# THE DEVELOPMENT OF MAPQFTOOL
## A Software Tool for National Qualifications Frameworks

Philippos Pouyioutas[*], Harald Gjermundrod and Ioanna Dionysiou
*Department of Computer Science, University of Nicosia, Nicosia, Cyprus*

Abstract:    This paper presents the preliminary stages of the design of MapQFTool, a software tool that will provide support to the understanding and comparability of the National Qualifications Frameworks (NQFs) of the various European countries. The paper starts by providing background information on the Bologna Process and the Qualifications Frameworks. It then addresses the limitations of trying to map the various NQFs against the European Qualifications Framework (EQF), and through the EQF against each other. It then proceeds with explaining the advantages of automating this process with a software tool and provides examples of information that can be generated through the proposed tool. A relational database design that will underpin the development of the tool is described, accompanied with screenshots of the system prototype and its architecture.

## 1 INTRODUCTION

The Bologna process (European Commission Education and Learning, 2008) aims at developing a European Educational Framework of standards, definitions and concepts so as to provide the basis for European countries to transform their educational system according to this framework. This will result in comparability/compatibility of the various European educational systems which will then yield collaborations amongst educational institutions, exchanges of students and teachers within Europe and transparency and transferability of qualifications, all being very important when looked from the point of view of students, Erasmus co-ordinators, prospective employers, Quality Assurance Agencies (QAAs), European Network of Information Centres (ENIC), and National Academic Recognition Information Centres (NARIC).

One of the first and most important concepts developed by the Bologna process is the European Credit Transfer System (ECTS 2009) that provides the framework for measuring the student workload in courses/modules/programmes and thus calculating the credits of these courses/modules/programmes.

Another important concept recently introduced is

the concept of the Learning Outcomes (LOs) (Kennedy et al., 2006), which allows courses/programmes to be expressed in terms of what a learner/student is expected to be able to do by the end of the course/programme. Employers will thus be able to identify what students are able (or at least should be able) of doing after completing their programmes/courses. Furthermore, by studying descriptions of studies expressed in terms of LOs and thus comparing with what they expect graduates to be able to do, employers could provide input for the re-engineering of programmes taking into consideration industry requirements. When it comes to Erasmus co-ordinators, LOs assist in the comparison of programmes and courses since they provide a common framework/platform for expressing the programmes/courses aims and objectives looked at from the student point of view. Last but not least, ENIC/NARIC networks are also provided with a common framework/platform for evaluating levels and degree qualifications.

The European Qualifications Framework (EQF 2010, EQF Newsletter1 2010) provides the basis for mapping the National Qualifications Framework (NQF) of each European country against this framework, thus transitively, mapping each country's educational system against another country's system. EQF and NQFs describe in terms of Learning Outcomes (knowledge, skills, competences) the various levels of education starting

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*[*] participating in the UNILO Project www.unilo.eu*
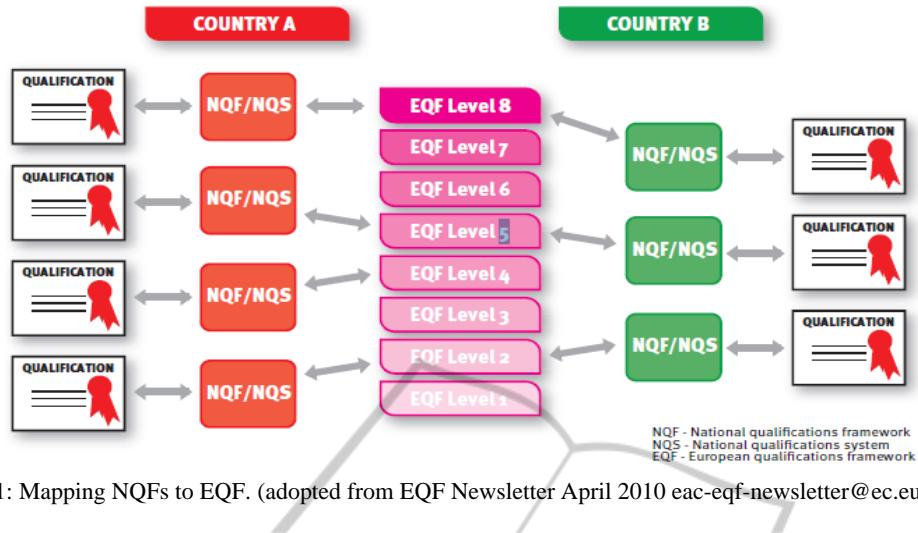
Figure 1: Mapping NQFs to EQF. (adopted from EQF Newsletter April 2010 eac-eqf-newsletter@ec.europa.eu)

from the pre-primary level and reaching the doctorate level. EQF caters for eight such levels, whereas NQFs may cater for a different number of levels. Many European countries may opt to adopt the eight levels of EQF into their NQF, thus providing a one-to-one relationship with EQF levels. Irrespectively of whether eight or more or less levels are adopted in a NQF, a mapping should be provided from the NQF to EQF so one can understand at which European level a national qualification level (and thus an award of that level) corresponds to. The mappings of all NQFs to EQF will thus allow transitively a mapping from one NQF against another and thus an understanding of different educational systems of countries and equivalence of levels and awards/degrees across Europe (Figure 1). This is extremely important for students, academic institutions, employers and National Quality Assurance Agencies.

Three European countries so far have published their NQFs reports: Ireland (Ireland 2009) and Malta (Malta 2009) already in 2009, and the United Kingdom (UK 2010a,b) earlier this year. It is expected that seven additional countries will be able to finalise their referencing in 2010, while most of the others will need 2011 to achieve this process. Still, all countries are expected to indicate the appropriate EQF level in each new qualification they issue by 2012 - which is the second target date suggested by the EQF Recommendation.

The rest of this paper is organized as follows. Section 2 explains the need for MapQFTool. Section 3 provides a relational database design to support the development of the proposed tool and exemplifies its functionality through screenshots of the prototype version of the tool that is being developed. It also provides examples of information that can be generated by the tool for the various stakeholders,

namely the European Commission, the National Quality Assurance Agencies, the educational institutions, etc. Section 3 completes by discussing the tool's architecture. Finally, Conclusions presents our future work.

## 2 THE NEED FOR MAPQFTOOL

The proposed tool will be very useful in presenting information to the various stakeholders. More specifically, the European Commission Agency responsible for EQF, Educational Institutions and National Quality Assurance Agencies in all European countries will be maintaining the database that will support the tool. Information regarding programmes of studies/awards offered by the institutions/countries, the NQF levels of each European country, the mapping of each award to the appropriate NQF level and the mapping of each NQF level to the appropriate EQF level will be maintained. This data will then be used to produce various useful information for all the aforementioned stakeholders, as well as to ministries of education, students, parents, employers and the general public. More specific details as to who is responsible for what part of the database data is given in Section 3 of this paper.

Although the setting up of all NQFs in Europe and the mapping of the awards against the NQFs levels and of the NQFs levels against the EQF levels has not been completed, it is expected that a manual process for producing information will be laborious, slow and prone to errors. On the contrary, the use of the proposed tool will provide fast error-free information, as a result of either predefined or ad-hoc reports/queries.
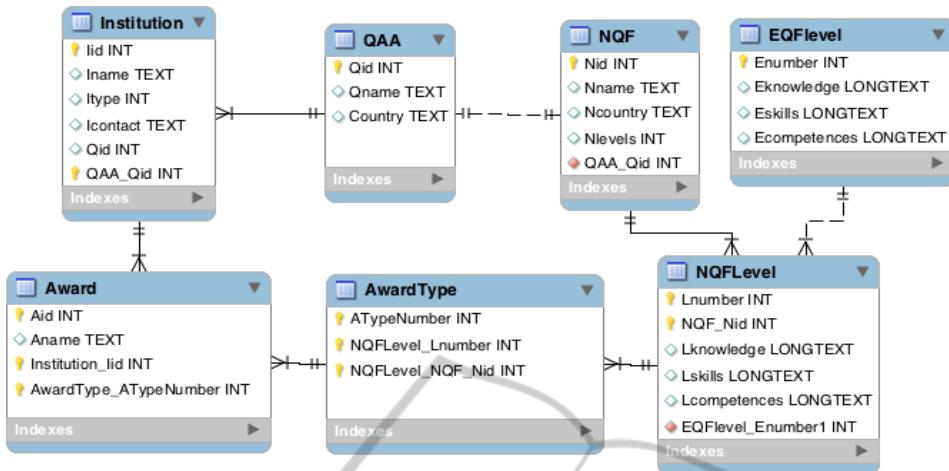
Figure 2: The ER Model of the Proposed Database.

More specifically the tool will be providing information such as:

1. Given an award, what is its NQF level
2. Given an award, what is its EQF level
3. Given an award in country A, what is its NQF level in country B
4. Given an award in country A, what are the equivalent NQF levels in all other countries
5. Given an award in country A what is its equivalent award(s) in country B
6. Given an NQF level in country A what is its equivalent EQF level
7. Given an NQF level in country A, what is its equivalent level in country B
8. Given an NQF level in country A, what are the equivalent NQF levels in all other countries
9. Given an EQF level what are/is the equivalent level(s) in the NQF of country A
10. Given an EQF level what are/is the awards of that level in country A
11. Given an EQF level what are/is the awards of that level in all countries

All the above queries are just samples of predefined questions that can be written in the database's query language/report writer and produce answers on the spot; they do not present the exhaustive list of information that can be produced by the system, but only samples that exemplify the functionality and use of the proposed tool.

# 3 THE RELATIONAL DATABASE DESIGN AND THE TOOL'S ARCHITECTURE

In this section we provide a relational database design that accommodates the system functionality as explained in the previous section. Figure 2 illustrates the ER model that describes the database entities, relationships and relational tables (including primary and foreign keys).

MapQFTool will be a web-based application, accessed over the Internet by the various stakeholders. Figure 6 depicts graphically the various users of the tool and its architecture. We next explain the users of the tool and the way it will function in terms of write/read access and authorization privileges and then elaborate on technical issues with regards to its system architecture. Screenshots of the prototype of the tool are also given to exemplify the way the tool will work.

## 3.1 Users of MapQFTool

The tool will provide web access to authorised users as shown in Figure 3. Public access through the "Other" option (Figure 3) does not need user name and password and is for the general public, whereas the other types of users will need to login to the system.

Each educational institution in each country will have write access to the MapEQFTool's database with regards to its own data and the programmes of study/awards that it offers (table Institution and part of the table Awards – Aid, Aname of Figure 2). For

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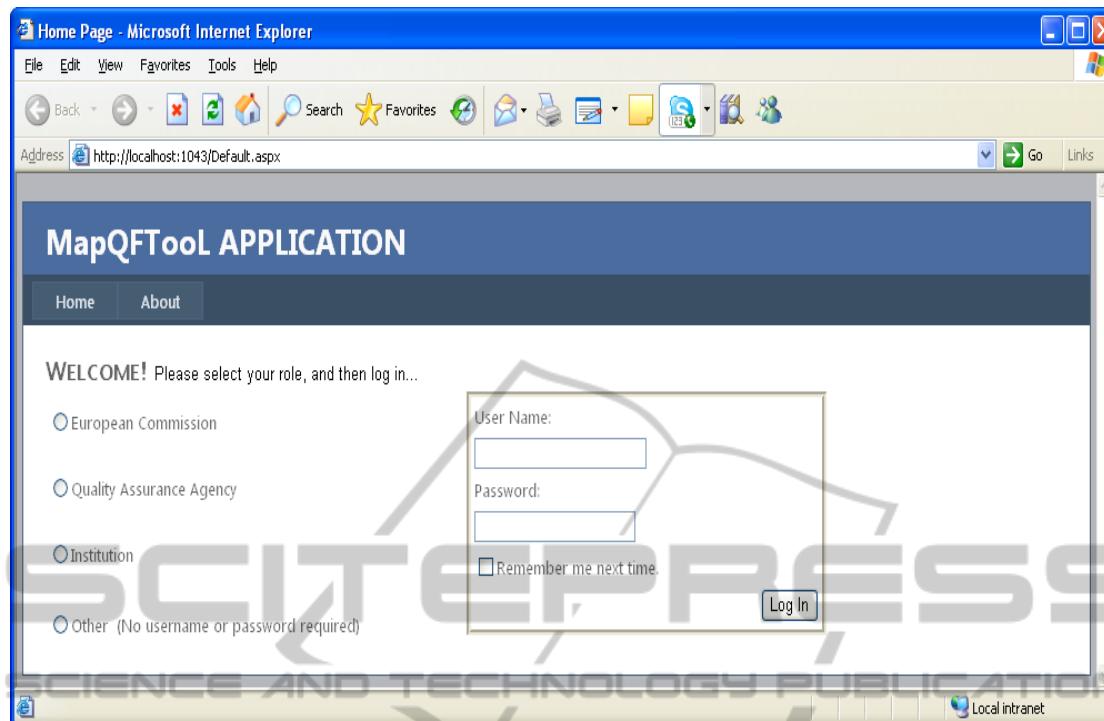
Figure 3: The Tool's log-in Screen.

example, an institution with Itype = "University", can add a new award with Aname "BSc Computer Science". The AwardType field will be completed by the National QAA since this will signify the award's recognition status and only the National QAA will be allowed to do that. In this case the type could be "Bachelor's Degree, 1st Cycle". An empty filed signifies no recognition. Other types of University awards are "Master Degree, 2nd Cycle", "Doctorate Degree, 3rd Cycle". For Secondary Education institutions an award Atype can be "Apolyterium, Leaving Certificate". The responsibility of the mapping of each institutions award to the NQF level will lie with the country's national Quality Assurance Agency (QAA). Each National QAA will thus be responsible/authorized for updating the country's NQF data (NQF table) the awards types data (AwardType table) and setting/maintaining the mapping from the country's institutions awards and (Lnumber, LNid) to the NQF level. The European Commission Agency responsible for EQF will be responsible/authorized for maintaining the National QAA data and the EQF levels and in collaboration with each country's National QAA, setting/maintaining the mapping from each NQF level to an EQF level. Figure 4 illustrates the creation of a NQF level by the appropriate National QAA. The knowledge, skills and competences are recorded but the mapping to the EQF level is restricted only to the European

Commission Agency which will be in charge for the mappings.

When it comes to read access users, students, parents, employers, ministries of education and labour, teachers and the general public will have access to the tool and be able to obtain information similar to the one discussed in Section 2. An example of a query and the way the tool supports such queries is given in Figure 5.

## 3.2 Technical Considerations of the Tool's Architecture

A 3-tier web application architecture will be used for the tool (see Figure 6). The information and request/reply flow between the three tiers are as follows: The user enters the web site using a Internet browser. The front-end web-service receives a request from the client browser, and this is forwarded to the web service, which queries the database and generates a webpage with the requested information that is then sent back to the user's browser. One of the benefits of this architecture is the clear separation between the presentation layer, application logic layer, and the data access layer. As the tool will be a web service, the users could access it from anywhere as long as they have access to an Internet browser. This simplifies the tool usage for the average users, as there will be no need to install
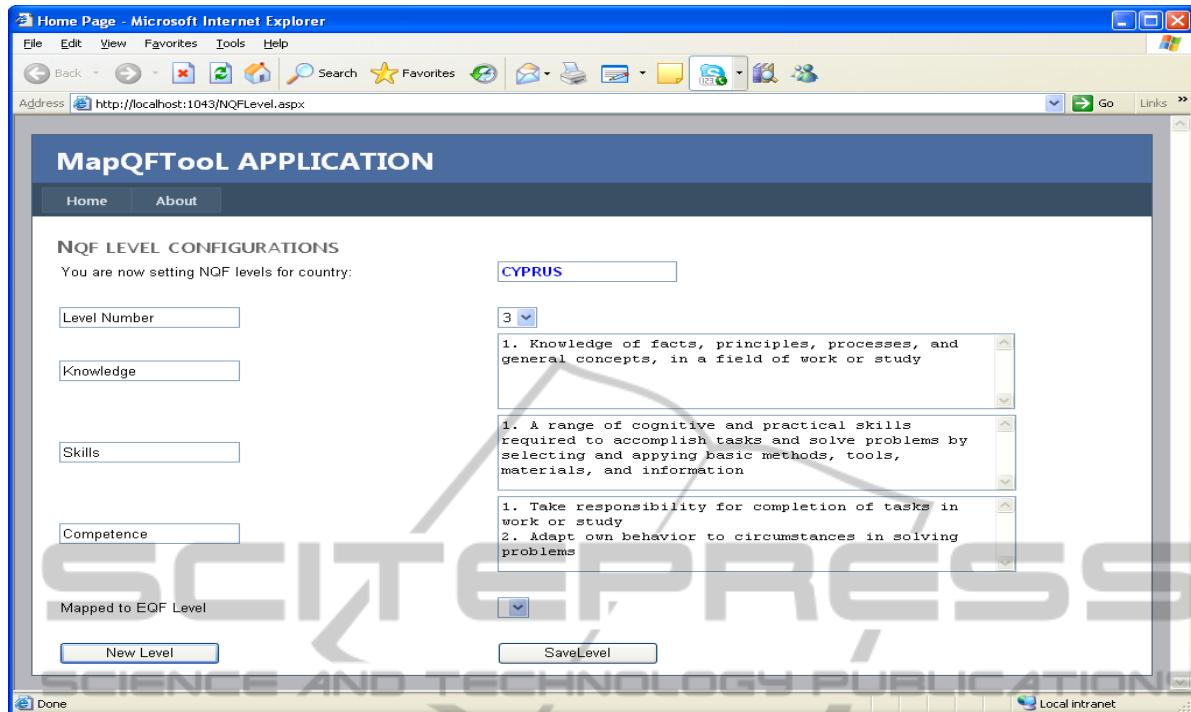
Figure 4: Create an NQF Level.
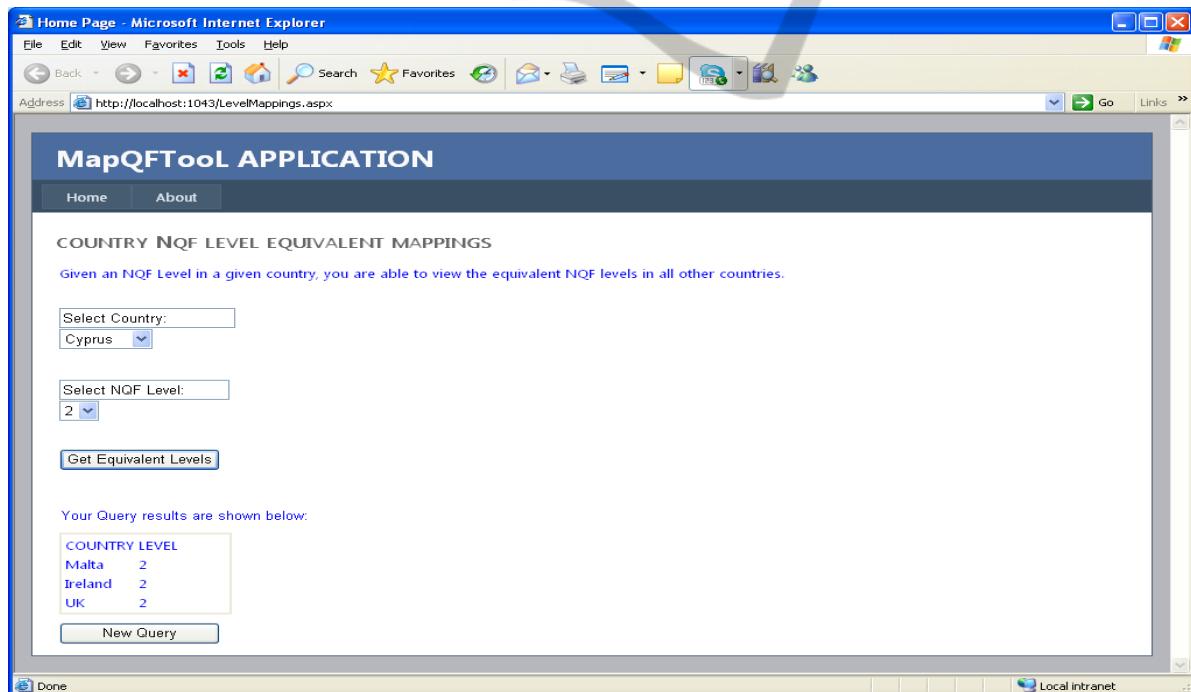


Figure 5: A sample of a Query.

any software on their personal computer.

The first two tiers will be developed using Microsoft's .NET platform. This platform provides for rapid development and reuse of the .NET

components like WYSIWYG (What You See Is What You Get) GUI building (web-forms), database connectors, and ASP.NET controls. The third tier will be developed using the MySQL database
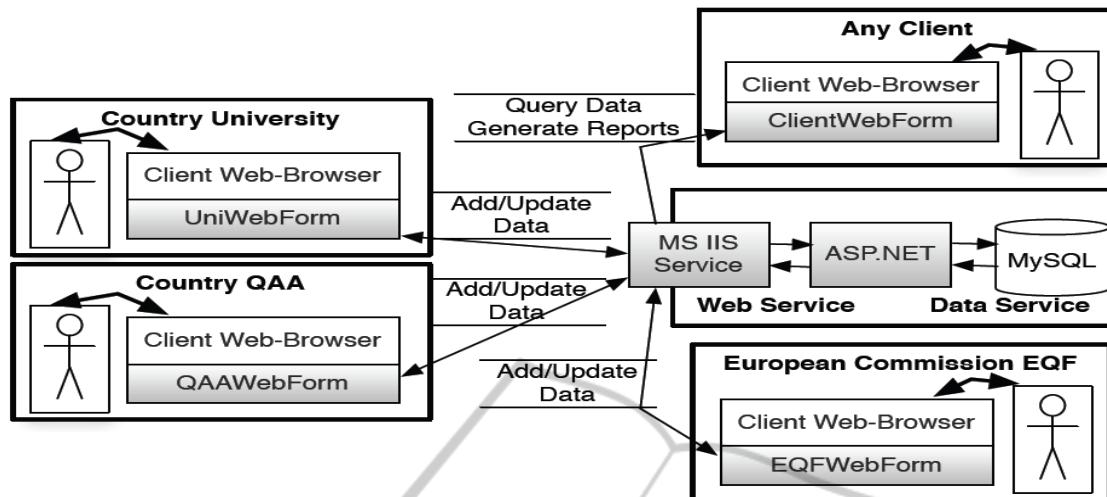
Figure 6: The Proposed MapEQFTool System Architecture.

service. The choice of using MYSQL as the back-end database system is due to the fact that it is an open-source service that supports a wide variety of platforms with respect to both programming languages and operating systems. Details on each of the 3 tiers of the architecture are briefly given below.

**Presentation Layer:** The presentation layer provides the interface to the end-user of the tool. Depending on the role of the user the tool will render a customized webpage. From there, the user could access the data, customize queries on the data, and depending on the privileges of the assigned role update the date. The users will not directly specify the database queries, but instead they will choose from options and set parameters that will automatically generate the specific queries. Hence, the technical knowledge that is required by the users is keep at a minimum.

The presentation layer will be developed using web forms from the .NET platform. The web forms allow for rapid development of web pages by reusing ASP components (explained later). The forms will be "connected" with the application logic that is handled by the second tier.

**Application Logic Layer:** The application layer performs the requested requests/actions from the users and returns the result back to the user. It consists of two components, namely the front-end web-service and the ASP component.

For the front-end web-service, Microsoft's Internet Information Services (IIS) will be used. The service will concurrently accept requests from multiple end-users and forward these to the ASP

components. Once the result is returned from the ASP component, the IIS service will forward the resulting web page to the appropriate end user.

The ASP (Active Server Pages) components are responsible for performing the application logic of the clients' requests; some of them are "connected" with a GUI element within the web page. The result of the request is a webpage (HTML) that is send back to the user. The C# programming language will be used for the application logic and the query options will be built using the LINQ (Brooks, 2008) component. The application logic is as explained above connected with the GUI elements. If the application logic needs data in order to generate a new web site, then it will make a request to the third tier to provide the required data.

**Data Access Layer:** The data access layer provides access to the back-end database that stores all the data. The database will receive its queries from the ASP as SQL queries and return the resulting data, which is used to generate dynamic web pages that are forwarded to the user.

The tool will use the MySQL database for its back-end storage. MySQL is an open source relational database management systems (RDBMS). The interaction with MySQL is performed using the SQL language. Connectors are provided to interact with MySQL programmatically using various programming languages and platforms. For the MapEQFTool we will use the connector for the .NET platform.

**Future Consideration:** First, the currently proposed architecture will consist of only one database service, but a distributed solution could be provided if scalability should be an issue.

Second, the top 2 tiers are developed using a proprietary framework provided by Microsoft for the Windows platform. There exists an open source project, Mono (Avery and Holmes, 2006) that provides implementation for the .Net framework on other platforms. An evaluation could be done if the top 2 tiers could be developed using an open source solution.

# 4 CONCLUSIONS

This paper has presented the MapQFTool to allow the various National Qualification Frameworks (NQFs) to be mapped against the European Qualification Framework and thus against each other. The need for the tool was discussed and justified by addressing the various limitations of carrying out manually this process and trying to compare and evaluate different qualifications and awards from different countries. In order to develop the tool, we provided a relational database design, presented some screenshots of the tool's prototype and discussed a system architecture, elaborating on the platforms chosen for its deployment.

We are currently in the process of building the database based on the proposed design and then proceeding with the full development of the tool. We expect that the tool will be a very useful asset to all stakeholders, namely the European Commission, the National Quality Assurance Agencies, the educational institutions and the general public.

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