tracy’s reflection on the dynamic nature of the ability of her junior colleague.

As an Educational supervisor, I have sometimes watched my foundation dentist carry out a simple manual procedure, and assumed that she not only understands the biological principles underpinning it, but also feels confident and competent at carrying out that particular procedure, having demonstrated her ability on one occasion. I realise that in reality, she probably requires a lot more practice ... (Tracy).

The view of distributed cognition taken in this paper suggests that knowledge is emergent, being dynamically produced in interaction (Sutton, 2010; Tribble, 2005). It is *performed* and, as with any other performance, it must be practised and can be affected by environmental conditions, stress, etc. As Brian reflected, learning and performance are contingent on a complex combination of factors, all of which contribute to the overall outcome.

...there are hurdles, distractions and difficulties but I believe perseverance, motivation, availability of desired circumstances and the right environment and proper guidance are all important factors (and several others) for our learning. The exclusion of even one of these factors may disrupt the progress and set the whole learning process back. (Brian).

This view contrasts with what is accomplished through traditional examinations, where single performances in controlled conditions often carry disproportionate weight and do not allow for the adaptive practices that professionals develop in the workplace to make use of available resources (Govaerts & van der Vleuten, 2013), such as working with different tools, software, networks; or communicating with colleagues.

Adaptive practices vs. reliance

A number of prominent assessment scholars have recognised feedback as key to formative assessment and learning more generally (e.g. Carless, 2007; Hounsell et al., 2007; Nicol & Macfarlane-Dick, 2006). As well as extrinsic feedback (e.g. through evaluative comments of other people or discussion within the learning network via comments on the blog posts), people and objects could facilitate intrinsic feedback through the natural consequences of actions (e.g. dropping a juggling ball because it was thrown too high). Material resources (including the blog posts) helped the students keep track of their progress (e.g. they could look back at previous drawings or watch videos of themselves). The relationship between the learner and their resources could,

therefore, be seen as an integral component of successful learning. Students were also able to try different approaches to learning a skill by adopting different kinds of material and social support. For example, Nathan demonstrated how adapting to different resources helped him to overcome a conceptual barrier in making an origami box.

Having to have a flexible approach and being able to switch to an appropriate mode is essential. Moving from text based instructions to visual and verbal was far more productive in aiding comprehension in this case. (Nathan)

For the purposes of summative assessment, does it matter *how* this skill was learned? Is one way of learning inherently better than another? What seems more important in the example above is that Nathan was able to support his own learning by adapting his learning practices. While traditional assessment values stable, independent kinds of knowledge, some of our students also discussed the challenge and the importance of finding and using appropriate materials to facilitate the learning process and it was evident that reducing material or social support too quickly could impair learning. If good assessment drives and informs learning (Hounsell et al., 2007; Ramsden, 2003), then it is not only the stability of knowledge but the process and potential of developing stable knowledge that should be assessed. In contrast, by assessing in tightly-controlled conditions, we miss out on opportunities to evaluate (and, therefore, motivate) students' ability to effectively integrate into complex social and technological environments.

Conclusions

In this paper, we have argued that assessment that values independent and isolated knowledge does not reflect students' ability to perform in the kind of conditions and environments in which they will find themselves after graduation. As such, it also limits their preparation for a future that is likely to require flexibility and adaptation as technological and cultural contexts change at an increasingly fast pace. We have drawn on ideas from distributed cognition, in which processes of thinking are shared across people, tools and objects, to question such traditional assessment practices. While recognising challenges for both teachers and students, we propose that it will be beneficial to develop assessment practices that encourage the adaptive development of effective learning and working practices while critically evaluating interactions with different people and technologies.

References

- Boud, D. (1995). Assessment and learning : contradictory or complementary ? In P. T. Knight (Ed.), *Assessment for Learning in Higher Education* (pp. 35–48). London: Kogan Page.
- Boud, D., & Soler, R. (2016). Sustainable assessment revisited. *Assessment and Evaluation in Higher Education*, 41(3), 400–413. <https://doi.org/10.1080/02602938.2015.1018133>
- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18, 32–42.
- Carless, D. (2007). Learning-oriented assessment: conceptual bases and practical implications. *Innovations in Education and Teaching International*, 44(1), 57–66.
- Clark, A. (2003). *Natural-born Cyborgs*. New York: Oxford University Press.
- Clark, A. (2008). *Supersizing the mind : embodiment, action, and cognitive extension*. Oxford: Oxford University Press.
- E-Quality Network (2002). E-quality in e-learning Manifesto. Presented at the Networked Learning 2002 conference, Sheffield, available at <http://csalt.lancs.ac.uk/esrc/>
- Fenwick, T., Nerland, M., & Jensen, K. (2012). Sociomaterial approaches to conceptualising professional learning and practice. *Journal of Education and Work*, 25(1), 1–13.
- Goodyear, P. (2004). *Advances in Research on Networked Learning (Computer-Supported Collaborative Learning, V. 4)*. Norwell, MA, USA: Kluwer Academic Publishers.
- Govaerts, M., & van der Vleuten, C. P. (2013). Validity in work-based assessment: Expanding our horizons. *Medical Education*, 47(12), 1164–1174. <https://doi.org/10.1111/medu.12289>
- Hounsell, D., Xu, R., & Tai, C.-M. (2007). Balancing assessment of and assessment for learning. *Higher Education*.
- Hutchins, E. (1995). How a cockpit remember its speeds. *Cognitive Science*, 19, 265–288.
- Johri, A. (2011). The socio-materiality of learning practices and implications for the field of learning technology. *Research in Learning Technology*, 19(3), 207–217.
- Knight, P. T. (2002). Summative assessment in higher education : practices in disarray. *Studies in Higher*

Education, 27(3).

- Kranzberg, M. (1986). Technology and history: "kranzberg's laws." *Technology and Culture*, 27(3), 544–560.
- Lave, J. (1988). The culture of acquisition and the practice of understanding. (IRL report 88-00087). Palo Alto, CA: Institute for Research.
- Lave, J., & Wenger, E. (1999). *Situated learning: legitimate peripheral participation*. Cambridge: Cambridge University Press.
- Nestojko, J. F., Finley, J. R., & Roediger, H. L. (2013). Extending Cognition to External Agents. *Psychological Inquiry*, 24(4), 321–325. <https://doi.org/10.1080/1047840X.2013.844056>
- Nicol, D., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: a model and seven principles of good feedback practice. *Studies in Higher Education*, 31(2), 199–218.
- Nyström, S., Dahlberg, J., Hult, H., & Dahlgren, M. A. (2016). Enacting simulation: a sociomaterial perspective on students' interprofessional collaboration. *Journal of Interprofessional Care*, 30(4), 441–447.
- O'Shea, C., & Fawns, T. (2014). Disruptions and dialogues: supporting collaborative connoisseurship in digital environments. *Advances and Innovations in University Assessment and Feedback*, 259–273.
- Papert, S. & Harel, I. (1991) Situating constructionism. In I. Harel, & S. Papert (Eds.), *Constructionism* (pp. 1-11). Westport, USA: Ablex Publishing.
- Parchoma, G. (2016). Reclaiming distributed cognition in networked learning: An inter-subjective, socio-material perspective. Proceedings of the 10 The International Conference on Networked Learning 2016, 113–119.
- Ramsden, P. (2003). *Learning to teach in higher education* (Second edition). London: RoutledgeFalmer.
- Rethans, J., Norcini, J., Baron-Maldonado, B., Blackmore, D., Jolly, B., LaDuca, T., ... Southgate, L. (2002). The relationship between competence and performance: implications for assessing practice performance. *Medical Education*, 36, 901–909.
- Sutton, J. (2009). The feel of the world: exograms, habits, and the confusion of types of memory. In A. Kania (Ed.), *Memento: Philosophers on Film* (pp. 65–86). London: Routledge.
- Sutton, J. (2010). Exograms and interdisciplinarity: history, the extended mind, and the civilizing process. In R. Menary (Ed.), *The extended mind* (pp. 189–225). Cambridge, Mass.: MIT Press.
- Sutton, J. (2013). Skill and Collaboration in the Evolution of Human Cognition. *Biological Theory*, 8(1), 28–36.
- Tribble, E. B. (2005). Distributing Cognition in the Globe. *Shakespeare Quarterly*, 56(2), 135–155.
- Vygotsky, L. S. (1978). *Mind in society: the development of higher psychological processes*. (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.). Cambridge, Mass.: Harvard University Press.
- Wenger, E. (1998). *Communities of practice: learning, meaning, and identity*. Cambridge: Cambridge Univ Press.