MAPQFTOOL

A Software Tool to Support National Qualifications Frameworks

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Abstract— **This paper presents MapQFTool, a software tool that provides 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 and explains the advantages of automating this process using a software tool. The paper finally presents the software tool and its functionality; this is done by giving the design of the underlying database, sample data, sample queries and their results, as well as its system architecture and development platform.**

Keywords- European Qualifications Framework, National Qualifications Frameworks and Software Tools Introduction

I. INTRODUCTION

The Bologna process [1] 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-coordinators, prospective employers, Quality Assurance Agencies (QAAs), European Network of Information Centres (ENIC), and National Academic Recognition Information Centres (NARIC).

The European Qualifications Framework [2][3] 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 from the pre-primary level and reaching the doctorate level. EQF caters for eight such levels, whereas NQFs may cater 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 (Fig. 1, adopted from EQF Newsletter April 2010, eac-eqf-newsletter@ec.europa.eu). This is extremely important for students, academic institutions, employers and National Quality Assurance Agencies.

Three European countries, which have been amongst the

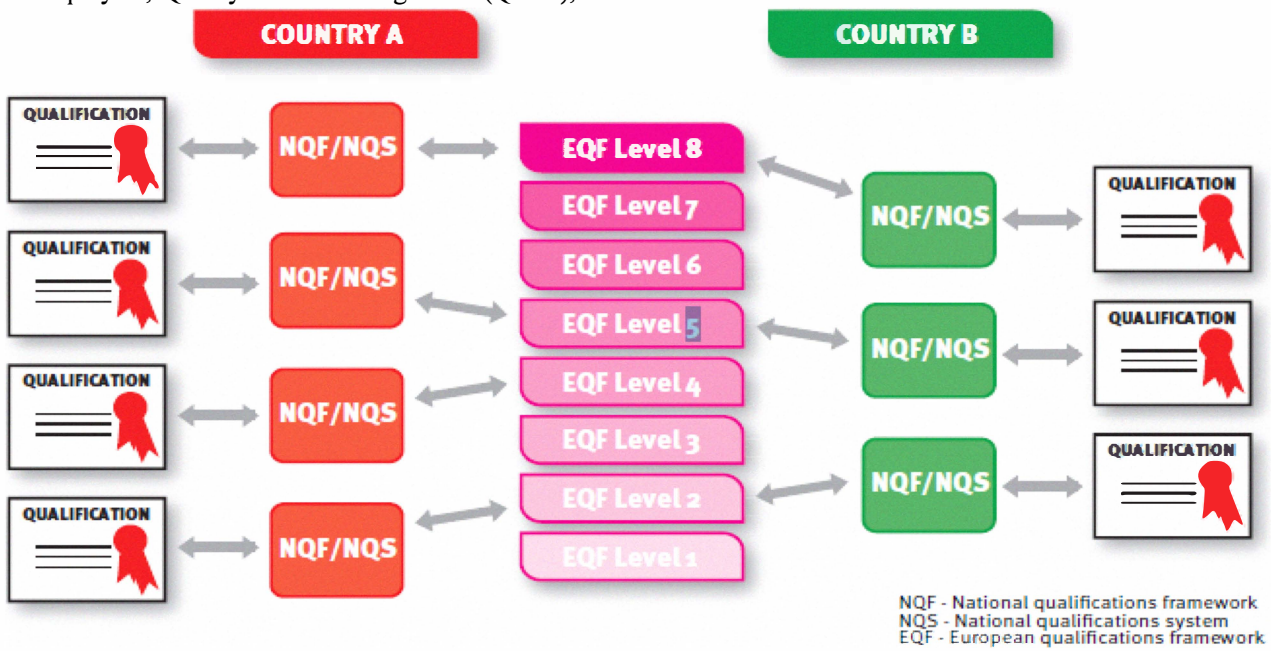

Figure 1. Mapping NQFs to EQF

first ones to publish their NQFs reports, are Ireland [4] and Malta [5] in 2009, and the United Kingdom [6][7] early in 2010. It is expected that 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. Thus, 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.

The rest of this paper is organized as follows. Section II explains the need for MapQFTool. Section III describes the users and the tool's functionality, along with sample usage scenarios. Section IV provides design and implementation details such as the platform used to develop the tool. Finally, Section V presents concluding remarks and future work.

II. THE NEED FOR MAPQFTOOL

The proposed tool will be very useful in presenting in easy and intuitive manner 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 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 III.

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.

More specifically the tool will be providing information to queries such as:

- Given an award, what is its NQF level
- Given an award, what is its EQF level
- Given an award in country A, what is its NQF level in country B
- Given an award in country A, what are the equivalent NQF levels in all other countries
- Given an award in country A what is its equivalent award(s) in country B
- Given an NQF level in country A what is its equivalent EQF level
- Given an NQF level in country A, what is its equivalent level in country B
- Given an NQF level in country A, what are the equivalent NQF levels in all other countries
- Given an EQF level what are/is the equivalent level(s) in the NQF of country A
- Given an EQF level what are/is the awards of that level in country A
- 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 expressed 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.

III. MAPQFTOOL USER PERMISSIONS AND FUNCTIONALITY

MapQFTool, being a web-based application, is accessed over the Internet by the various stakeholders. Fig. 2 depicts graphically the various users of the tool. The users of the tool and the way it functions in terms of write/read access and authorization privileges will be now explained.

Not all users should be allowed write access to the information; the appropriate access control mechanisms must

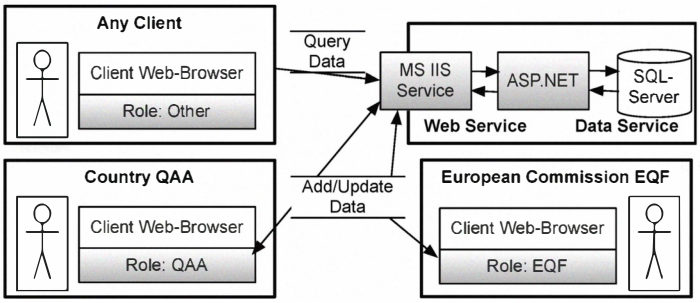

Figure 2. MapQFTool Architecture

be in place to restrict access to data based on the user's role in the overall system. For the time being, the read and write access permissions to the database information are considered. Write access is restricted to the European Commission and the European NQAAs. The European commission is responsible for maintaining the data pertaining to the EQF and for creating and maintaining all the NQAAs. Similarly, each NQAA is responsible for maintaining the data pertaining the NQF, to the institutions of the country of the NQAA, its award types (along with their mappings to the appropriate EQF level) and the awards given by its institutions. Open access is supported for users such as students, educational institutions, ministries of education and labour, teachers as well as the general public such as parents and employers, who are able to obtain information similar to the one discussed in Section II. Thus, the tool supports a role-based access control, with the three roles to be European Commission EQF, National QAA, and other. The latter role does not require any authentication credentials (user

name and password) as it is for the general public, whereas the other roles will need to follow an authentication process.

Screenshots of the prototype of the tool are given to exemplify the tool functionality. Starting with Fig. 3, the user is presented with a list of NQAAs that are currently registered in the system. Under the European Commission EQF role, this list could be updated accordingly, whereas the remaining two roles have only viewing authorization. In this particular case, the system maintains three NQAAs for countries Country A, Country B, and Country C respectively.

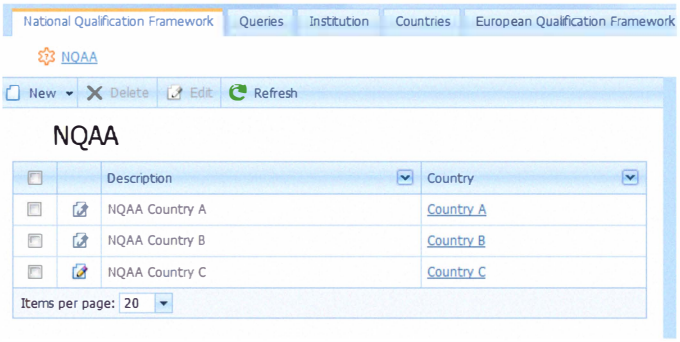

Figure 3. Registered NQAAs

Clicking on the country field, a new form is rendered with information about the specific country's NQAA. Fig. 4 shows details such as email and address of Country A's NQAA. In addition, one could also view the mappings of Country A's NQF levels to their equivalent EQF level for each award type that the country offers (note that due to space restrictions, only the levels list is only partially shown). For example, Country A offers PhD, DProf, and MD, which are all assigned an NQF level of 8 with an equivalent EQF level of 8 as well. Needless

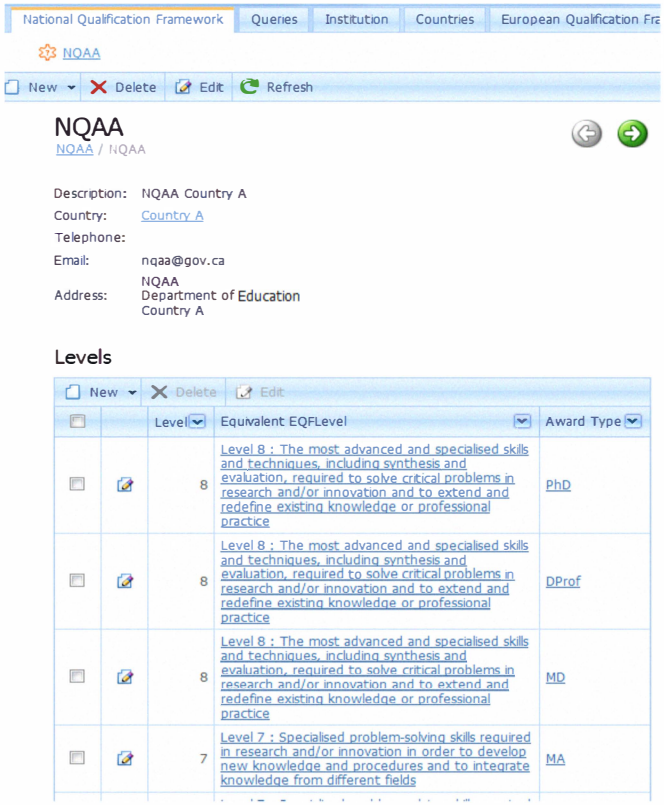

Figure 4. NQAA Level and Mappings

to say, the NQF-EQF level mappings could be different.

Details on the awards offered by an educational institution located in a specific country are illustrated in Fig. 5. Students attending University of A1, located in Country A, could be awarded seven different awards. This list is maintained by the NQAA.

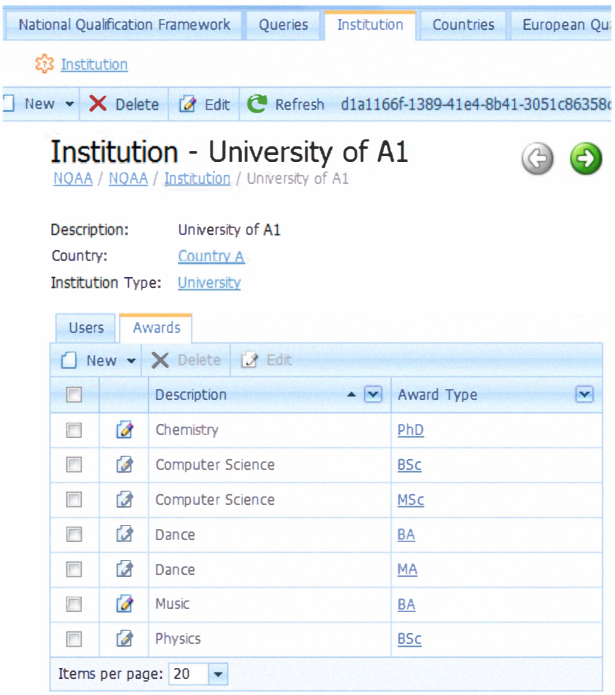

Figure 5. Awards Offered by a University

In order to demonstrate the search capabilities of MapQFTool, two queries are performed and their results are shown below.

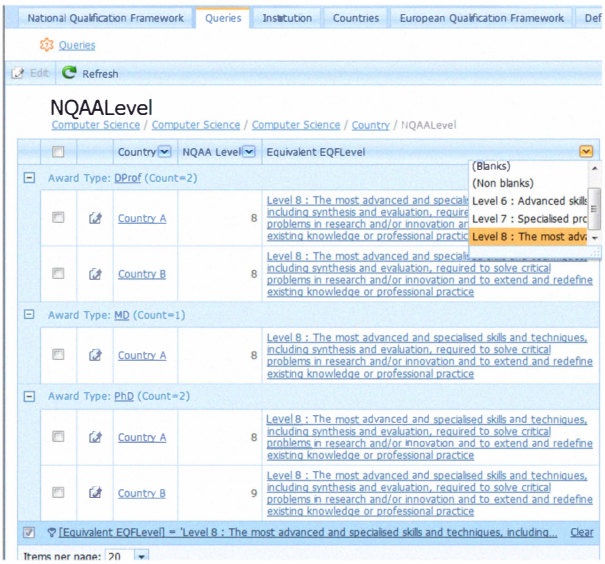

Figure 6. Query on the EQF Level

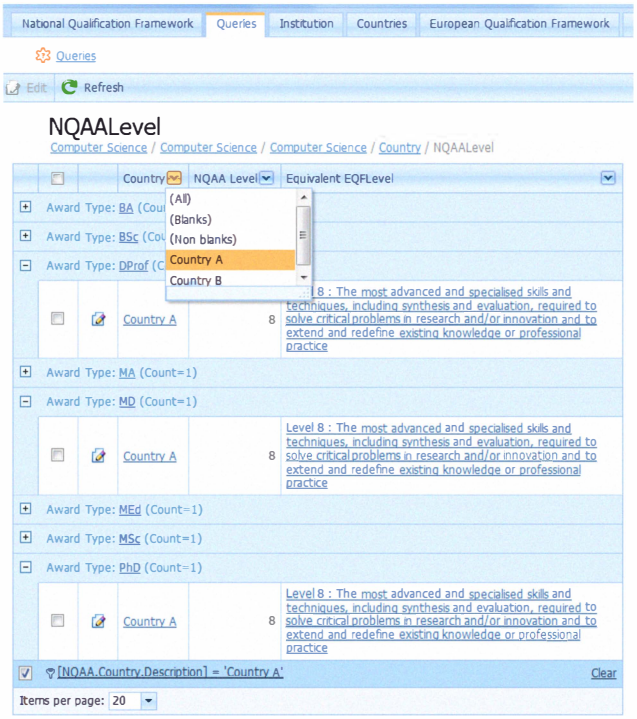

Figure 7. Query on the Country

The first query lists the equivalent NQF levels in all registered countries for a particular EQF. Fig. 6 illustrates the results of this query for EQF level 8. Country A's PhD, MD, and DProf award types satisfy the search criteria along with Country B's PhD and DProf. Note that Country B's PhD award type is assigned an NQF level of 9, which is mapped to EQF level 8. An even more specialized search could be performed, where the results of the first query are further filtered by the country name. Fig. 7 shows the results for Country A only.

IV. DESIGN AND IMPLEMENTATION DETAILS

This section focuses on the environmental development and architecture of the tool. The object model is presented along with the generated relational database that accommodates the system functionality as explained in the previous sections.

A. *Environmental Development*

The MapEQFTool is build using Microsoft's .NET platform with the DXperience tools provided by DevExpress. The .NET 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 DXperience tool is an add-on tool to the .NET framework and it assists the developer in developing business applications. The feature that is utilized in this project is the automatic mapping from the object model to the relational data model to store data in a relational database. The developer manipulates the object model, with all the translation and storage details to be handled by the DXperience.

B. *Architecture*

A 3-tier web application architecture will be used for the tool (see Fig. 2). The information and request/reply flow between the three tiers are as follows: The user enters the web site using an 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 among 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 user, as there will be no need to install any software on his/her personal computers.

1) *Presentation Layer*

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

2) *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 (Active Server Pages) component.

For the front-end web-service, Microsoft's Internet Information Services (IIS) is used. The service concurrently accepts requests from multiple end-users and forwards these to the ASP components. Once the result is returned from the ASP component, the IIS service forwards the resulting web page to the appropriate end user.

The ASP 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. 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.

3) *Data Access Layer*

The data access layer provides access to the back-end database that stores all the data. The database receives its queries from the ASP as SQL queries and returns the resulting data, which is used to generate dynamic web pages that are forwarded to the user. The tool uses Microsoft's SQLServer database for its back-end storage. SQLServer is a relational database management system (RDBMS) supporting T-SQL and ANSI SQL query languages. There also exists an Express edition, which has less functionality, but fully satisfies all the requirements that are needed for the MapQFTool. Connectors are provided to interact with SQLServer programmatically on the .NET platform.

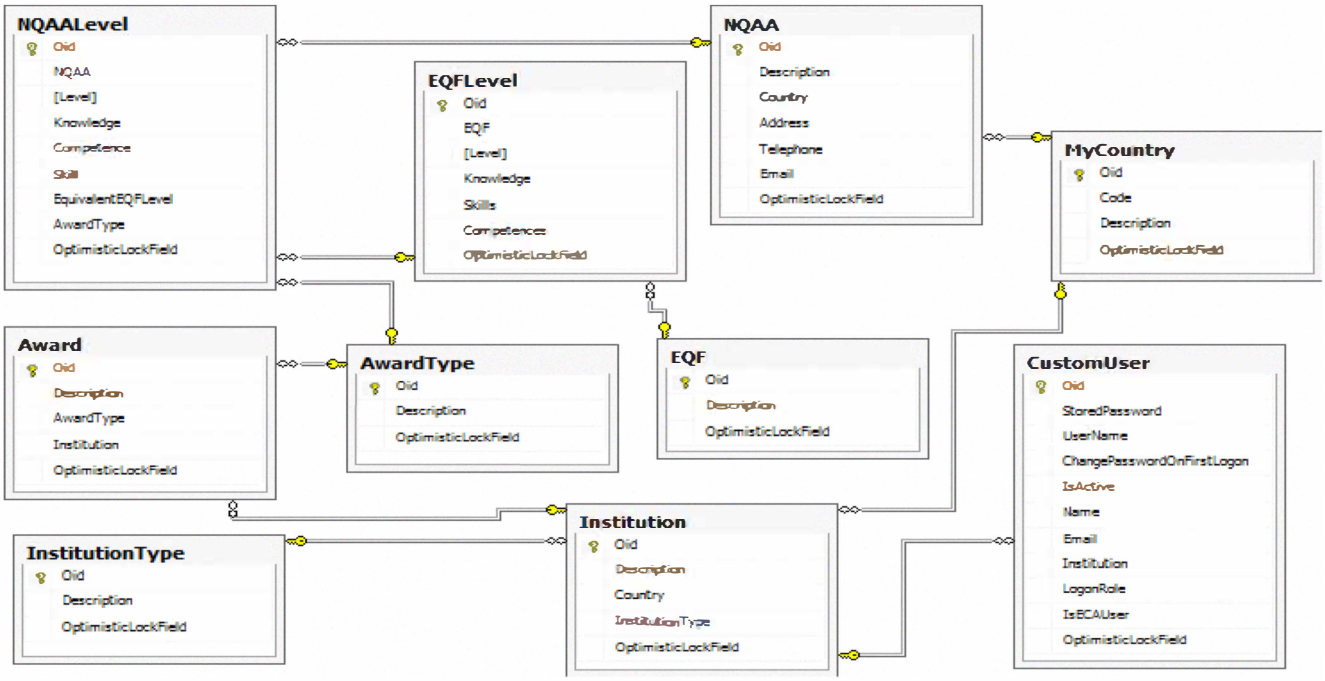

Figure 8. The Generated Database Schema

C. *Object-Model and Derived Database*

Traditionally, the first step to be taken when developing a database application is to design the database schema, followed by developing the application using an object-oriented design. When data is to be retrieved or stored to the database, the data is extracted from the objects and SQL queries are executed to either retrieve or store data to the various tables. The .NET framework has build-in tools to ease the development of database applications by being able to extract from a database its organization and automatically generate the object model. This is helpful and eases the development, but the database must be designed first.

On the other hand, object-oriented design is becoming the popular way of developing applications, where the data is encapsulated by its functionality. In this paradigm, if data needs to be stored in a database, the object model must be converted in a way such that each class becomes a table and each class instance becomes a table row. In addition, the relationships between classes must also be converted to relations between tables.

The DXperience tool supports an object-oriented design perspective when developing software. The DXperience is an extension to the .NET framework that simplifies the task of developing database applications. The designer doesn't need to be concerned with the specifics of designing a database and specifying queries. The design of the application is done by using object-oriented principles. If the instances of a specific class need to be stored (to a database), then the only thing that must be done is to have the class inherit from XPO (Xpress Persistent Objects) class. A schema for the database is generated automatically and the data the user enters in the application is stored automatically to the database.

Fig. 8 illustrates the generated database schema for the MapQFTool that describes the database entities, relationships and relational tables (including primary and foreign keys). In order to verify that an acceptable schema is being generated, a database schema was designed, independently from the tool, and when compared they were actually the same.

V. CONCLUSIONS

This paper has presented the MapQFTool, which provides for 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. To this end, data and predefined queries to exemplify the functionality of the tool were provided. Finally, the design of the database underpinning the tool was presented, along with a discussion on the system architecture, elaborating on the platform chosen for its deployment.

It is envisioned 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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