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THE EU AGENCY SUPPORTING COUNTRIES TO DEVELOP THROUGH LEARNING

NETWORK OF NATIONAL QUALIFICATIONS DATABASES

Open architecture and guidelines for establishing National Qualifications Databases

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Executive Summary

Qualifications databases are integral to implementing qualification frameworks, enabling navigation and comparison of qualifications, facilitating qualifications recognition, and monitoring the evolution of qualifications systems. These databases underpin services like automated guidance systems, digital credentialing systems, and more.

This document aims to guide partner countries in developing robust national qualifications databases. The European Interoperability Framework (EIF) is critical in this endeavour. The EIF aims to boost the effectiveness of digitally-connected public services, facilitate seamless cross-border interactions, promote open standards and specifications, and encourage the reuse of digital resources. It also advocates for user-centric design and inclusive decision-making processes. Creating a qualifications database involves several vital considerations categorised under regulatory, organisational, semantic, and technical dimensions.

Regulatory considerations imply the establishment of a national qualifications database. This essential tool would serve as the official source of qualification data, becoming a cornerstone in fostering a shared foundation of trust. Various laws should oversee the data collection, ensuring it is carried out transparently, efficiently, and securely. In more detail:

- Establish a national qualifications database as the official source of qualification data;
- Create a commonly agreed source of trust;
- Legislation to govern the data collection process for transparency, efficiency, and security;
- Use subsidiary legislation to codify data formats.

Organisational considerations primarily focus on integrating business processes (i.e. structured organisational procedures) with a robust governance structure. Aligning these structured organisational procedures with a solid governance framework is vital. The processes should encompass everything from the initial design of qualifications to establishing a common format, ensuring thorough approval and quality control before publication. In more detail:

- Integrate and align business processes;
- Define processes related to the design of qualifications;
- Process for approval and quality control before publication;
- Set up issue-management and evaluation after publication;
- Propose a governance structure based on the separation of powers (governance, strategic, operational functions).

Semantic considerations seek to preserve the integrity and comprehensibility of data exchanges between different parties. Data and information should be seen and treated as valuable assets in the complex network of national qualifications databases. A well-crafted information management strategy, coupled with agreements on reference data, plays a crucial role in achieving semantic interoperability. In more detail:

- Ensure data preservation and precise understanding of format and meaning;
- Treat data and information as valuable assets;
- Reach agreements on reference data;
- Adopt the European Learning Model (ELM) for semantic interoperability;
- Use ELM directly or map national systems and frameworks to ELM for cost-effective implementation.

Technical considerations involve detailing the essential features and functionalities that a national qualifications database should support. These databases offer an insight into the evolving design conventions associated with their use, serving as valuable references for those seeking to develop or improve a qualifications database. In more detail:

- Basic Functionalities:
    - Collection: Allows qualification designers to submit qualifications.
    - Identification and Versioning: Assigns unique identifiers and manages updates to qualifications.
    - Verification: Ensures listed qualifications meet minimum data quality standards.
    - Storage: Securely stores all qualifications for long-term access.
    - Publication: Makes data available to the public, including human users and machines.
    - Search: Allows users to search for qualifications and filter results.
    - Display: Makes complete and current information accessible to all users.
    - Export: Allows other databases to query the database, promoting regional/international collaboration.
- Technical Requirements:
    - Mandatory Backend Requirement: Uses the European Learning Model Format, implements role management, establishes a data intake model, verifies data quality measures against schemas, provides persistent URIs for unique qualifications, and provides public endpoints to access/export data.
    - Optional Backend Requirements: Recommends storing data as RDF, using triple stores for RDF data, designing a high-availability infrastructure, ensuring high resilience, implementing search with bespoke tools, and providing search/display endpoints.
    - Frontend Requirements: Ensures responsive design, user-friendly interface, compatibility, accessibility, performance, flexibility, maintainability, and internationalisation.

In conclusion, establishing national qualifications databases, guided by the presented guidelines, will enhance semantic interoperability, foster a shared understanding among stakeholders, and significantly contribute to the recognition and mobility of qualifications across the participating partner countries. The commitment to legal, semantic, organisational, and technical aspects will ensure these databases become robust and reliable sources of qualifications data.

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Introduction

Objectives of the document

These guidelines for establishing a qualification database for ETF partner countries target national policymakers, qualifications experts, IT experts, and all stakeholders working in education, qualifications, and digital transformation.

The need for interoperability in the qualifications database arises from the diverse IT systems and data formats used across subsectors and components of the qualifications system. Interoperability allows for the seamless exchange and utilization of data, enabling stakeholders to search, link, and compare qualifications easily. It facilitates the identification and comparison of qualifications, supports learning recognition, and promotes learners' and workers' mobility. Additionally, interoperability enables the integration of qualifications information with other relevant datasets such as learning opportunities, courses, programs, and training providers. Thus, ensuring interoperability is a core element of these guidelines, benefiting all stakeholders.

These guidelines draw on EU best practices and lessons from developing similar databases in other countries and regions. They provide a flexible and adaptable framework tailored to each partner country's specific needs and contexts.

The document begins by outlining the fundamental concepts and principles that form the foundation for developing a qualifications database. Additionally, it highlights the primary takeaways and state-of-the-art approaches observed in each of the countries visited (i.e., Egypt and Tunisia) as examples of good practice.

The guidelines then provide detailed instructions for establishing and managing a comprehensive qualifications database, taking into account the European Interoperability Framework (EIF)[1]. This includes guidance on regulatory, organisational, and semantic considerations. The guidelines also provide technical recommendations for promoting stakeholder engagement and collaboration to ensure the sustainability and scalability of the qualifications database.

By utilising the insights provided in this document, the software requirements can be refined to better align with the needs of partner countries and promote the interoperability of national qualifications databases across borders.

In conclusion, the guidelines presented in this document provide a comprehensive framework for ETF partner countries, including national policy makers, qualifications experts, IT experts, and other stakeholders, to establish their own qualifications database. By following these guidelines, partner countries can ensure that their qualifications database is transparent, reliable, and accessible to all stakeholders. This, in turn, can improve the quality and relevance of education and training systems, support the recognition of learning outcomes, and facilitate the mobility of learners and workers. To fully realise these benefits, it is crucial for national qualifications databases to be aligned and interoperable with the Joint Qualifications Database and ETF's standardised software, enabling cross-border comparison and sharing of data among stakeholders.

The importance of open data

The increasing need for global cooperation and collaboration leads to a growing demand for sharing and accessing information related to national qualifications databases. Adopting open data principles

1 See Annex 1

for the international republication of qualification data can facilitate interoperability, improve transparency, and promote collaboration between organisations and countries.

Open data promotes transparency, collaboration, and innovation across public sector organisations. By making data freely accessible and reusable, it fosters interoperability by allowing different systems and services to exchange information seamlessly. Furthermore, open data enables citizens and businesses to access and utilise valuable public information, driving economic growth, informed decision-making, and the development of innovative solutions to societal challenges.

The organisation should prioritise legal interoperability to promote the republication of qualification data as open data. This should involve identifying potential barriers to data sharing, such as sectoral or geographical restrictions, unclear data licensing models, and outdated security and data protection requirements.

Instructions to use the document.

To effectively use this document, it is recommended to follow the steps:

- Start by familiarising yourself with the main concepts and terminologies used in the document. This will help you better understand the technical aspects of the guidelines and the recommendations presented. (See Chapter 4 and Annex 1).
- Review the background section to gain context on the work done during the fact-finding missions (Egypt, Tunisia) and the main takeaways outlined. This will provide insight into each partner country's specific needs and state. (See Chapter 5.1).
- Study the chapters on regulatory and organisational considerations to understand the best practices for promoting and implementing interoperability among ETF partner countries. There is a checklist for each chapter summarising the main takeaways. These checklists can serve as a reference during the execution of the guidelines. (See Chapters 6.2 and 6.3).
- Based on the considerations in the regulatory and organisational sections, also study the semantic and technical considerations, presenting front-end (FE) and back-end (BE) recommendations. It is essential to consider these recommendations carefully when establishing the national qualifications database. (See Chapters 6.4 and 6.5).
- By following these steps, readers can effectively utilise the guidelines presented in this document to establish their qualifications database, ensuring transparency, reliability, and accessibility to all stakeholders.

Concepts

This section concisely explains the key concepts and terminologies utilised throughout the document. It offers a general understanding of the main ideas and terms discussed. For more comprehensive and detailed information, please refer to Annex 1, where you will find in-depth explanations and additional supporting material related to the concepts and terminologies outlined in this section:

Open architecture

It is an approach for establishing and managing national qualifications databases in an interoperable manner. This includes guidance on fundamental concepts and principles that form the foundation of developing a qualifications database, models, and recommendations.

Interoperability

Refers to the functionality of information systems to exchange data and enable information sharing. Interoperability includes semantic and technical considerations and additional non-technical aspects

such as organisational and regulatory (policy, legal) considerations since multiple stakeholders and organisations are involved.

Interoperability principles

Nine principles are highlighted below to govern the framework for qualification databases. They are aimed at underpinning the functions, infrastructure and standards of any system:

User-Centricity

A diverse ecosystem of stakeholders will be using and benefiting from the system and supporting its implementation. Their needs vary considerably, and they should be considered when defining the framework's use cases. In addition, the needs and requirements of distinct stakeholders should be carefully analysed and integrated when designing and developing the infrastructure that allows for identifying, awarding, storing, sharing, and verifying a certificate. As such, the framework's infrastructure should be easy for all stakeholders. The system should not be designed for experts only. Instead, learners and job seekers should be at the centre of the framework.

Balance of Centralisation vs Decentralisation

Centralised systems are generally easier to manage than decentralised systems as they operate on a single standard. The former also tends to be of lower complexity and, therefore, easier to use and have a lower overall operation cost (due to scale efficiencies). However, once implemented, the sheer size of centralised systems means that systems can be difficult and expensive to iterate and can stifle innovation. As such, the system design should reflect the existing organisational structures within a country – with roles and responsibilities being assigned to existing public authorities wherever possible.

The decision between a distributed or centralised approach (see Chapter 6.3.3) for collecting and managing information in qualifications databases should consider the existing organisational structures within a country, as this alignment will ensure efficient management and lower complexity while still allowing for innovation and iterative improvements.

Inclusion and accessibility

The framework should consider the diversity of users using the qualifications database. Multilingualism is an essential feature as it enables the comparison of qualifications from different countries. As such, the infrastructure should assume that all qualifications will be available in local and common languages (such as English, French, or Arabic). The framework's infrastructure should be accessible to all individuals (including people with disabilities, older adults, and other disadvantaged groups) regardless of their level of digital skills.

Openness

Considering that this framework aims to encourage better use of qualifications data, it should be built on open standards and foster the use of open-source software technologies. Furthermore, the qualifications data itself should be considered public data, which is freely re-usable by any party. Such open approaches tend to reduce costs, promote collaboration between different parties, ensure interoperability, and reduce the risk of lock-ins with dominant solution providers, allowing thus for flexibility and freedom.

Data protection by design and by default

Following data protection best practices, the database should ensure the implementation of technical and organisational measures, such as pseudonymisation and data minimisation, to collect and process only the strictly necessary personal data for each specific purpose (notably, the amount of

personal data collected, the extent of their processing, the period of their storage and their accessibility).

Transparency

The framework's infrastructure should present each end-user and stakeholder with the correct information at the right time to allow them to use qualification data for their intended purpose. Transparency applies to the publication process and, if included within the scope of the system, to the approval of qualifications. It implies traceability of how each function is implemented each time it is used, availability of the underlying metadata within a digital qualification and of summative data on the whole system to stakeholders.

Resilience

The system should continue functioning and reliably offering its services even in adverse conditions. As such, the framework and its infrastructure should be resistant to fraud (i.e., from malicious use of the system for unintended purposes) and ensure data integrity (i.e., protection of data from unauthorised changes due to hacking) and data availability (i.e., ensuring that data are always accessible and are not destroyed by natural disasters, mistakes in technical implementations or hacks).

Reusability

Existing solutions, specifications, standards, and tools developed by others that are proven sound, functional, and relevant elsewhere should be considered and reused to the extent possible. Furthermore, new solutions, specifications, standards, and tools should be further reusable by others in the public interest.

A practical example of reusability can be found in the Semantic Interoperability Centre Europe (SEMIC) operations. SEMIC is known for developing and disseminating reusable data models, such as Core Vocabularies. The Core Vocabularies developed by SEMIC are simplified, reusable, and extensible data models agreed upon at the European level. They can be used by different systems and applications across the EU, reducing the need to create and manage similar data in each country or region. By promoting a shared understanding and use of data, SEMIC's actions enable better interoperability among EU countries and contribute to more efficient use and reuse of digital resources globally.

Qualifications as a Public Good

Qualifications databases facilitate numerous use cases, such as helping people better navigate their learning pathways, recognising qualifications for employment purposes, or comparing qualifications to inform curricular design. In each case, the qualifications database supports essential public policy elements in education and employment. As such, there is a strong argument for public support and the provision of this service to support these policies.

Interoperability model

The interoperability model, which serves as a conceptual framework to describe the architecture required for a national qualifications database, aligns with the European Interoperability Framework (EIF)[2]. By adhering to the EIF, the model ensures a common framework for promoting interoperability between public services, addressing the layers of interoperability that impact the delivery of digital public services:

2 See Annex 1.

- **Legal considerations**: Ensuring that legislation does not impose unjustified barriers to data reuse in different policy areas. This will facilitate interoperability between public services at semantic and technical levels.
- **Organisational considerations:** Formal agreements on the conditions applicable to cross-organisational interactions; documenting and integrating or aligning business processes and relevant information exchanged.
- **Data/semantic concerns (semantic interoperability) considerations:** The semantic aspect refers to the meaning of data elements and the relationship between them. It includes developing common vocabularies and schemata[3] to describe exchanged data and ensures that all parties understand data elements in the same way.
- **Technical considerations**: Setting up the necessary information systems environment to allow an uninterrupted connection between systems using formal technical specifications whenever possible.

In the following sections (See chapter 6), the document delves deeper into these considerations by exploring the various interoperability layers. It also discusses the different frameworks and initiatives developed to promote interoperability, including the European Learning Model (ELM)[4] and the European Skills, Competences, and Occupations (ESCO)[5].

3 For example, ESCO and ELM. See chapter 6.

4 European Learning Model for Stakeholders | Europass

5 Homepage (europa.eu)

Background

The Network of Qualifications databases

The Digitalisation of Qualification Systems is a priority for the coming years. Partner countries are moving from lists of occupations, occupational standards, qualifications, and educational programmes to online digital registers of interoperable qualifications.

Digital databases can help better monitor the progress of qualifications reforms in partner countries. In particular, they can help to monitor how qualifications frameworks are populated with new qualifications; to what extent transversal skills such as entrepreneurship, green skills and digital skills are integrated; how emerging needs are translated into new provisions, and where new occupations and skills emerge.

The sharing of databases also allows for comparing qualifications and part qualifications or micro-credentials. By comparing different databases, countries can make better decisions on which new qualifications to develop and on integrating aspects of qualifications from other databases on their own. This can reduce the costs and time needed to renew qualifications. These new qualifications are often a starting point for new provisions and a precondition for more flexible pathways (including more individualised learning in companies and online). Increasing the number of new qualifications across countries will have a knock-on effect on the modernisation of learning and assessment processes.

The European Commission has already developed EUROPASS[6] for the member states that can be used by individuals, companies, training providers, employment services, guidance counsellors, and credential evaluators that contain information on qualifications, lifelong learning, and job opportunities. Individuals can hold e-portfolios and share digitally signed certificates with training providers and employers.

The Commission has developed a Qualification Dataset Register (QDR) to link the databases of member states and standardise the data so that they are interoperable. For the EU member states and the seven pre-accession countries, the EQF Recommendation provides a relevant context regarding the minimal data fields to make national qualifications databases interoperable.

Qualifications are often a proxy for funding learning, and this will become even more important when learning is further individualised. The Skills Pact launched by the Commission to address the Post Covid Crisis is providing an enormous boost in funding for adult learning that will generate a need for more appropriate skill sets smaller than formal qualifications in the form of micro-credentials that will need to be integrated with the NQF databases and be stackable (i.e., combinable). Due to demographic developments and the constant need to keep up to date, and the increased individualization of learning, growth in small micro-credentials is expected in the coming years. Having quality-assured and combinable micro-credentials is, therefore, a critical development that can only be supported with proper IT infrastructure.

The EU has also developed ESCO as a common language to define skills and occupations that are continuously updated. ESCO can be used to analyse qualifications and skills and perform Big Data analysis of labour market data such as online vacancies. The COVID remote working and learning habits have changed education and training profoundly, with more fluid cross-border cross-fertilization. Online provision is growing rapidly, while the increase of workplace learning (with every company providing different contexts) provides a less standardised training offer. The challenge is to measure lifelong learning, using qualifications and micro-credentials to demonstrate that people are competent.

6 Europass is a European initiative that aims to help individuals communicate their skills, qualifications, and experiences in a standardised and easily understandable format. It provides a portfolio of documents that allow individuals to present their educational background, work experience, language proficiency, and other relevant information to employers, educational institutions, or other organisations (https://europa.eu/europass/fr)

The ETF can utilise a diverse range of tools to guide partner countries in developing their qualification databases and effectively monitoring their qualification systems. This includes employing traditional methods such as briefings, documents, and training sessions and exemplifying the possibilities. The approach should begin by assessing the current status of the countries' databases, engaging with their existing databases, and facilitating the transition towards new interoperable systems.

Countries are at different stages of qualification database development. Though most ETF partner countries have national qualifications databases or registers, they vary significantly in the scope and information on qualifications provided. There are significant variations across countries in using elements for data fields and using learning outcomes to describe qualifications in the databases. There are databases that do not include learning outcomes descriptions of qualifications at all or include them depending on the type of qualifications, or they are not reflected in the database as a data field but are included separately through the qualification documents. This diversity presents a significant limitation to the comparison and transparency of qualifications across countries.

National situation

Country visits were conducted to assess the state of the qualifications field and identify challenges and opportunities for improvement. During these visits, the ETF met with key stakeholders to gather information and assess the current state of qualifications data collection and management. The observations revealed significant challenges in collecting and centralising qualifications data and a need for user-friendly services to search, display, and compare qualifications. The assessment also identified a growing recognition of the importance of linking qualifications to national skills classifications. Based on these observations and conclusions, the team have developed recommendations and an approach for building an open architecture and guidelines document for qualifications management (realised using the present document).

The aim is to guide and support countries in developing comprehensive qualifications databases that can benefit individuals, employers, and economies.

In Tunisia, for example, the collection of qualifications data is fragmented among different stakeholders and data sources, and there is currently no user-friendly service available to search, display, and/or compare qualifications. This lack of centralisation challenges individuals who want to know about their earned qualifications, as diplomas do not usually include learning outcomes. Therefore, Employment agencies must offer interpretation services to help citizens understand the skills they have acquired.

Additionally, no single entity is responsible for collecting all qualification data, making it difficult to establish a comprehensive database for the country.

However, there is a growing recognition of the importance of linking qualifications to a national skills classification. Key stakeholders welcome the idea of a Joint Qualifications Database, although local stakeholders have expressed concerns about adopting a European approach without sufficient adjustment for national realities. Furthermore, European funding directed towards developing qualifications and quality assurance in Tunisia is often fragmented among specific sectors and agencies, making it challenging to develop a national database under current arrangements.

During the visit to Egypt, stakeholders expressed interest in developing a National Qualifications Framework (NQF) database. There was agreement on the principle of transparency, including access, readability, and linkability. However, there was also partial scepticism, with concerns raised about the role of the NQF. Other broader issues, such as TVET reform, migration, mobility, VNFIL, and linking qualifications with Labour Market Information (LMI), were also discussed. The role of the African Continental Qualifications Framework (ACQF) and the European Qualifications Framework (EQF) were also considered, with overlapping responsibilities and the need for guiding rules.

Based on these visits, along with virtual visits conducted in Moldova and Ukraine, a set of common findings has been determined:

None of the countries has an operational national qualifications database covering all levels of its qualifications framework with full coverage.

No country has a central point which collects all qualifications within its qualification framework.

In each country, a good portion of qualifications data is unavailable as structured data.

While some countries tag qualifications with learning outcomes, using a standardised taxonomy such as ESCO to map skills against international standards is not common.

None of the countries offer public standardised APIs to access their qualifications data.

Existing datasets and databases in countries are not interoperable either internally or trans-nationally.

Therefore, the main conclusion of the fieldwork in the countries mentioned above is that each country needs to build or extend an entire national qualifications database. This Open Architecture and guidelines document outlines a plan to achieve that goal.

Building an Interoperable Qualifications Database: Key Considerations

Summary checklist and diagram

Summary checklist

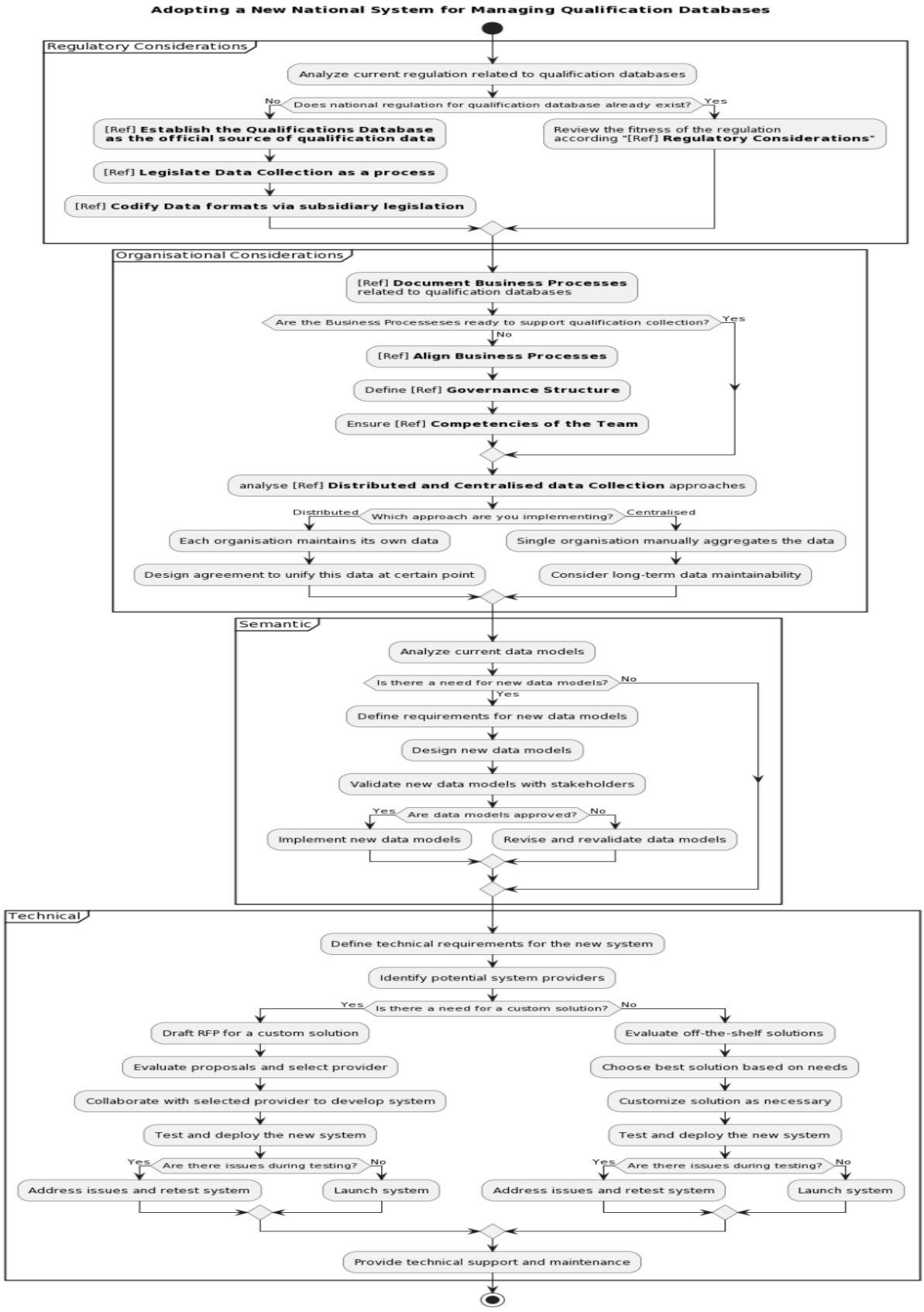
The summary checklist provides a concise overview of the key takeaways from the chapters described below. It serves as a convenient reference point to quickly grasp the essential points covered in the following sections.

	Main recommendation	Guidelines on implementation
Regulatory	Officially establish the Qualifications Database	• Indicate the official source of data for all qualifications data as a qualifications database via legislation; • Establish authority for maintaining the database via legislation or regulation. • Consider qualifications data as public data. Establish via legislation which categories of qualification data should be open to everyone.
	Legislate Data Collection as a process	• Implement laws and policies to regulate the collection, storage, and sharing of data in national qualifications databases; • Create a clear framework that outlines roles, responsibilities, and standards for managing data in these databases.
	Codify Data formats via subsidiary legislation	• Standardize data formats to improve efficiency, effectiveness, and service delivery while enhancing data quality; • Use subsidiary legislation to ensure consistent and compatible data exchange through codified data formats.
Organisational	Document Business Processes	• Create clear and comprehensive documentation of business processes (i.e., structured organisational procedures) within the qualifications database; • Record activities, workflows, and procedures related to managing qualifications, learning outcomes, and metadata; • Serve as a reference point for stakeholders to identify inefficiencies, redundancies, and areas for improvement in qualifications database operations.
	Aligning Business Processes	• Establish clear objectives and outcomes for collaboration in line with each organization's overall goals; • Identify integration points and gaps to align or integrate processes; • Develop and implement adjusted processes to bridge gaps, ensuring stakeholder understanding and agreement on changes made.
	Distributed and Centralised data Collection	• Consider the option of a distributed or centralized approach for collecting and managing information in qualifications databases; • Understand that the chosen model affects interoperability, efficiency, and effectiveness; • Evaluate the trade-offs between autonomy and control in a distributed model versus streamlined implementation and maintenance in a centralized model.
	Involve competent teams	• Develop data management skills for effective training system handling;

		• Improve communication abilities to facilitate collaboration across organizations; • Gain proficiency in business process modelling and technical expertise for efficient training system operations.
	Enhance commitment to quality	• Ensure accuracy and up-to-dateness of the qualifications database; • Promote accessibility and interoperability for seamless data exchange; • Support scalability and alignment with organizational goals, enabling efficient sharing and comparison of qualification data.
Semantic	Treat Data and Information as Valuable Assets	• Implement an information management strategy to handle valuable assets effectively; • Establish agreements on reference data for semantic interoperability; • Utilize data-driven design and linked data technologies to enhance semantic interoperability and foster stakeholder collaboration.
	Use the European Learning Model (ELM)	• Develop a common data model by reaching agreements on reference data for semantic interoperability; • Implement an information management strategy to ensure data is appropriately generated, collected, managed, shared, protected, and preserved; • Consider adopting the European Learning Model (ELM) as an interoperability solution to improve education and qualifications systems and reduce barriers to mobility.
	Consider interconnectedness with ESCO, Credit Systems, Qualification Frameworks	• Use ESCO as a reference to align learning outcomes and qualifications in the ELM, improving transparency and comparability; • Leverage European frameworks to enhance transparency, comparability, recognition, and mobility of qualifications and learning outcomes; • Link qualifications to skills and occupations, utilize credit systems and qualification frameworks to support lifelong learning and career advancement.
Technical	Data management	• Support different user groups by addressing their specific use cases within the qualifications database; • Establish a streamlined Data Intake Model and verify data quality against schemas; • Enable easy access and export of data through Persistent URIs and a public endpoint.
	Technical requirements	• Implement qualifications data base basic functionalities; • Consider Backend requirements; • Consider Frontend requirements.

Summary diagram

The summary diagram provides another overview of the key takeaways from the chapters described below. In this form, it is possible to review the logical sequence of actions leading towards establishing the National Qualification Database.


Adopting a New National System for Managing Qualification Databases
Regulatory Considerations
Analyze current regulation related to qualification databases
Does national regulation for qualification database already exist?
No
Yes
[Ref] Establish the Qualifications Database as the official source of qualification data
Review the fitness of the regulation according "[Ref] Regulatory Considerations"
[Ref] Legislate Data Collection as a process
[Ref] Codify Data formats via subsidiary legislation
Organisational Considerations
[Ref] Document Business Processes related to qualification databases
Are the Business Processeses ready to support qualification collection?
Yes
No
[Ref] Align Business Processes
Define [Ref] Governance Structure
Ensure [Ref] Competencies of the Team
analyse [Ref] Distributed and Centralised data Collection approaches
Which approach are you implementing?
Distributed
Centralised
Each organisation maintains its own data
Single organisation manually aggregates the data
Design agreement to unify this data at certain point
Consider long-term data maintainability
Semantic
Analyze current data models
Is there a need for new data models?
No
Yes
Define requirements for new data models
Design new data models
Validate new data models with stakeholders
Are data models approved?
Yes
No
Implement new data models
Revise and revalidate data models
Technical
Define technical requirements for the new system
Identify potential system providers
Is there a need for a custom solution?
Yes
No
Draft RFP for a custom solution
Evaluate proposals and select provider
Collaborate with selected provider to develop system
Test and deploy the new system
Are there issues during testing?
Yes
No
Address issues and retest system
Launch system
Evaluate off-the-shelf solutions
Choose best solution based on needs
Customize solution as necessary
Test and deploy the new system
Are there issues during testing?
Yes
No
Address issues and retest system
Launch system
Provide technical support and maintenance

Regulatory Considerations

Organisations that contribute to providing services, such as a national qualifications database, function within their own legal framework. The concept of legal interoperability is to ensure that organisations operating under different legal frameworks, policies, and strategies can collaborate effectively. To achieve this, it is necessary to ensure that legislation does not impede the establishment of services like national qualifications databases within and between organisations and to have clear agreements on managing differences in legislation across borders, which may involve creating new legislation.

"Interoperability checks" can screen existing legislation to identify potential barriers, such as sectoral or geographical restrictions on data use and storage, unclear data licensing models, over-restrictive requirements for specific digital technologies or modes of delivery, conflicting demands for similar business processes, outdated security and data protection needs, among others.

ICT should be considered as early as possible in the law-making process. The proposed legislation should undergo a "digital check" to ensure its compatibility with the digital world, identify any barriers to digital exchange, and assess its ICT impact on stakeholders.

Below are described the essential aspects that ensure legal interoperability for organisations, including those managing national qualifications databases:

Establish the Qualifications Database as the official source of qualification data

This can help to promote transparency and consistency in the assessment and recognition of qualifications and reduce the risk of fraudulent or misleading information.

Establishing a qualifications database should be mandated by law or regulation, with the law indicating a centralised database to serve as the authoritative source of information on qualifications. By establishing the Qualifications database as the official source of qualification data, other organisations can have confidence in the accuracy and reliability of the information they use to make decisions about hiring, training, or regulatory compliance. This can help to promote trust and confidence in the qualifications system and support the development of a skilled and competent workforce.

Establish Open Licences for the Use of Qualifications Data

Qualifications databases are premised upon the principle that data on which qualifications are available within a specific country and detailed metadata on the learning methodologies required to obtain the qualification and its learning outcome should be available to everyone free of charge. Many of the best uses of qualifications databases arise when the government allows browsing of data via its portal and when third parties integrate that data into new services.

Thus, services such as the recommendation of courses based on a person’s life history, comparison of qualifications to establish new qualifications and recognition of qualifications for purposes of employment all can be better served by releasing data to the public.

It is, therefore, necessary to establish via legislation which categories of qualification data should be open to everyone and available to resume freely without limitation (such as data on the content of qualifications) and which data is reserved for public authorities (such as internal data on approval workflows, or the specific detailed curriculum.

Legislate Data Collection as a process

Organisations managing national qualifications databases must implement a process of creating and enforcing laws, policies, and procedures related to the collection, storage, processing, and sharing of data. This means that the organisation would put in place a framework that regulates how data is collected and managed.

Data collection legislation involves defining specific roles and responsibilities for managing data, including who is responsible for collecting data, how it will be processed, and who has access to it.

The process also includes defining data quality standards and data protection measures to ensure that personal data is not misused or mishandled.

Such legislation ensures that data management practices are transparent, efficient, and secure. It can also help promote data sharing and interoperability between different organisations, leading to more efficient and effective delivery of qualifications-related services.

Codify Data formats via subsidiary legislation

This approach refers to creating laws, policies, or regulations that establish specific data formats/models. Organisations use data formats to collect, store, process, and share data.

The purpose of codifying data formats via subsidiary legislation is to ensure consistency and interoperability in data exchange between different organisations. Standardising data formats makes it easier for organisations to exchange data and integrate their systems with others. This can result in more efficient and effective delivery of services, reduced duplication of efforts, and improved data quality.

Subsidiary legislation typically provides more detailed regulations that complement existing primary legislation. In the case of codifying data formats, this could involve creating regulations that specify the format, structure, and content of data that must be used for specific types of transactions or interactions between organisations. Qualification databases focus primarily on open, non-personal information, such as educational qualifications and professional certifications.

Summary Checklist: Key takeaways from the chapter

To achieve legal interoperability, organisations must conduct interoperability checks, evaluate legislation for interoperability, and undergo a digital check to ensure compatibility with the digital world. Additionally, legislating data collection as a process, codifying data formats via subsidiary legislation, and establishing the Qualifications Database as the official source of qualification data can help to promote data interoperability, improve data quality, and ensure compliance with relevant laws and regulations. By prioritising interoperability, data quality, privacy and security, organisations can create more efficient, effective, and user-friendly public services that benefit all stakeholders.

- Perform "interoperability checks" to identify any regulatory barriers to cooperation.
- Assess regulations regularly once they are put into application.
- Consider ICT as early as possible in the regulatory-making process. Conduct a "digital check" on proposed regulations to ensure they suit both physical and digital environments, identify barriers to digital exchange, and assess their ICT impact on stakeholders.
- Ensure that regulations do not block the establishment of shared public services within and between jurisdictions.
- Implement a framework to regulate how data is collected and managed, including defining specific roles and responsibilities for managing data, data quality standards, and data protection measures.
- Prioritise interoperability by adopting open standards for data exchange, using common data models, and establishing data governance frameworks that define roles and responsibilities for managing data and policies for data sharing, access, and use.
- Establish a centralised qualifications database that serves as the authoritative source of information on qualifications to promote transparency and reduce the risk of fraudulent or misleading information.
- Mandate the establishment of a qualifications database by law or regulation, particularly in industries or professions with strict requirements for qualifications.
- Understand each participating organisation's legal framework.
- Aim to adopt open data principles for international republication of qualification data.
- Prioritise legal interoperability for open data sharing.
- Implement a legal data collection, storage, processing, and sharing framework.
- Establish data quality standards and data protection measures.

- Codify data formats via subsidiary legislation for consistency and interoperability.

Organisational Considerations

Organisations need to integrate or align their workflows and practices to work together effectively within a qualifications database. This means documenting the processes so that everyone agrees on using commonly accepted techniques to ensure everyone understands their role.

Mutual assistance, joint action, and interconnected business processes must be formalised to ensure transparent relationships between providers and users. This can be done through instruments like MoUs and SLAs[7], and for cross-border actions, multilateral or global agreements are preferred.

Specifically, aspects of such collaboration are described below.

Document Business Processes

Business processes are structured organisational procedures: a set of related, structured tasks or activities conducted to produce a specific end-state. Each process involves specific steps, roles, inputs, and outputs that work together. These can include anything from Qualification submission to the database, and its validation, to user access management or publication to the public.

Documenting business processes for a qualifications database involves creating a clear, concise, and comprehensive record of the activities, workflows, and procedures that make up the organisation's operations related to managing qualifications, learning outcomes, and associated metadata. Proper documentation serves as a reference point for all stakeholders, helping to identify inefficiencies, redundancies, and opportunities for improvement. Furthermore, it fosters communication and collaboration between organisations by providing a shared understanding of the processes involved in maintaining the National Qualifications Database.

Several widely accepted modelling techniques can be employed to document and align business processes for enhanced collaboration:

- **Business Process Model and Notation (BPMN)**: A graphical notation standard for representing business processes in a workflow format, BPMN provides a common visual language for all stakeholders, making it easy to understand and communicate complex processes.
- **Unified Modelling Language (UML**): A general-purpose, developmental modelling language used in software engineering; UML can also be applied to model business processes. It offers various diagrams, such as activity diagrams and use case diagrams, to represent different aspects of a process.
- **Flowcharts**: Flowcharts are a simple, visual way to represent a process or workflow, using various symbols to depict different steps and decision points. They are beneficial for illustrating high-level overviews of processes and identifying potential bottlenecks.

While organisational processes are different for each implementation of a qualifications database and are heavily influenced by national conditions, several core processes need to exist in the case of any database.

Qualifications Design

This describes the processes through which qualifications are authored and/or reviewed. This process is usually taken care of by teams of subject matter experts, who are responsible for determining the needs of the community or market, translating these needs into units of attainable learning, and

7 MoUs: a document that outlines the terms and details of an agreement between two or more parties

SLAs: Service Level Agreements," which are contracts or agreements that define the expected level of service between a service provider and a customer, including metrics, responsibilities, and guarantees.

defining the learning outcomes of the qualification in terms of knowledge and skills. This process will typically lean on skills intelligence, industry reports, qualifications standards, skill taxonomies, qualification design guidelines and other similar documents. The output of the process is typically a documented qualification.

Standardisation and Documentation

While qualifications can be documented in many formats depending on users' needs, a qualifications database needs to be documented in a standardised digital format. Such a process typically includes filling in information about the qualifications using standardised templates and tagging them with metadata such as qualification framework or ISCED levels, standardised skills, languages of instruction, etc. The output of the process is typically a completed qualifications template.

Approval of Qualifications

Most countries will have one or more procedures that confer an ‘official’ or ‘approved’ status on a qualification. Depending on the situation, this might be done by the following:

Publication of the qualification by an approved authoring organisation,

Approval of the qualification by a quality assurance or licensing authority, or

Publication of the qualification in the official journal of the government

In each case, the output of the process is legal permission for the qualification to be offered to students by education and training organisations.

Quality Control

To maintain a database, quality control is essential. This involves using a mixture of human and automated checks to ensure that qualifications sent to a database for publication meet all the criteria for publication. These will include:

Format & completeness checks, such as ensuring that all fields are appropriately filled in,

Content checks, such as ensuring that descriptions are complete, grammatically correct and easily legible,

Similarity checks to check whether qualifications are new, updates to existing qualifications, or replacements of existing qualifications,

Official checks include ensuring that all approvals have been gained before publication.

Publication

The publication process involves the management of the tools required to collect the outputs from all the steps described above digitally, assign identifiers to the outputs, record those outputs in a single database, and make the qualifications available to the general public via that database. The output of the process is the (filled) qualifications database itself.

Issue-Management

There are multiple scenarios under which data in a qualifications database may prove to be incorrect. Reasons could include a human error in any of the processes described above, a change in circumstances (such as the closing of an institution offering a qualification), updating of reference classifications and much more. Therefore, a well-run database will have a process whereby any interested party may report a suggestion, complaint or concern regarding the database. These issues should then be analysed individually or collectively and, where necessary, investigated, leading to recommendations for changes to the data or processes that are then implemented. The output of the process is the decisions on how to handle each issue.

Technical Maintenance

Several processes are necessary to ensure the database functions correctly from a technical standpoint. These include server maintenance, installation of security updates, cycling of logs, management of access credentials, backup processes and other technical tasks. The output of these processes is typically a more stable and resilient database system.

Evaluation and Management Review

To ensure that the databases meet the needs they were designed for and that they represent appropriate value for money for the taxpayer, the entire system should be reviewed cyclically on 1-3 year cycles. The objectives of such a review include identifying non-performing processes, analysing the state of the database's content, analysing the impact on its target users and broader society, and evaluating the governance of the database. The output of such processes typically is a set of recommendations for improvement to be implemented before the following cyclical review.

Governance Structure

Establishing a robust governance structure is critical for successfully implementing organisational interoperability. A well-defined governance framework should provide clear guidance on decision-making processes, roles and responsibilities, and the delegation of authority.

This structure will ensure that all participating organisations are accountable and transparent in their actions, leading to improved collaboration and more effective service delivery.

Typically, a governance structure for a qualifications database will include three levels:

A governance level will be responsible for setting up national policies on the qualifications database, mandating the inclusion of qualifications in the database, and taking financial and operational decisions.

A strategic level will decide which qualifications are to be included within the database, as well as decisions on updating and removing qualifications from the database. Where qualifications are managed by different entities (e.g., having different approval flows for higher education and vocational qualifications), several such entities may make decisions within their specific areas of competence.

An operational level will take day-to-day decisions regarding quality control, minor updates, technical maintenance, etc.

Align Business Processes

Once documented using accepted modelling techniques, organisations must agree on how to align their processes for delivering services. This involves identifying overlap, redundancies, and synergies among the participating organisations. Aligning business processes may require adjusting or creating new processes to ensure seamless collaboration.

Key steps in aligning business processes include:

i. Analyse existing processes: As mentioned in the previous section.
ii. Define objectives and desired outcomes: Establish clear goals and objectives for the collaboration, ensuring they align with the overall goals of each organisation. Example objectives:
    a. For Quality Control, the desired outcome could be to increase the accuracy and completeness of qualifications before they are published to the public.
    b. In the Publication process, an objective could be to streamline the process of assigning identifiers to qualifications by all involved organisations.
    c. For Evaluation and Management Review, the goal might be to identify non-performing processes and devise actionable recommendations for improvements consistently.

iii. Identify integration points and gaps: Determine where processes can be integrated or aligned and identify any gaps hindering effective collaboration. Example integration points and gaps:
    a. In the Technical Maintenance process, an integration point could be synchronising server maintenance schedules with other processes, while a gap might be the lack of proper backup processes.
    b. In the Issue-Management process, a gap might be the absence of a straightforward procedure for handling errors or model changes in the database. An integration point could be linking this process with all national stakeholders to inform them of the changes.
    c. For Governance Structure, potential gaps might exist in clarity around roles and responsibilities, and an integration point could be aligning the decision-making process across different levels (VET/Higher education etc.).

iv. Develop and implement new or adjusted processes: Design or modify existing ones to bridge identified gaps and enhance collaboration. Ensure all stakeholders understand and agree on the changes. Example of new or adjusted processes:
    a. In Qualifications Design, a new process could introduce a validation step involving input from the market for which the qualification is desirable.
    b. Adjusting the Standardisation and Documentation process could include creating a universal template for all learning outcomes to ensure consistency.
    c. For Approval of Qualifications, a new process could be implementing a comprehensive checklist for quality assurance or recognition authorities to follow before approval.

v. Monitor and refine: Continuously monitor the performance of the aligned processes, adjusting as needed to maintain efficient and effective collaboration. Monitoring example:
    a. Regular monitoring of the Quality Control process could help identify common errors or issues, and these insights could be used to refine the process.
    b. Continuous monitoring of the database system's stability and resilience for Technical Maintenance can help identify areas for refinement, such as server maintenance or security updates.
    c. In Evaluation and Management Review, regular review of international standards (e.g. ELM) and their implementation could be carried out to ensure the process's effectiveness and make necessary refinements.

Organisations can enhance their collaboration efforts by documenting and aligning business processes using accepted modelling techniques, leading to more efficient and effective service delivery to users.

Distributed and centralised data Collection

Organisations involved in developing and managing qualifications databases must decide on the most appropriate method for collecting and managing information, whether through a distributed or centralised approach. The choice between these two models will significantly impact the qualifications database system's interoperability, efficiency, and effectiveness.

In a distributed collection model, each organisation maintains its own data on qualifications, learning outcomes, and associated metadata and shares relevant information with the central national database as needed. This approach offers increased autonomy and control over data, potentially enhancing data security. However, ensuring consistency and interoperability between different databases may require more effort.

Conversely, a centralised collection model for qualifications databases involves a single organisation manually pooling all data into a single, shared repository. This approach can facilitate a more streamlined rollout - only a single organisation has to implement the qualifications database. However,

it may present challenges regarding long-term data maintainability, actuality, and the resources required to maintain a centralised system.

Competencies of the Team

The success of organisational interoperability in the context of the qualifications database relies heavily on the teams' competencies. It is vital to assemble a team with diverse skill sets to ensure effective collaboration, seamless data exchange, and efficient management of the qualifications database system.

Critical competencies for a team working on qualifications database interoperability include:

- Understanding of education and training systems: Familiarity with the national education and training landscape, as well as the specific organisation, is vital for ensuring the relevance and accuracy of the qualifications database.
- Data management: Knowledge of data collection, storage, and analysis techniques is essential for managing the qualifications database and ensuring data consistency and integrity.
- Inter-organisational communication: Strong communication skills are necessary for fostering collaboration and maintaining clear lines of communication among stakeholders from different organisations and countries.
- Business process modelling: Team members should have expertise in documenting and aligning business processes using accepted modelling techniques, which is crucial for seamless collaboration between organisations.

Quality objectives

A commitment to quality must underpin organisational interoperability initiatives in the context of the qualifications database. This involves setting clear quality objectives that define the desired outcomes and performance standards for the collaboration. Quality objectives should be measurable, achievable, and aligned with the organisations' overall goals in developing and managing the qualifications database system.

Examples of quality objectives for qualifications database interoperability include:

- Accuracy to the common data model: Ensure the qualifications database adheres to a common data model, promoting consistency and comprehensive data exchange between regions and countries.
- Up-to-dateness: Regularly update and maintain the qualifications database to reflect the most current information on qualifications, learning outcomes, and associated metadata.
- Accessibility: Make the qualifications database accessible to all relevant stakeholders, including educational institutions, employers, learners, and workers.
- Interoperability: Facilitate seamless data exchange and collaboration between participating organisations and countries, enabling efficient sharing and comparison of qualification information.
- Scalability: Ensure the qualifications database system can accommodate future growth, new participants, or changing requirements without compromising performance or quality.

Organisations can enhance the interoperability and overall quality of qualifications databases by focusing on these quality objectives. This, in turn, contributes to improving education and training systems, supports the recognition of learning outcomes, and facilitates the mobility of learners and workers.

Summary Checklist: Key takeaways from the chapter

To achieve organisational interoperability and align business processes effectively, organisations must address several key factors, including establishing a robust governance structure, selecting an

appropriate collection method, assembling a competent team, and setting clear quality aims. By addressing these factors, organisations can enhance their collaboration efforts and deliver more efficient and effective services to their users.

- Identify common goals for your organisation.
- Ensure that your business processes are aligned with those of other organisations.
- Ensure that services are user-focused.
- Formalise mutual assistance, joint action, and interconnected business processes through MoUs, SLAs, or global agreements.
- Document business processes using accepted techniques, such as BPMN, UML, and flowcharts, for a shared understanding of qualifications database management.
- Define clear collaboration objectives and desired outcomes, ensuring alignment with overall organisational goals.
- Identify integration points and gaps to enhance collaboration and address hindrances.
- Continuously monitor and refine aligned processes to maintain efficient and effective collaboration.
- Establish a robust governance structure with transparent decision-making processes, roles, and responsibilities.
- Choose between a distributed or centralised data collection model, considering factors like data security, ease of access, and resource requirements.
- Assemble a diverse team with education, data management, communication, and business process modelling expertise.
- Ensure adherence to a common data model for consistency and seamless data exchange.
- Regularly update and maintain the qualifications database for accuracy and relevance.
- Make the database accessible to all relevant stakeholders.
- Continuously monitor progress towards quality objectives, identifying areas for improvement and making necessary adjustments.

Semantic Considerations

Semantic interoperability ensures that data and information exchanged between parties are preserved and understood in precise format and meaning. This covers both semantic and syntactic aspects:

- Where the semantic aspect concerns the meaning of data elements and the relationship between them.
- While the syntactic aspect describes the exact format of information in terms of grammar and format.

To improve semantic interoperability, data and information should be seen as valuable public assets. Below are described core aspects to ensure the semantic interoperability for the network of national qualifications databases:

Treat Data and Information as Valuable Assets

Data and information should be perceived as valuable assets that must be appropriately generated, collected, managed, shared, protected, and preserved. Implementing an information management strategy at the highest organisational level is essential to avoid fragmentation and set priorities. Utilising data-driven design approaches and linked data technologies can significantly improve semantic interoperability in innovative ways for the national qualifications database.

To facilitate a genuinely seamless flow of information, this standardisation effort needs to extend beyond the boundaries of a single sector or organisation. In this context, the importance of cross-sectoral communities and initiatives becomes apparent, bridging the gap between different sectors and bringing about more uniform data understanding and exchange protocols.

Support Cross-Sectoral Communities

Sector-specific and cross-sectoral communities must be identified or set up to create open information specifications. Encouraging relevant communities to share their data with the National Qualifications Database and international platforms will help foster collaboration and improve interoperability in these diverse educational sectors.

Given the diverse landscapes within sectors like vocational training, primary education, informal learning, and higher education, it is of utmost importance to push forward alignment initiatives in data understanding (i.e., semantic interoperability). This will guarantee a fluid exchange of information, unrestricted data mobility, and ease of data portability among various organisations within these sectors.

One such possible up-and-coming alignment initiative in education is the European Learning Model (ELM), elaborated further below.

Use the European Learning Model (ELM)

Most organisations working with education and skills data use different data models to describe information on qualifications, learning opportunities, programmes, providers, learning outcomes, assessment, and quality assurance processes. This makes it very difficult to compare information and link different data sets.

The European Learning Model (ELM)[8] was developed by the European Commission to allow a common standard for comparing and linking data across multiple use cases. It results from ten years of work involving merging different overlapping models, harmonising terms with existing vocabularies and developing new vocabularies where they don't exist, and testing terms for appropriateness and cross-border understanding and utility across more than 20 countries. As such, the European Learning Model v3 represents the most comprehensive and internationalised data model for learning.

ELM is the interoperability solution for countries seeking to improve their education and qualifications systems. It provides a common framework for learning outcomes and qualifications, which helps to ensure that educational achievements are recognized across different countries and sectors. Using a shared model, partner countries can reduce the barriers to mobility for learners and workers, which can help support economic growth and social cohesion.

The model encourages a focus on learner-centred approaches by emphasising the comprehensive description of learning outcomes and skills. It incorporates multiple vocabularies, in particular ESCO (the European Skills, Competences and Occupations Framework)[9], which is used in the ELM as a reference to align learning outcomes and qualifications, improving thus transparency and comparability of qualifications. This also helps to link qualifications with skills and occupations demanded in the labour market.

The recently released ELM v3[10] implements an ontology-based approach, allowing for creating of knowledge graphs and enhancing AI models for skills assessment, learning pathways, and job recommendations. It is also translated into all EU-27 + EEA languages. The ontology-based approach also allows countries to create their own customised applications of the profile - for example, selecting a core set of 20-40 properties from the over 800 on offer to specify their own national qualification profiles.

ELM v3 offers numerous benefits, including long-term support, interoperability with other models and frameworks (e.g. EQF, ESCO, ISCED-f), alignment with policy developments, and free issuance of European Digital Credentials for Learning.

[8] European Learning Model for Stakeholders | Europass
[9] Homepage (europa.eu)
[10] Launch of the European Learning Model | Europass

Overall, the ELM can serve as a valuable tool for partner countries seeking to modernise and improve their education and training systems and to foster cooperation and collaboration across borders (with EU member states, for instance).

Map existing data with the ELM

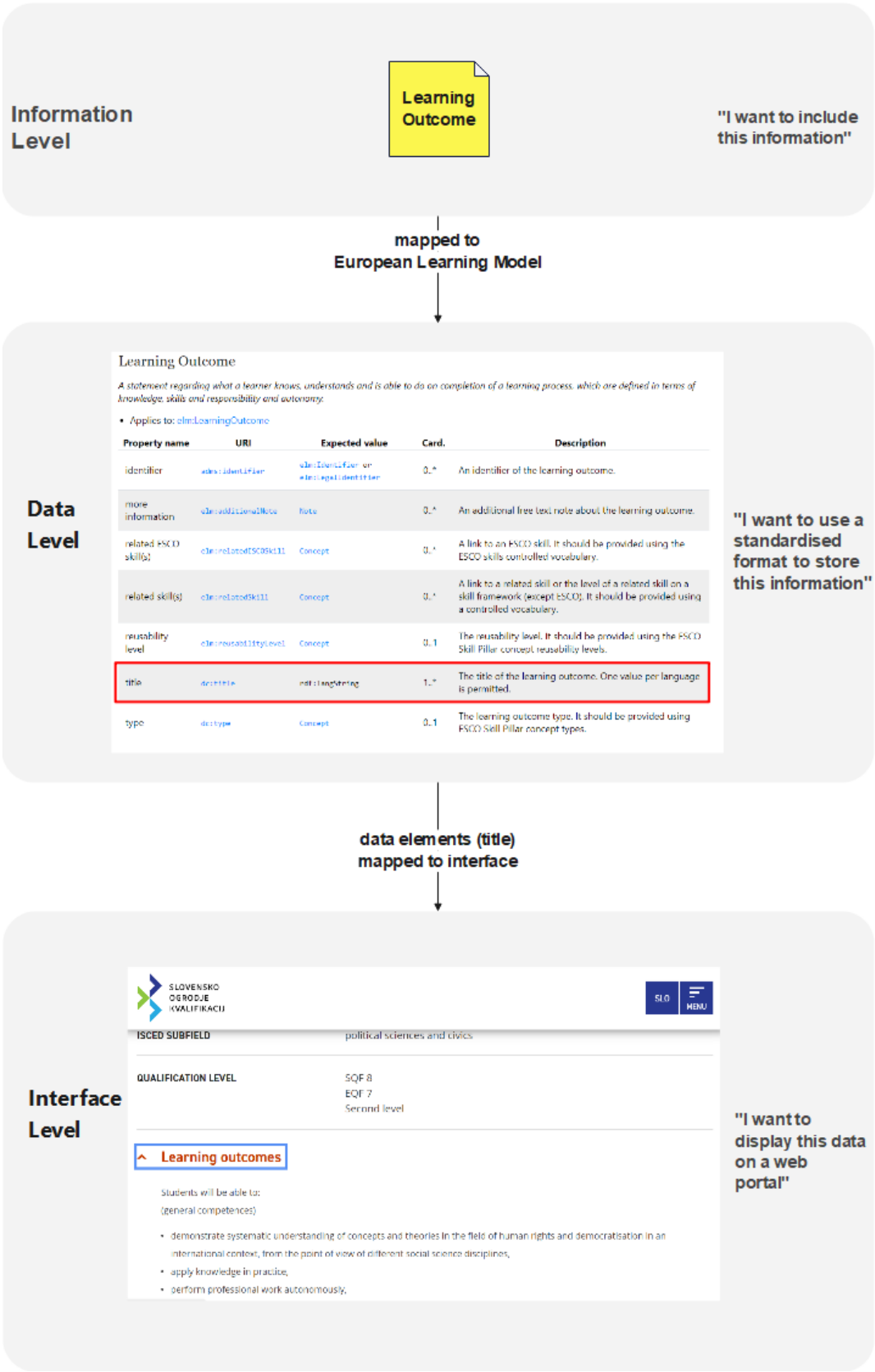
From a technical point of view, the use of the European Learning Model (ELM) as an interoperability solution requires a mapping of countries' existing data with the ELM properties. Mapping with the ELM can provide a foundation for interoperability and facilitate the exchange of information between different education and training systems. The mapping process involves identifying and aligning the relevant ELM concepts[11] with the corresponding concepts in the partner countries' education and training systems.

To map existing data on qualifications with ELM, countries can start by identifying the relevant data fields and aligning them with the ELM properties. This can involve mapping the qualification levels, fields of education, learning outcomes, and other relevant information to the corresponding properties in the ELM.

An example of mapping the concept of a learning outcome is provided below.[12] This process would need to be repeated for every property for which you would want to record data:

[11] ELM consist of classes, their properties and associations between classes. Properties and associations can be compulsory (and have [1] cardinality). See the description of the ELM concepts and corresponding properties on Github

[12] See the description of the concept of a learning outcome, corresponding properties and associations in the ELM on Github



Once the data fields have been aligned with the ELM properties, countries can use the ELM's standard formats and schemas to ensure the data is semantically interoperable. This

involves developing a vocabulary and schema to describe the data exchanges, ensuring that all communicating parties understand data elements in the same way. The country may also need to use secure communication protocols to ensure the data is transmitted and received securely.

Below is an example of business-level mapping that can be established using spreadsheet software. Such a mapping file can then be communicated to the technical team to encode it into specific programming notation.

National Database structure

National database structure		
Class	**Property**	**Example**
d:kvalifikace	d:nazev	Dispečer silniční dopravy
d:kvalifikace	d:kod	37-055-M
d:kvalifikace	d:uroven	4
d:kvalifikace/d:autorizujici	d:nazev	Ministerstvo dopravy
d:zkouska/d:kompetence	d:nazev	Kalkulace ceny přepravy
d:kvalifikace/d:platnost	d:do	20.10.2022
d:kvalifikace/d:povolani_nsp	d:nazev	Dispečer silniční dopravy

ELM mapping[13]

ELM mapping		
Class	**Property**	**Example**
qualification	title	Dispečer silniční dopravy
qualification/identifier	notation	37-055-M
qualification/NQFLevel	uri	4
qualification/accreditation/accreditingAgent	legalName	Ministerstvo dopravy
qualification/learningOutcome	title	Kalkulace ceny přepravy
qualification/accreditation	expiryDate	20.10.2022
qualification/entitlesTo/limitNationalOccupation	prefLabel	Dispečer silniční dopravy

[13] See the description of the concept of a qualification, corresponding properties and associations in the ELM on Github

National database structure		ELM mapping	
Class	Property	Class	Property
d:kvalifikace	d:nazev	qualification	title
d:kvalifikace	d:kod	qualification/identifier	notation
d:kvalifikace	d:uroven	qualification/NQFLevel	uri
d:kvalifikace/d:autorizujici	d:nazev	qualification/accreditation/accreditingAgent	legalName
d:zkouska/d:kompetence	d:nazev	qualification/learningOutcome	title
d:kvalifikace/d:platnost	d:do	qualification/accreditation	expiryDate
d:kvalifikace/d:povolani_nsp	d:nazev	qualification/entitlesTo/limitNationalOccupation	prefLabel

To facilitate the mapping process, it may be necessary to establish common standards and guidelines for data exchange and develop tools and resources to support data mapping and alignment. This may involve the creation of data dictionaries or the development of software tools to automate the mapping process. Additionally, it can be useful to establish collaborative networks between partner countries to share best practices and promote the adoption of common standards and frameworks for data exchange.

Summary Checklist: Key takeaways from the chapter

Organisations can follow the European Learning Model (ELM) to ensure semantic interoperability, which offers an interoperability solution for countries to improve their education and qualifications systems. It provides a common framework for learning outcomes and qualifications, promoting mutual recognition and mobility across countries and sectors. The ELM's extensibility allows for incorporating new frameworks, making it adaptable to changing needs. The ELM's interconnectedness with other European frameworks enhances transparency and comparability of qualifications. Adopting the ELM can support quality education and training, facilitating cross-border cooperation and collaboration.

- Treat data and information as valuable assets by properly generating, collecting, managing, sharing, and preserving them.
- Ensure that all parties involved in their exchange accurately understand data and information.
- Agree on referencing the data, such as taxonomies, controlled vocabularies, thesauri, code lists, and reusable data structures/models, to achieve semantic interoperability.
- Adopt data-driven design and linked data technologies to significantly improve the organisation’s semantic interoperability.
- Support the establishment of sector-specific and cross-sectoral communities to create open information specifications.
- Use interoperability solutions such as European Learning Model (ELM) to facilitate the recognition of qualifications and learning outcomes in a broader way.
- Establish a clear understanding of this framework against the organisation or country-specific data structure.
- Identify the systems and frameworks for Learning Outcomes, Learning Activities, Digital Learning Resources, and Assessment.
- Determine the corresponding ELM properties for each system or framework.
- Map existing data on qualifications with ELM by identifying relevant data fields and aligning them with the ELM properties, including qualification levels, fields of education, learning outcomes, and other relevant information.
- Identify any gaps or areas for improvement that must be addressed to align with the ELM.
- Take advantage of the extensibility of the ELM by incorporating new frameworks and systems as they emerge, ensuring adaptability to changing needs.

Technical Considerations

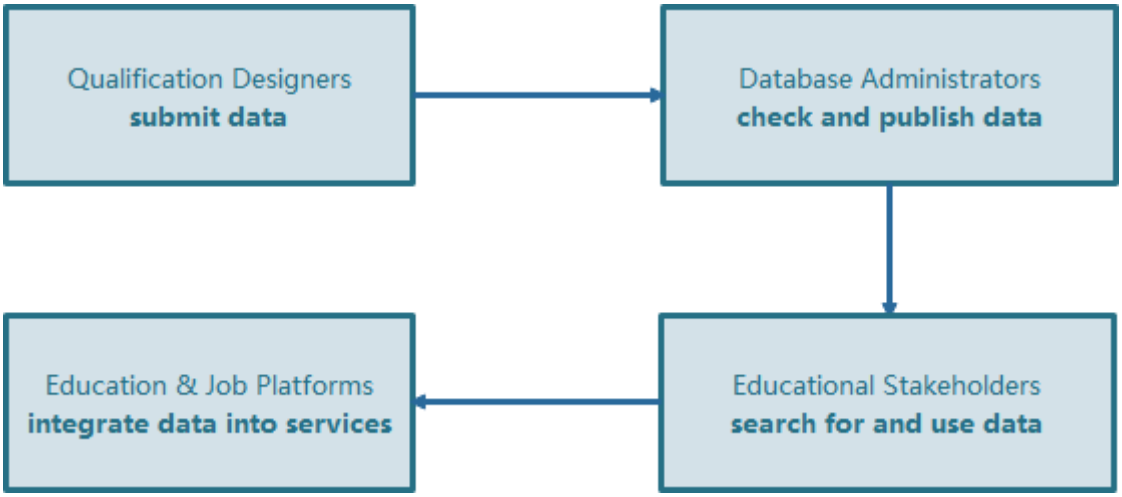
Technical interoperability pertains to the interconnection of systems and services, including the applications and infrastructures involved. It encompasses various aspects such as interface specifications, interconnection services, data integration services, secure communication protocols, and data presentation and exchange. The issue of legacy systems poses a significant challenge to achieving interoperability. In the past, public administrations developed applications and information systems in a decentralised manner, focusing on addressing local and domain-specific issues. Consequently, this approach led to fragmented ICT systems that are challenging to interconnect.

The existence of numerous legacy systems in public administration and the fragmentation of ICT solutions further compounds the challenge of achieving technical interoperability. The sheer scale of public administration exacerbates this issue, resulting in a plethora of ICT systems that are difficult to interconnect. To overcome this challenge, formal technical specifications should be used to ensure technical interoperability wherever possible.

Below are detailed aspects to ensure technical interoperability for the network of national qualifications databases:

Functionalities to be supported

At the highest level, a national qualifications database (NQD) supports use cases defined by four different target groups:



Basic Functionalities

The following are the common essential functionalities required of any qualifications databases - as such they constitute the 'minimum viable product' required for every database:

- **Collection** - the NQD needs to allow qualification designers to submit their qualifications for inclusion in the database and/or to collect data from existing databases or datasets of qualifications.
- **Identification and Versioning** - the NQD needs to be able to assign a unique reference to each qualification in its database - it needs to implement policies that decide what to do in case of minor updates, major updates, replacements or withdrawal of qualifications.
- **Verification** - the NQD needs to check that all listed qualifications meet minimum data quality standards before proceeding to publication (further covered in the section "Semantic Considerations").

- **Storage** - all qualifications must be stored in an appropriate database, with appropriate safeguards in place to ensure that they can be accessed over a timescale measured in decades.
- **Publication** - all data in the databases must be made fully available to the general public, both to human users and to machines (e.g., via APIs[14]).
- **Search** - a search functionality allows anyone to search for any qualification in the database and filter the results by various criteria (E.g., Qualification type, country, language, skills, occupations, ISCED level)
- **Display** - full and current information (together with historical information where applicable) needs to be available to all users via a web browser.
- **Export** - the entire database needs to be indexable/queryable by other databases to allow for the creation of regional/international qualifications databases.

Potential other Functionalities

These further functionalities can add value to users and, if implemented, are best implemented directly into the NQD:

- **Conversion** - allows users to enter data in multiple formats and/or in multiple data models - with the NQD handling the work of converting these into a single unitary format. Without this feature, each database user needs to originally keep their data in a uniform format.
- **Approval and Review** - under this model, the legal and administrative processes that lead to the review, approval and publication of a qualification are all handled within the database - essentially turning the database into a national qualification management system rather than just an information source.
- **Multilingual Records** - allows qualifications to be stored in multiple languages, in particular using a language commonly spoken across a region to aid international comparability. This can be done by allowing data entry in multiple languages or by using machine translation to create a common translation.
- **Automated Skill Matching** - uses Artificial Intelligence to analyse the titles, descriptions and other information provided with qualifications and extract skills in a standardised taxonomy, such as ESCO, to help with comparing qualifications.

Furthermore, the following functionalities can be built on top of a qualifications database, i.e., using the data from a qualifications database. As such, they can be integrated into the qualifications database itself or be launched as completely separate services or portals:

- **Comparison** - allows users to select two or more qualifications from the database and compare them in terms of programme length, curriculum, learning outcomes, assessment methods and other relevant criteria.
- **Intelligence** - uses big-data analysis to extract trend data from the qualifications and the skills inside those qualifications - mainly for the purpose of education and employment research and policymaking. It allows for analysis of which subjects are being taught, emerging subjects (and those retiring), skills being taught, changes in skill profiles of courses and much more.
- **Guidance** - when paired with a learning and employment history of a user or with a questionnaire where they describe their aspirations, the qualifications database can be used to suggest personalised learning pathways for them to further their career.
- **Digital Credentials** - qualifications can be used as templates to create digital credentials - whereby the qualification record, together with information about the student, their grades and learning, make up the metadata of a digital credential.

14 API: Is a way for two or more computer programs to communicate with each other. It is a type of software interface, offering a service to other pieces of software. By using APIs the data from one data base can be linked to another database. APIs will keep the information in both databases up to date.

Technical Requirements

These technical requirements cover the minimum technical infrastructure required to implement the Basic Functionalities described above.

Mandatory Backend Requirement

For any NQD to reach its core objectives of creating an authoritative and transparent source of qualifications information, it must:

Use the European Learning Model Format

The ELM is an RDF vocabulary with an RDF ontology and set of application profiles. Additionally, there are XML schemata available to support the encoding of information in XML. The schemata also define controlled vocabularies as fixed value lists for several properties in the schema. ELM is applicable in many contexts. They can be applied to encode, publish, and exchange qualification metadata in many technologies, including:

- RDF[15] accessible via SPARQL[16] endpoints.
- RDFa embedded in HTML pages.
- RDF serialised as RDF/XML or Turtle[17]
- XML[18]

The European Learning Model should be used:

- As the framework against which to map your data, using concepts from the model to describe your data.
- As the schema to structure your database and store your data.
- As the format under which to make data available for export

The European Learning Model is available online[19]. The relevant files for qualifications databases are found under the loq folders.

Implement Role Management

Role management should be set up with the following functionalities:

Role	Abilities
Database Administrator	- Create Dataset Administrators - Delete Dataset administrators. - Delete a Dataset
Dataset Administrator	- Create a Dataset - Delete a Dataset - Create and delete dataset users. - (Optional) Approve dataset user actions. - All functionalities below

15 https://www.w3.org/TR/rdf11-concepts/

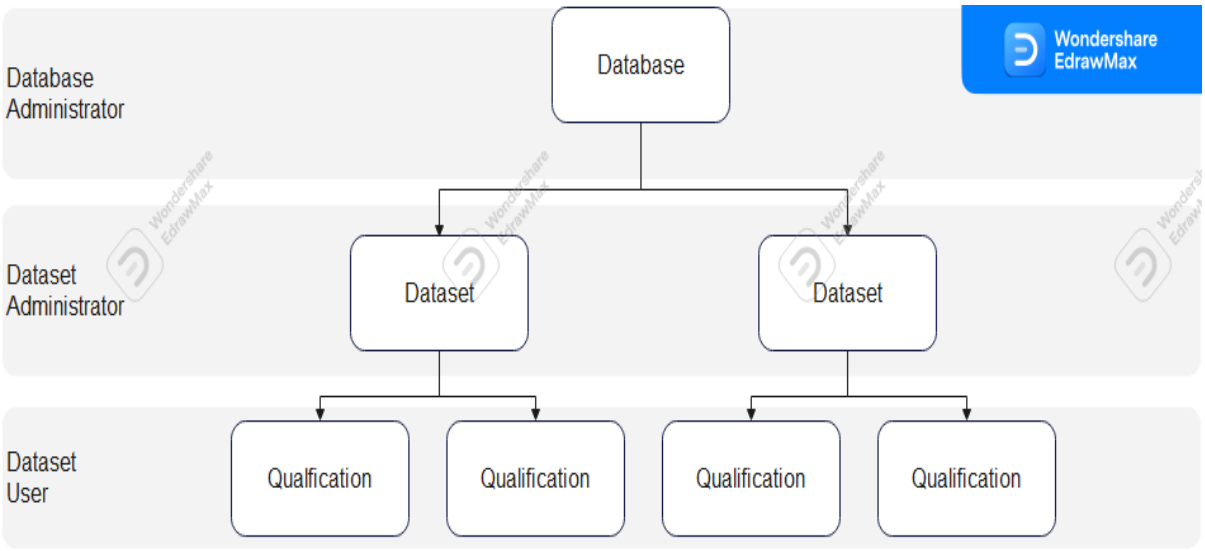
16 SPARQL 1.1 Query Language

17 https://www.w3.org/TR/turtle/

18 Extensible Markup Language (XML) 1.0 (Fifth Edition)

19 https://github.com/european-commission-empl/European-Learning-Model/

Dataset User	- Add qualifications to a dataset. - Edit qualifications in a dataset. - Delete qualifications from a dataset. - All functionalities below
Public User	- Search for qualifications - View qualifications



Establish a Data Intake Model

Depending on the structure of how data on qualifications is currently held (as elaborated in the section "Distributed and Centralised data Collection") in a country, one of three models may be applied to input data into the qualifications database:

- **Direct entry** - where data and workflows have not been digitised[20], then the data input must serve to digitise the data and to partially automate the workflows. Therefore, the system must support (a) data entry forms for the designers of qualifications to enter data and (b) an approval workflow for this data to be published in line with national procedures.
- **Import from Structured Data Sources** - under this model, it is assumed that data is available in structured formats such as CSV, access databases, or various kinds of form-management tools. Where data is available in these formats, the national qualifications database should be given the ability to (a) upload the data in the formats used in the respective country, (b) check and clean the data provided before publication, (c) convert the data to a standardised national format (such as the European Learning Model), and (d) approve the data for publication once cleaning is complete.
- **Import from other Databases** - this input method can be used where databases already exist for different sectors/levels of education, but no single national database exists. Since the data already exists in official databases, it is assumed that data cleaning and approval processes have already been handled. The prime functionality for such a database is one aggregation. This requires the ability to (a) ingest data from each of the national databases and (b) convert that data to a standardised national format (such as the European Learning Model)

20 Data is considered to be digitised when it has been made available as structured data. Cases where the document has been digitised but the underlying data has not been structured (such as in conversion to PDF), is not considered to be digitisation for our purposes.

Verify Data Quality Measures against Schemas

As part of using a standardised data model, any system should also verify its data against schemas published by the model. Apart from any internal validation done by the system, all data should be validated against external XLS, RDF-SHACL or JSON Schema files supplied with the models. Only data that fully passes validation should be published in the database.

Make each unique qualification available from a Persistent URI

The database should include a:

- Mechanism to check for duplicates to ensure that each qualification is only represented once.
- A mechanism to assign a unique identifier to each uploaded qualification.
- A mechanism to generate a pURI that will be associated with the unique identifier.
- A redirection engine will direct the pURI to a webpage with information about the qualification. Even if the webpage structure changes, it should be possible to still redirect users to the new page from the original pURI.

Provide a Public Endpoint to Access and/or Export Data

To be able to create regional and not just national qualifications databases, it is essential that the data in the database be accessible via public endpoints. Such endpoints should follow these principles:

- Preferably be available via a RESTful API interface or a SPARQL endpoint.
- Be available in a regionally accepted common data format such as the European Learning Model.
- Make data available in a serialisation of RDF (i.e., RDF/XML, JSON-LD or TTL formats).
- Allow for the scraping/downloading of the whole database for aggregation into other databases.

In general, public endpoints should observe the good practices for the publication of data, such as:

- FAIR Principles[21];
- 5-star deployment scheme for Open Data.[22]

Optional Backend Requirements

In addition to the requirements described above, it is recommended that the following technical considerations be taken into account when creating a database:

- **Store data natively as RDF** - this data format option gives the widest suite of interoperability (as opposed to integration) options and is likely to be more future-proof than other options. While it is possible to code data in another format and then make it available via an RDF endpoint, this adds significant system complexity.
- **Store RDF data in triple stores** - triple stores are bespoke databases for creating knowledge graphs in RDF. They are extremely high-performance, can deal with enormous datasets and use standardised queries to insert or extract data.
- **Design a High Availability Infrastructure** - whether deploying the database as a cloud application or using redundant servers behind a load balancer, design the infrastructure to ensure maximum uptime even under high load or in the case of failure of components. Qualifications databases contain important public data - with use cases around recognition and checking the authenticity of qualifications being particularly sensitive and requiring constant uptime.
- **High Resilience** - qualification records are likely to need to be referenced over a time spanning decades. As such, the entire database needs a robust storage and backup strategy,

21 https://www.go-fair.org/fair-principles/

22 https://5stardata.info/en/

incorporating real-time, batch and offsite backup - with the last level preferably also using backup on physical media such as tape or optical disk.

- **Implement Search using a bespoke tool** - given the need to search a large database of qualifications, as well as (for certain use cases) to compare qualifications and extract meaning from the records of qualifications - it is recommended to use technologies such as SOLR[23] or Elasticsearch[24] to implement the search and comparison functionalities of the database, rather than code these from scratch.
- **Provide search and display endpoints** - apart from the endpoints described above to download an entire dataset, provide additional endpoints that allow an external service to search for qualifications and/or to obtain a qualification from a URI. Such endpoints may provide data in any common RDF-based format (JSON-LD is preferred here).

Frontend Requirements

From the perspective of ensuring the interoperability of services, there are no specific requirements for the front end other than to make the back end available. The configuration of the front end is entirely up to each country to decide how to implement. This section contains a set of suggestions, as well as examples from other countries, which can be used to better formulate these requirements.

The front end should typically be made up of two components:

An off-the-shelf content management system such as Drupal or WordPress.

A plugin for the content management system that allows access to the data from the qualifications database.

The front-end should comply with the same basic requirements any frontend should use:

- **Responsive Design**: The front end of the web application should be designed to work seamlessly across all devices, including desktops, laptops, tablets, and smartphones.
- **User-friendly Interface:** The interface should be easy to use and navigate, with clear labels, intuitive controls, and consistent design patterns.
- **Compatibility**: The front end should be compatible with multiple web browsers, including Chrome, Firefox, Safari, and Edge.
- **Accessibility**: The front end should be designed to be accessible to users with disabilities, including those who are visually impaired, hearing impaired, or have motor disabilities.
- **Performance**: The front end should be optimised for fast page load times, minimal network requests, and minimal rendering time.
- **Flexibility**: The front end should be flexible and adaptable to changes in the application's requirements or user needs.
- **Maintainability**: The front end should be designed to be easy to maintain and update, with modular code and clear documentation.
- **Internationalisation**: The front end should be designed to support multiple languages and cultural conventions to enable global accessibility.

The website should generally have three main functionality categories:

- Delivery of information about the qualification system
- Search and Discovery of Qualifications (the actual database)
- Any other functionalities (such as qualification comparison etc.)

For the information delivery, typical elements that are often included in national qualifications databases:

- Information about the educational system in the respective country.

23 https://solr.apache.org/

24 https://www.elastic.co/fr/

- A description of the qualification's framework, together with any supporting legislative or administrative documents, such as a referencing report.
- Generic information about studying and/or working in the country, together with links to other portals.
- Information about the organisations managing the qualifications database and their procedures.

Summary Checklist: Key takeaways from the chapter

Using the information in the technical section, the main action points are:

- Define the principles your national qualifications database should follow.
- In consultation with stakeholders, determine the minimum set of functionalities for a first release of a national qualifications database.
- Consider examples of qualifications databases from European countries like Slovenia, Malta, and Sweden for frontend design inspiration (See Annex 2).
- Prioritise which functionalities are desirable but reserved for future releases.
- Create a set of technical requirements for the back end of the system using this open architecture as a guide.
- Survey a set of existing national qualifications databases to gain inspiration for how to present the service.
- Define requirements for the front end of the qualifications database.
- Prepare content to be integrated into the web portal that will host the qualifications database.
- Procure the service in line with the requirements (including non-functional requirements).
- Use the European Learning Model (ELM) as the framework for structuring and storing qualification data.
- Establish a data intake model with options for direct entry, import from structured data sources, and import from other databases.
- Assign unique, persistent URIs to each qualification for easy access and reference.
- Provide public endpoints to access and/or export data, preferably using RESTful API interfaces or SPARQL endpoints.
- Once delivered, test the service internally and with stakeholders.
- Launch the qualifications database.

Conclusion

This document provides a valuable resource for ETF partner countries looking to establish their own qualifications database. The guidelines presented are based on best practices and lessons learned from similar initiatives in other countries and regions, offering a flexible and adaptable framework that can be tailored to meet the specific needs and state of the art of each partner country.

By following the recommended steps and considering the regulatory, organisational, semantic, and technical considerations outlined in this document, partner countries can implement a comprehensive solution (Qualifications database) that promotes the quality and relevance of education and training systems, facilitates the recognition of learning outcomes, and supports the mobility of learners and workers.

Establishing a qualifications database can provide numerous benefits to partner countries:

Improved quality and relevance of education and training: By establishing a qualifications database, partner countries can enhance the quality and relevance of their education and training systems. This can be achieved by facilitating the recognition of learning outcomes and supporting the mobility of learners and workers across borders.

International recognition and competitiveness: Partner countries can improve their international recognition and competitiveness by aligning their qualification systems with the European frameworks

and ETF's standardised solution. This can enhance their attractiveness as a destination for international students and workers, as well as increase their opportunities for collaboration with other countries and institutions.

Facilitated access to labour markets: By having a transparent and accessible qualifications database, partner countries can provide their citizens with better access to local and international job opportunities. This can help reduce unemployment rates, increase economic growth, and promote social inclusion.

Efficient and cost-effective solution: Establishing a qualifications database that is interoperable with the European frameworks and ETF's standardised solution can be a cost-effective and efficient solution for partner countries. By following the recommended guidelines, partner countries can benefit from the best practices and lessons learned from similar initiatives in other countries and regions without having to reinvent the wheel.

Support from ETF and the European Commission: Partner countries can benefit from the support of the ETF and the European Commission in establishing and maintaining their qualifications database. This can include technical assistance, training, and access to funding opportunities.

ANNEX

Annex 1. Concepts and terminologies

European Interoperability Framework

This document uses The European Interoperability Framework (EIF) as a conceptual framework to describe the architecture required for a national qualifications database. The EIF is a set of recommendations for promoting and implementing interoperability among public administrations.

The EIF provides a common framework for the development and delivery of public services, with the aim of ensuring that public services are accessible, efficient, and effective. The framework is based on a set of principles and guidelines that promote the use of open standards, open-source software, and open specifications in public service delivery.

The current version of the EIF,[25] which was released in 2017, is divided into three sections:

- **Principles**: This section defines the key principles that underpin the EIF, including user-centricity, openness, transparency, and reusability.
- **Guidelines:** This section provides guidelines for implementing the principles of the EIF, including recommendations for the use of open standards, open-source software, and open specifications.
- **Recommendations**: This section provides specific recommendations for implementing the EIF in different contexts, such as e-government, e-health, and e-procurement.

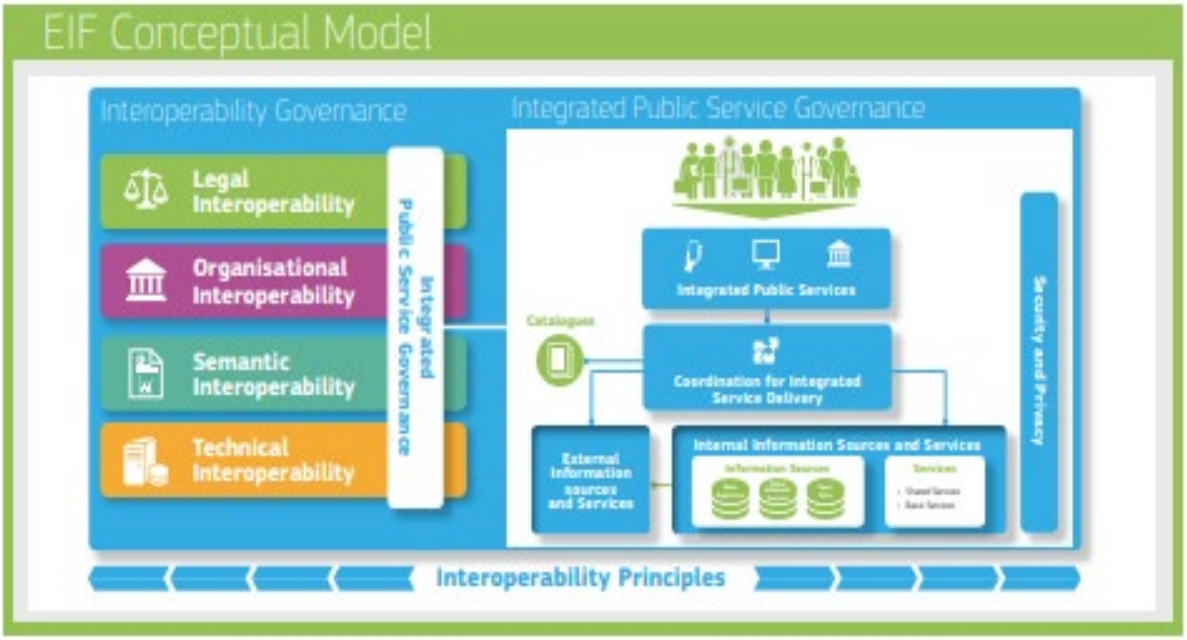
The EIF is intended to promote interoperability among public administrations, enabling them to work together more effectively and efficiently. It also aims to reduce the costs and complexity of public service delivery and to promote innovation and competition in the public sector.

The EIF's interoperability model is relevant to all digital public services and can be viewed as an essential aspect of the interoperability-by-design approach. It comprises four layers of interoperability: legal, organisational, semantic, and technical, as well as an overarching component of integrated public service governance that spans across all four layers. Additionally, there is a background layer of interoperability governance.

The model is illustrated in the diagram below.

EIF conceptual model

25 New European Interoperability Framework Promoting seamless services and data flows for European public administrations.



The framework referred to here provides a structured approach to organising the present document in alignment with the EU's best practices for data exchange. The framework comprises several main areas of consideration, including legal, organisational, semantic, and technical aspects.

- **The regulatory considerations:** When different public administrations contribute to public services, they work within their own national legal frameworks. Legal interoperability ensures that organisations operating under different legal frameworks, policies, and strategies can work together. This can involve avoiding legislation that blocks the establishment of trans-national public services and creating clear agreements for dealing with differences in legislation across borders. Interoperability checks should be performed to identify barriers to interoperability, and coherence between legislation should be assessed regularly. Digital checks should also be conducted to ensure legislation is suitable for both physical and digital worlds and to identify any barriers to digital exchange. Legal value and data protection should be maintained when exchanging information between member states, and additional agreements may be necessary to overcome potential differences in legislation implementation.

- **The organisational considerations:** refers to public administrations aligning their business processes, responsibilities, and expectations to achieve commonly agreed-upon and mutually beneficial goals. This involves documenting and integrating or aligning business processes and relevant information exchanged. The goal is to make services available, easily identifiable, accessible, and user focused. To work together efficiently and effectively to provide trans-national public services, different administrative entities may need to align their existing business processes or establish new ones. This requires documenting them in an agreed-upon way and with commonly accepted modelling techniques, including the associated information exchanged, so that all public administrations contributing to the delivery of European public services can understand the overall (end-to-end) business process and their role in it.

- **The semantic considerations**: is essential for ensuring that exchanged data and information retains its precise format and meaning throughout exchanges between parties. This involves preserving the meaning of data elements and the relationship between them through developing vocabularies and schemata to describe data exchanges and ensuring that all parties understand data elements in the same way. To achieve this, reference data agreements in the form of taxonomies, controlled vocabularies, thesauri, code lists, and reusable data structures/models are key prerequisites. Innovative approaches like data-driven-design coupled with linked data technologies can substantially improve semantic interoperability. It is important to have universally applicable information standards and specifications to enable meaningful information exchange among public organisations.

- **The technical considerations**: refers to the connections between systems and services in terms of technical interoperability, including interface specifications, data integration services, and secure communication protocols. Legacy systems pose a significant challenge to interoperability, as public administrations have historically developed domain-specific solutions in a fragmented manner. This has resulted in a multitude of ICT islands that are difficult to interoperate. To overcome this challenge, technical interoperability should be achieved through formal technical specifications whenever possible.

The EIF framework provides crucial recommendations for promoting open data and interoperability. One significant recommendation is to "publish the data as open data unless certain restrictions apply." This principle emphasises the default approach of making data openly accessible and reusable, contributing to transparency and collaboration across public sector organisations.

Additionally, it suggests establishing clear guidelines for data sharing, including the use of standardised formats, metadata, and APIs. By adhering to these recommendations, organisations can ensure that data is easily discoverable, understood, and integrated, enhancing interoperability between systems and services.

The framework also highlights the importance of data quality and reliability. It recommends implementing processes to maintain data accuracy, completeness, and timeliness. By ensuring high-quality data, organisations can build trust and confidence in the information shared, leading to improved decision-making and reliable outcomes.

Furthermore, it encourages the adoption of common vocabularies and semantic interoperability. Using standardised terms and concepts facilitates the exchange of information between different systems and domains, promoting consistency and effective communication.

Data Models, Linked Open Data, RDF, and Interoperability

Q1. What is linked open data?

Linked Data (LD) is structured data, which is interlinked with other data, so it becomes more useful through semantic queries. Linked Data refers to a set of design principles for sharing machine-readable interlinked data on the Web. When combined with Open Data (data that can be freely used and distributed), it is called Linked Open Data (LOD).

Linked Data breaks down the information silos that exist between various formats and brings down the fences between various sources. It facilitates the extension of the data models and allows easy updates. As a result, data integration and browsing through complex data become easier and much more efficient.

The four design principles of Linked Data are:

- Use URIs as names for things: The Uniform Resource Identifier (URI) is a single global identification system used for giving unique names to anything. URIs can be used to distinguish between different things or know that one thing from one dataset is the same as another in a different dataset.
- Use HTTP URIs so that people can look up these names: As the HTTP protocol provides a simple mechanism for retrieving resources, when things can be identified by URIs in conjunction with this protocol, they become easier to find. This expedites publishing any kind of data and adding it to the global data space.
- When a user looks up a URI, provide useful information, using the standards (RDF, SPARQL.): To be able to use URIs efficiently, one should use RDF or SPARQL for querying. The RDF is a graph-based representation format for data publishing and interchange on the Web developed by the W3C. It is also used in semantic graph databases (also known as RDF triple stores) – a technology developed for storing interconnected data and inferring new facts out of existing ones. SPARQL, on the other hand, is the W3C-standardised query language for retrieving and manipulating data stored in RDF format. As such, it allows us to search the Web of Data (or any database) and discover relationships.
- Include links to other URIs so that they can discover more things. Similarly, to the hypertext web, links to other URIs makes data interconnected and enables us to find different things. By interlinking new information with existing resources, the organisation maximises the reuse and interlinking among existing data and create a richly interconnected network of machine-processable meaning.

Q2. What is interoperability?

Interoperability is the ability of two or more components or systems to exchange information and to use the information that has been exchanged.

There are two main types of interoperability:

- **Syntactic Interoperability:** Where two or more systems can communicate and exchange data. It allows different software components to cooperate, even if the interface and the programming language are different.
- **Semantic Interoperability**: Where the data exchanged between two or more systems is understandable to each system. The information exchanged should be meaningful, since semantic interoperability requires useful results defined by the users of the systems involved in the exchange.

Let's consider a case where two different universities are trying to exchange student transcript data.

University A uses an XML-based system for maintaining student data, while University B uses a JSON-based system. Despite the difference in formats, they've agreed on a common structure to represent the data when exchanged. They are using a defined schema that dictates the order and type of data fields to be used, such as { "1_student_name", "2_course", "3_grade" }.

In this case, both universities have achieved syntactic interoperability. They have managed name fields the same in a structured and orderly way, but this does not mean that the receiving system (University B) can interpret or use the information in the same way that University A intended. That's where semantic interoperability comes in.

Let's continue the above example. Suppose in the "2_course" field, University A uses codes like "CS101" to denote "Introduction to Computer Science", while University B uses course titles directly. Even if University A sends a student's data to University B with the course code "CS101", University B won't understand what specific course it denotes unless there's a shared understanding or mapping.

If they establish a common understanding of these course codes - say, a dictionary where "CS101" corresponds to "Introduction to Computer Science" - this represents semantic interoperability. Now,

when University B receives the data, it understands what "CS101" signifies, ensuring that the data exchanged is not only structured but also meaningful.

The most appropriate way to achieve interoperability is to follow the principles of semantic modelling and make use of semantic technologies and standards as described below.

Q3. What is a semantic data model? What are the different types of semantic data models?

A data model is an abstract model that organises elements of data and standardises how they relate to one another and to the properties of real-world entities.

Semantics is the study of meaning, concerned with the relationship between entities, concepts, ideas. When applied in computer science, semantics helps machines interpret more accurately what data means so as to interact more efficiently and productively with machines and data resources.

Semantic data modelling can be defined as the development of descriptions and representations of data in such a way that the latter's meaning is explicit, accurate, and commonly understood by both humans and machines.

A semantic data model is a method of organising data that reflects the basic meaning of data items and the relationships among them. This organisation makes it easier to develop application programs and to maintain the consistency of data when it is updated. A semantic data model can be seen as a common vocabulary used by different organisations, programs, machines, applications etc in order to have a common understanding of the data they are using or exchanging.

There is a wide range of data artefacts that are considered as semantic data models: metadata schemas, controlled vocabularies, taxonomies, ontologies, knowledge graphs, entity-relationship (E-R) models, property graphs, and other conceptual models for data representation.

An Ontology is a formal description of knowledge as a set of concepts within a domain and the relationships that hold between them. It ensures a common understanding of information and makes explicit domain assumptions thus allowing organisations to make better sense of their data. An ontology formally specifies components such as individuals (instances of objects), classes, attributes, and relations as well as restrictions, rules and axioms.

Ontologies, are highly valued data models that have the ability to:

- Express relationships and enable linking multiple concepts to other concepts in a variety of ways (unlike taxonomies and relational databases schemas)
- Achieve interoperability
- Improve metadata and provenance, and thus enhance data quality
- Introduce a sharable and reusable knowledge representation but can also add new knowledge about the domain

An Application Profile (AP) is a specification that re-uses terms from one or more base standards (ontologies, data models etc.), adding more specificity by identifying mandatory, recommended, and optional elements to be used for a particular application, as well as recommendations for controlled vocabularies to be used.

Q4. What is RDF?

As already introduced, RDF stands for Resource Description Framework and is a standard for describing web resources and data interchange, developed, and standardised with the World Wide Web Consortium (W3C). While there are many conventional tools for dealing with data and more specifically for dealing with the relationships between data, RDF is the easiest, most powerful, and expressive standard designed by now. To be more specific, RDF is a general method of describing data by defining relationships between data objects. RDF enables effective data integration from multiple sources, detaching data from its schema. This allows multiple schemas to be applied,

interlinked, queried as one and modified without changing the data instances. RDF is built around the existing Web standards: XML and URL (URI).

RDF connects data pieces together via triples (three positional statements of the form subject-predicate-object). An RDF statement states facts, relationships, and data by linking resources of different kinds. With the help of an RDF statement, just about anything can be expressed by a uniform structure, consisting of three linked data pieces.

Q5. What is a Knowledge Graph and how is it related to ontologies and RDF?

A knowledge graph is a collection of interrelated entities, concepts, and events where the types and the relationships between them are expressed by nodes and edges between these nodes. Knowledge graphs put data in context via linking and semantic metadata and this way provide a framework for data integration, unification, analytics and sharing.

The ontology, as the schema that formalises the knowledge of a domain, can be applied to a set of individual facts to create a knowledge graph. The ontology describes the structure of the knowledge in a domain and enables the knowledge graph to capture the data and provide the best framework for data integration, unification, linking and reuse.

As a powerful and expressive framework for representing data, RDF is used for building knowledge graphs – richly interlinked, interoperable, and flexible information structures.

Knowledge graphs, represented in RDF, provide the best framework for data integration, unification, linking and reuse, because they combine:

- Expressivity: The standards of RDF(S) and OWL (known as Semantic Web standards) allow for a fluent representation of various types of data and content: data schema, taxonomies and vocabularies, all sorts of metadata, reference, and master data.
- Formal semantics: All Semantic Web standards come with well specified semantics, which allow humans and computers to interpret schema, ontologies, and data in unambiguous manner.
- Performance: All the specifications have been thought out, and proven in practice, to allow for efficient management of graphs of billions of facts and properties.
- Interoperability: There is a range of specifications for data serialisation, access (SPARQL Protocol for endpoints), management (SPARQL Graph Store) and federation. The use of globally unique identifiers facilitates data integration and publishing.
- Standardisation: All the above is standardised through the W3C community process, to make sure that the requirements of different actors are satisfied – all the way from logicians to enterprise data management professionals and system operations teams.

Annex 2. Examples of Qualifications Databases

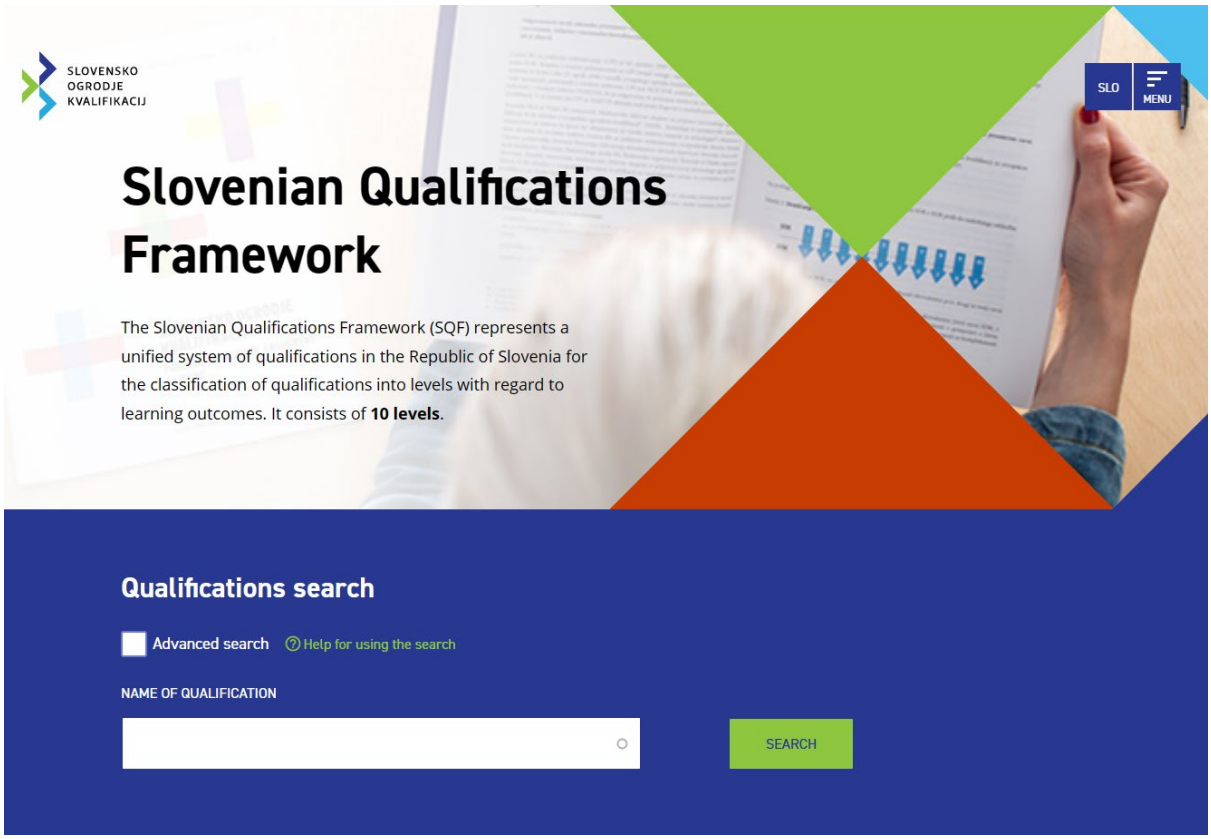
Examples of Qualifications Databases

The following sections present examples of qualifications databases from European countries, which can be used as inspiration in designing the front-end for qualifications databases. All of these databases use the European Learning Model as their backend, and their data is aggregated into the course search functionality of the Europass platform, making their data available at both national and European levels.

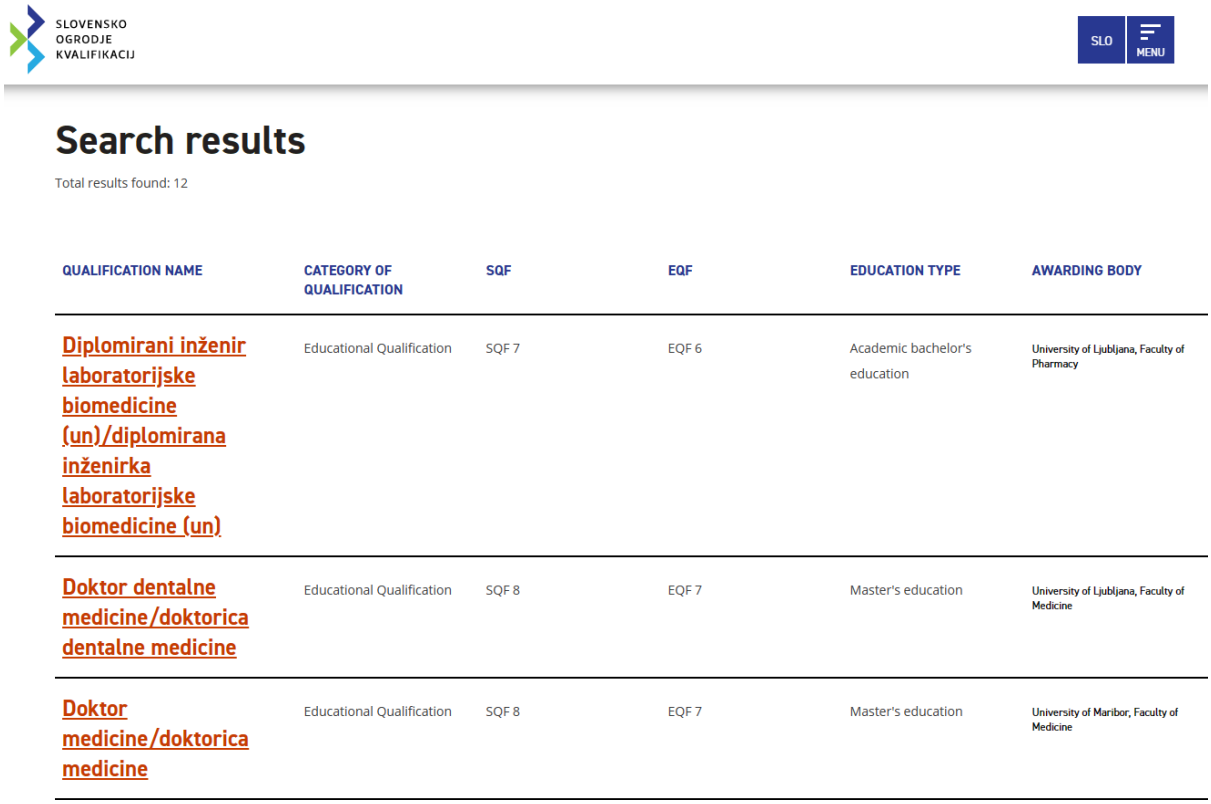
Slovenian Qualifications Database

The Slovenian qualifications database is available in English and Slovenian.

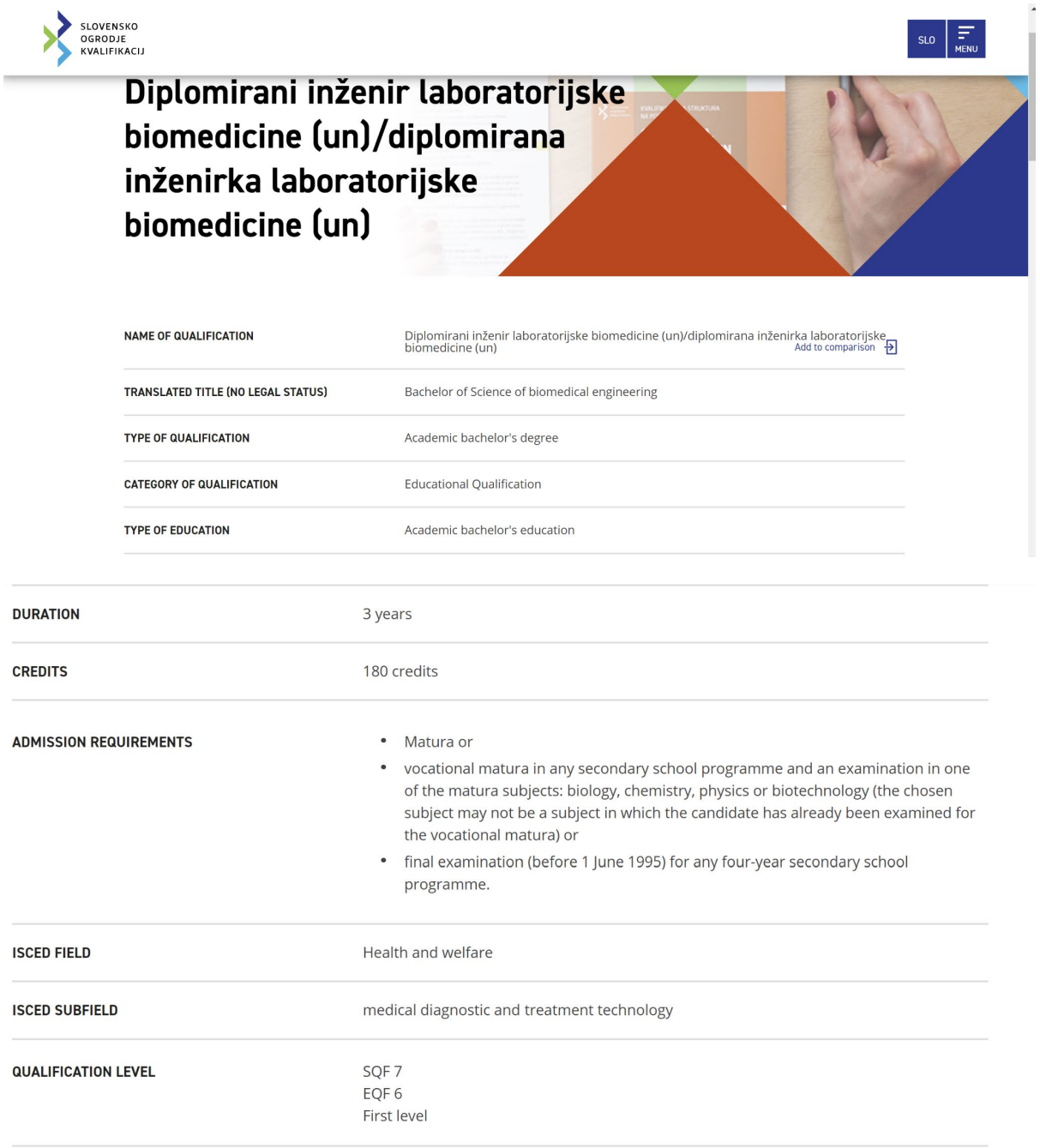
The front-page of the website puts the qualifications search in the most obvious placement, while information functionalities are hidden behind a dropdown menu on the top right:



Search Results for qualifications present a table of qualification name, category NQF/EQF level, education type and awarding body:



A qualification detail page provides detailed information about the qualification using the data fields supplied by the European Learning Model:



SLOVENSKO OGRODJE KVALIFIKACIJ

SLO MENU

Diplomirani inženir laboratorijske biomedicine (un)/diplomirana inženirka laboratorijske biomedicine (un)

NAME OF QUALIFICATION	Diplomirani inženir laboratorijske biomedicine (un)/diplomirana inženirka laboratorijske biomedicine (un) Add to comparison
TRANSLATED TITLE (NO LEGAL STATUS)	Bachelor of Science of biomedical engineering
TYPE OF QUALIFICATION	Academic bachelor's degree
CATEGORY OF QUALIFICATION	Educational Qualification
TYPE OF EDUCATION	Academic bachelor's education
DURATION	3 years
CREDITS	180 credits
ADMISSION REQUIREMENTS	• Matura or • vocational matura in any secondary school programme and an examination in one of the matura subjects: biology, chemistry, physics or biotechnology (the chosen subject may not be a subject in which the candidate has already been examined for the vocational matura) or • final examination (before 1 June 1995) for any four-year secondary school programme.
ISCED FIELD	Health and welfare
ISCED SUBFIELD	medical diagnostic and treatment technology
QUALIFICATION LEVEL	SQF 7 EQF 6 First level

The Slovenian Database also includes a qualifications comparison tool, allowing for side-by-side comparison of qualifications based on their core metadata fields (such as Title, Learning Outcomes, Field of Education etc):

Compare qualifications

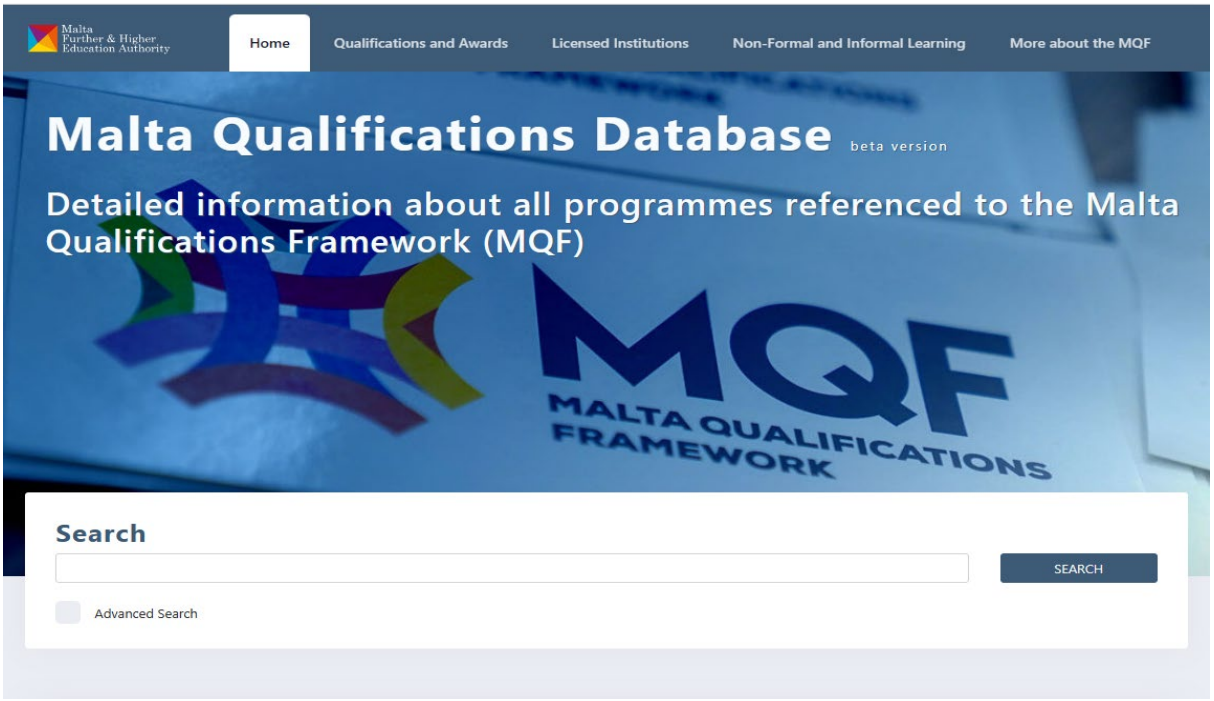
	DIPLOMIRANI INŽENIR LABORATORIJSKE BIOMEDICINE (UN)/DIPLOMIRANA INŽENIRKA LABORATORIJSKE BIOMEDICINE (UN)	ARANŽERSKI TEHNIK/ARANŽERSKA TEHNICA
Translated title	Bachelor of Science of biomedical engineering	Window Display Technician
Type of qualification	Academic bachelor's degree	Upper secondary technical education
Category of qualification	Educational Qualification	Educational Qualification
Type of education	Academic bachelor's education	Upper secondary technical education
Duration of education	3 years	4 years
Credits	180 credits	240 credits

Entry conditions	• Matura or • vocational matura in any secondary school programme and an examination in one of the matura subjects: biology, chemistry, physics or biotechnology (the chosen subject may not be a subject in which the candidate has already been examined for the vocational matura) or • final examination (before 1 June 1995) for any four-year secondary school programme.	• Elementary education or • lower vocational education.
Field	09 Health and welfare	02 Arts and humanities
Subfield	0914 Medical diagnostic and treatment technology	0212 Fashion, interior and industrial design
SQF Level	SQF 7	SQF 5
^ Learning outcomes	A student is qualified to: • analyse, critically evaluate and find solutions to specific laboratory problems that appear in various working environments, • demonstrate autonomy in professional work and the analysis of professional problems, • undertake individual professional work and research, work in a group and demonstrate the knowledge necessary for the communication and publication of results, • demonstrate relevant knowledge for the understanding, introduction, application and evaluation of modern techniques and methods used in the professional and research spheres of laboratory medicine,	Certificate holders will be able to: • demonstrate understanding of and develop an entrepreneurial mindset from idea to realisation, • demonstrate understanding of customers' purchasing behaviour and marketing strategies and design a marketing mix, • plan and organise installations and work processes and the indexing and archiving of business documentation, • carry out high-quality and professional work in the working environment in accordance with regulations, good business practices and standards, • participate in sales promotion campaigns, personal sales, contacts with the public and advertising,

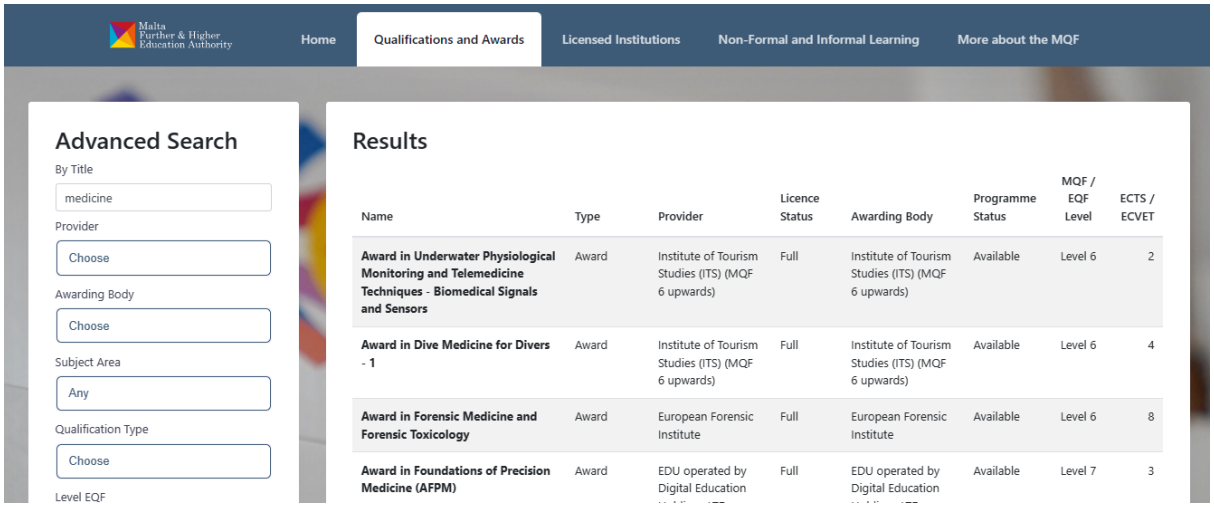
Malta Qualifications Database

The Malta qualifications database is available in English and Maltese.

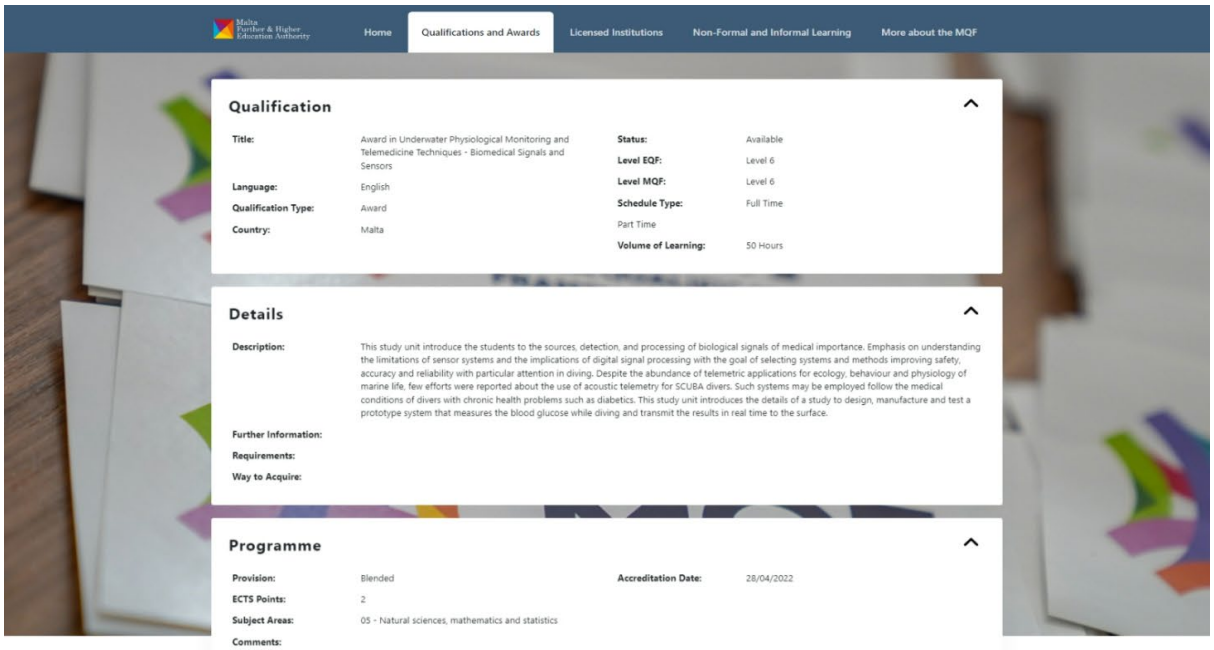
The front-page of the website puts the qualifications search in the most obvious placement, while information functionalities are presented from a navigation bar menu:



Search Results for qualifications present a table of qualification name, type, provider, awarding body, status and qualifications framework level. It also provides various filtering options to further narrow down results:



A qualification detail page provides detailed information about the qualification using the data fields supplied by the European Learning Model:



Malta Further & Higher Education Authority

Home | Qualifications and Awards | Licensed Institutions | Non-Formal and Informal Learning | More about the MQF

Qualification

Title: Award in Underwater Physiological Monitoring and Telemedicine Techniques - Biomedical Signals and Sensors

Language: English

Qualification Type: Award

Country: Malta

Status: Available

Level EQF: Level 6

Level MQF: Level 6

Schedule Type: Full Time

Part Time

Volume of Learning: 50 Hours

Details

Description: This study unit introduce the students to the sources, detection, and processing of biological signals of medical importance. Emphasis on understanding the limitations of sensor systems and the implications of digital signal processing with the goal of selecting systems and methods improving safety, accuracy and reliability with particular attention in diving. Despite the abundance of telemetric applications for ecology, behaviour and physiology of marine life, few efforts were reported about the use of acoustic telemetry for SCUBA divers. Such systems may be employed follow the medical conditions of divers with chronic health problems such as diabetics. This study unit introduces the details of a study to design, manufacture and test a prototype system that measures the blood glucose while diving and transmit the results in real time to the surface.

Further Information:

Requirements:

Way to Acquire:

Programme

Provision: Blended

ECTS Points: 2

Subject Areas: 05 - Natural sciences, mathematics and statistics

Comments:

Accreditation Date: 28/04/2022

Awarding Body

Name: Institute of Tourism Studies (ITS) (MQF 6 upwards)

Comments: Self-Accrediting Institution up until MQF Level 5; For Programme MQF Level 6 upwards, licensed with NCFHE

Website: www.its.edu.mt

Provider

Name: Institute of Tourism Studies (ITS) (MQF 6 upwards)

Comments: Self-Accrediting Institution up until MQF Level 5; For Programme MQF Level 6 upwards, licensed with NCFHE

Website: www.its.edu.mt

Regulatory Body

Name: Malta Further and Higher Education Authority (MFHEA)

Comments: Known as National Commission for Further and Higher Education (NCFHE) prior to January 2021

Website: https://mfhea.mt/

Learning Outcome

Learning Outcomes 1

Outcome Type: Competence

Description: a) Comprehensively demonstrate how to identify the better sensing unit for each condition, its proper use, and the correctness of the acquisition procedure. b) Be responsible for identifying critical control points of any relevant process. c) Systematically manage established protocols to mitigate and/or prevent identified hazards.

Reusability Level: Occupation Specific

Learning Outcomes 2

Outcome Type: Knowledge

Description: a) Comprehensively identify the techniques regarding the acquisition, processing and interpretation of biological and medically relevant signals. b) Critically assess and establish the typical user and display interfaces lists, the signal flow path and the details of various biological sensor types. c) Comprehensively identify the tools required to relate what the user sees on the front panel to the signal captured at the sensor. d) Comprehensively identify what is a biomedical sensor technology. e) Comprehensively identify the benefits of use surface and implantable electrodes, photometry, biochemical sensors, force and position detectors and piezoelectric devices. f) Comprehensively demonstrate familiarity in acquire the correct signals directly on the diver during and/or after the dive to assess the level of risk (i.e. decompression sickness). g) Define and understand risk identification criteria. h) Properly identify critical control points of any task related process. i) Assess the relevance as to potential harm to people or materials.

Reusability Level: Occupation Specific

Learning Outcomes 3

Outcome Type: Skill

Description: The learner will be able to: a) Demonstrate how to manage the better sensing unit for each dives' data collection and analysis under the guidance of a Researcher - II. b) Demonstrate knowledge of all procedures in acquisition, processing and interpretation of biological and medically relevant signals.

Reusability Level: Occupation Specific

MQF | Co-funded by the Erasmus+ Programme of the European Union

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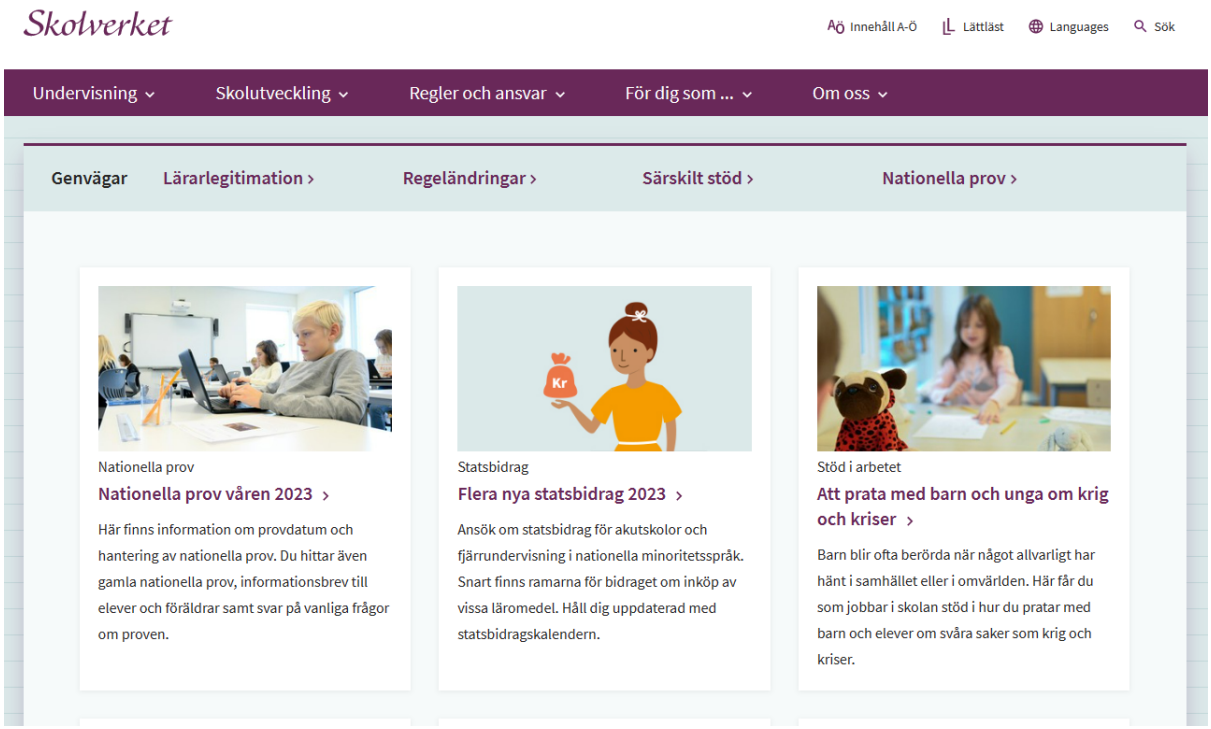
About Contact

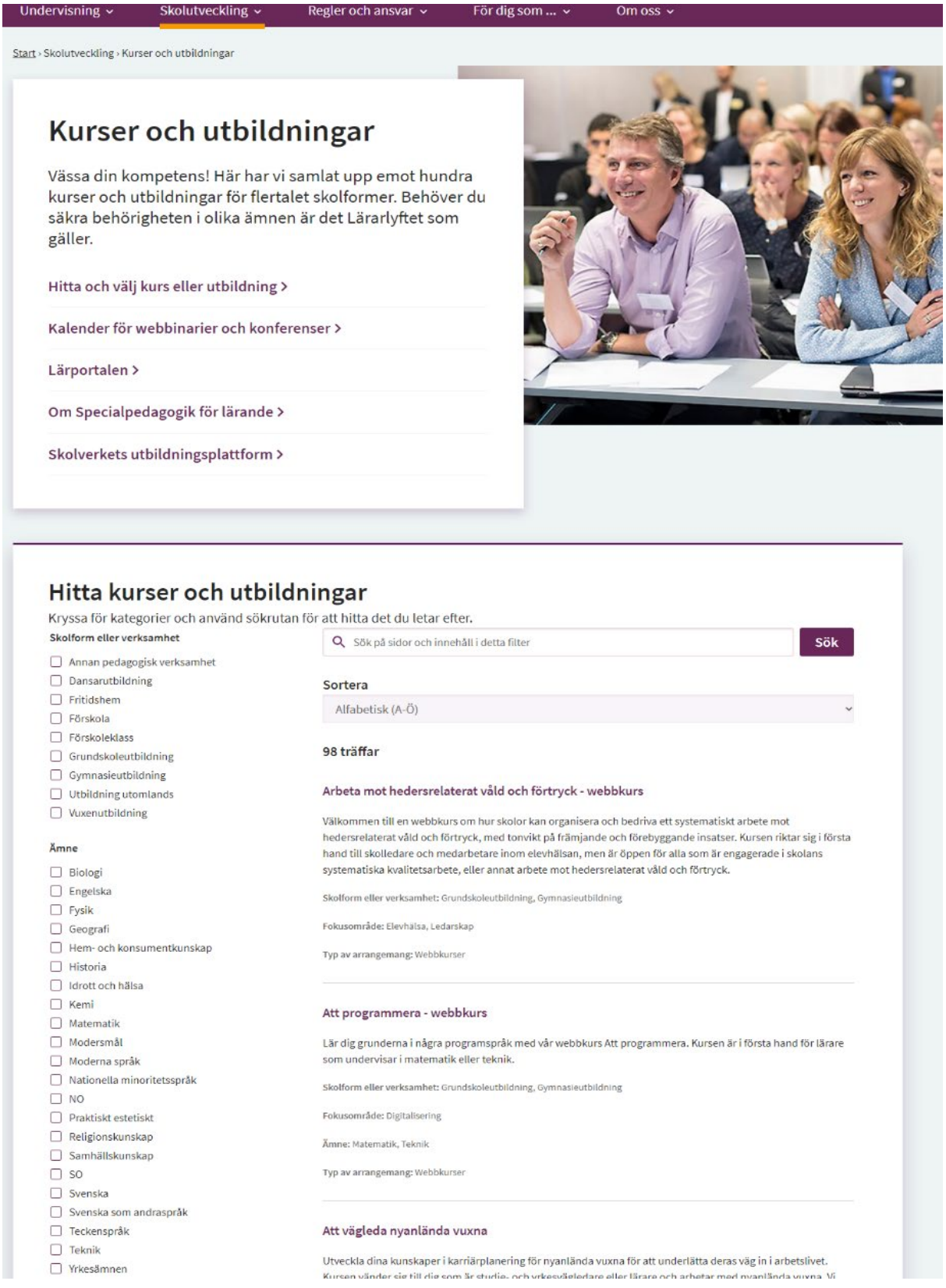
Swedish Qualifications Database

Sweden has several different qualifications databases for different levels and sectors of education. One of them is the ‘schools database’.

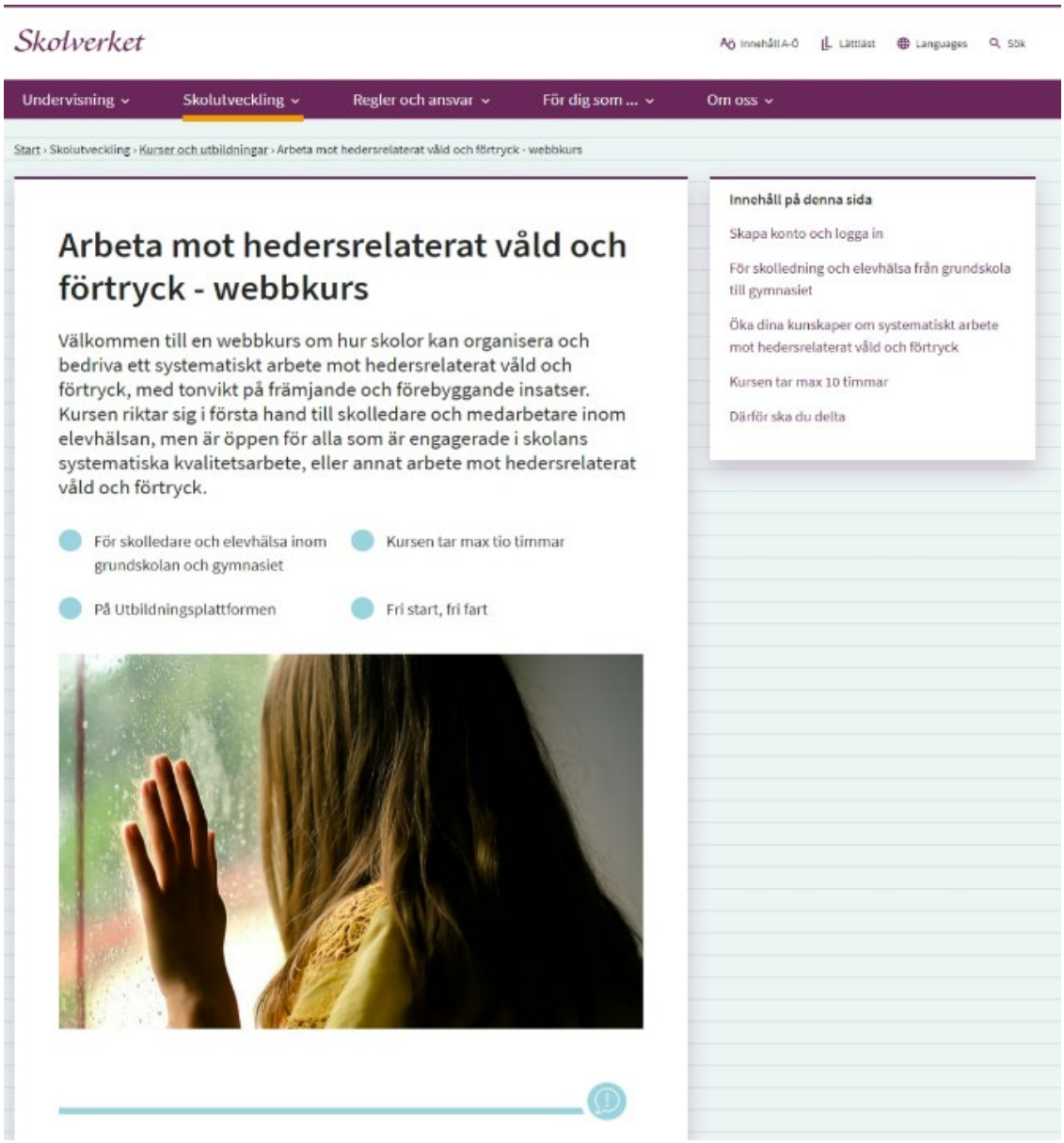
In this example qualifications search is only one function of a much larger portal that deals with all services linked to schools. As such, the link to the qualifications database is found in a dropdown menu, accessible from the front page.



A qualifications search page, allows users to search for courses by type (this page is for short adult courses), and filter the results by various criteria:



The information pages from users are designed in such a way as to not look like database entries, but rather to take the form of information articles about each qualification - they are still mapped and aligned to the European Learning Model:


Skolverket
Innehåll A-Ö
Lättläst
Languages
Sök
Undervisning
Skolutveckling
Regler och ansvar
För dig som ...
Om oss
Start › Skolutveckling › Kurser och utbildningar › Arbeta mot hedersrelaterat våld och förtryck - webbkurs
Arbeta mot hedersrelaterat våld och förtryck - webbkurs
Välkommen till en webbkurs om hur skolor kan organisera och bedriva ett systematiskt arbete mot hedersrelaterat våld och förtryck, med tonvikt på främjande och förebyggande insatser. Kursen riktar sig i första hand till skolledare och medarbetare inom elevhälsan, men är öppen för alla som är engagerade i skolans systematiska kvalitetsarbete, eller annat arbete mot hedersrelaterat våld och förtryck.
För skolledare och elevhälsa inom grundskolan och gymnasiet
Kursen tar max tio timmar
På Utbildningsplattformen
Fri start, fri fart
Innehåll på denna sida
Skapa konto och logga in
För skolledning och elevhälsa från grundskola till gymnasiet
Öka dina kunskaper om systematiskt arbete mot hedersrelaterat våld och förtryck
Kursen tar max 10 timmar
Därför ska du delta

ACRONYMS

E.T.F.	European Training Foundation.
E.I.F	European Interoperability Framework
I.C.T	Information and communication technology
B.P.M.N	Business Process Model and Notation
U.M.L	Unified Modelling Language
E.L.M	European Learning Model
E.U	European Union
F.E	Front-end
B.E	Back-end
E.S.C.O	European Skills, Competencies and Occupations
MoUs	Mode of Use
SLAs	Service Level Agreement
S.E.M.I.C	Semantic Interoperability Centre Europe
L.O.D	Linked Open Data
U.R.I	Uniform resource identifier
R.D.F	Resource description framework
A.P.I	Application Programming Interface
Q.D.R	Qualification Data Register
E.Q.F	European qualifications framework

ETF Working together Learning for life
European Training Foundation

N.Q.F	National Qualifications Framework
V.E.T	Technical and Vocational Education and Training
V.N.F.IL	Validation of Non-formal and Informal Learning
L.M.I	labour Market Information
A.C.Q.F	African Continental Qualifications Framework
I.S.C.E.D	International Standard Classification of Education
X.M.L	Extensible Markup Language

ETF Working together Learning for life
European Training Foundation