Using technology for knowledge transfer between academia and enterprises

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Structured Abstract

Purpose –Advanced web technology offers possibilities for blending two complementary sources of knowledge, academic and entrepreneurial, within a single web-based framework. The main goal of our project is to establish an open educational resources (OER) platform and network for fostering technology enhanced learning (TEL) within HE institutions and enterprises in the Western Balkans. Another objective is to provide training for members of universities and enterprises for production of OER materials. The third objective is to produce materials in various languages, in video, audio and textual format, supported by electronic terminological resources, services, and functionalities for searching and browsing.

Design/methodology/approach – The TEL platform consists of tools and resources: learning, language and implementation resources. Among the tools some are available open source and commercial tools, some are in-house tools developed by the University of Belgrade Human Language Technology Group. Learning resources are both academic: course planning materials, video lectures, thematic content, and entrepreneurial: case studies, best practice examples, expert presentations and software demonstrations. Language resources supporting the multilinguality of the platform, terminology and its search and browse functions are lexical and textual resources and grammars. Implementation resources consists of best practice design principles and licensing tools to promote OER.

Originality/value – Designing usable, effective and interactive TEL environments is a demanding task, which requires creativity and a significant amount of expertise. Especially when knowledge is elicited from two essentially different environments, the academia and the enterprises. The need for multilinguality of OER is a consequence of the novel holistic approach that takes into account all the languages a learner may use. Hence the language support system within our TEL platform, which provides for OER in different languages and allows learners in a specific domain to get acquainted with domain terminology both in their mother tongue and in other languages.

Practical implications –The proposed TEL platform opens a new dimension in OER by blending two major sources of knowledge: the academia and the enterprise. It thus contributes to the important task of preparing university students for their future jobs, but also enables them to improve their academic knowledge after graduating, by offering them a live-long learning opportunity. Finally, it supports mastering of educational

materials and expert terminology in different languages, in contrast to more traditional approaches that look at one language at a time.

1   Introduction

The knowledge of professionals with higher education can roughly be divided in two parts: academic knowledge they gain as university students and entrepreneurial knowledge they acquire as practitioners. Although it is safe to say that academic and entrepreneurial knowledge are complementary and intertwine in various ways, the sources of these two types of knowledge and the knowledge acquisition process are in general separated, as higher education offering academic knowledge precedes the solving of practical problems within enterprises that generates expert knowledge. Although higher education institutions (HEI) endeavor towards keeping academic curricula up-to-date with novel entrepreneurial knowledge, this has become a critical issue, especially in engineering disciplines. Technological development generates entrepreneurial knowledge at an ever growing pace, whereas changes in academic curricula require procedures that are time-consuming and considerably slower. But academic knowledge also evolves on its own accord, and the knowledge of a graduate student becomes partly outdated over the time.

Although the acquisition of the two types of knowledge is separated, the need for blending of academic and entrepreneurial knowledge has been recognized (Etzkowitz, 2004). Namely, students are exposed to practical knowledge during their studies, however usually to a modest extent, through student practice and internship in enterprises. On the other hand, once they graduate, and become employees, they are more and more often encouraged to enhance their academic knowledge within the life-long learning paradigm (Longworth, 2013). Nevertheless, blending of knowledge and establishing a continuity of knowledge acquisition still represents a challenge that needs new approaches and tools to be developed.

Technology-enhanced learning (TEL) relies on information technology (IT) to offer support in improving the quality of learning and its outcomes. Designing effective TEL environments in an efficient and affordable way is a demanding task, which requires

creativity and a significant amount of expertise (Goodyear & Retalis, 2010). Within IT, web technology is now widely used in TEL, especially since the Semantic Web or Web 3.0 has been developed (Daconta, Obrst, & Smith, 2003). A variety of web-related educational innovations are now available, enabling further advances in the sharing of educational ideas, materials, and knowledge. Social networking, blogs, wikis, cognitive tutors, virtual learning communities, and especially web-based learning management systems (LMS) are being more and more used in TEL (Rhoads, Berdan & Toven-Lindsey, 2013).

Within TEL, the idea of making university courses publicly available on the web as open courseware (OCW) has emerged, leading to development and implementation of massive open online courses (MOOC), which, in addition to traditional course resources such as videos, readings, and problem sets, also offers interactive user forums aimed at building a community for professors, teaching assistants and students. OCW is embedded within the even wider open educational resources (OER) initiative, where materials are offered openly and freely to educators, students, and self-learners to use and reuse for teaching, learning, and research (Bissell, 2009). The materials are released under an open source license which permits their use, reuse and redistribution with limited or no restrictions.

In this paper we describe an approach to making available both entrepreneurial knowledge to students on a wider basis and novel academic knowledge to graduate employees in enterprises, within a TEL platform founded on OER principles. This web-based platform will enable higher education institutions to publish different academic learning resources in the form of video and lectures, printed course materials and the like, and enterprises to use similar forms to offer expert knowledge, such as case studies or presentations of software implementation in practice.

The platform is being developed within a project funded by the European Executive Agency Education, Audiovisual and Culture (EACEA) in Brussels. Its primary target are universities and enterprises of the Western Balkans (WB), and accordingly educational materials will be published in WB languages, which belong to "small" but closely related languages, but also in "big" languages such as English and Russian. Given the envisaged variety of languages within the platform, a language support system will be embedded to support multilinguality, but also terminology issues and query handling.

The TEL platform will also serve as a model for developing similar platforms as nodes within a TEL network encompassing a larger number of universities and enterprises. The network will feature a common portal for indexing and facilitating access to the various OER within the nodes.

Section 2 of this paper outlines the main goals to be achieved by the proposed approach, whereas the main features of the platform are given in Section 3. Section 4 is dedicated to its language support system, followed by conclusions in Section 5.

2　　　Objectives to be accomplished

The main goal of our approach is to enable knowledge transfer between academia and enterprises by making OER materials from both sources freely available on the web, and thus foster enhanced learning within higher education institutions and life-long learning within enterprises. Students will be offered an insight into expert knowledge gained through practice within enterprises, whereas employees involved in life-long learning will have access to state of the art high quality academic courses and thus continue with their professional development in a way more suitable to their professional activities than that of the traditional life-long learning programs. By blending these two types of knowledge within one technological framework, the TEL platform developed within this project, our approach additionally contributes to improvement and enhancement of relations between the academia and the enterprises and integration of creative research potential with industry and academic institutions.

The second objective within our project is to develop and implement guidelines and procedures for quality assurance of OER in WB according to best practice offered by the EU, and provide training by qualified OER trainers for both HEI and enterprise staff involved in production of OER materials.

As its third objective the project will produce course materials in several different languages, in various forms such as videos, audio streams and written material. The materials will be supported by electronic terminological resources, as well as services, and search and browse functionalities. Given the composition of the project partners the platform will be initially populated by materials from the domains of ICT, geoinformatics, mining and environmental protection.

Our TEL platform will thus provide educational support for a variety of users at different levels, offering an educational continuum. It will even support the initial phase

of higher education, namely preparation of university admission exams, which precedes enhanced academic education, workplace education and life-long learning. In brief, better quality and accessibility of education through TEL will thus be achieved, enabling OER learners from both universities and enterprises to study the educational materials at their own pace. Our approach also contributes to the development of virtual mobility, as it will enable students to follow a course at another university from their home campus and thus prepare themselves better for continuing their studies elsewhere. It will also increase transparency by offering an insight in the academic content various HEI are offering, which helps students make their choice of the university that best suits their needs. Besides enhancing cooperation between academia and enterprises in general, our TEL platform can be used as a valuable tool for facilitating and enhancing cooperation between different universities, on issues such as development of joint courses, or mutual recognition o diplomas.

Finally, as our TEL platform is conceived as a WB-targeted OCW-based project some of its goals coincide with those of the Open consortium Europe. Namely, as the interest of European universities in OER and OCW rapidly grew, a consortium of HEI led by the Delft University of Technology has been formed. Besides Delft University the main partners within Open consortium Europe are Universidad Politécnica Madrid, Universitat de Barcelona, Katholieke Universiteit Leuven and Université de Lyon, as well as the OpenCourseWare Consortium (OCWC), Creative Commons (CC) and European Association of distance Teaching Universities (EADTU). The universities that initiated the consortium were subsequently joined by more than fifty European partners from Austria, Belgium, Cyprus, Denmark, France, The Netherlands, Poland, United Kingdom and Spain, where the movement is especially popular with almost 40 universities offering free online courses. Partner universities within the consortium are currently offering more than 14,000 courses online.[1]

Ultimately, our approach helps OER learners from both universities and industry to fill in the gaps in their knowledge by acquiring new knowledge and become familiar with new technology.

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[1] *http://www.opencourseware.eu/*

3   Conceptual design of the TEL platform

An overview of the conceptual design of our TEL platform is depicted in Fig. 1. The platform consists of four groups of components, namely:

•   *Tools* - composed of FMG CMS, an in-house Content Management System (CMS) developed by the University of Belgrade, Faculty of Mining and Geology (FMG), the Learning management system encompassing several specific content and learning management software tools, and Development tools, software to support the development, use, reuse and delivery of learning content;

•   *Learning resources* - both academic, in the form of course planning materials, video lectures, thematic content and the like, supported by evaluation tools, and entrepreneurial, such as case studies, best practice examples, expert presentations and software demonstrations;

•   *Language resources* – lexical and textual resources and grammars to support the multilinguality of the platform, terminology and its search and browse functions;

•   *Implementation resources* - best practice design principles and licensing tools to promote open publishing of materials.

The content management system FMG CMS was initially developed within FMG as a custom course management system to support blended learning, which started gaining popularity at FMG in the last decade. Namely, where teachers at FMG expressed their interest in integrating IT with traditional face-to-face class activities in their teaching, an in-house tool was developed to provide online publishing of educational materials, organization of tests and e-communication with students. Later on, blended approach at FMG was further enhanced by introducing Moodle (Modular Object-Oriented Dynamic Learning Environment), a free software e-learning platform, conceived by Martin Dougiamas, who is still the lead developer of the Moodle.Org community. Moodle helps educators to create online courses and fosters interaction within the teacher-student community, especially collaborative content development. As of April 2014 there were around 69,000 registered Moodle sites offering 7.8 million courses by 1.2 million teachers to 73.8 million users in 235 countries.[2]

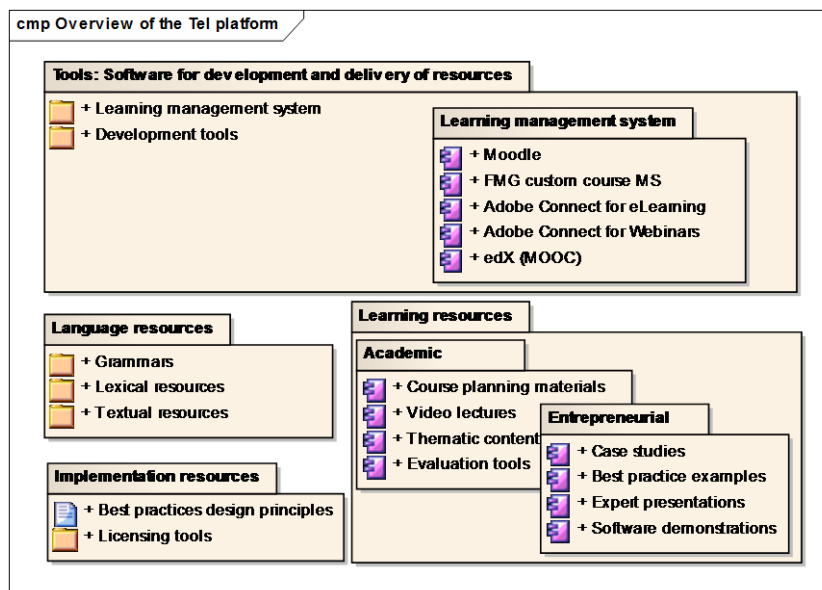[2] *https://moodle.org/stats/*

Figure 1: Conceptual map of TEL platform

Besides the FMG custom course management system and Moodle, the Learning management system includes other powerful tools such as Adobe Connect for eLearning, Adobe Connect for webinars, and EdX, a massive open online course (MOOC) platform.

Adobe Connect is a platform that supports e-learning, webinars, and organization of web meetings. Its Adobe Connect for eLearning component is a comprehensive solution enabling mobile learning that is accessible from anywhere, at any time, by means of virtually any PC or mobile device. It features state of the art content authoring tools, as well as tools for measuring real-time engagement in virtual classes and tracking individual student progress. Another component envisaged in our TEL platform, Adobe Connect for Webinars, offers templates for creation of landing pages, speaker information, registration pages, login pages and emails. These templates and content can be customized using several components, such as images, tables, charts, and carousels. It also provides engagement monitoring in real time via an engagement dashboard.[3]

The EdX platform, recently (2012) conceived by MIT and Harvard University is aimed at supporting massive open online university courses. The platform has been developed as open-source software, akin to Moodle, and is available to other HEI under

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[3] *http://www.adobe.com/rs/products/adobeconnect.html*

edX Terms of Service.[4] An important feature of edX is its interactive online learning software offering production of series of short videos, each followed by an exercise where students can immediately check their understanding of the concepts introduced by the videos. The platform also offers creation of online textbooks, as well as discussion forums for student-teacher interaction. Finally, edX provides for online laboratories, as for example in its first MOOC, a course on circuits and electronics, where students were able to built virtual circuits in an online lab (Breslow et al., 2013).

All the aforementioned tools will be integrated within the TEL platform's LMS to provide a synergy of functionalities for efficient realization of the proposed approach. A backend control panel within the platform will enable teachers in the academic environment to track the progress of students while using the learning resources, and thus have an insight into how they are mastering specific concepts, especially those featuring entrepreneurial learning content. This insight could further be used to filter out especially motivated students, and engage them in "peer to peer knowledge sharing", namely in helping students who have problems in understanding some concepts. Motivated students could also be encouraged to become teacher assistants (TA) and publish their own educational materials on the platform.

As for the entrepreneurial environment, the TEL platform's backend control panel provides similar opportunities for tracking the progress of graduate students who started to work in companies and are now involved in life-long learning. The same way university teachers in the academic environment monitor their students, supervisors within the enterprise can monitor how their employees are keeping pace with new knowledge within the learning content offered by academic institutions.

As for development tools, several commercial tools will be used, such as Visual Studio .NET, Adobe Dreamweaver and ArcGIS as well as LeXimir, a multipurpose tool for lexical resources management and query expansion developed at FMG (Stanković et al., 2011).

Besides specific tools, the TEL platform has corresponding resources, which have already been briefly described at the beginning of this section. An important place among the resources is occupied by language resources, which will be described in more detail in the following section.

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[4] *https://www.edx.org/edx-terms-service/*

Besides the TEL platform, our approach envisages the development of an infrastructure for implementation of a TEL network, involving a larger number of universities and enterprises within the WB, and thus giving broader access to OER. The network will consist of nodes at universities and enterprises, featuring their own TEL platforms similar to the platform described in this section, and a common portal for indexing OER and other supporting TEL content throughout the network. Audio, video and written text materials from all partner institution nodes will be indexed and annotated with metadata, thus providing enhanced searching capabilities. Namely, when a critical amount of learning resources is reached, it is very important that they are well described and tagged in a standard way in machine readable form. This approach has many advantages:

• Results returned by search engines are more relevant and better described;

• Those interested in course materials (both educators and learners) can find and compare learning materials that best suit their current needs;

• Developers of educational resources and platforms for development of educational resources can create applications and resources in a well described standard format, thus enhancing the value of the educational materials and their visibility for all potential users (educators, learners, educational and public institutions).

OER metadata management in our TEL platform will follow the guidelines set by international standards and initiatives such as ISO/IEC 19788 Metadata for learning resources depicted in Fig. 2. This standard is intended to provide compatibility with existing ISO Dublin Core (DC) Learning Object Metadata (LOM) standards and to support global requirements for adaptability both from the multilingual and cultural perspective. It has two main goals:

• Provide standard metadata elements and their attributes in order to facilitate the identification and specification of metadata elements when describing a learning resource;

• Offer support for learners, educators as well as specialized software in searching, discovering, retrieving, evaluating, and using learning resources.
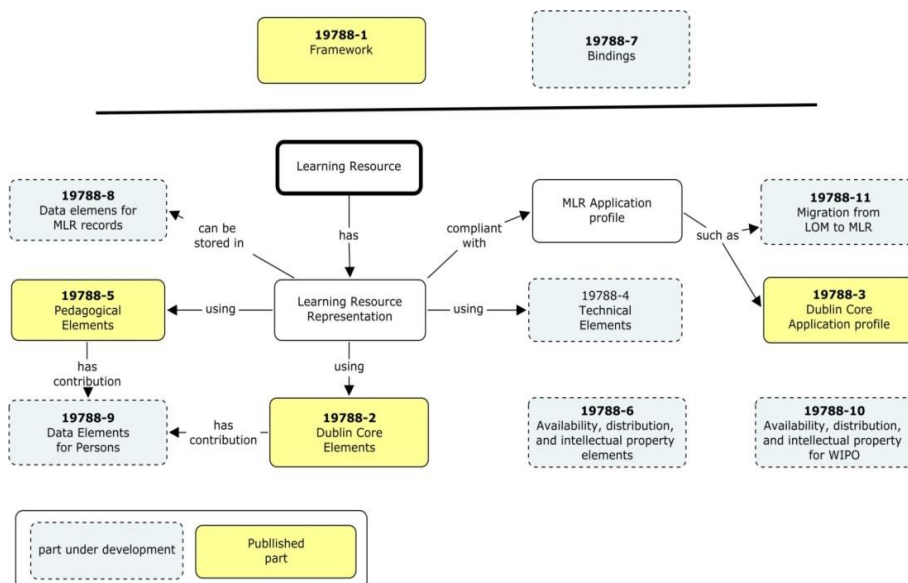
Figure 2: ISO/IEC 19788 Metadata for learning resources

Parts 1, 2, 3 and 5 of the ISO/IEC 19788 standard, marked in yellow are released as international standards, while the seven remaining parts, marked in light blue, are still under development.[5]

4   The language support system

The need for multilinguality of OER is a combined effect of globalization and European integration, favoring a holistic approach that takes into account all the languages a learner may use, as opposed to the more traditional approach looking at one language at a time (Cenoz & Gorter, 2011). Hence, our approach envisages that learning materials within the TEL platform can be in various languages, thus providing an efficient answer to one of the major criticisms of OER being biased towards the so called "big" languages. In order to resolve successfully the issues related to multilinguality, especially terminological issues, but also in order to improve the search and browse functions within the TEL platform, special attention is given to its language support system (LSS). The main goal of LSS is to sustain expert terminology in a multilingual environment and enhance multilingual communication between academic institutions and enterprises.

The language support system, whose structure is outlined in Figure 3, is based on electronic language resources, namely, lexical resources, textual resources and grammars. Bilingual dictionaries in electronic form are one of the simplest multilingual lexical resources. However, for their full functionality in languages with complex morphology, such as Serbian, they need to be coupled with morphological dictionaries. Morphological dictionaries of Serbian simple words and compounds in the so-called LADL format (Krstev et al., 2010) are thus also part of the lexical resources used by LSS. Besides Serbian, such resources exist for many other languages, including English and Russian, which are also envisaged as OER languages within our TEL platform. Another important lexical resource offering support for multilingual terminology is the Serbian wordnet. In brief, a wordnet consists of sets of synonymous words representing specific concepts, called synsets, with a semantic network formed on basis of semantic relations between them. Akin to standard dictionaries, each synset word, or literal, is composed of a literal string and a sense tag, representing the sense of the literal string specific to that particular concept. The multilinguality potential of wordnets stems from the interlingual index (ILI), which establishes relations between synsets representing the same concept in different languages (Krstev et al., 2004).

Finally, among lexical resources within LSS are terminological resources such as GeolISS term and RudOnto (Stanković et al., 2012). GeolISS is a thesaurus of geological terms with entries in Serbian and English, developed at FMG within the GeolISS project.[6] Thesauruses are complex terminological resources, usually related to a specific domain, with as semantic structure formed by semantic relations between terms, and thus in some of their features resembling wordnets. RudOnto is another complex terminological resource, also developed at FMG with the goal to gradually develop into the reference Serbian resource in e-format for mining terminology. Currently RudOnto comprises of concepts in Serbian, their English equivalents, and a small number of equivalents in other languages.
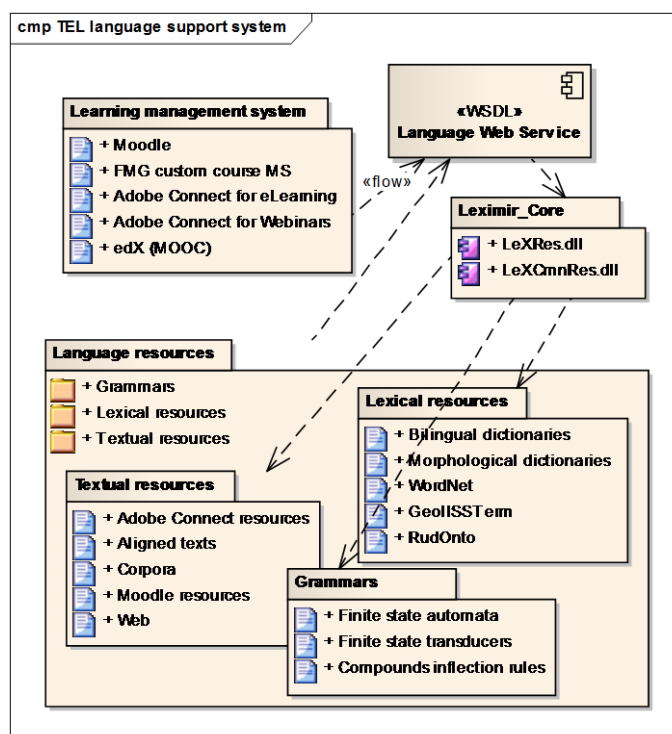

Figure 3: The TEL language support system

The TEL language support system also handles various textual resources. Some of them are directly related to LMS tools, such as Adobe connect and Moodle resources. In addition to that, textual resources feature aligned texts an corpora. Aligned texts are pairs of texts in different languages, mainly an original and its translation, aligned on some structural level, most often the sentence. Aligned texts in LSS are in the standard, Translation Memory eXchange (TMX) format, which is XML-compliant. Corpora are large and structured sets of texts, both monolingual and multilingual, the latter often composed of aligned texts. Finally the web itself represents a textual resource that LSS makes use of.

Specific features of Serbian grammar need corresponding language resources in the form of grammars. Grammars within LSS are implemented by the so called finite state automata, finite state transducers and compound inflection rules (Krstev, 2008).

The language support system handles various types of requests issued by the tools from the learning management system, usually in the form of a query. The requests are handled by a WSDL (Web Services Description Language) described Language Web

Service, basically composed of a web application and a web service. When handling a query, the Language Web Service uses a component of the multipurpose tool LeXimir, namely the function library LeXimir_Core. A query originating from the LMS is accepted by the web application, which forwards it to the web service. The web service then invokes LeXimir_Core, which processes the query using the available resources. During this processing the system can perform a morphological expansion of the query to improve recall, which is especially important for morphologically rich languages such as Serbian. In order to support the multilinguality of the TEL platform, LSS can also expand the query in one language to another language, e.g. a query in Serbian to English or Russian, and vice-versa.

With all the aforementioned features LSS takes a prominent place within the concept implemented by the TEL platform, offering invaluable support for better understanding and handling of the multilingual OER content.

5   Conclusions

The TEL platform described represents a step forward in OER by blending two major sources of knowledge: academic and the entrepreneurial. Its aim is to provide a leaning continuum, from enrichment of university students' knowledge with entrepreneurial knowledge that might prove useful in their future jobs, to keeping their academic knowledge up-to-date once they have graduated, by offering them a live-long learning opportunity as employees.

There are, however, several critical issues, which might impede the implementation of the envisaged concept. The first one is how to motivate qualified academic and/or entrepreneurial staff to produce high quality OER content in continuity. A similar problem might arise on the learners' side, as students might lack interest or willingness to invest some additional effort in learning and knowledge sharing. Finally, authorship issues might be also an impediment due to lack of adequate legislation regulating the practices and principles of publishing and using OER content, especially in the WB region.

As for the technical issues, successful development of the TEL platform requires coordination of activities among partners with possibly different levels of IT skills. Implementation of the OER network, on the other hand, needs successful organization of public procurement and acquisition of appropriate equipment. As for smooth operation of

both the platform and the network, the hardware and software infrastructure and communication links must function flawlessly.

In brief, there is a lot of work to be done before the TEL platform enters full exploitation to the benefit of university students in their preparation for the labor marker, and those who have graduated, in their lifelong learning endeavor.

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