Semantic Web Learning Technology Design: Addressing Pedagogical Challenges and Precarious Futures

Patrick Carmichael

Faculty of Education and Sport, University of Bedfordshire, UK, patrick.carmichael@beds.ac.uk

Abstract

Semantic web technologies have the potential to extend and transform teaching and learning, particularly in those educational settings in which learners are encouraged to engage with 'authentic' data from multiple sources. In the course of the 'Ensemble' project, teachers and learners in different disciplinary contexts in UK Higher Education worked with educational researchers and technologists to explore the potential of such technologies through participatory design and rapid prototyping. These activities exposed some of the barriers to the development and adoption of emergent learning technologies, but also highlighted the wide range of factors, not all of them technological or pedagogical, that might contribute to enthusiasm for and adoption of such technologies. This suggests that the scope and purpose of research and design activities may need to be broadened and the paper concludes with a discussion of how the tradition of *operaismo* or 'workers' enquiry' may help to frame such activities. This is particularly relevant in a period when the both educational institutions and the working environments for which learners are being prepared are becoming increasingly fractured, and some measure of 'precarity' is increasingly the norm.

Keywords

Semantic web technologies; case-based learning; higher education; participatory design; workers' enquiry

Introduction: Reflecting on the 'Ensemble' Project

The *Ensemble* project, the full name of which was 'Ensemble: Semantic Technologies for the Enhancement of Case-Based Learning' was a large research and development project funded under the UK's Technology Enhanced Learning (TEL) Programme. The project was funded from 2008 until 2012 and was concerned with exploration of the potential of emerging semantic web and linked data technologies to enable, support and extend teaching and learning in areas of higher education. The project generated and evaluated a range of software tools, demonstration projects and case studies of the ways in which semantic web tools and approaches could be integrated not only into online environments but also into existing learning environments and activities including role-plays, fieldwork, performances and student research projects. A key recommendation from the project as a whole was that for emergent semantic and linked data technologies to reach their full potential in education, software designers and developers needed to engage in extended collaborations with teachers and students, and to focus on pedagogical practices and aspirations, rather than simply trying to develop abstract models of educational systems, knowledge domains, or learners (Carmichael & Jordan, 2012).

Strands of work from the project have continued, informing development in areas including digital archiving (Martinez-Garcia, Corti, & Bell, 2013), research methods training (Carmichael, 2011), semantically rich annotation of video content (Morris, 2012), and the use of semantic web and linked data approaches in a range of areas of professional education as well as in higher education and school settings (see for example: Brooks, 2012; Litherland, Carmichael, & Martinez-Garcia, 2013; Stott, Litherland, Carmichael, & Nuttall, 2014). Members of the project have also drawn on a range of frameworks and traditions to theorise learning, design and the interdisciplinary working of the project. As well as accounts of participatory design and participatory research approaches (Tracy & Jordan, 2012), aspects of the project's work and findings were theorised in terms of Actor Network Theory (ANT) and 'post-ANT' (Rimpiläinen, 2015; Tscholl, Patel, & Carmichael, 2011); spatial theories (Edwards, Tracy, & Jordan, 2011); post-representational and assemblage theories including the

Proceedings of the 10th International Conference on Networked Learning 2016, Edited by: Cranmer S, Dohn NB, de Laat M, Ryberg T & Sime JA.

19

ISBN 978-1-86220-324-2

work of Guattari, Deleuze, and de Landa (Carmichael & Litherland, 2012; Carmichael, 2015); and the theme of software design as 'simulation' was explored in relation to the work of Baudrillard and Deleuze (Carmichael & Tscholl, 2013).

Tracy (2016), in the accompanying paper in this symposium, identifies the limits and barriers to participation that emerged in the course of the project, and this paper complements and extends the arguments developed there by suggesting that it is necessary to redirect enquiries and design activities to take account not only of limitations imposed by curricula, educational organisation and pedagogical practices, but also to reflect the increasingly unpredictable and fractured nature both of educational systems and of the workplaces and networks which learners will need to negotiate.

Cases, Authenticity and Design

The Ensemble project explored how different combinations of semantic web technologies (including linked data in repositories and from other sources; metadata, taxonomies and ontologies; data aggregation and search tools; and data visualisation and manipulation interfaces) could be integrated into teaching and learning environments, activities and curricula. Semantic web technologies were anticipated to be a good match for those settings where some variety of 'case-based learning' was already established, or where this represented the part of the aspirations of teachers, learners and curriculum developers. The project proposal suggested that:

> "Case-based learning is the pedagogy of choice when knowledge domains are complex, unpredictable, politically or ethically contentious, or so rapidly changing and fluid that a curriculum defined in terms of knowledge or competencies alone is inadequate as the basis of developing expertise."

The potential of semantic web technologies to contribute to such teaching and learning is a result of:

- the opportunities they offer for teachers and students to bring current, authentic data into learning environments
- the potential for aggregation of heterogeneous online content in different formats
- the support they offer for reasoning across data and cases from diverse sources
- the basis they provide for simulations, role-plays, and scenario-building activities where learning outcomes were contingent and unpredictable
- the role in supporting open-ended tasks in which initial problems, cases or scenarios could be developed in different directions, with sometimes unpredictable learning outcomes

The project engaged with teachers and learners across a range of disciplinary settings including biosciences, journalism, management, archaeology, contemporary dance and environmental sciences (Martinez-Garcia, Morris, Tscholl, Tracy, & Carmichael, 2012), with later work extending into accounting and finance, and teacher education. In some of these settings, what constituted a 'case' was already well established and some variety of case-based pedagogy was already used: so, for example, teachers in management used business cases modelled on their own experiences as managers and consultants. In others, there was an aspiration to transform a curriculum that was currently dominated by established and teacher-selected content to one that was more based around authentic data and problems, and that encouraged learners to undertake case studies themselves, develop content, and share their knowledge. This latter approach aligned well with institutional concerns to encourage students to be seen as 'co-designers' of learning and 'co-producers' of knowledge rather than passive recipients (Healey & Jenkins, 2009; Neary & Winn, 2009).

The project drew on participatory research, design and evaluation practices, with design workshops and detailed study of pedagogical practice informing rapid prototyping approaches. It did not explicitly frame its design activities as 'design based research' (DBR) as discussed in the accompanying paper in this symposium (Jensen & Dohn, 2016). However, there were many features in common with the model set out there, including a commitment to close collaborative working throughout the design and evaluation process; iterative approahes;

Proceedings of the 10th International Conference on Networked Learning 2016, Edited by: Cranmer S, Dohn NB, de Laat M, Ryberg T & Sime JA.

20

ISBN 978-1-86220-324-2

and a high level of sensitivity to contextual factors (Amiel & Reeves, 2008; Wang & Hannafin, 2005). Another important element in common with DBR was the use of existing technological frameworks, platforms and resources. This stemmed both from the nature of the curricular challenges that project participants identified, and from the nature of semantic web technologies and applications. What emerged from design activities were ideas for the integration of existing technologies; enhanced search interfaces to existing resources; data visualisation tools, particularly where learners had to engage with complexity; and means of authoring, editing and annotating diverse digital content.

The distinction between research and design activities was, then, blurred, with 'designing' coming to be understood as a means of gaining insights into existing, emergent and potential pedagogical practice: even aside from the potential technological developments that they might inform. Participants set out not only their perceptions and experience of knowledge domains and pedagogical practices (both current and potential), but also a range of broader concerns ranging from disciplinary practices in relation to data sharing and reuse; the relationship between disciplinary practice and signature pedagogies; future directions for their discipline and field; and their own prospects for employment and participation in professional and academic practices and discourses. This is the focus of the remainder of this paper.

Curriculum, Pedagogy and Design with Semantic Technologies

The Ensemble project's dual interests in 'case-based' pedagogies and semantic web technologies were broadly informed by what Barnett (2004) describes as the 'ontological turn' in higher education. Case-based pedagogies have the potential to overcome the concern that "students are not assisted and supported in situating and localising knowledge within specific manifestations of practice … a focus on knowledge acquisition leaves to students the difficult task of integrating such knowledge into practice"(Dall'Alba & Barnacle, 2007, p. 680). At the same time, we were concerned to explore whether appropriately implemented semantic web technologies could overcome the tendency of 'technologized' learning to be (as Heidegger suggests) part of the continuing subordination of ontological questions to pedagogical and epistemological models based on the acquisition of knowledge and the development of decontextualised, transferable, measurable skills and competencies.

In the early phases of the Ensemble project, what emerged from design workshops and other activities were ideas that were couched primarily in terms of the enhancement of existing pedagogical practice. Examples included visualisation tools to support undergraduate student learning in plant sciences and education studies; demonstrations of how dissertations in archaeology could be enhanced by the inclusion of linked data; and the development of digital 'cases' for use in postgraduate maritime operations and management, again bringing data sets from different sources into digital texts and encouraging learners to select, manipulate and interpret those data as part of a simulation activity (Martinez-Garcia et al., 2012, pp. 107-109). While there were specific aspects that were recognised as being of value - having the potential to 'enhance' teaching and learning, in other words - teachers, and to some extent learners as well, were guarded and cautious about the extent to which they wished to engage with the full potential of semantic web technologies. Citing concerns about 'information overload' and the need to maintain a focus on specific learning outcomes and assessment criteria, what emerged from these early projects were, for the most part, 'closed world' learning environments, in which semantic web technologies were implemented within strict boundaries or parameters. Where students could link to external data sources in addition to those within the 'closed word' of teacher defined material, these were generally highly reliable publications, datasets or catalogues. A good example was very visually rich 'Timeline' of plant evolution (Jordan, Griffiths, & Johnstone, 2010) that used a range of prepared data sets together with links to selected web resources, online publications and images, but which was explicitly limited in its scope to address the particular pedagogical concerns of teachers of undergraduate biosciences.

A more ambitious web application drew on design discussions with teachers of journalism, who identified an activity, in which learners studied the varied coverage of major natural disasters in the global media, as having the potential to be developed using visualisation and data linking technologies. In response to these ideas, data from highly reliable sources were used to show seismic activity around the world in almost 'real time', while at the same time coverage from global media providers referring to these events were displayed alongside. Implementing this project involved presenting no data over which teachers had control, and this highlighted

their concern that, while they were keen to teach using 'real cases', they were more confident teaching about specific cases about which they felt they had expertise, rather than allowing students to explore more widely.

The experiences of these early activities of the project, and particularly the emerging awareness that semantic web technologies might simply find their principal role in enhancing rich but 'bounded' web applications informed a shift in emphasis in the later stages of the project. While the activities described above involved participatory approaches, they tended to be framed in terms of building complete web applications, with teachers and students being involved in initial specifications and subsequent evaluations. Concerns also emerged about the ease with which teachers and students could edit, reproduce and develop the applications further without the support of the project team. As a result, further design and development activities adopted an even closer relationship with participants, who worked alongside technologists as part of very rapid prototyping and evaluation activities, in part enabled by the use of the "Exhibit" Semantic Web Framework developed at MIT (Huynh, Karger, & Miller, 2007), whose developers also supported and participated in the project.

What emerged from this phase of the project was markedly different: the shift in emphasis not only led to different kinds of web applications being designed and developed, but also to a much broader range of issues being surfaced through the design process. These went beyond the specification of enhancements to address pedagogical and epistemological issues, and began to align more closely with personal, identiary and ontological issues that had previously been elusive. Rather than this being a result of the particular affordances of the technologies involved, this emerged from a combination of thinking about technological opportunities, and personal issues, within a fluid and flexible design environment – design based research, but more widely scoped than that which is solely concerned with developing technological applications or platforms, and with the potential to inform understanding of the social lives of participants.

Enhancing Learning or Preparing for Precarity?

Detailed reanalysis of some of these design activities used Guattari's notion of 'transverality' to develop an understanding of these, their limitations, and their outcomes (Carmichael & Litherland, 2012). The extended conversations that took place meant that the groups of researchers, developers, teachers and learner were more like instances of the 'transverse group' described by Guattari as: "… the subject group that … endeavours to control its own behaviour and elucidate its object … and produce its own tools of elucidation … [the group] both hears and is heard" (Guattari, 1984, p. 14). Unlike many other collectivities and collaborative organisations this kind of group: "keeps on asking whether it is right, whether it should be totally transforming itself, correcting its aim and so on" (Guattari, 1984, p. 39). This perspective leads to seeing the purpose of learning technology design not as the means of fulfilling some kind of utopian 'potential' of any technology to enhance or transform, but rather the establishment of pedagogical and social practices that encourage continuing divergence and what Pellejero describes as the "multiplication of perspectives" (2009, p. 106). 'Rapid prototyping' became not a means of reaching a design more quickly but rather an means by which a multiplicity of options could be considered, not only in relation to immediate pedagogical needs, but broader aspirations, intentions and concerns.

Further work (Carmichael, 2015) has drawn on Deleuze's ideas of time as a synthesis as set out in *Difference and Repetition* (Deleuze, 2004), in order to illuminate two of the research settings (environmental education and contemporary dance) where design activities had indeed taken on a highly 'transverse' character. This led in unexpected directions and to outcomes that challenged both initial assumptions about the potential of semantic web and linked data approaches in education, and any simple notion of technological 'enhancement' of learning. Exploring the interplay between expressions of the habitual, expressions of desire for change and innovation, and identiary concerns about past, present and future 'selves' provides insights into why groups of teachers and students had responded to the opportunities to have a role in technology design in radically different ways.

Both of these analyses highlight the notion of 'precarity' and the increasing needs of participants (both teachers and learners) to prepare for both institutional and personal uncertainties. Raunig argues that precarity involves "the repeal of guaranteed and lasting employment to the expansion of various forms of 'atypical employment'

Proceedings of the 10th International Conference
on Networked Learning 2016, Edited by: 22
Cranmer S, Dohn NB, de Laat M, Ryberg T &
Sime JA.

ISBN 978-1-86220-324-2

(which has meanwhile become typical) … the extension of working hours … into the sphere … all the way to issues of social security [and] the precarisation of residence" (2010, p. 78). Rather to the surprise of project researchers assessments of the potential of semantic web and linked data technologies were often couched less in terms of short-term learning outcomes and technological enhancements to existing classroom practice and in some cases ranged across themes such as the possibility of redundancy, future employment on zero-hours contracts and the difficulty of finding accommodation, as 'portfolio workers', and even to the existence of their subject or field of study.

This was most evident in the case of contemporary dance students, for whom a future of self-employed 'multiworking' was a near certainty. They were only too aware of futures in which they might spend time training, auditioning, performing, teaching and managing. Alongside these activities they might spend time employed in other jobs unrelated to performance other than by virtue of keeping them fed, clothed and housed, while being able to run to an audition at an hour's notice. For them, participation in the project, and in the design workshops was a means by which they could assess the affordances of the semantic technologies; reflect on their current practice and how these new technologies might be integrated into it; and to have a hand in the development of new technological applications which might improve their future working conditions. It was no mistake, then, that once they had worked with the researchers and developers of the *Ensemble* team to draw up the specifications for a video portfolio tool (Morris, 2012), they wanted it to be deployed not only on institutional web platforms (allowing their performances to be assessed by teachers) but also through social media platforms such as *Facebook* or on personal websites. What might be valuable for assessment within the university setting could be potentially even more so in representing and promoting themselves beyond it.

Towards Workers' Enquiry for Technology Enhanced Learning?

Following Guattari, inspired by the accounts of 'precarity' that emerged from discussions that were ostensibly about educational software design, and framed by broader discussions of the role of higher education has more recently inspired a review of some of activities and findings of the Ensemble project. This has led to a consideration of the tradition of 'workers' enquiry' or *operaismo* that developed within the Autonomist Marxist movement in the 1960s and 1970s. This, too, was a response to precarity - of migrant and service workers - and to an awareness that social studies of workplaces were, in isolation, inadequate to express the complexities of working lives.

A comprehensive account of the development of *operaismo* is beyond the scope of this paper; the most accessible account in English is by Wright (2002) and a range of the key documents relating to the development of the movement across Europe in the 1960's and 1970's is available as a collection edited by Lotringer & Marazzi (2008). The relevance of autonomist thought more generally to higher education has recognised: Dyer-Witherford (1999) draws on autonomist ideas in his critique of the knowledge economy in relation to educational systems, and again in his work on contemporary higher education (Dyer-Witheford, 2005), while Hall (2015) reviews its characteristics and explores its potential for understanding educational technologies in general. However, what is of interest here are the specific insights that *operaismo* might offer for the *design* of learning technologies, with design being seen as a particular kind of work and enquiry that benefits from deep contextual understanding and the essential participation of multiple interested parties.

Key in the *operaist* tradition is Raniero Panzieri, who argued for the centrality of 'Workers' Enquiry' as the means by which new social formations and working practices could both be understood and influenced. The parallels with Guattari's self-aware, self-directing and reflective transverse group are evident. Enquiry, Panzieri suggested, was not simply concerned with developing better theories of class composition or class struggle, but was, rather, a critical aspect of practice: 'co-research' (*conricerca*) "focussing mainly on working conditions … a research that workers and intellectuals must lead together" (Mancini, 1977). This distinction between enquiry 'on workers' and 'workers' enquiry' is explored further by Wellbrook (2014) and is neatly summarised by Woodcock, who states that "at the core [of workers enquiry], the project is one of knowledge production and political organisation, and there has to be an awareness of this tension" (2014, p. 510).

Proceedings of the 10th International Conference
on Networked Learning 2016, Edited by: 23
Cranmer S, Dohn NB, de Laat M, Ryberg T &
Sime JA.

ISBN 978-1-86220-324-2

Wellbrook and Woodcock's articles appear in a special issue of the journal *Ephemera* published in 2014 in which contributors position *operaismo* historically and in relation to contemporary political events, discuss its relation to themes such as precarity and informational work, and offer a number of case studies. What is telling, though, is that most of these accounts devote little actual space to discussing actual methods of enquiry; where they are mentioned, they draw on conventional social science approaches, or argue for some kind of action research. However, the accounts they provide resonate with many of the themes that emerged in the course of the *Ensemble* project. There is the same sense of teachers and students having to find ways of working in highly regulated, technologically rich environments, and having to reconcile rapidly changing technologies with academic and professional identities. There are also parallels in the accounts of participants with strong sets of beliefs and values having to reconcile these with practical concerns about assessment outcomes, quality assurance regimes and their future employment and employability. What is different, of course is the centrality, in *Ensemble,* of design: the purpose of the research team, if not always the participants, was to *make* something. But if what it to be designed, made, and then implemented represents not just an abstract outcome of the enquiry phase (like a set of user requirements, for example) but the action that arises from it (a prototype that can be used), then participating in the design of something becomes a politically charged act – particularly, if, as has been suggested above, what it designed is an expression of a particular 'future', with all the opportunities and challenges that carries with it.

Design activities, suitably organised and conceptualised, represent opportunities for researchers and participants to explore not only obvious affordances and potential applications of new technologies, but also broader questions of the kinds discussed here and the issues of agency, power and regulation that accompany them. Looking back at the work of the *Ensemble* project, we discover that many of the participants either had concerns much broader than the 'enhancement' of learning, and in many cases they cited external forces and constraints on their current practice or that to which they aspired. For the dance students, the 'political' related to their potential future employment. In other cases, the political agendas that emerged related to organisational issues in higher education and, in turn to their credibility as academics or as representatives of particular fields: so, for example, a perception that assignments might be made less demanding if students had easier access to open data, publications or other online resources as a result of semantic search tools being introduced. Other participants were concerned that if technologies were 'too good' they were 'signing their own redundancy papers', as the requirements for experts presenting cases, or experienced staff leading fieldwork, or managing student learning online, would be eroded.

Perhaps most critically, for all the apparent opportunities that the semantic web and linked data technologies offered teachers and learners as participants in an integrated global data space, these were not first and foremost in their minds as they undertook their own 'workers' enquiries' into the potential of these technologies. Rather, it was the particularities of their own situations, the tensions, and the uncertainties that were surfaced through design workshops. Conceptualising technology design not as abstraction of generalities but rather as a particular kind of creative, generative and reflective work in precarious and uncertain times may ultimately lead us to rather more interesting and in the long term, emancipatory and transformative, outcomes.

Acknowledgements

References

Amiel, T., & Reeves, T. C. (2008). Design-based research and educational technology: Rethinking technology and the research agenda. *Educational Technology & Society*, *11*(4), 29-40.

Proceedings of the 10th International Conference
on Networked Learning 2016, Edited by: 24
Cranmer S, Dohn NB, de Laat M, Ryberg T &
Sime JA.

ISBN 978-1-86220-324-2

Barnett, R. (2004). Learning for an unknown future. *Higher Education Research & Development*, *23*(3), 247-260.

Brooks, P. (2012). Dancing with the Web: students bring meaning to the semantic web. *Technology, Pedagogy and Education*, *21*(2), 189-212.

Carmichael, P. (2011). Research Capacity Building in Education:the Role of Digital Archives. *British Journal of Educational Studies*, *59*(3), 323-339.

Carmichael, P., & Jordan, K. (2012). Semantic web technologies for education – time for a 'turn to practice'? *Technology, Pedagogy and Education*, *21*(2), 153-169.

Carmichael, P., & Litherland, K. (2012). Transversality and Innovation: Prospects for Technology-Enhanced Learning in Times of Crisis. In D. Cole (Ed.), *Surviving Economic Crises through Education.* New York: Peter Lang.

Carmichael, P. (2015). Not Just About Gadgets: time, innovation and change in the design of learning technologies. *E-Learning and Digital Media*, *12*(3-4), 279-294.

Carmichael, P., & Tscholl, M. (2013). Cases, Simulacra and Semantic Web Technologies. *Journal of Computer Assisted Learning*, *29*(1), 31-42.

Dall'Alba, G., & Barnacle, R. (2007). An ontological turn for higher education. *Studies in Higher Education*, *32*(6), 679–691.

Deleuze, G. (2004). *Difference and Repetition.* London: Continuum.

Dyer-Witheford, N. (2005). Cognitive capitalism and the contested campus. In G. Cox & K. J. (Eds.), *Engineering Culture: on the Author as (Digital) Producer* (pp. 71-93). New York: Autonomedia.

Dyer-Witherford, N. (1999). *Cyber-Marx: Cycles and Circuits of Struggle in High-technology Capitalism.* Chicago, IL: University of Illinois Press.

Edwards, R., Tracy, F., & Jordan, K. (2011). Mobilities, moorings and boundary making in developing semantic technologies in educational practices. *Research in Learning Technology*, *19*(3), 219-232.

Guattari, F. (1984). Molecular Revolution: Psychiatry and Politics.

Hall, R. (2015). The Implications of Autonomist Marxism for Research and Practice in Education and Technology. *Learning, Media and Technology*, *40*(1), 106-122.

Healey, M., & Jenkins, A. (2009). *Developing undergraduate research and inquiry.* York: Higher Education Academy.

Huynh, D., Karger, D., & Miller, R. (2007). *Exhibit: lightweight structured data publishing.* Proceedings from WWW '07: Proceedings of the 16th International Conference on World Wide Web, Banff.

Jensen, J., & Dohn, N. B. (2016). *Challenges and possibilities for Design Based Research with semantic web technology.* Proceedings from 10th International Conference on Networked Learning, Lancaster.

Jordan, K., Griffiths, H., & Johnstone, K. (2010). *An Interactive Timeline of Plant Evolution.* UK Centre for Bioscience/Higher Education Academy.

Proceedings of the 10th International Conference on Networked Learning 2016, Edited by: Cranmer S, Dohn NB, de Laat M, Ryberg T & Sime JA.

25

ISBN 978-1-86220-324-2

Litherland, K., Carmichael, P., & Martinez-Garcia, A. (2013). Ontology-based e-Assessment for Accounting Education. *Accounting Education*, *22*(5), 498-501.

Lotringer, S., & Marazzi, C. (2008). *Autonomia: Post-Political Politics.* Cambridge, MA: Semiotexte/MIT Press.

Mancini, S. (1977). *Socialismo e democrazia diretta. Introduzione a Raniero Panzieri.* Bari: Dedalo Libri.

Martinez-Garcia, A., Corti, L., & Bell, D. (2013). *Integrating DDI with metadata for qualitative data: implementing the QuDEx standard.* Proceedings from European DDI Conference (EDDI '13), Paris.

Martinez-Garcia, A., Morris, S., Tscholl, M., Tracy, F., & Carmichael, P. (2012). Case-Based Learning, Pedagogical Innovation, and Semantic Web Technologies. *IEEE Transactions on Learning Technologies*, *5*(2), 104-116.

Morris, S. (2012). Case Study: Using the Semantic Web to Enhance the Teaching of Dance. Retrieved 1 Sep, 2015, from http://www.w3.org/2001/sw/sweo/public/UseCases/LJMU/.

Neary, M., & Winn, J. (2009). Student as Producer: Reinventing the Undergraduate Curriculum. In L. Bell, H. Stevenson, & N. M. (Eds.), *The Future of Higher Education: Policy, Pedagogy and the Student Experience.* London: Continuum.

Pellejero, E. (2009). Minor Marxism: An Approach to a New Political Praxis. *Deleuze Studies*, *3*(Supplement:'Deleuze and Marx'), 102-118.

Raunig, G. (2010). *A Thousand Machines.* Cambridge, MA: Semiotexte/MIT Press.

Rimpiläinen, S. (2015). Multiple enactments of method, divergent hinterlands and production of multiple realities in educational research. *International Journal of Qualitative Studies in Education*, *28*(2), 137-150.

Stott, T. A., Litherland, K., Carmichael, P., & Nuttall, A. (2014). Using Interactive Virtual Field Guides and Linked Data in Geoscience Teaching and Learning. In V. Tong (Ed.), *Geoscience Research and Education: Teaching at Universities* (pp. 163-188). London: Springer.

Tracy, F., & Jordan, K. (2012). Students as designers of semantic web applications. *Technology, Pedagogy and Education, 21*(2), 171-188.

Tracy, F. (2016). *Problematising Participatory Research for Developing Semantic Web Technologies*. Proceedings from 10th International Conference on Networked Learning, Lancaster.

Tscholl, M., Patel, U., & Carmichael, P. (2011). (Un)Locating Learning: Agents of Change in Case-Based Learning. *International Journal of Actor Network Theory and Technology Innovation*, *3*(2), 17-31.

Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development*, *53*(4), 5-23.

Wellbrook, C. (2014). A workers' inquiry or an inquiry of workers? *Ephemera*, *14*(3), 357-374.

Woodcock, J. (2014). The Workers' Inquiry from Trotskyism to Operaismo: a political methodology for investigating the workplace. *Ephemera*, *14*(3), 493-513.

Proceedings of the 10th International Conference on Networked Learning 2016, Edited by: Cranmer S, Dohn NB, de Laat M, Ryberg T & Sime JA.

26

ISBN 978-1-86220-324-2

Wright, S. (2002). *Storming Heaven: Class Composition and Struggle in Italian Autonomist Marxism.* London: Pluto Press.