A DBTechNet Project for VET Teacher Training on Database SQL Transactions

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ABSTRACT

DBTechNet is a network of teachers, trainers and professionals from HE institutions, VET institutions, and ICT companies. To synchronize the coverage of basic database topics in VET and HE curricula, DBTechNet has conducted a survey in a number of European VET institutions. The survey has revealed the absence of SQL transactions in many of today's VET curricula, although transaction technology is crucial for reliable data access. In response to this finding, the LLP "DBTech VET Teachers" project got initiated in order to introduce the topics of SQL transactions and concurrency control to VET teachers and trainers. This is along the lines of the need for a priority shift towards flexible and effective professional skills (re-)training programs that facilitate the adaptability of the workforce to new labour market trends in today's volatile EU economy.

Categories and Subject Descriptors

H.2 [**Database Managment**]: Systems—*Transaction processing*; K.3 [**Computers and Education**]: Computer and Information Science Education —*Information systems education*

Keywords

VET teacher training, in-company training, pedagogy, lifelong learning, database technology, DBMS, SQL transactions

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1. BACKGROUND OF THE DBTECH VET TEACHERS PROJECT

Databases are needed everywhere in the modern information society as they are the basis of all applications requiring reliable, secure and scalable data storage and access. Database management system (DBMS) products used by the Information and Communication Technologies (ICT) industry are constantly developing, providing powerful capabilities and improved productivity to application developers. However, in spite of the existing standards, DBMS products may behave differently in practice. Quality in data access programming requires the understanding of the capabilities and the behaviour of the DBMS used. Knowledge and expertise on well-designed SQL transactions tuned for specific DBMS products comprise critical sought-for professional skills in the relevant labour market. As the modern society, the business world, and everyday life activities become more and more dependent on ICT, erroneous data in a database or in a query result outcome may lead to wrong decisions or even to catastrophic actions, thus being worse to having no data at all. Unfortunately, Information Technology (IT) teachers (and even application developers) often lack the knowledge and the skills required to face today's challenge for quality professional training on database technologies. The knowledge and skills gap widens as application architectures become more complicated, and data access technologies do not get the deserved attention in Higher Education (HE) and Vocational Education and Training (VET) curricula.

The knowledge of teachers in database technologies tends to be too academic, lacking the experience of using modern DBMS products in real life applications. In addition, academic textbooks often make simplifications in order to facilitate the presentation of the DBMS functionality to the student, simplifications that deviate (quite often: substantially) from the functionality of the corresponding real life implementations. Consequently, DBMS software often operates differently from the way it is assumed to operate in the

classroom and in academic textbooks. Application developers in the ICT industry are usually overwhelmed with development work and they do not always have enough time to experiment with the detailed behaviour of the DBMS products they use. Developers often trust in what they have been taught or what they have read, without verifying the behaviour of the DBMS product(s) used.

More up-to-date, professional (as opposed to research-) oriented education is needed in order to meet the lifelong learning requirements of today's learners: teachers, trainers and IT professionals. Due to the rapidly changing nature of the ICT industry, an IT teacher/trainer is expected to make a great effort in order to remain up-to-date with the developments in his/her field, as compared to his/her colleagues in other discipline areas. So, a collaborative effort need be undertaken in order to address this problem; one that involves the cooperation between VET and HE institutions, and the ICT industry.

DBTechNet [1] is a network of teachers, trainers and professionals from European HE institutions, VET institutions, and ICT companies. Established in 1997, the network has now expanded to involve members from nine EU member states. During the last fifteen (15) years, and with the support of the European Union Lifelong Learning Programme (EU LLP), the partnership has developed a framework for courses in database technologies [5], together with Educational and Training (E&T) content on key database professional skills topics. The E&T content consists of tutorials and virtual laboratory workshops (VLW), as described in [2] and [6]. The course material is specifically developed with an integrated learning concept in mind that combines three different learning models [8]: The details of the learning model used are described in [10]. HE experts develop and offer course modules that utilize the DBTechNet developed E&T content. The course modules are offered over the Internet, and they are subject to a pedagogically innovative practice whereby the relevancy of the skills taught is verified via "learn-by-doing", utilizing free editions of leading database products, pre-installed in free virtual computers. The latter comprise effective tools for training application developers, as well as VET and in-company trainers since, despite the existence of standards, database products vary in their functionality and implementation details.

The use of virtual computer based laboratory practising makes possible the exploration of the functionality, the administration, and the use of DBMS systems with full administrator privileges. This is not possible in secured industry environments. In this respect, virtual computers may be considered to comprise safe learning "sandbox"-type environments, attractive also to professionals. If some part of the system fails to operate properly or becomes corrupted, the whole virtual computer can be purged, and the study work can continue with a fresh new copy of the virtual computer [2].

In order to synchronize the coverage of basic database topics in today's VET and HE curricula with the needs of the European IT industry and job market, DBTechNet has conducted a survey across a number of European VET institutions, HE institutions, and IT companies. Among other findings, the survey result outcome has revealed the superficial coverage of SQL transactions in today's VET curricula, especially when it comes to teaching key professional skills that are of a high demand in today's IT job market. Database transaction technology is crucial for reliable data access. In this respect, an LLP project code-named "DBTech VET Teachers" (DBTech VET for short) got initiated. The primary aim of the project is to introduce the modern trends on DBMS transaction technologies to VET teachers and in-company trainers. This is along the lines of the need for a priority shift towards flexible and effective professional skills (re-)training programs that facilitate the adaptability of the workforce to new job market trends in today's volatile EU economy.

DBTech VET is to capitalise on the innovative dimension of the deliverables produced by the two previous EU-funded DBTechNet projects: DBTech Pro, and DBTech EXT [1]. The project started in October 2012 and it is scheduled to terminate in September 2014. Fifteen (15) partners participate, representing VET institutions, HE institutions, and ICT companies from Estonia, Finland, Greece and Spain.

2. PROJECT AIMS AND OBJECTIVES

The primary target groups of the project are VET teachers who specialize in software application development, in-company trainers from the ICT industry, and database professionals. Secondary target groups include HE teachers, students, and recent graduates with an expressed interest in the SQL transactions technology, preferably recent graduates who are about to begin their professional career as application developers in the ICT industry.

Along the lines of the EU Leonardo da Vinci - Transfer of Innovation Programme set priorities and objectives, DBTech VET aims at:

- promoting quality and innovation in vocational education and training systems, institutions and practices
- improving the quality and increasing the volume of cooperation between institutions or organizations providing learning opportunities, enterprises, social partners and other relevant bodies throughout Europe
- facilitating the development of innovative practices in the field or vocational education and training other than at tertiary level and their transfer, including from one participating country to others
- improving the transparency and recognition of qualifications and competences including those acquired through non-formal and informal learning
- supporting the development of innovative ICT-based content services, pedagogies and practice for lifelong learning
- addressing the need for initial and continuous training to VET teachers, in-company trainers, tutors and VET institution managers

The project deliverables are expected to have a major positive impact on the teaching of database technologies in VET institutes so that it reflects the current and real needs of the European ICT industry, utilizing a teaching methodology that conforms to the European pedagogical standards. The produced materials will be subject to local updating in all partner countries, plus they will be available in six (6) languages: English, Estonian, Finnish, Greek,

[1] http://dbtech.uom.gr

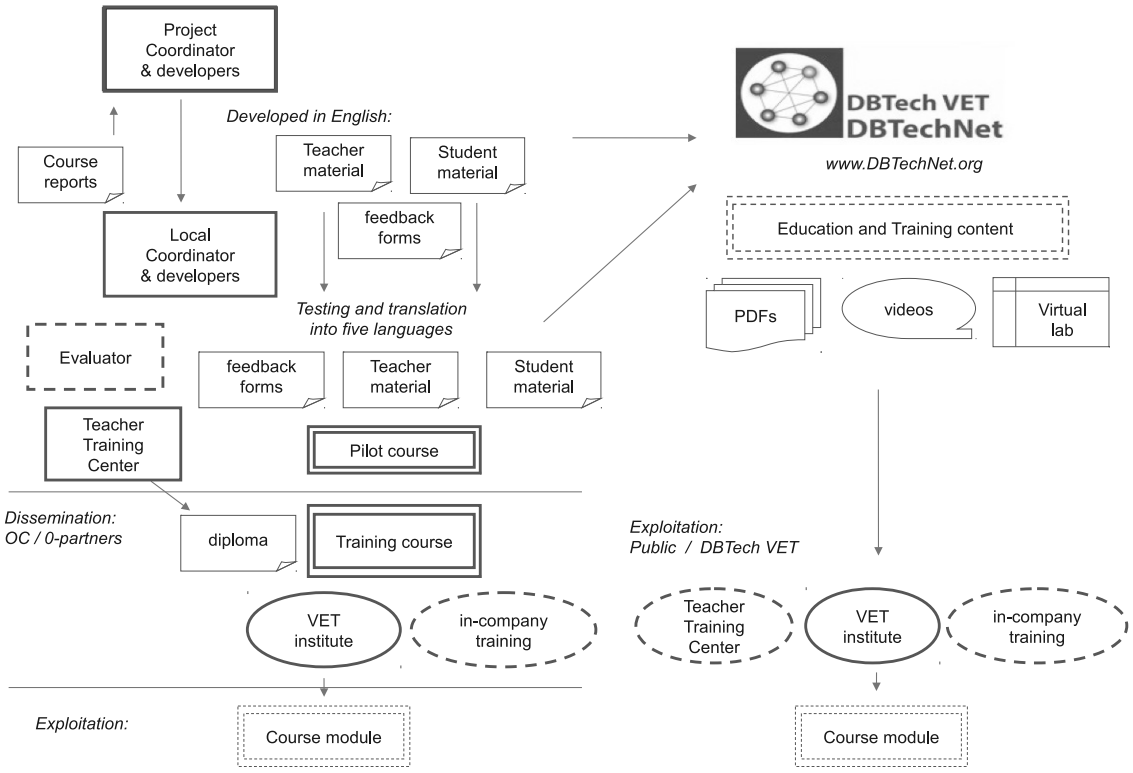

Figure 1: Overview of the project outcomes

Spanish, and Russian. VET teacher training is to be conducted on real life software systems, in a way that is attractive to the learners/trainees, encouraging experimentation, learning-by-doing, and learning-by-verifying.

DBTechNet members share the common belief that by having the HE and VET institutions adopt the same or analogous course modules, one major step forward will be taken in the direction of promoting prior learning and skills recognition to VET students. Such a development will make possible for the latter to proceed with a study at HE institutions, on their path of lifelong learning.

Another aim of the project is to enhance the collaboration between HE institutions, VET institutions, and ICT industry, by promoting the transfer of knowledge and skills between and across them. Equivalently, the aim is to facilitate the introduction of new topics and content to the VET curricula; topics and content that reflect (a) the current trends in database technologies, and (b) the needs of the European labour market.

3. MAIN OUTCOMES

The tangible outcomes include a course module on SQL transactions with its complete education and training (E&T) content. The latter includes a virtual database lab with hands-on self-practising exercises, plus instructions for the teacher/trainer on the pedagogy and the usage of the course module's content (Figure 1).

The topics of SQL transactions and concurrency control are addressed in the DBTech EXT virtual laboratory workshop entitled "Concurrency Control & Recovery" [2]. The developed educational and training content includes tutorials and hands-on-laboratory exercises learners can practice with via a ready to use portable virtual computer with preinstalled leading database software products [2, 9]. As part of the exploitation of the DBTech EXT outcome and as an act of innovation transfer, DBTech VET utilizes these materials in the form of a course module, enhanced with supporting teacher materials suitable for use by VET institutions, and in basic level courses at HE institutions. The project's list of activities includes the translation of the E&T content into the national languages of the partners, plus its piloting and quality testing by all three types of project partners: HE (content developers), ICT (conformance to labour market needs), VET (adaptation to the VET level). This innovative cooperation between VET, HE and the industry comprises an excellent example of how this type of collaboration schemes can be successfully realized in practice, in accordance with the objectives of the EU Lifelong Learning Programme [3]. The entire E&T content of the course is to become freely available on the Web for the European VET institutions, HE institutions, and the ICT industry to use and benefit from.

The intangible project outcomes are: (a) to assist the VET and HE institutions in the development of vocational training curricula that address the needs of the European IT labour market, and (b) to improve the co-operation between VET and HE institutions, both at the local (member

[2]http://dbtech.uom.gr/course/view.php?id=9
[3]http://ec.europa.eu/education/lifelong-learning-programme

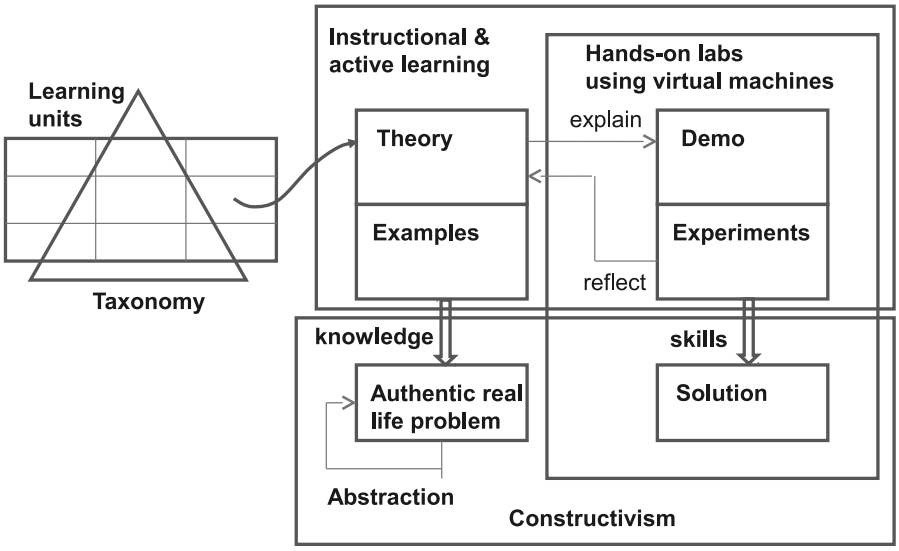

Figure 2: Learning Model Overview [10]

state) as well as at the European level [4]. The project is expected to have a positive impact on the quality of database training offered by the VET institutions, by improving the taught knowledge and skills in topics like reliable data accessing operations in databases. A direct consequence of this will be the improvement of the vocational competence of the VET graduates in the European labour market. The SQL Transactions course may also be seen to comprise a module that can be integrated into existing undergraduate HE database course curricula, thus facilitating credit transfer for VET students who wish to continue their studies at HE institutions.

Activities to be undertaken at each one EU member state represented in the project will involve the translation of the E&T content into the corresponding language, plus the offering of the training course to local audiences and (where possible) to participants from neighbouring countries. Special care will be taken to ensure sustainability by including activities expected to become self-financed following the termination of the 2-year DBTech VET project.

4. LEARNING INNOVATIONS

The competitiveness of the European ICT industry needs to be improved and this can only be achieved through high quality professional skills oriented education and training on state-of-the-art technologies. The topics, the knowledge and the skills taught should reflect the current and the foreseeable future needs of ICT industry. A crucial prerequisite for achieving this goal is the continuous collaboration between learning institutes and the ICT industry, alongside with the continuous development and assessment of the corresponding educational and training materials.

In the recent years, a paradigm shift towards student-centred learning (SCL) is emerging to comprise a new pedagogical approach widely shared among the European Student Union (ESU) and Education International (EI) organization. The approach incorporates important views on the learning content and teaching methods that shape the whole learning process. The integrated e-learning model that was developed and tested in the previous DBTechNet projects is along the lines of this new pedagogical approach [10].

The design of a learning module begins by structuring the learning domain, as in the case of the DBTechNet framework of courses and topics [7]. The domain is seen to consist of learning units involving as few inter-dependencies as possible. Tutorial material and example cases demonstrating the concepts, the techniques, and the skills involved comprise the learning content of each one unit (Figure 2).

The DBTech VET project aims at developing not just the learning content but also a complete course unit for teacher training. Thus, project activities include the transfer of innovation from the previous DBTechNet projects. Testing the materials and the didactic solutions is built into the learning activity so that the teacher/trainer has a role in the course development process. The overall gain may be summarized as follows:

- improved quality of database teaching
- standardization and re-use of the learning material
- cost effective support for the learner, backed by the DBTechNet network of database experts
- vocational training on state-of-the-art database technologies
- vocational training leading to improved competence in the IT labour market, at the EU level

In the course of developing the SQL transactions course module, a transferable model for tailoring an up-to-date pedagogical approach has been established. The model takes into account the need for frequent course curricula updating, plus the national qualification frameworks and recognition of prior learning. Topics relevant to the current trends in the IT labour market and reflect the needs of the ICT industry. Interest and motivation raises when the learner

encounters contradictions between his/her previous knowledge and the modern systems realizations. An example of this is the case where the learner notices that programming code that operates perfectly in single-user environment fails to execute correctly when it runs concurrently with other programs that access the same database in a multi-user environment.

5. COURSE OFFERINGS

The profile of the "SQL Transactions" course and the accompanying E&T content were considered and put to test during the DBTech VET project's kick-off meeting in Malaga, Spain in 11-13 February 2013. The meeting included a three-hour presentation of the tutorial part, plus a four-hour hands-on-laboratory practising session on the part of the course that makes use of the DBTechNet (Debian Linux) virtual machine. Meanwhile, selected parts of the course-to-be materials had been tested independently with student audiences at the Alexander T.E.I. in Thessaloniki, Greece, and at the HAAGA-HELIA University of Applied Sciences in Helsinki, Finland.

On 19 April 2013, part of the course's material was pilot-run in the form of a one-day workshop that was taught in English to an audience of local and invited teachers at the Tallinn Polytechnic School, Estonia. An analogous one-day pilot event was held on 28 May 2013, at the Oulu vocational college (OSAO) in Oulu, Finland. The audience consisted of OSAO vocational teacher/trainers, and academics from the Oulu University of Applied Sciences.

In May-June 2013 the "SQL Transactions" course is to be pilot-run in Greece. The E&T materials to be used, and the teacher/training sessions will be in their original version, in English. Over a period of four weeks, a total of twelve (12) training hours will be conducted: eight (8) hours of tutorial teaching over the Internet, and four (4) hours of face-to-face, hands-on laboratory practising. The topics to be covered comprise a selected subset of the complete first version of the course. The offering is to be of a pilot nature and its organization will be jointly undertaken by the Institutes of Lifelong Education (ILLE) and the Information Technology departments of the Athens and the Thessaloniki TEI institutions. The hands-on laboratory practising will be the only one course component that is to require the physical presence of the learners/trainees and it will be run in two parallel four-hour sessions: one in Athens and one in Thessaloniki. There will be no registration fee requirement and, upon successful completion, participants are to receive a TEI ILLE/DBTechNet issued certificate of attendance. The course is expected to involve an audience of twelve (12) participants in Athens, and another twelve in Thessaloniki: a total of twenty four (24) learners/trainees. VET teachers/trainers are to comprise the primary target group of course participants, together with teacher/trainers from the local municipality authorities' lifelong learning educational divisions as well as I.T. professional (some from the banking sector) who seek to acquire new knowledge and skills on transaction concurrency and control technologies. Participation from the neighbouring Balkan countries will be welcome. It is also expected that the offering of the course in Greece is to initiate a collaboration between DBTechNet and the Hellenic General Secretariat for Lifelong Learning [4]: the national co-ordinating authority of lifelong learning activities organized and implemented by state agents and social partners.

In early October 2013, the complete version of the "SQL Transactions" course is to undergo its first dissemination offering in Spain. It will run for five weeks, and for a total of thirty (30) training hours. Course organization and offering are to jointly be undertaken by the Malaga Teacher Center (CEP) and the Computer Science Department of the University of Malaga (UMA). The complete range of E&T materials to be used, and all teaching/training sessions will be in Spanish. CEP [5] is responsible for primary- and secondary education as well as for VET teacher training in the broader Malaga region. The DBTech VET course is to involve a total of thirty-five (35) VET teacher/trainers in the role of trainees/learners. Participation in the course is to be free of charge, and, upon successful completion, the learners/trainees will receive a CEP/DBTechNet issued certificate. It is expected that, with the experience of the course offering in question, CEP is to update the VET course curricula to include the new DBTechNet (modular) course content, initiating procedures of in-house teacher training sessions with the trainees of the CEP-UMA course offering in the role of trainers of wider VET teacher/trainer audiences. The aim is to have the updated version of the CEP VET course curricula become effective during the 2013-14 academic year.

Behind the tailoring of the "SQL Transactions" course to the needs of a modern vocational education and training curriculum in the database technology discipline area, lies a big challenge for the DBTech VET project. The challenge of addressing key IT professional skills topic in a way that: (a) increases the competitiveness of VET graduates in the European IT labour market, (b) brings the HE graduates closer to the practice (as opposed to the theory) of skills they need to possess in the beginning of their professional career, and (c) offers the opportunity to the IT professional who undergoes lifelong learning training to acquire knowledge and skills that lie within his area of specialization, yet beyond the systems and practices at his work environment.

Considering the above, a continuous effort is to be made during each one of the DBTech VET course offerings to always motivate the learner in the direction of improving his knowledge and skills on the topics considered, regardless of his background, expertise and degree of specialization. More specifically, be it a VET/in-company teacher/trainer, or IT professional, it is equally important for the trainee/learner to be motivated towards achieving and maintaining increased awareness on:

- the existing differences in the way different DBMS products implement and support even basic SQL transaction services. One needs to always experiment and verify with the DBMS used in order to develop reliable applications
- the fact that, despite supporting the ISO/SQL isolation levels, the DBMS has no way of protecting its content from carelessly written application programming code that effectively has the same catastrophic consequences to the data content of the database, as in the case of absence of the ISO/SQL transaction concurrency control mechanisms

[4]http://www.gsae.edu.gr/en/

[5]http://www.cepmalaga.com/

	ANSI/ISO SQL: 2006	DB2 LUW 9.7	Oracle 12.1	SQL SERVER 2012	MySQL/InnoDB 5.6	PostgreSQL 9.2	Pyrrho 4.8
autocommit (server-side)	n/a	n/a	n/a	yes	yes	yes	yes
Transaction Limits							
explicit start	yes	n/a	n/a	yes	yes	yes	yes
implicit start	yes	yes	yes	(configurable)	(configurable)	n/a	n/a
COMMIT	yes	yes	yes	yes	yes	yes	yes
implicit commit on DDL	n/a	n/a	yes	n/a	yes	n/a	n/a
ROLLBACK	yes	yes	yes	yes	yes	yes	yes
implicit rollback on concurrency conflict (deadlock)	(yes)	yes	no (exception raised)	yes	yes	no (xaction invalidated)	yes, at commit
implicit rollback on error	left open	n/a	n/a	(configurable)	n/a	no (xaction invalidated)	yes
SAVEPOINT	yes	yes	yes	yes	yes	yes	n/a
ROLLBACK TO SAVEPOINT	yes	yes	yes	yes	yes	yes	n/a
RELEASE SAVEPOINT	yes	yes	yes	n/a	yes	yes	n/a
Isolation levels							
READ UNCOMMITTED	yes	UR	n/a	yes	yes	n/a migrate to "read latest committed"	n/a
"read latest committed"	n/a	CS (currently committed)	"read committed"	(configurable)	"read committed"	"read committed"	n/a
READ COMMITTED	yes	CS	n/a	yes	n/a	n/a migrate to snapshot	n/a
REPEATABLE READ	yes	RS	n/a	yes	n/a	n/a migrate to snapshot	n/a
snapshot	n/a	n/a	"serializable"	(configurable)	"repeatable read"	"serializable"	"serializable"
SERIALIZABLE	yes	RR	explicit locking	yes	yes	explicit locking	"serializable"

Figure 3: ISO/SQL transactions and implementations in DBMS products (note: [a] isolation level names in upper-case reflect ISO/SQL semantics, [b] n/a: not applicable)

- the best practices on transactions-based application software development, for example: one should avoid the inclusion of user interface dialogues in the SQL transaction logic, otherwise the latter may lead to potentially disastrous waiting times in the production environment
- the simplifications often made in database textbooks for the sake of facilitating the understanding of the concepts involved. There exist cases where such simplifications deviate substantially from the way DBMS products implement transaction isolation, in practice. For example, there exist textbooks that relate the phantom anomaly only to data insertion, not to data update operations. Such an explicitly or implicitly made simplification makes it difficult for the learner to, say, realize the fact that multi-versioning concurrency control (MVCC) alone does not suffice for implementing the ISO/SQL "Serializable" isolation level in practice, and
- the existing differences in the way various DBMS products implement the ISO/SQL transaction isolation levels (Figure 3).

The course and its multilingual E&T content are to be licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Unported License [6].

[6]http://creativecommons.org/licenses/by-nc-sa/3.0/deed.en

6. EPILOGUE

The DBTechNet network of European teachers, trainers, and I.T. professional has a history of fifteen (15) years of excellence in teaching and training professional skills on selected database technology topics [1]. Aiming at increasing the VET and HE graduate's competitiveness in today's highly demanding EU labour market, the DBTech VET project is to capitalize on the pedagogical methodology and the E&T content developed in two previous EU Leonardo da Vinci Program funded projects: DBTech Pro and DBTech EXT. It is a dissemination project, focusing on SQL transaction technologies. Beginning in May 2013, the "SQL Transactions" course module is to be offered in Greece and later on in Spain. The target audiences will be VET teacher/trainers, in-company trainers, and IT professionals. Both course offerings will be of a pilot nature, probing into the grounds of promising target prospects, like (a) the integration of the course module into the VET curricula (CEP-UMA course offering, in Spanish), (b) addressing the need for quality lifelong learning/training on professional skills of interest not just to the VET learner, but also to the HE education student/graduate, and to the IT professional, and (c) attracting the interest of participants from countries in the vicinity of the venue hosting/offering the course (Athens and Thessaloniki TEI course offering, in English). In September 2014, the "SQL Transactions" course module will be ready for dissemination in all EU member states represented in the DBTech VET partnership, its E&T content being available in six (6) languages: English, Estonian, Finnish, Greek, Russian, and Spanish.

Last but not least, all of the DBTech VET project activities are subject to continuous quality management and modifications, along the lines of the EU set project evaluation guidelines [3] with regard to internal (formative as well as summative) and external evaluation.

7. ACKNOWLEDGEMENTS

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