Watanabe, T. and Seta, K. (Eds.) (2015). Proceedings of the 11th International Conference on Knowledge Management.

Privacy in Learning Analytics – Implications for System Architecture

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Abstract: This paper explores the field of ICT standardisation related to learning analytics, a new class of technologies being introduced to schools, universities and further education as a consequence of increased access to data from learning activities. Learning analytics has implication for how the individual manages data and knowledge about herself and her learning, highlighting issues of privacy, ownership of data, and consent to share and use data, – issues that are not yet been fully discussed in the field of learning technology development in general, and standardisation of learning technologies in particular. What do these issues mean for standardisation and design of LA architectures? Based on requirements of open architecture, transparency and trust, and ownership and consent this paper proposes a search architecture for learning analytics based on open and linked data. The proposed middle layer highlights dynamic usage agreements and student agency and represents an alternative approach to the LA architectures now being developed in international standardisation fora.

Keywords: Learning analytics, data sharing, interoperability, privacy, data ownership and consent, standardisation

1. Introduction

Unveiling and contextualising information so far hidden in different educational data in order to analyse it and present it for different stakeholders, – this is the promise of learning analytics (LA) according to Greller and Drachsler (2012). LA will offer new insights for learners and improve effectiveness and efficiency for institutions. "This new kind of information can support individual learning processes but also organisational knowledge management processes" (Greller & Drachsler, 2012). Ambitious to harness the new capabilities of "big data" in education it is easy to forget that when translating education into numbers one "makes education actionable through the production and stabilization of specific kinds of views of what education and learning should be" (Williamson, 2015). Once, however, this political or normative aspect of learning analytics is out in the open teachers, parents and the learners themselves will start asking questions on what happens when they start sharing data. This will introduce new requirements for design of LA technologies.

More and more of the forces that create global change are driven by data, and based on new practices of sharing data, e.g., mobile devices, social media, big data, sensors, and location-based services (Scoble & Israel, 2013). These services are also exploited in education, and thus data mining and learning analytics are topics that start to appear on the agenda of standards organisations dealing with ICT for learning, education and training. ISO/IEC JTC 1/SC36[1] has established a new working group on learning analytics, which met for the first time in June 2015 in Rouen, France. In addition, a number of initiatives work towards defining learning analytics architectures, e.g., industry consortia like Apereo,[2] and IMS Global[3]; and government agencies like UK Jisc, Keris of Korea, or country initiatives like one found in Estonia. These architectures are ranging from high-level description of

1 www.iso.org/iso/iso_technical_committee%3Fcommid%3D45392

2 www.apereo.org

3 www.imsglobal.org

LA systems to reference implementations of running code. Till now, requirements raised by data sharing are not brought into the center of interest for LA standardisation (Cooper & Hoel, 2015)

Data sharing, understood as the release of data for use by others, i.e., other persons or organisations (Cooper & Hoel, 2015), is needed by many applications of learning analytics. Data from more than one source are needed to realise the potential of LA. For example, large-scale data is often a prerequisite for educational data mining techniques or multi-variate statistics. Alternatively, it is usually the case that the data required to undertake learning analytics resides in different software systems, and that data from a variety of different sources is vital. Although the data from an institutional learning platform or a MOOC may be considered large and varied, the scale and coverage of such datasets may be insufficient to give good analytics because of the great variety of learner and contextual attributes (Verbert et al., 2011). This challenge applies to both learning science research and to potential products and services built around data generated during learning activities. This situation motivates the idea that data sharing between organisations - potentially including public and private sector bodies - is an important enabler for effective learning analytics. Data sharing is also indicated by Cloud Computing models of service and IT provision, where expertise or technology is provided by a separate organisation to the education provider.

The requirements for data sharing set educational establishments apart from archetypical Big Data corporations like a retail store or a online shop. Work in the European LA community exchange project LACE[4] has shown that these requirements to a large extent are related to concerns about data protection, privacy and ethics, data control, and trust. These legal and organisational issues have traditionally played a minor role in international standardisation work within the field of learning technologies, where technical and semantic interoperability have dominated.

In this paper requirements of legal, organisational and semantic-technical nature are explored to see what implications they will have for design of LA architectures. The paper builds on current work within the community of LA researchers and stakeholders, particularly the work of the European coordination and support action project, LACE. Based on the legal and organisational requirements so far identified, what would be the technical-semantic design options that could be pursued for standardisation?

The rest of this paper is organised as follows: First, a review of recent research on the effects of extensive data sharing for LA is presented. Then three sets of requirements are derived and used for evaluating current LA architecture proposals and to develop a new proposition for a new middle layer bridging between data sources and LA processes. This first explorative proposal is discussed, and the paper concludes with some reflection how this work should be progressed and could contribute to current standardisation in the field of LA.

2. Related work

In absence of clear evidence of the benefits of learning analytics there is a growing body of research pointing to the possibility of adverse effects of extensive use of data from multiple sources for analytics. The concerns are centered around student vulnerability (Slade & Prinsloo, 2013; Prinsloo & Slade, 2013) and different aspects of privacy, data protection, and ownership to data (Hoel et al., 2015; Cooper & Hoel, 2015).

Prinsloo and Slade (2015) suggest using student vulnerability as a lens for analysis, stating that "[t]hrough the quantification practices in higher education, students' vulnerability is increased when they see themselves, their potential and their futures, as presented in the number of clicks, logins, time-on-task". Prinsloo and Slade (2105) maintain that we are more than our data, and therefore we need to take into account the contexts in which numbers are created. They want to strengthen the student agency and have suggested a framework to mitigate the student vulnerability and optimise student agency, including the duty of reciprocal care; the contextual integrity of privacy and data; the centrality of student agency and privacy self-management; the need to rethink consent and employing nudges; developing partial privacy self-management; adjusting privacy's timing and

4 www.laceproject.eu

focus; and moving toward substance over neutrality and moving from quantified selves to qualified (Prinsloo & Slade, 2015).

In focussing on vulnerability and student agency when looking at the individual, and education as a moral practice when looking at the institution (Jisc, 2015) it becomes clear that we have to go beyond binary solutions to the issues of privacy, data protection, consent to give access to data, etc. It is not about ticking a box to give consent to use or not to use one's data. It is not about privacy as having or not having control of data, or secrecy or not secrecy.

Borocas and Nissenbaum (2015) understand informed consent as a limited waiver of rights and obligations. They state "[i]t is time for the background of rights, obligations, and legitimate expectations to be explored and enriched so that notice and consent can do the work for which it is best suited" (Borocas & Nissenbaum, 2015). It is not the case that privacy is an "unsustainable constraint if we are to benefit, truly, from big data" (Borocas & Nissenbaum, 2015). However, privacy needs to be seen in the right context. "[C]onsent is not required for acceptable, expected behaviors, but only for those that departs from it. The burden on notice, therefore, is to describe clearly the violations of norms, standards, and expectations for which a waiver is being asked and not to describe everything that will be done and not done in the course of treatment or research…(…) Where, for example, anonymizing data, adopting pseudonyms, or granting or withholding consent makes no difference to outcomes for an individual, we had better be sure that the outcomes in question can be defended as morally and politically legitimate. When anonymity and consent do make a difference, we learn from the domain of scientific integrity that simply because someone is anonymous or pseudonymous or has consented does not by itself legitimate the action in question" (Borocas & Nissenbaum, 2015).

Xu (2011) has developed a privacy framework based on privacy literature, bounded rationality theory, control agency theory, and social contract theory. The goal of the framework is to provide understanding of the major drivers and impediments of information disclosure in the context of online social networks. It has been shown that individuals express privacy worries but behave in ways that contradict their statements. The phenomenon is called the privacy paradox, and is another reason why there is a need to move beyond control and access as lenses to understand privacy, and look more towards the context integrity perspective on privacy. It is noted that Xu bases his framework (Figure 1) on the dialectics between privacy as control vs privacy as restricted access. However, he applies several theoretical lenses. "[A]n individual's perceived privacy is (..) viewed as perceived control over information release and perceived ease of information access, with the considerations of optimistic bias. (…) Users may genuinely want to protect their personal data, but because of bounded rationality, rather than carefully calculating long-term risks of information disclosure, they may opt for immediate gratification instead" (Xu, 2011).

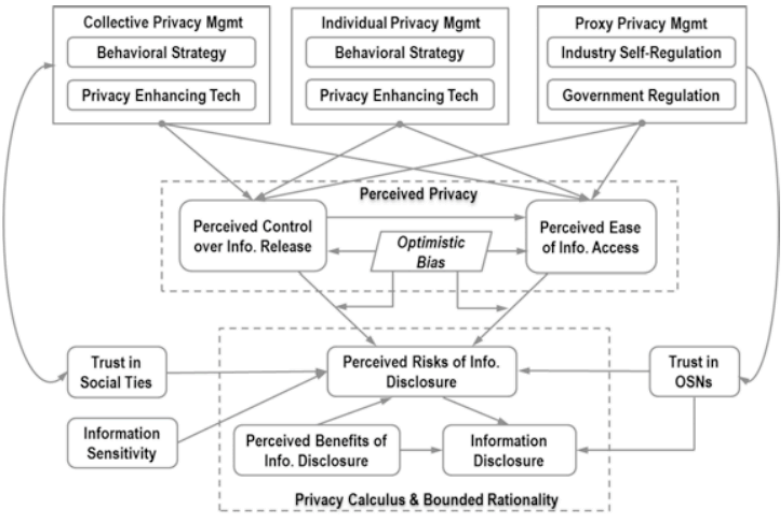

Figure 1. Proposed theoretical framework for Privacy 2.0 by Xu (2011)

A report on Data Sharing Requirements and Roadmap by the LACE project (Cooper & Hoel, 2015) grouped the concerns related to data sharing according to the interoperability levels defined in the European Interoperability Framework (European Commission, 2010): *Legal issues:* Lack of awareness of what is possible within the law, National differences, and Current legislation is out of date; *Organisational issues:* Privacy, and Inadequate decision-maker knowledge; *Technical and semantic issues:* Incompatible technical implementations, Inappropriate architectural assumptions, Inadequate domain-level semantic models, and Lack of adoption of existing specifications.

Based on this problem space Cooper and Hoel (2015) recommend that these activities could be undertaken: *Legal Issues:* Raise awareness of what is possible within the law; *Organisational issues:* Anonymisation and statistical disclosure control, Analytics models as shared data, Remote access analytics, Trusted data analysis, User-managed access, Common codes of practice and standardised data agreements, and Develop understanding and consensus around risk-based approaches to privacy protection; *Technical and semantic issues:* Shared open architectures and common frameworks, Code-bashes (plugfests) - addressing mid-level practical interoperability, and Practice-oriented pre-standardisation at the domain-level.

The roadmap of activities towards solutions developed by Cooper and Hoel (2015) is very high level and gives limited directions for design. Furthermore, it is not clear how legal and organisational concerns are turned into requirements for technical-semantic design. It is therefore useful to look further into the case studies Cooper and Hoel used to come up with these recommendations, in order to see if more concrete requirements could be derived from their data.

Through community engagement supported by LACE project and other actors a great number of questions and concerns related to LA are collected (Cooper & Hoel, 2015). Hoel et al. (2015) analysed 220 questions to see how the captured concerns could be understood in terms of propositions for solutions. They found that "Technical requirements were not explicitly stated in any of the 220 questions, and the need for technical alignment was only indirectly present (…) Most clearly, technical solutions are needed for exchange of information about ownership to data. Also the idea of learning as a risk-based activity offers technical design challenges" (Hoel et al., 2015).

Ownership and control of data, – a complex set of issues that relate data used for analytics to the individual is identified by Hoel et al. (2015) as the most prominent challenge to solve, also for technical-semantic design.

One idea for technical solutions could be gleaned from a case study in this LACE report (Cooper & Hoel, 2015), which describes a Norwegian pilot of a cross-sector service platform brokering between services and systems that have information about users and a range of specialised educational services, some of which could be dealing with learning analytics. The service providers connect to and retrieve information through standardised APIs, while the end users of the services are authenticated through a national identity management service.

2.1. Research Questions refined

At the current state of development of LA solutions, issues of legal, organisational and technical-semantic nature seem to be interwoven, justifying actions on all levels of interoperability. Traditionally, the LET standards community has been grappling with questions of systems interoperability, content repositories and learning objects. Data-driven education where data about learning activities are a learning resource in its own right makes it pressing to solve issues on legal and organisational levels. The technical-semantic challenges, however, remain. This paper explores what it means for technical-semantic interoperability within the field of LA when privacy requirements, or more widely, legal and organizational challenges, are translated into technical solutions.

Methodologically, this research is positioned in the first Relevance Cycle of the three research cycles of Design Science (Hevner, 2004; 2007), addressing requirements and field testing. The purpose is to come up with candidate concepts that describe the problems and opportunities in the application domain from a people, organisational systems, and technical systems perspective.

3. Requirements

Community exchange among stakeholders of LA technologies gives a clear indication that the interoperability issues that need to be tackled first are not of technical nature but related to legal and organisational challenges. Alignments of legal practices and codes of ethics may seem abstract and bound to cultural, legal and organisational systems; however, alignment processes involve exchange of information, which offers challenges of technical and architectural nature. It is important to specify these technical systems considering the full range of requirements, as recent history has shown that ill designed systems could prove fatal for the success of new LA approaches (Cooper & Hoel, 2015, section 3.8).

The following requirements are derived from issues identified through desk research and LA community exchange:

Open architecture: Learning analytics components may be developed as proprietary or open source, however, the architecture itself should be developed using open standards and open solutions. There are several technical and economic reasons for this, like making it easier to achieve a critical mass of multiple products fitting the architecture; flexibility for institutions in selecting components without having to invest in a single large monolithic system, etc. However, one should also acknowledge that an open architecture would make it easier to achieve data sharing and develop trust between different stakeholders based on transparency, another main requirement highlighted in this study.

Transparency and Trust: This cluster of requirements is supported by a wide range of non-technical features like codes of practice; competency development; open research practices sharing research results and data, publishing predictive models; etc. However, quite a few of these measures can and should be supported by technical solutions being an integral part of LA systems.

Ownership and consent: Even if data could be harvested through institutional practices assuming implicit consent to data sharing as the learners sign up for courses and enroll in a study, in the end, the question of access to data always comes back to the individual and her willingness to share. These requirements build on the 'context integrity' perspective on privacy developed by Nissenbaum (2009). From this perspective questions of ownership and consent are not to be dealt with once and for all when students register to a course; it is a matter of maintaining a continuous conversation on privacy issues making sure that the student actively and at all times agrees to share data for different types of analytics, and that the institution is able to justify its learning analytics research and interventions. Most ICT systems have some kind of identity management solutions, however, their scope is often only simple authentication and authorisation. There is a need to rethink how ownership and consent features could be embedded in these solutions.

4. Towards Design Propositions

Several architectures have been proposed for learning analytics. In 2011 an Open Learning Analytics Architecture (OLA) was proposed by Siemens et al. (2011). The Apereo Learning Analytics Initiative has developed a set of interlocking pieces of open source learning analytics software described in their LA Dimond model (Figure 2). However, a mature conceptual framework supported by a fully functional end-to-end reference implementation has yet to fully emerge (Sclater et al., 2015).

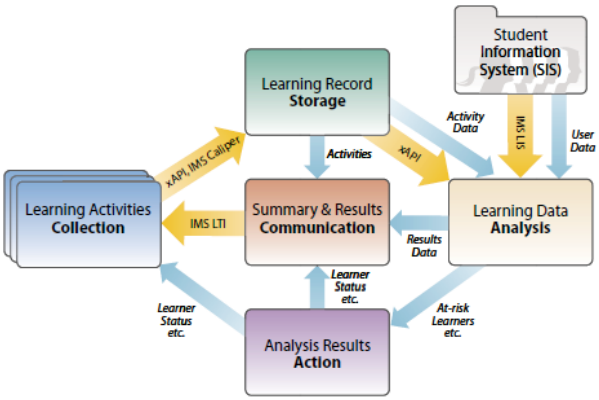

Figure 2. Apereo diamond model of an open learning analytics architecture (Siemens et al., 2011)

Jisc, a UK based public body, has attempted to conceptualise an end-to-end basic learning analytics system, which is now procured for higher education. Data comes primarily from the student record system, the virtual learning environment (VLE or learning management system) and a variety of library systems. Institutions are also beginning to use data from other systems such as attendance monitoring and assessment systems (Cooper & Hoel, 2015).

While the Apereo model (Figure 2) is silent about student ownership of data and consent to share it is interesting to observe that the Jisc model has defined a Consent Platform with a Student Consent Service, logging self-declared data (Sclater et al., 2015). This part of the Jisc system has still to be designed. It is also interesting to note that when Jisc in beginning of 2015 tried to procure the development of this service no suppliers came forward, and the Student Consent Service therefore will be developed in-house (Sclater, 2015).

In the architectures described in Figure 2 and by Jisc the data end up in a Learning Records Store hosted locally or most probably in the cloud as Software as a Service. Access to this Learning Records Warehouse is provided though an Authentication and Authorisation service giving access to the Access API or direct access through queries. It is natural to think of access policies as a function of being member of groups, e.g., class, course, educational role, etc., not as a function of a more dynamic negotiation about the purpose of the analysis and the pedagogical and cultural context of the learning taking place. In order to foreground both student and institutional agencies, and to put emphasis on contextual and temporal aspects of data access this paper suggests to explore a linked and open data approach to learning analytics systems, lifting the access negotiation into a search middle layer. This middle layer will dynamically give access to search capabilities depending on a number of rule sets developed by the key stakeholders of learning analytics.

The architecture described in Figure 3 is based on open and linked data being exposed by institutions, vendors, local authorities and other players (also individual students) with access to data relevant for learning analytics. These actors may have their own fully functional LA systems, but also having interest in getting access to richer datasets by taking part in a data exchange system based on open data. Therefore, they publish parts of their data as open and linked data, making sure that different approaches to anonymisation are followed. Anonymisation is not a panacea, and as the risk of re-identification is growing the more datasets are combined it is necessary to introduce some access control also to search of the 'open data' being exposed in this architecture. The organisations (and individuals) contributing data and stakeholders representing users, vendors and other parties using the LA system enter Usage Agreements regulating who has access to the Search Process and how this process is to be carried out. The Search Process Rules govern who gets access to the Ontologies that enable meaningful search. The Search Process also fires off post-search actions defined in the Search Process Rules, which aim is to enhance and maintain the legitimacy of the data sharing and search process.

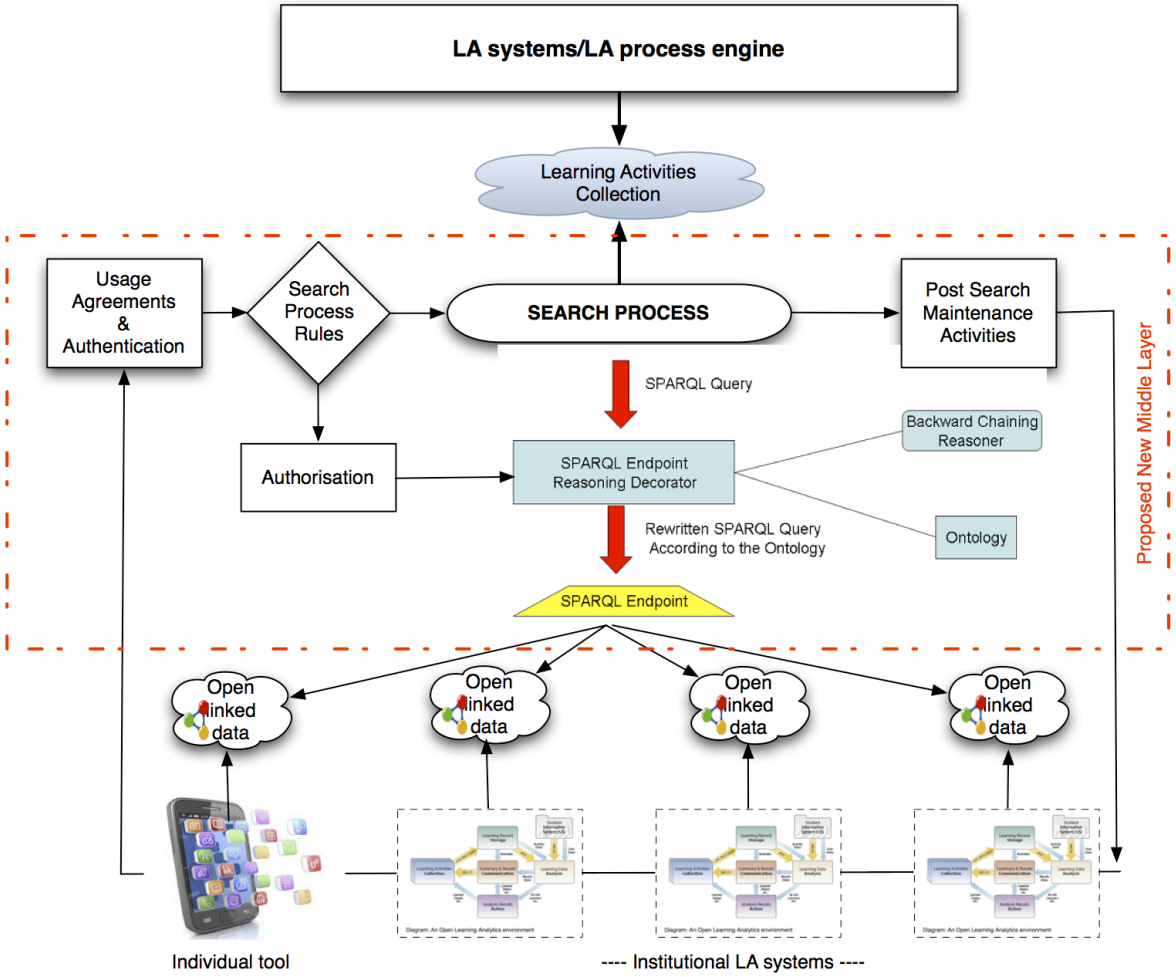

Figure 3. Search architecture for learning analytics based on open and linked data

The result of the search is sent to a Learning Activities Collection that feeds the processes of learning analysis, communication and intervention described in Figure 2 or similar architectures. However, this paper does not describe how the Search process defined in this middle layer, is used by learners, teachers, and institutions for analytics. The model should be further specified in order to show how different end-users initiate search.

The main contribution of this proposal is the design of a Usage Agreements and Post Search Maintenance Activities. Both constructs need to be further developed, based on these and other ideas:

- The middle layer described in Figure 3 is dynamic, i.e., Post Search Activities will feed back to Usage Agreements and Search Process Rules through active stakeholder participation.
- The end users of learning analytics, primarily students and teachers are (also) initiating search, and therefore taking part in the search process improvement loop.
- Usage agreements should be built through interaction with the data subjects.
- Learners and teachers should through Post Search Activities be able to learn more about how the data are shared and used so they can contribute to improved privacy and data protection.

5. Discussion

The aim of the proposed LA Search Architecture is to strengthen student agency and institutional dialogue related to data sharing for learning analytics. The architecture is built on top of existing and more monolithic systems, and it is up to each data store manager to expose their data as open and linked data, and to be part in a LA Search Agreement. The student should also be able to share from social media, mobile apps and other tools if found useful for learning. In preparation for exposure of one's data as open and linked data the data owner will have to revisit the data structure of the different data sets in order to select which data fields to expose, which anonymisation technology to use, and

how to supplement the datasets with a shared ontology to enable intelligent search. (If the data owner is a student using an app or a small enterprise with a new LA solution it is clear that this process is complicated and will need both organisational support and tools.) It is these authors' hypothesis that this preparation for data sharing together with an emphasis on privacy and ownership of data in the Usage Agreements and Post Search Activities will lead to more targeted and pedagogically motivated data sharing, perhaps with a more local scope and limited time range. A focus on consent for use and clear purpose for use will counteract the tendency to keep all activity data from most systems in store for an indefinite period of time, just because it is possible to do so of technological and economical reasons.

The idea of exposing learning activity data as open data is interesting because it will lead to a much needed discourse on what types of data it is advisable to share within the educational domain. When the access rules are separated from the data warehousing it creates a pressure on the data owners to select data sources with care. Furthermore, more open data on learning activities might boost innovation in learning analytics as more actors would be able to join the data sharing community.

Usage Agreements needs to be set up through negotiations that are balanced in terms of who controls access to data. Even if one recognises "the centrality of student agency and privacy self-management" (Prinsloo & Slade, 2015) one has to leave space for the institution to follow its business interests and be able to use the data that is solicited to support learning and teaching. The only way to get the balance right is through open negotiations, accountability and transparency. If one sees this as a negotiated balance it is clear that the tipping point can change over time. The proposed architecture allows for re-negotiations through the feedback loop and the Post Search Activities.

The main purpose of LA systems is to answer questions about learning progress, to adapt the learning process, to support course design, and in other ways to improve education. Data management is a support activity, which should not by design be distractive. Therefore, the Post Search Activities, taking input form both the Search process and the learning analytics activities (out of scope of the model in Figure 3), should be designed as a non-intrusive part of the LA system. Sometimes, for example when privacy concerns are in the news, or when the LA interventions are surprising or questionable, or for other reasons, the end user should be able to ask questions about the data, which the analysis builds on. What data are used? How did the system capture data about my activities? Who has given permission to use my data? For how long are the data available for analysis? etc. Such questions are never asked and answered when you sign up for a system. In embedding such a process that ensures accountability and transparency about data sharing in the system itself, it becomes a quality improvement process that contributes to the sustainability of the LA system as a whole.

6. **Conclusions**

Data sharing, i.e., the release of data for use by others is a precondition for effective learning analytics. This paper has chosen as a premise for design of architectures for learning analytics that data sharing, often taken for granted by some of the high level LA system architectures, is a non-trivial issue. As the issues often are of a non-technical nature, this paper has focussed on interoperability challenges related to legal and organisational – one may even say pedagogical and political – levels in order to solicit conditions that could be turned into technical and semantic requirements.

Prinsloo and Slade (2015) espouse a move from quantified to qualified selves in designing LA solutions. This means to give more priority to design features that promote student agency and make sure that numbers do not speak for themselves, but through continuous negotiations of meaning through interactions with both systems and their stewards. When the standards community now is challenged with the task of defining architectures for learning analytics it is important that they see the whole picture and recognise both soft and hard requirements. LA architectures are not only about data exchange between system components. Learning could be seen as a conversational activity (Laurillard, 2013), and therefore, any LA system that does not support conversations about the achievements of learning is missing the target.

This paper explores an approach to LA system architecture that differs from the systems design being discussed till now. The proposal is based on search in open and linked data taking place in a middle layer between data sources (both institutional and individual) and learning analytics process engines. The approach is explorative and conceptual, and the proposal is far from thought through. The aim of this exploration is to show that being serious about issues like privacy, data ownership, barriers to data sharing, and student vulnerability would take the design of LA architectures in a different direction from what is proposed in the LA system designs that have been discussed till now in standardisation groups like IMS Global and ISO/IEC JTC 1/SC36.

The next steps of this first design cycle should be to further specify the Usage Agreement process, the Search Rules service, and the Post Search Maintenance process (Figure 3) in order to solicit feedback form the main stakeholders before commencing on a new design cycle. A weak aspect of the proposed solution might be to apply access rules to open and linked data endpoints. This needs to be further researched to see if privacy requirements are met through restricting the access to the search ontology and through other means of anonymisation.

Acknowledgements

This paper is partly written with funding from the European Commission Seventh Framework Programme as part of the LACE Project, grant number 619424

References

Barocas, S. & Nissenbaum, H. (2015) Big Data's End Run around Anonymity and Consent. In J. Lane, V. Stodden, S. Bender & H. Nissenbaum (eds.), Privacy, big data, and the public good, (pp. 44-75). New York, NY: Cambridge University Press.

Cooper, A. & Hoel, T. (2015) Data Sharing Requirements and Roadmap. Deliverable 7.2 from LACE project, online at http://www.laceproject.eu/deliverables/d7-2-data-sharing-roadmap.pdf

European Commission (2010). Annex 2 to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions 'Towards interoperability for European public services', COM(2010) 744 final. Available from http://ec.europa.eu/isa/documents/isa_annex_ii_eif_en.pdf, accessed 29 June 2015

Greller, W., & Drachsler, H. (2012). Translating learning into numbers: A generic framework for learning analytics. International Journal of Educational Technology & Society., 15(3), 42–57.

Hevner, A. (2007). A Three Cycle View of Design Science Research. Scandinavian Journal of Information Systems, 2007, 19(2):87-92, 1–6.

Hevner, A., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. Mis Quarterly, 28(1), 75–105.

Hoel, T., Mason, J. & Chen, W. (2015) Data Sharing for Learning Analytics – Questioning the Risks and Benefits. In Ogata, H. et al. (Eds.) (2015). Proceedings of the 23rd International Conference on Computers in Education. China: Asia-Pacific Society for Computers in Education

Jisc (2015): Code of practice for learning analytics, online at http://www.jisc.ac.uk/guides/code-of-practice-for-learning-analytics, accessed 29 June 2015

Laurillard, D. (2013). Rethinking university teaching: A conversational framework for the effective use of learning technologies. Routledge.

Nissenbaum, H. (2009). Privacy in Context. Technology, Policy, and the Integrity of Social Life. Standford University Press

Prinsloo, P. & Slade, S. (2015). Student vulnerability and agency in networked, digital learning. In Proceedings of the European Distance and E-Learning Network 2015 Annual Conference Barcelona, 9-12 June, 2015. ISBN 978-615-5511-04-2

Reigeluth, T. 2014. Why data is not enough: Digital traces as control of self and self-control. Surveillance & Society 12(2): 243-354. http://www.surveillance-and-society.org | ISSN: 1477-7487

Sclater, N. (2015). Jisc's Learning Analytics Architecture – who's involved, what are the products and when will it be available? Blog post of June 15th, 2015, available online at http://analytics.jiscinvolve.org/wp/2015/06/15/jiscs-learning-analytics-architecture-whos-involved-what-are-the-products-and-when-will-it-be-available/, accessed August 7th, 2015

Sclater, N., Berg, A., & Webb, M. (2015) Developing an open architecture for learning analytics. Paper presented at EUNIS 15, Dundee, UK.
Scoble, R. & Israel, S. (2013). Age of Context: Mobile, Sensors, Data and the Future of Privacy. Patric Brewster Press, United States.
Siemens, G., Gasevic, D., Haythornthwaite, C., Dawson, S., Shum, S. B., & Ferguson, R. (2011). Open Learning Analytics : an integrated & modularized platform Proposal to design , implement and evaluate an open platform to integrate heterogeneous learning analytics techniques. Knowledge Creation Diffusion Utilization.
Slade, S. & Prinsloo, P. (2013). Learning analytics: ethical issues and dilemmas. In American Behavioural Scientist, 57(1), (pp. 1509–1528).
Verbert, K., Drachsler, H., Manouselis, N., Wolpers, M., Vuorikari, R., & Duval, E. (2011). Dataset- driven research for improving recommender systems for learning. In Proceedings of the 1st International Conference on Learning Analytics and Knowledge (pp. 44–53). New York, New York, USA: ACM Press. doi:10.1145/2090116.2090122
Williamson, B. 2015. Digital education governance: data visualization, predictive analytics, and 'real- time' policy instruments. Journal of Education Policy. DOI: 10.1080/02680939.2015.1035758
Xu, H. (2011). Reframing Privacy 2.0 in Online Social Network. In University of Pennsylvania, Journal of Constitutional Law, 14(4), (pp. 1077-1102).