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A MODEL FOR NEW LINKAGES FOR PRIOR LEARNING ASSESSMENT

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Abstract: Technology can help to develop new approaches for today's assessment practice. This contribution presents a project that concentrates on the use of electronic portfolios and Latent Semantic Analysis (LSA) to assess prior learning experiences of learners. After an introduction the assessment triangle is presented as a reference framework. The role of the electronic portfolio for prior learning assessment is identified. Latent Semantic Analysis is introduced as an innovative assessment technology. A report about a recently conducted cased study at the Open University of the Netherlands follows. A problem discussion and research outlook rounds up the article.

Introduction

Although technology may have lead to educational innovations in some institutions most assessment practices of today are still the same as 10 years ago. Mc Donald et al. (2006) argue that students can escape bad teaching bad not bad assessment. Assessment is always embedded into a social context and it influences behavior of students because it transports a message about what is appreciated in a given learning context and what is not. Sluijsmans et al. (2006) point to the fact that current technology-enhanced assessment practice still focuses more on testing than assessment. Additionally in most higher education institutions assessment is still done completely without the use of technology. This leads to a "bizzare practice" „where students use ICT tools such as word processors and graphic calculators as an integral part of learning, and are then restricted to paper and pencil when their "knowledge" is assessed" (Ridgway et al, 2006).

For the use of computers in testing and assessment different concepts like computer-assisted assessment (CAA) or eAssessment are used. Conole and Warburton (2005) present a review of computer-assisted assessment. According to them computer-assisted assessment includes also optical mark reading to analyze paper-and-pencil tests and the use of portfolios to collect learning products. Computer-based assessment (CBA) is – according to them – the use of computers to "mark answers that were entered directly into a computer" and they differentiate between web-based, networked and standalone CBA. Ridway et al. (2006) conducted another literature review on e-assessment with a similar perspective. In conclusion they define an agenda for the future of technology-enhanced assessment that includes the assessment of

metacognition, the analysis and assessment of cognitive processes and the support of reflection and critical thinking skills.

Apparently all of the above mentioned reviews of the field of technology-enhanced assessment do not mention several new approaches to analyze and score open responses or narrative text from learners. This paper introduces a new method and technique to assess students' prior learning through the use of electronic portfolios in combination with a content analysis technique called latent semantic analysis (LSA). In the next section we will provide context for our assessment approach and present an assessment framework. Next we introduce the electronic portfolio as an important technological advancement for assessment practice and define its role in prior learning assessment. Third we introduce a model for prior learning assessment with Latent Semantic Analysis as and (electronic) portfolios. Fourth we report about a case study we conducted in the framework of the European integrated project TENCompetence, and finally discuss preliminary results and give an outlook on future research.

New Linkages for Prior Learning Assessment

While traditional assessment is focused on the comparison of learners in competence based educational programs assessment judgements should be based on comparisons between individual performance and performance requirements set in a standard or learning target description. Competence-based assessment is not a traditional examination but a process in order to collect evidence about the performance and knowledge of a person with respect to such a competence standard. Joosten – ten Brinke et al. provide an overview about the traditional and new assessment methods and they point to the difference between performance assessment and competence assessment (Joosten-Ten Brinke, et al. 2007). While performance assessment is focused only on an isolated part of a "performance" of a learner competence assessment is much broader and can include several test and assessment types like or self-assessment, peer-assessment or portfolio assessment. A competence assessment process can use several sources to judge about the competence level of learners. These sources can stem from tests, a monitoring of behaviour or documents that were written by the learner. In the literature authors often differentiate between formative and summative assessment. While formative assessment is given during learning as a kind of feedback summative assessment is more a judgment at the end of a performance mostly connected to grading. Many students think of summative assessment when it comes to assessment situations because this is the

dominant practice in higher education institutions. But especially formative assessment is a powerful tool to support students to reach high-order skills (Sadler, 1989).

No matter what kind of assessment is used every assessment situation consists of several elements. Pellegrino et al. (2001) have developed a framework for assessment called the 'assessment triangle'. According to this framework any assessment consists of the following elements that should be made explicit.

Every assessment has an underlying model of cognition and cognitive growth in a domain. This model should be clear to assess and differentiate between low-level concepts and high-level concepts in a domain. The observation part consists of a "set of beliefs about the kinds of observations…that provide evidence of students' competencies" (Pellegrino, 2001). These observations are based on tasks or a performance that demonstrates their knowledge or skills. The interpretation part is about making sense of this evidence. New assessment methods can provide new linkages between the aspects of this framework.

In our project we focus on providing a new linkage from observation to interpretation for the assessment of prior learning. In some European countries and in Canada this issue is addresses by a procedure called APL/RPL (Accreditation/Recognition of Prior Learning) or PLAR (Prior Learning Assessment and Recognition). PLAR is used in the admission phase of educational programs to assess possible prior learning experiences and to allow exemptions in the study program chosen (Merrifield, 2000). The decisions for exemptions are based on prior output of learners. In a typical case the students send in material they have written in their former education or work context. Domain experts of the institution have to decide about possible exemptions after analyzing this material. The result of the time-and cost-intensive procedure is an individualized curriculum.

For technology-enhanced learning Nordeng et al (2004) reformulate this problem in the following way: "How can the students themselves be able to assess their position relative to a future learning environments consisting of a diverse set of learning activities from which learners somehow may take their pick? The learner's history and goals define an entry position relative to the learning activities. A different entry position is likely to result in a different partition of the set of available activities in activities to skip and to complete".

Later on we will present Latent Semantic Analysis as a new linkage for the assessment of prior learning as introduced in Van Bruggen et al. (2004). But first we will discuss the role of the electronic portfolio in assessment and accreditation of prior learning.

ePortfolios in APL

The implementation and use of electronic portfolios (eportfolios) has been recently discussed intensively although the targets of the electronic portfolio roadmap to equip every citizen of Europe with an ePortfolio until 2010 were too courageous. Baker (2006) states that "the word "ePortfolio" has almost become a code word for a variety of important concepts … an ePortfolio can be one of many different things depending on audience perspective and purpose". We see electronic portfolios as digital collections of what a person has learned or produced over time. This includes the products as well as the process to these products.

Reformative educationalists like Freinet introduced the use of portfolios in his classrooms already in the 1920ies of the last century. Although the technical progress has changed tremendously since then the targets for using portfolios in education have stayed nearly the same. Documentation and self-reflection of the learning process are the main reasons to use portfolios in learning and competence development (Tillema, 2001).

Electronic portfolios can serve several roles in competence development. Smith and Tillema (1998, 2003) introduce different types of portfolios to clarify the many interpretations of this instrument: The dossier portfolio, the training portfolio, the reflective portfolio and the personal development portfolio. A dossier portfolio is a collection of performance proofs for entry to a profession or programme. A training portfolio is an exhibit of learning during a programme, which focuses on products or competencies build from the time the learners participate in the programme. A reflective portfolio is a composed collection of evidence of a specific competence requirement consisting of best-practices in combination with a self-appraisal. A personal development portfolio is a documentation of professional growth of an individual over a longer time that might also include discussions with peers with similar interest.

Although all types of electronic portfolios are important for the lifelong learning perspective for our focus the dossier-type electronic portfolio is the most important one. In the process of prior learning assessment the electronic portfolio is at the same time a means and an outcome of the assessment situation. Barker points to the conjunction between (electronic) portfolios and prior learning assessment. The PLAR procedure is often the starting point for an electronic portfolio. Learners pick products from their prior education and enrich them with additional more structured information. But the authors see much more potential for the use of electronic portfolios if they are used continuously: "The idea of developing an ELR in advance of choosing a training option or seeking career advancement is not unconventional, however, it is made more by the application of assessment techniques and principles inherent

in good PLAR prior to choosing a training option or seeking career advancement, to help make those decisions, rather than after making decisions and seeking, e.g., advanced placement in a course or program" (Barker, 2000).

The electronic portfolio can serve indeed as a good tool to support these advanced placements decisions. But the electronic portfolio alone is not enough because it can only help to support the observation part of the above presented framework because it offers learners a place for documentation and reflection. To provide computer-support also in the assessment linkage between observation and interpretation we introduce Latent Semantic Analysis in the next part of the paper as a method to assess the prior learning of students and to support these placement decisions.
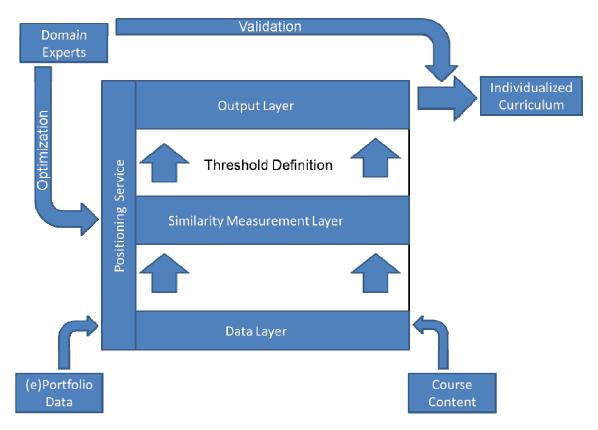
A model for Prior Learning Assessment with Latent Semantic Analysis

Latent Semantic Analysis (LSA), in the past sometimes referred to as Latent Semantic Indexing (LSI), is a theory and method for extracting and representing the contextual-usage meaning of words by statistical computations (Landauer et al, 1998). It provides a method to calculate the similarity of text or parts of textual information. The whole process of this analysis consists of several steps like the pre-processing of the text, some weighting and normalizing mechanisms, the construction of a term-document matrix and a mathematical function called singular-value decomposition (SVD), which is similar to factor-analysis. The end result of this process is a latent semantic space, in which the main concepts (or types) of the input are represented as vectors. Concepts in this space are similar if they appeared in the same context and so their vectors are close together in the space providing a measurement for the similarity of text. LSA is applied in several research fields like informatics, psychology or medicine.

For technology-enhanced learning the application of Latent Semantic Analysis can help to solve some basic problems like increased tutor load or formative feedback during learning. Since LSA is only a general "theory of meaning" as one of the inventors of the technique, Tom Landauer, stated it recently, there are several applications of LSA in technology-enhanced learning (Wild et al, 2007, Landauer, 2007). The most prominent example for the use of LSA in an educational environment is the assessment and feedback of free text in intelligent tutoring systems. Some examples of these applications are the Intelligent Essay Assessor (Foltz et al, 1999), Summary Street (Steinhart, 2001) and Select-a-Kibitzer (Wiemer-Hastings & Graesser, 2000) to mention only a few. Some researchers have used

LSA to provide students with text that is appropriate to their current knowledge (Wolfe et al, 1998, Dessus, 2004).

Our application of LSA is similar but has a different motivation and context. In the framework of the European Integrated project TENCompetence we are currently aiming at the development of an infrastructure for lifelong competence development (Koper & Specht, 2007). We are using LSA to assess prior knowledge of learners for placement or positioning decisions and finally the construction of personalized learning paths or individualized curriculum through a learning network. The model for the application is presented in figure 1.

Figure 1: Positioning Service Model

The content of courses and data in (e)portfolios of students is compared regarding their similarity based on the assumption that the similarity of concepts in a domain and a personal portfolio will give an indication about the student's prior knowledge for this domain. Domain experts are used to validate the mode and to help in optimising the results from the positioning service. The result of these analyses should be taken into account for the creation of a personalized learning path/individualized curriculum. Some learning activities on the way to the target competencies a learner wants to achieve may be exempted because of the results of this prior learning analysis. In the next part of the paper we present a case study about this application of Latent Semantic Analysis.

Prior Learning Assessment Case Study

To test our model and the usefulness of LSA for prior learning we conducted a case study in an introductory psychology course at the Open University of the Netherlands. The course was an online course consisting of 18 learning activities based on a textbook. Every chapter covers a subtopic of the psychology domain. Students were asked in advance to build a dossier-type portfolio of products they produced in their past education or work context. Since we could not expect that students knew exactly which topics would be presented in the chapters they have been asked again after every learning activity, how much of the presented material was new for them.

We used Latent Semantic Analysis to analyze the similarity between the students' documents and the content in the learning activities of the course. The basic corpus to build the semantic space consisted of other psychology books, texts from the Dutch Wikipedia and the content of the course. All student documents were "projected" into this latent semantic space and we calculated the cosine similarity measure between the student's documents and the learning activities of the course.

Depending on the policies of the current environment the learners could get exemptions for learning activities with high similarity measure. To evaluate these results we are currently conducting an expert validation. Domain experts were asked to rate the similarity of documents and to decide about exemptions based on this similarity. Another measure we are interested in is the time that experts spend to come to a decision because one of our main reasons to research technology-enhanced assessment for prior learning is the increase of the efficiency of today's assessment practice.

Preliminary results

The results of the analysis are promising. A first inspection of the results shows us that the similarity measurement that are produced by the system can differentiate between learners who sent in different material and between the learning activities and chapters. While the material of some students who sent in non-scientific psychological content produced very low values a bachelor thesis in psychology that has been collected from a colleague produced high values to the learning activities that show a topical similarity to the thesis. Table one shows a (cosine) similarity measure table between learning activities and documents in an electronic portfolio. While some documents in this portfolio show low values there are several very high results.

Learning Activitiy/Student Documents	Learner Document 1	Learner Document 2	Learner Document 3	Learner Document 4	Learner Document 5	Learner Document 6
Learning Activity 1	0.34	0.38	0.44	0.51	0.78	0.73
Learning Activity 2	0.26	0.31	0.28	0.35	0.81	0.51
Learning Activity 3	0.24	0.41	0.20	0.29	0.64	0.52
Learning Activity 4	0.33	0.46	0.23	0.29	0.53	0.49
Learning Activity 5	0.94	0.90	0.24	0.39	0.62	0.89
Learning Activity 6	0.26	0.50	0.30	0.53	0.48	0.42
Learning Activity 7	0.51	0.28	0.89	0.33	0.24	0.55

Table 1: Cosine similarity measure matrix as a result from LSA analysis of eportfolios/course content

In the TENCompetence project a so called "positioning service" delivers these results to a navigation service so that learning activities with a very high correlation can be exempted for the recommendation of the next best learning activity and in the future for the construction of a personalized learning path. Another possible application is the support of the traditional PLAR procedure. LSA can support the domain experts to analyze student's material. In the next part of the paper we discuss some limitations of the presented approach and give an outlook on future research.

Discussion and Outlook

Although the results of the presented approach are encouraging we have to keep in mind that an assessment situation has more elements according to the framework presented above. While we provide here a new linkage between the observation and interpretation part the results of the analysis still need interpretation. In addition, it has to be clear which model of cognitive growth is the basis for the assessment. Especially in domains where a high level performance cannot be measured through textual expression the presented approach will not be of much help.

But there are more limitations of the presented approach. Some limitations are connected to the use of electronic portfolios in general and some limitations stem from the use of Latent Semantic Analysis to analyze prior learning.

A general problem of electronic portfolios – especially in the context of lifelong learning – is an issue like portability of the electronic portfolio as a whole and the collected artefacts (Carrol & Calvo, 2005). Since there are several technical standards like the IMS ePortfolio standard (IMS, 2005) or the IMS LIP (IMS, 2001) we believe that this problem is merely an implementation and development issue. Every electronic portfolio system should be based on such standards to guarantee the portability. Another more general issue of the use of electronic portfolios is the validation and verification of evidence submitted. Especially in times where plagiarism in higher education is increasing the origin of artefacts is an important issue that involves also ethical implications and trust issues (Barker, 1999). Is the presented work really done by the owner of the portfolio?

Other issues stem from the use of Latent Semantic Analysis. LSA results depend on several corpus factors and pre-processing procedures that cannot be described here into detail. An important issue for successful analysis is the size of the basic corpus that is used as a query basis for the Latent Semantic Space. In the future we will address this issue to collect experiences about the trade-off between the size of the corpus and the reliability of the results of LSA for prior learning assessment. Another disadvantage of using LSA for assessment is the limitation to highly textual domains. Competence assessment that takes into account a physical performance cannot be analyzed with the presented method. In addition LSA can only find a similarity when the concepts used by the learners are represented in the semantic space. But there are several special presentation types (forms, descriptions of experimental designs etc.) that show an inherent higher prior learning than the purely textual content can show. In this case domain experts can deduct this but LSA cannot. A real advantage of using LSA for prior learning assessment is that students do not have to think about the design of their portfolios because it is only based on textual information and it does not rely on the format, structure or design.

While we concentrate currently only on the exemption application of the results there are several other possibilities to make use of them. One possibility is the identification of suited peer tutors for learning activities who can help other learners with lower experiences and knowledge. Another option for using a prior learning analysis is the topic of open educational resources. The described method can be applied to identify resources which are in the 'range of interest' of the learner meaning that prior knowledge can be identified but not on a very

high level so that there is still a probability that the learners might like the resource (Kalz et al, 2008)

While we worked with dossier portfolios at this time, for lifelong learning the personal development portfolio has several implications for a prior learning assessment that does not only take into account products of prior learning but also the reflection about these products. A really continuously updated electronic portfolio could help the learner not only on a course level but for the lifelong learning perspective without the need to collect material every time when entering a new educational context again.

Currently we are dealing in this project only with a content-based approach to analyze prior learning of learners. In the future we will address also more structured data like metadata and ontologies for prior learning assessment (Kalz et al, 2007).

Acknowledgement

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