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Data-driven Infrastructure for Evidence-based Education and Learning

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Current eLearning infrastructures often include a Learning Management System (LMS), various ubiquitous and classroom learning tools, Learning Record Stores (LRS) and Learning Analytics Dashboards (LAD). Applying Learning Analytics (LA) methods to process data collected within such infrastructure can support various stakeholders. Learners can reflect on learning experiences, teachers can refine their instructional practices, and researchers can study the dynamics of the teaching-learning process with it. While LA platforms gather and analyze the data, there is a lack of specific design framework to capture the technology-enhanced teaching-learning practices. We proposed the Learning Evidence Analytics Framework (LEAF) and in this paper focus on the computational support for evidence extraction and analysis in a data-driven educational scenario.

1. Introduction

The concept of Evidence-Based Practices has its root in medicine and coined by doctors at McMaster University in Hamilton, Ontario in early 1990s (Kvernbekk T., 2017). According to Kvernbekk, EBP involves the use of the best available evidence to bring about desirable outcomes, or conversely, to prevent undesirable outcomes. Davies, P. (1999) reviews the concept of evidence-based practices in education. He proposes that evidence in the context of education needs to be established where its lacking and can be used in the following four ways:

1. Pose an answerable question about education;
2. Know where and how to find evidence systematically and comprehensively using the electronic (computer-based) and non-electronic (print) media;
3. Retrieve and read such evidence competently and undertake critical appraisal and analysis of that evidence according to agreed professional and scientific standards;
4. Organize and grade the power of this evidence and determine its relevance to their educational needs and environments.

While literature takes various theoretical perspective on Evidence-based education (Davies, P. 1999), Research-based education (Hargreaves, 1996), Literature-based education (Hammersley, 1997), Context-sensitive practice (Greenhalgh and Worrall, 1997) they mostly debate about rigorous studies to establish causalities similar to medical practices. What is missing is any research agenda of how technology can support the process and relevant discussions regarding issues in the current age of data-driven education. This position paper focuses on the notion of evidence-based education in the age of e-learning. Technology now supports logging of teaching-learning (TL) interactions and Learning Analytics has matured tremendously over the period to provide robust methods to analyze and predict learning behaviors and outcomes in different TL contexts. Hence there is relevance in rethinking about the question Davies (1999) asked regarding "What is evidence?" and how the four objectives can be supported by technology. This would push the boundaries of learning analytics and move towards an evidence-based education system that can assist the various stakeholders in the teaching-learning scenarios.

In the Learning Analytics community, SOLAR, the term evidence has recently come up in the context of a workshop in LAK 18 regarding evidence-based institutional LA policy (Tsai Y.S., Gašević D., Scheffel, M., 2018, sheilaproject.eu) and in LAK 17 by work presented by Ferguson & Clow (2017) where they introduce Learning Analytics Community Exchange (LACE) project's Evidence Hub. The Evidence Hub (http://evidence.laceproject.eu/) followed the evidence-based medicine paradigm to synthesize published LA literature and meta-analyze four propositions about learning analytics: whether they support learning, support teaching, are deployed widely, and are used ethically. But neither of the works look at technological affordances required to extract evidence of learning from logged data and make it available for the practitioners to adopt in their own context. We proposed a technological design framework, LEAF for evidence-based education and learning in this data driven age to find evidence of learning from the logged data of teaching-learning interactions. Figure 1 gives an overview (Ogata et.al. 2018; Majumdar R., 2018a).

2. Learning Evidence Analytics Framework

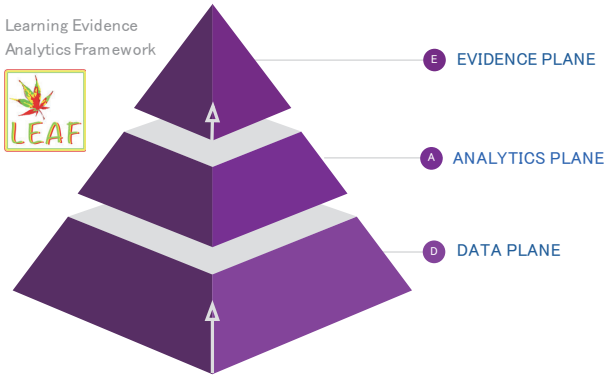

Figure 1. Extraction of evidence from teaching-learning data

Our Learning Evidence Analytics Framework (LEAF), is a technological design framework to support evidence-based education by integrating with existing learning analytics infrastructure. Figure 2 gives an overview of the components of

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LEAF. We follow the DAPER (Data-Analysis-Planning-Execution monitoring-Reflection) model of data driven activities (Majumdar et.al 2018b) to guide the activity flow within the described framework.

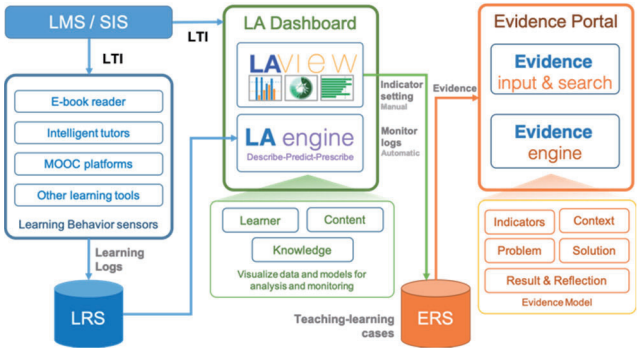

Figure 2. Components of Learning Evidence Analytics Framework (LEAF)

The data plane gathers data streams from various sources of teaching learning tools. For example, in our BookRoll system we can get learners reading activity data, their assignment score data from different learning management systems such as Moodle or Sakai, their health and physical activity data from GOAL system. Such a pool of learning behavior sensors, would also enable various connected services to create richer teaching-learning ecosystems. Data is stored in the Learning Record Store (LRS).

The power of such a data-driven ecosystem would be harnessed at the analytics plane by creating models and services for smartly supporting the stakeholders. For example, the data synchronized in our system can be used to create a context model for the learner. Based on that, analysis of the health and learning balance of the individual is possible. The objective of such measurement is focused to support learners to be aware of their status rather than to be directed by the technology. Similarly, in the case of the teachers, analytics can assist by suggesting intervention possibilities for automatically detected low engaged students. Learning Analytics Dashboards plays an important role there to present the analysis to the end users.

We seek to extract an evidence plane capturing effectiveness of the decisions taken by the users assisted by analytics models. Such a plane could be created by capturing meta-knowledge of results of applying models along with the broader perspective of having the context of the collected data. This evidence plane aims to keep the human agency in loop by capturing the user's reflection of the process. It captures the context, problems, indicators of the problem, the solution selected by the user, and collates its results. Based on the available infrastructure and information we aim to automatically extract some of these data. Else the user provides it through an evidence input portal.

3. Conclusion

Some of the research issues and challenges are enlisted for further investigation:

- How to extract evidences from data?
- How to design data format of evidences?
- How to evaluate evidences (rate them, evaluate similarities, meta-analysis, etc)?
- How to support search or context-aware recommendation of evidences?
- How to support teachers and students to apply evidences in their context?

While their exists endeavors to synthesize evidence from literature, LEAF aims to extend that and extract evidences from log data, considering contextual teaching-learning practices and harnessing the power of learning analytics methods and infrastructures. Our research agenda would give a fresh perspective on Davies' four use of evidence in education in this technology enhanced data-driven age.

Acknowledgement

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