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Converging Lenses: PLE diagrams, PKM Workflows and Scholarly Ontologies

Lentes convergentes: Diagramas PLE, flujos de trabajo PKM y ontologías académicas

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Abstract
This paper reviews the emergence and development of three different perspectives on knowledge work – PLE (Personal Learning Environments), PKM (Personal Knowledge Management) and Scholarly Ontologies. Each is described briefly, followed by an overview of how they align and might usefully be used as approaches to introducing students to formal methods of knowledge processes in their learning.
En este artículo se revisa la aparición y el desarrollo de tres perspectivas distintas para aproximarse al trabajo con el conocimiento: los PLE (Entornos Personales de Aprendizaje), las PKM (Redes de gestión del conocimiento) y las ontologías académicas. Cada una de las perspectivas se describe brevemente, y a continuación se presenta una visión general de cómo se armonizan, complementan y pueden ser útiles como enfoques para la introducción de los estudiantes en los métodos formales para procesar el conocimiento en sus diversos ámbitos de aprendizaje.
Keywords: PLE, PKM, Ontologies, Pedagogies

Resumen
Este artículo revisa el surgimiento y desarrollo de tres perspectivas diferentes sobre el trabajo del conocimiento: PLE (Entornos personales de aprendizaje), PKM (Gestión personal del conocimiento) y Ontologías académicas. Cada uno se describe brevemente, seguido de una descripción general de cómo se alinean y podrían usarse de manera útil como enfoques para presentar a los estudiantes métodos formales de procesos de conocimiento en su aprendizaje.
En este artículo se revisa la aparición y el desarrollo de tres perspectivas distintas para aproximarse al trabajo con el conocimiento: los PLE (Entornos Personales de Aprendizaje), las PKM (Redes de gestión del conocimiento) y las ontologías académicas. Cada una de las perspectivas se describe en ocasiones, ya continuación se presenta una visión general de cómo se armonizan, complementan y pueden ser útiles como enfoques para la introducción de los estudiantes en los métodos formales para procesar el conocimiento en sus diversos alcances de aprendizaje.
Palabras clave: PLE, PKM, Ontologías, Pedagogías

1. Introduction

The increase in knowledge work, and in digital knowledge work, as well as the growing amount of information which is required for even the most basic decisions brought a new focus on how individuals manage knowledge digitally. Several concepts compete as ways to make explicit the nature of this process. While all are different, all are similar in their broad sweep and may be aligned in our pedagogy. This paper looks at three currently distinct ways of deal with this, shows how they align and suggests how to incorporate this alignment into our pedagogy

The three areas considered are PLE/PLN, Workflow models and Scholarly ontologies. PLE are viewed as a web of tools centred on the learner. PLE diagrams lack a time or process directionality and presented activities in broad strokes Workflow models for knowledge work add a time or process dimension - indeed, this is the core of their modelling. Scholarly Ontologies represent research activities in much greater detail. While they are usually presented in a sequence, this is not an essential feature as they focus on actors and activities.

2. PLE/PLN

The PLE concept blossomed around 2007 as a result of papers and blog posts by Atwell, Anderson, Weller, Van Harmelen (T. Anderson, 2006; Attwell, 2007; Van Harmelen, 2008; Weller, 2008) and others. PLE was presented as a counterbalance to the top-down institutional learning technologies which were coming into vogue at the time. Advocates of the model were resistant to the emerging paradigm of the institutional learning management system which advocates a one size fits all model for the delivery of digital content. They often looked back at the earlier days of teaching and learning on the web where the presentation of learning materials was much more varied and simpler. Early practitioners in digital learning had been radical innovators who naturally resisted the new wave of institutional LMS which were rigid and unfriendly.

PLE initially were seen as a collection of technological affordances which would support the learners in collecting and processing information from a range of diverse sources. PLE were often anchored in specific digital tools, or described in terms of specific digital tools rather than in terms of the affordances which they offered

Many published descriptions of PLE were presented as diagrams, often hub and spoke diagrams with the learner at the centre of a collection of digital tools which made up the learning environment. These Web 1.0 and early Web 2.0 tools often had single, very specific functions: searching, bookmarking, tagging, social networking and writing by mainly by long form blogging, with some early microblogging tools. These tools thus dealt mainly with finding, sorting and sharing knowledge, but the internal reflections of the learner were rarely shown although some PLE diagrams did include times and spaces for reflection. Many PLE diagrams were archived online, but sadly these have not survived.

Over time, many of the tools described in the first wave of PLE have disappeared. New tools have emerged. Whereas the tools referenced in first generation PLE were often limited in functionality, and no one tool addressed the full spectrum of the PLE concept, newer tools can offer multiple functions which support different parts of the PLE.

It is also the case that the PLE model by empowering learners to create their own learning environment, which is centered on them, and focused on their needs. The aspiration was that they would be equipped with a collection of tools which they can carry with them once they left the learning institution. The development of the PLE was perceived to be particularly important not only for lifelong learning but also for learners were outside the traditional academically orientated university sector.

Later it was realised by some that the PLE concept should also include non-technical channels through which learning may flow. Some understandings of the concept also

included ideas about reflective spaces or spaces and times for reflective learning as part of the learners PLE.

Some writers (Cigognini et al., 2011) on PLE and PKM or personal knowledge management have included the idea of a process in their models. These recognise that the various human and technology-based inputs into learning are part of a sequence of activities with a beginning middle and end. This leads us to consider workflows

3. Workflow Models

A separate strand of development has been the emergence of scholarly workflows. The term 'scholarly workflow' is relatively new. However, it represents an idea with a long past. Workflows emerge as an object of study with the advent of Frederick Taylor's ideas of scientific management in the early 1900s. In science 'workflows' might be regarded as a neologism for methods; and scientific method of thinking about problems has a robust history. With the digitalisation of management, business workflows began to be studied by the emerging area of 'business process engineering' based on the work of Davenport and Hammer in the 1990s.

In practice the methods used in laboratory sciences to define the process by which experiments were conducted was effectively a workflow before the term became popular. The need to explicitly describe research methods and formalise protocols for scholarly communication arises first in the sciences. As the social sciences emerge in the C19, part of their program required following the 'scientific model' for research and communication. The expansion in student numbers in the humanities, and the increased use of quantitative methods like cliometrics and distant reading brought with it a shift from teaching methods as a craft in an apprenticeship model to clear and explicit teaching of methods.

The scientific method has several steps, ranging from 4 to 10 depending on how you chose to divide it. Most begin with an observation or a question, involve research about the topic and the formation of a hypothesis, an experiment to test the hypothesis, analysis of results and presentation of those results.

The emergence of large-scale scientific databases and the increasing digitalisation of laboratory tools allowed for more formal expressions of parts of the research and laboratory workflows. This has now progressed to the point where laboratory equipment for many experiments can be controlled digitally and remotely. This means that the relevant workflows can be described in computer code and experiments can be designed and managed digitally (Oinn et al., 2004).

As one moves along the continuum from hard sciences towards softer sciences and into social sciences and humanities it become more difficult to express research practices in clearly defined terms. Nonetheless, there are several conceptual models which describe knowledge work as a process in a clear way.

RAW arose from a need to make clear the steps in the process of research, analysis and writing to undergraduates. It sets out to do this by explicitly breaking the process into clear steps, mainly using digital tools to show how to gather, critically read articles and sources,

analyse and combine evidence into a plan for an argument and write the finished essay. Each step of the process was required, assessed and graded.

GUSC. In GUSC, Ismail drew on and combined on several proposed frameworks in organisational knowledge management. It combined earlier knowledge process models by Avery, Grundspenkis, Jarche, Martin and Razmerita These were mainly aimed to solve the problem of knowledge process management in the business domain(Avery et al., 2001; Ismail & Ahmad, 2011; Jarche, 2009; J. Martin, 2000).

Seek-Sense-Share is a very popular, elegant, and effective conceptual model of personal knowledge management which traces its roots back to 2009. It originally mapped to tools then current and popular but over time has changed to both recognise new tools for each stage, as well as being presented in higher level, more abstract versions and being linked to the changing structures of organisational culture over human history(Jarche, 2009).

Scholarly Ontologies

Mapping workflows requires clear descriptions of the elements of the workflows. In research and scholarly activity this has taken the form of scholarly ontologies.

The gulf that exists between the discourse on PLE and the development of scholarly ontologies is clearly seen by the extent to which the literature on PLE does not intersect with the literature on scholarly ontologies. Thus, citations of foundational papers on PLE such as Atwell scarcely refer to ontologies and never to scholarly ontologies. Conversely, citations from influential early papers on scholarly ontologies do not discuss PLE (Tho et al., 2006). Melding scholarly ontologies with the PLE concepts requires first some description of Scholarly Ontologies

One of the first efforts to describe the basic building blocks of scholarly research and the steps of the process comes from John Unsworth's description of scholarly primitives from a paper in 2001 (Unsworth, 2000). This paper was partly animated by the description of the research process in the human genome project. Unsworth enumerated seven basic scholarly actives or scholarly primitives:

- Discovering
- Annotating
- Comparing
- Referring
- Sampling
- Illustrating
- Representing

These ideas were advanced in McCarty & Short's discussion of a methodological commons (S. Anderson et al., 2010). This strand was one off any expanded on in an AHRC funded research Methods Network project between 2005 and 2008(*AHRC ICT Methods Network: Supporting the Digital Arts and Humanities : Home*, n.d.). Other early papers under the heading of 'scholarly ontologies' dealt with argument mapping in scholarly papers(Uren et al., 2006). Later work by Buckingham Shum and others drove into the area of knowledge

mapping(Okada et al., 2008). Given the strong visual element in representations of PLE, the work on knowledge visualisations and later knowledge graphs is an important related field.

The volume of work published across these areas is extensive and growing. They are increasingly specialised and siloed, and often repeat each other unknowingly but are all involved in developing tools to enhance managing personal learning. These have all contributed to the development of NeMO, the NeDIMAH Methods Ontology, and the 'Scholarly Ontology'(Pertsas & Constantopoulos, 2017)

NeMO, and the Scholarly Ontology, are multi-layer ontologies with increasing levels of domain specificity at the lower levels (Pertsas 2017). The top level "contains the most general concepts and properties" while the lower levels describe increasingly fine grained and domain specific descriptions of activities. At the top level, the Scholarly Ontology has Actors, Events and Objects, broken into Conceptual Objects and Physical Objects. Working down, Actors may be Individuals or Groups; Events may be Projects or Courses. Physical Objects are limited in range, but Conceptual Objects as a category has many subcategories, reflecting the heavy lifting of knowledge work which comes under this heading. Here the SO becomes complex, and the worked examples of NeMO may be easier to follow (Pertsas & Constantopoulos, 2017).

NeMO is compliant with the CIDOC CRM. CIDOM CRM is a reference model developed since the 1990s, originally to provide a common standard for cultural heritage data. CIDOC CRM is primarily devised to explore events in the past which can be studied either by direct observation or through the material evidence from those events. It therefore provides a broad, standard and widely accepted framework for describing scholarly activity (*Home | CIDOC CRM*, n.d.). CIDOC CRM has been and is being extended to cover a range of domains (Hiebel et al., 2017; Niccolucci, 2017; Theodoridou et al., 2010).

NeMO provides mappings of other ontologies such as DH Commons, Oxford ICT and TaDiRAH to itself as well as worked examples (*DCU OnTo - NeDIMAH Ontology Navigation*, n.d.). NeMO deals mainly with activities, rather than People or Objects as Scholarly Activity does.
Top level categories in NeMo are

1. Conceiving
2. Seeking
3. Acquiring
4. Processing (4.1 Modifying 4.2 Analysing 4.3 Organising 4.4 Producing 4.5 Preserving)
5. Communicating (5.1 Collaborating 5.2 Disseminating)

Area 1, 2 and 3 are relatively simple, as is 5 but 4, Processing, is extensively subdivided into 127 subareas. In the available online examples of the application of NeMO to specific problems, the lowest level refers to specific digital tools associated with the most fine-grained description of activities. These worked examples are presented Excel spreadsheets on the NeMO website (*DCU OnTo - NeDIMAH Ontology Navigation*, n.d.).

Tools

It is important for learners to understand the underlying principles and not to be focussed on particular tools for the work since digital tools come and go. Learners should know how to

apply the underlying principles using a range of tools and be able to move work between tools.

Nonetheless, tools are fundamental to the PLE debate. The PLE concept emerged around the same time as two major developments - the large-scale institutional learning management system (LMS) and the opportunities for personal content creation offered by 'Web 2.0' The LMS offered simple, institution wide and institution centred delivery of a uniform learning product thorough a common and consistent, if clunky, user interface which provided leaners with a single point of entry to all the courses at one institution. The PLE concept stressed the use of a range of tools which the learner would own, control and be responsible for, and which would support a lifelong learning journey across many institutions. The most common representation of the PLE was a diagram with the learner at the centre, surrounded by a range of tools used in different parts of the learning process.

The diversity of digital tools in the PLE concept posed challenges. It required learners to manage a range of tools rather than the one stop shop of the LMS. It required learners to be able to manipulate information across these tools, moving materials between platforms (which were often not readily compatible). When tools disappeared, as many did, it required lifelong learners to migrate information from dead tools to new ones. A key article on PLE listed no less than 19 different tools of which 5 have disappeared (Atwell, 2007). This seems excessive but reviewing 11 surviving PLE diagrams from the web which list specific tools all list more than 20. Among those there is some duplication of function – several list multiple blogging tools for example. Most listed applications provided only 1 specific function. Many PLE advocates were comfortable with these challenges, and indeed rejoiced in their ability to hack data and tools. The average learner, however, was probably not and institutions would have been unwilling to support such a diversity of tools

For institutions, the possibility that academics would provide content in different platforms in different modules in the same course was problematic in terms of management and equity of access, and they did not encourage or facilitate it. The problem of creating a viable management system (Johnson & Liber, 2008) to reconcile the PLE with institutional needs was never satisfactorily resolved.

Popular tools in early PLEs posed several challenges. Many early Web2.0 tools offered only a single function. Interaction between tools was limited or non-existent which meant that moving information around required manual intervention, although that is not always a bad thing. However, for users who created a well-designed set of tags, not being able to easily move certain tags to other applications was a limitation. Migrating information from tools which were retired was difficult. The disappearance of tools, often with little warning, was a problem. Not surprisingly, Web 2.0 tools all required account creation, with the need ot manage userids and secure passwords. Many tools which survived, often in slightly different forms, are no longer free but are subscription based. All of these were obstacles in the path of those who sought to create effective PLEs for themselves or to evangelise for the PLE concept.

One of the most common tools in the early PLE years which has gone was delicious, a social bookmarking service. Social bookmarking tools allowed users to capture bookmarks, sort them by tags and share the links. However, they were unable to overcome the problem of

'link rot' on the web when sites disappeared. More recently 'web clippers' which capture all or part of webpages are now integrated into web browsers and, importantly, into most popular note taking tools. Web clipping offers an advantage over social bookmarking in that they save locally a copy of the webpage of interest.
Other contemporary tools show similar useful developments. Many note taking applications like OneNote, Evernote, Notion, and others now support not only web clipping of all types of content but also tagging, and sorting by tagging, sharing and collaboration. Tools like Obsidian include elements of visual representation of notes coloured by tag. Collaborative annotation tools make shared, public sensemaking possible. Thus, Zotero was originally conceived as an open-source tool to manage bibliographic collection and citations. As such it was not often mentioned in early PLE. However, Zotero has over the past decade added tagging, adding notes to items and full pdf highlighting and commenting. As a result, it not only supports gathering information for a PLE, but also segues into analysis and sense making (Center for History and New Media, n.d.). Most contemporary tools also use simpler, standards based native file formats and include support for exporting data more readily.

Manging a PLE has also been made easier by the development of tools to generate, store and use secure passwords. For institutions, the ability to link a range of applications to single sign on portal for learners makes it possible to consider using more than one LMS to rule them all.

4. Synthesis

These distinct methods or lenses: PLE, PKM, Workflows and Scholarly Ontologies all operate separately but on the same subject matter. All have developed distinctive ways of mapping knowledge work, with differing terminology. It is not surprising that they align at the highest level, as we can see below.

In the table, the two leftmost columns show how some exponents of PLE described their learning environments in terms of activities rather than tools (M. Martin, 2007; Weller, 2008). The middle columns show the Read-Analysis-Write workflow and Seek-Sense-Share as examples of the discourse on workflows.(Cosgrave, 2009; Jarche, 2009, 2014). The rightmost two columns show Unsworth's 'Scholarly Primitives' and the highest level of the NeMO ontology (*NEMO Resources*, n.d.; Unsworth, 2000).

PLE		Workflow		Ontology	
Martin	Weller	RAW	Jarche	Unsworth	NeMO
Gathering	Resource Search Resource Gathering	Read	Seek	Discovering	Conceiving Seeking Acquire
Processing		Analysis	Sense	Annotating Comparing Referring Sampling	Processing
Acting	Sharing Work Files Communication Peer Networking	Write	Share	Illustrating Representing	Communication

5. Teaching

These ways of understanding knowledge work have developed separately over the past 15 years although it is difficult to imagine that practitioners in these strands were unaware of the different threads. Since they all deal with the same process; it is not surprising that they show strong similarities and can be readily aligned. It is useful to present an overview to show these similarities. It is possible that comparison and synthesis may lead to cross fertilisation which would enrich these methods. It would be counter-productive to attempt to collapse all these in "one ring to rule them all" since this would quench the diversity which may be important in presenting this to learners with diverse needs and ways of understanding.

It is therefore useful for our pedagogy to be informed by an understanding of PLE, PKM, workflows and scholarly ontologies lenses of knowledge work. It is important to breakdown the processes of knowledge work and require learners to step through the stages outlined above. In an age when learning to learn is vital, critical and digital literacy requires exposing our students to the stages of research, analysis and writing across many media and explicitly require and reward performances of understanding at each stage of the process.

Understanding their PLE can help learners to develop personal, reflective and self-regulated learning skills (Blaschke, 2019; Dabbagh & Kitsantas, 2012; Tur et al., 2016). Encouraging learners to being their journey by diagramming their initial understanding of their PLE, before developing it through a series of steps which allow them to meet workflows and ontologies will allow them to develop a deeper understanding and get under the hood of their leaning process "as students may not have advanced knowledge of how to use the technology for academic purposes" (McLoughlin & Lee, 2010).

Appropriate assignments should require learners to step through the process of defining research questions, searching for and evaluating resources, sharing reading summaries,

discussing multiple points of view and debates, collaborative drafting, peer critique and collaborative writing and knowledge sharing (Cosgrave, 2014).

6. Conclusion

The development of a range of new tools and methods for working through the personal learning or personal knowledge workflows in more detail does offer new opportunities to develop our pedagogy to meet the needs of a data rich digital society. While we now have better tools for writing and sharing content, key parts of the PLE process remain deeply personal. Improving digital tools can help to scaffold the PLE process but are unlikely to become a substitute for 'soft skills' like critical thinking, creativity, or innovation. It is easier to fall back on the affordances of the institutional LMS than it is to explicitly show the merits nurturing of a PLE. Nonetheless, a key value behind the PLE – emphasising personal, lifelong learning over short term institutional convenience is even more important in our complex and unpredictable age.

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