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„A matching concept for the validation of prior learning process“

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1. Introduction

1.1. Motivation / Problem statement

We learn every day and in everything we do. This learning happens in almost every situation. Of course, formal learning in schools comes first in life. In school we learn the most basic elements someone needs for life. But learning is not limited to school or university. Every individual learns something when he or she simply participates in society. Furthermore, people also learn during work or traveling. People learn in many different situations in life. On the one hand, this concerns working life and on the other hand one's own leisure time. People also learn by doing volunteer activities. This concept which compromises all forms of learning is also called "lifelong learning". The European Commission (2000, p.3) defines lifelong learning as *"all purposeful learning activity, undertaken on an ongoing basis with the aim of improving knowledge, skills, and competences".* Lifelong learning is, therefore, a comprehensive concept that includes all types of learning.

Europe is moving in the direction of a knowledge-based economy. This makes information, knowledge, and skills more and more important. The European Commission's lifelong learning strategy aims not only to improve employability but also the adaptability of the workforce.

Working life also has changed considerably in recent decades. Workers will change jobs several times today and in the future. However, for this change to be successful, workers must successfully transfer their knowledge, skills, and competences to their new job, new environment or even new country (European Commission, 2000; Colardyn & Bjornavold, 2004). The goal of the European Union is to enhance the mobility of workers and learners. It should be possible to work or study in more than one country. This is only possible if acquired skills in one country are also accredited in another country. The European Qualification Framework plays an important role. The aim is to make qualifications easier to understand across Europe through different qualifications and education systems and thereby promoting the mobility of workers and learners between countries (Griffiths & García-Peñalvo, 2016; Harris, 2012; Sava & Lupou, 2009; Colardyn & Bjornavold, 2004).

However, for workers and learners to be able to use their qualifications in different countries, these qualifications must first be validated and recognized. Qualifications and the resulting

competences are acquired in a variety of ways. This happens on the one hand through formal educational pathways but also through so-called non-formal or informal learning. Especially qualifications from non-formal or informal learning are not always officially recognized and validated. In order to facilitate this recognition, there are various tools that support this validation process. However, it is not clear in the literature or in practice whether these tools really support the process to validate competences. How can a user make sure that a certain tool really helps to recognise and validate competences? (Cedefop, 2017; Berlanga et al., 2008)

1.2. Introduction to key concepts

There are basically three different categories of learning (Cedefop, 2015):

- Formal learning
- Non-formal learning
- Informal learning

Although there are three different types of learning, formal learning in schools or universities is still seen as the most important form to learn. However, the goal must be to determine the entire learning process of an individual in society as well as in the labor market. This is referred to as "validation of prior learning". According to the European guidelines for validation of non-formal and informal learning: *"Validation is, first, about making visible the diverse and rich learning of individuals. This learning frequently takes place outside formal education and training – at home, in the workplace or through leisure time-activities – and is frequently overlooked and ignored. Validation is, second, about attributing value to the learning of individuals, irrespective of the context in which this learning took place"* (Cedefop, 2015, p.14). Basically, validation is about making the whole knowledge or the competences of a person visible. It is completely irrelevant how the knowledge acquisition took place. The knowledge acquired through non-formal or informal learning should be given a certain value and in the next step also supplement formal knowledge. At the university level, for example, the aim may be that students no longer have to take certain courses because they already acquired the skills of the course in another way (University of Lapland, 2010).

Validation of prior learning is, therefore, a key aspect of lifelong learning strategies. As long as learning and the related competences and skills acquired outside formal education remain invisible, the objective of lifelong learning cannot be achieved.

The Process of Validation

The European guidelines for the validation of non-formal and informal learning identified four phases for the process of validation: Identification, Documentation, Assessment, and Certification (Cedefop, 2015).

1. Identification of the learning outcomes through non-formal and informal learning,
2. Documentation of the learning outcomes,
3. Assessment of the learning outcomes and
4. Certification of the results of the assessment.

Appropriate tools for the validation process are important and necessary to be able to receive a valuable outcome. According to the European Inventory Report of 2016, the use of standardized tools is not widespread, as just a few countries like Austria or Germany are using IT tools. However, some IT tools can be found in the different country reports which support individual phases or the entire validation process. The European guidelines also recommend that individual countries should develop appropriate tools for the process (Cedefop, 2015). The Europass or Youthpass are such tools, which are support the documentation of learning outcomes. Furthermore, there are tools like the job-card system, skills passports, portfolios or online CVs. There are also tools like AiKomPass, YourRock, TENCompetence Portfolio, Myelvin, My Career or ProfilPass which were developed by individual countries or scientific researchers (Cedefop, 2015; García-Peñalvo & Conde, 2013; Berlanga et al., 2008; Ball, 2016). There exists also a database with more than 300 tools for validation of formal, non-formal and informal learning (BEVIN). However, it is not always clear if every single tool is really matching with the validation process and can therefore be used to validate knowledge and competences.

1.3. Research objective

A lot of literature can be found about the whole validation process and also about the different aspects of each phase. Furthermore, there is also research focus on the underlying theories and on the various strategies and approaches (Council of the EU, 2012; Diedrich, 2013; Sava & Lupou, 2009). With its recommendations and guidelines, the European Union has instructed the member states to identify and recognize the learning outcomes of people who have acquired them in different situations outside of formal learning. The member states are using various

methods and tools for this purpose. On one hand, there are tools such as the Europass, which are used by all member states. On the other hand, many states also develop their own tools for specific purposes or areas of interest. The AiKomPass, for example, is an instrument for making competences visible and documenting them for employees in the metal and electrical industry (Cedefop, 2017; Ball, 2016). Although there are already many IT tools for the validation process, it is not always clear whether the respective IT tools fulfill the purpose they are supposed to fulfill. For example, Is the Aikompass really a tool that can be used for any part inside the validation of prior learning process? Is YouRock really a tool that can be used to make competences visible? Is the ProfilPass really matching with the validation process and can therefore be used for it?

Therefore, the **research objective** of this master thesis is to develop a method that evaluates whether given IT tools match with the validation of prior learning process. With this concept one can make processes, in this case the validation process, with tools. This method is then evaluated within the framework of a developed tool. This tool is created using Python, ADOxx, which is a meta-modeling development and configuration platform (Karagiannis & Kühn, 2002), and an algorithm. I can test the developed concept with the tool afterwards.

To be able to verify whether the validation process and an IT tool matches, a suitable algorithm is needed that can perform this matching meaningfully. A suitable model for this could be the vector space model. With the vector space model, a document is transformed into a vector so that it can be compared with others. In the specific case of this master thesis, one class of vectors characterize relevant descriptors within each phase of the validation of prior learning process and the other class of vectors characterize relevant descriptors of specific IT tools. Therefore, a common semantic between the phases and the tools must be found or developed first. This would result in a common basis which is necessary for the vector space model (Salton et al., 1975).

1.4. Research methodology

The objective of this master thesis is to develop a method that realizes and supports the matching of IT tools for the validation of prior learning processes. The selected research methodology to achieve this objective is the design-science based approach, which was introduced by Hevner and Chatterjee (2010). Every objective of a design-science research

project is to develop an artifact, which addresses problems. The design-science approach does not provide a strict process for doing design-science research but provides an information system research framework as seen in figure 1. This research framework is applied to my master thesis project.

The environment consists of people, organizations and technologies. The organizations have certain strategies as well as cultures and processes. From this, organizations and people derive so-called "business needs". Information System (IS) research is about developing an artifact according to the business needs. The knowledge base provides the foundations and methods necessary for such a development.

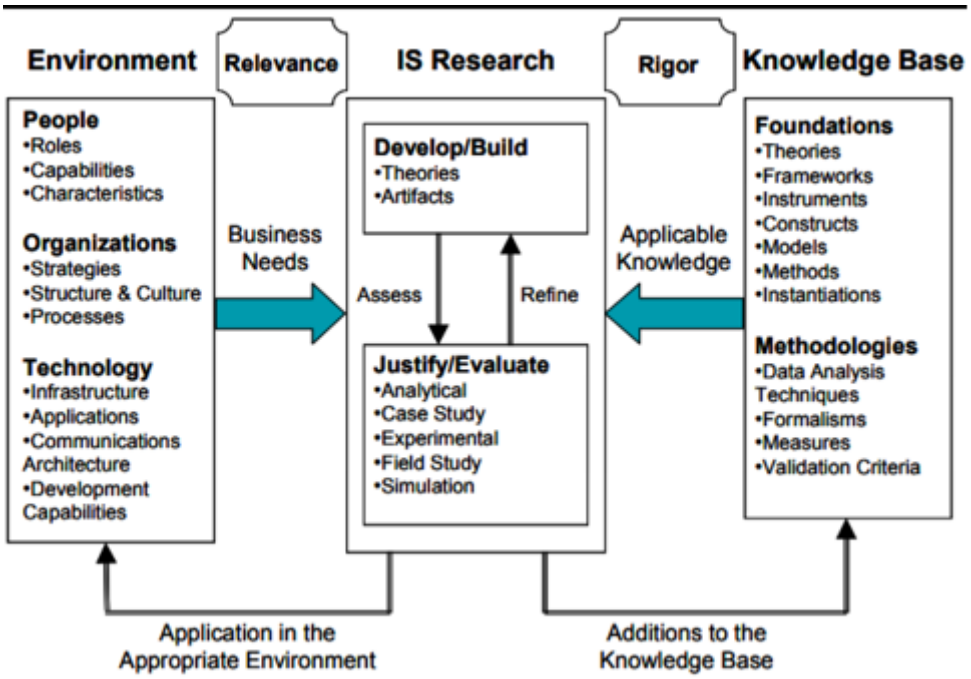


Figure 1: Design Science (Hevner & Chatterjee, 2010, p.274)

Furthermore, every design research project should include three design research cycles as shown in figure two. The relevance cycle connects the contextual environment, for example, people, organizational systems and technical systems with the activities of the design science. The rigorous cycle provides the knowledge base of existing knowledge. It is very important to research the existing knowledge to ensure that each project is a useful contribution to the research area. The central design cycle, which is iterative, involves the development of artifacts and processes as well as an evaluation (figure 2) (Hevner, 2007).

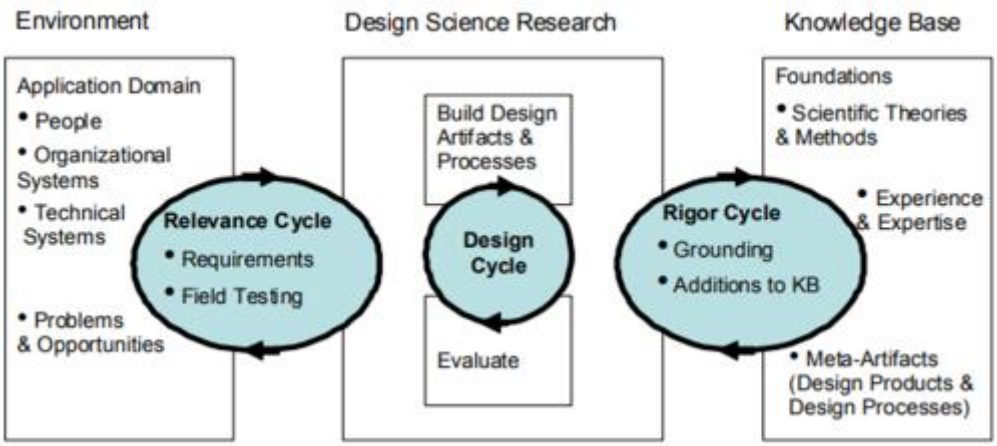


Figure 2: Design research cycle (Hevner, 2007, p.2)

This master thesis is based on this generic framework. However, not all elements of it are used, but only selected ones. Figure 3 shows the elements needed for this master thesis.

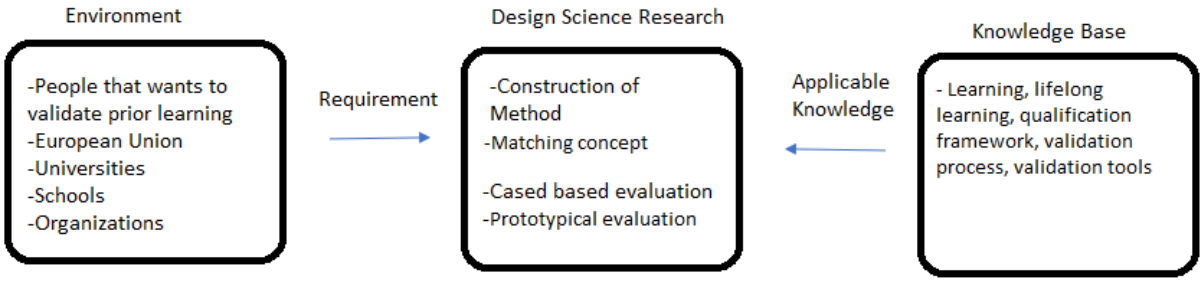


Figure 3: Framework of the master thesis

Figure 3 shows the research framework used in the master thesis, which is an instantiation of the design science research methodology. As shown in figure 3, the contextual environment for this work is general people who would like to validate their competences or what they have learned. In addition, the European Union, but also universities or schools have an interest in it. The knowledge base consists of the literature on learning, forms of learning, lifelong learning, the general validation process and of course the different validation tools. Not only literature is used, but also case studies or guidelines are analyzed. The design cycle consists of method development and evaluation. On the one hand, the evaluation is carried out using a cased-based approach and a prototypical evaluation.

1.5. Basic concept

Before going into more detail about the research approach, the basic concept of this master thesis must first be explained. This basic concept will then help to classify and understand the individual steps that are explained in the research approach. Why is formal, informal and non-formal learning written about at all? And why is the Process of Validation important in this context? Figure 4 shows the basic concept graphically. Step 1 shows that people learn throughout their lives (lifelong learning). This learning has different forms in the form of formal, informal and non-formal learning and subsequently leads to learning outcomes. In step 2, people then try to validate these learning outcomes or what they have already learned, so that it can then be demonstrated in a job or at university, for example. This validation is done through the four-step validation process with the process steps Identification, Documentation, Assessment and Certification. This process or the individual steps are defined by certain characteristics. The validation process is supported by tools such as YouRock or ProfilPass, which are shown in step 3. These tools are also defined by certain characteristics. However, in order for this support to be possible, the tools must match the process, that is, the characteristics must be brought to the same level. This matching is done in step 4, which is especially useful for people who want to validate and recognize especially informally acquired competences.

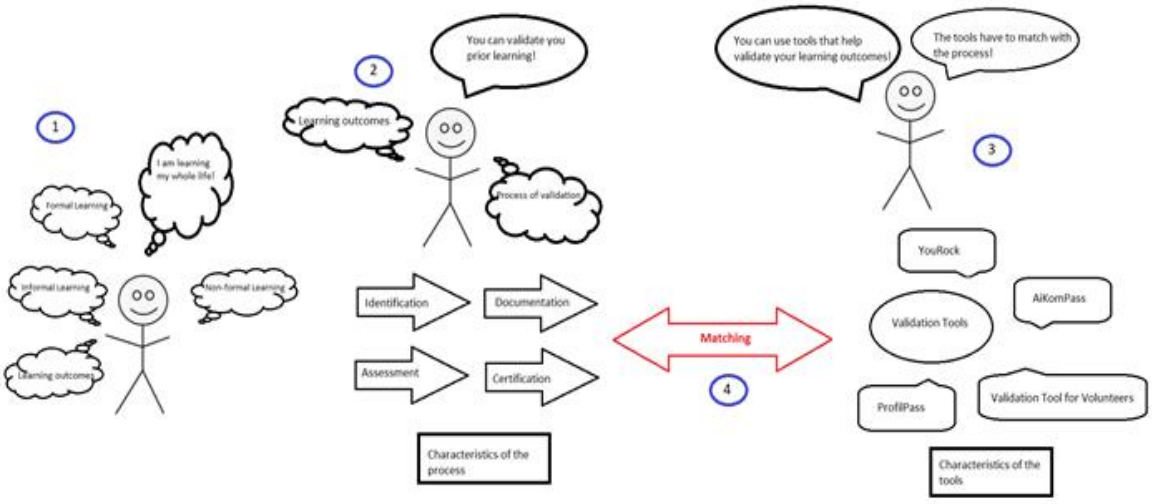


Figure 4: Basic Concept

1.6. Research approach

The research approach is based on the design science research methodology by respecting the guidelines from Hevner and Chatterjee (2010). The research approach is divided into five different steps which should support the research objective.

Step 1: Conducting a literature review and gathering knowledge

The literature view is very important to understand the whole concept of the validation of the prior learning process. The validation process is not just a simple execution of each of the four process steps but rather a complex procedure to reach certain goals. Therefore, relevant literature and knowledge should be analyzed. Furthermore, it is important to gather relevant knowledge concerning the different IT tools which are used within the developed artifact. This knowledge should also help define the relevant characteristics in step 2.

The literature review was conducted using the three-step Rapid Structured Literature Review (RSRL) method by Armitage & Keeble-Allen (2008). This literature review made it possible to explain and describe the concept of learning in more detail on the one hand, and to work out the three different forms of learning on the other. Furthermore, the literature analysis has shown that there are many different approaches to validate learning outcomes. As the most important and prominent approach the guidelines of the European Union were used. The literature review has also shown that, according to practice and theory, there are many different tools that try to support the validation process. The knowledge gained from the literature review is applied in the global picture (figure 4) in step one and step two, so that the individual terms and concepts are understood at all.

The literature analysis was done in chapter 2.

Step 2: Defining characteristics of the validation process and of the appropriate IT tools and defining the matching concept

In order to process the literature, which is fundamentally available, there are three different components. On the one hand, there is a need for a framework or method for the procedure or how the elements can interact with each other in order to enable subsequent validation. This is made possible by the qualitative content analysis of Mayring (2004). Using this method, four different categories were identified and described with characteristics. The characteristics represent the second component. With the help of these characteristics it is possible to describe the individual categories. The third component then refers to how an evaluation is carried out.

This assessment is performed using a matching concept. Using this concept and a corresponding algorithm it is possible to match tools with the validation process. Based on this concept, requirements for the research objective, the method, were finally derived.

Step 2 of the research approach was done in chapter 3.

Step 3: Prototypical evaluation

With the prototypical evaluation (Vom Brocke, 2011) it is possible to verify whether the concept described is technically feasible. In principle, the prototypical evaluation consists of three different components: The modelling procedure, the meta model and the algorithm. Using the ADOxx Development Toolkit an own meta-model as well as an associated modelling procedure was developed. The algorithm on the other hand was developed with Python and Natural Language Processing (NLP). First, the generic contents of the modeling procedure, the meta-model and the algorithm are discussed. Then the specific contents are described and implemented. The prototypical evaluation is described in chapter 4.

Step 4: Case-based evaluation

During this step, the developed artifact is evaluated and improved. This step is an iterative step. According to Hevner and Chatterjee (2010) the evaluation in the design-science research is crucial. There are several evaluation methods as seen in figure 5. The most appropriate evaluation method for this specific master thesis is the cased-based evaluation.

By means of this evaluation, three different scenarios are modelled and tested. In the first scenario, the YouRock tool, a matching result with the Validation of prior learning process of 94% is obtained. The second scenario was tested using Moodle and gives a result of 46%. The third and last scenario was performed with a fictitious tool and gives a result of 0%.

1. Observational	Case Study: Study artifact in depth in business environment
	Field Study: Monitor use of artifact in multiple projects
2. Analytical	Static Analysis: Examine structure of artifact for static qualities (e.g., complexity)
	Architecture Analysis: Study fit of artifact into technical IS architecture
	Optimization: Demonstrate inherent optimal properties of artifact or provide optimality bounds on artifact behavior
	Dynamic Analysis: Study artifact in use for dynamic qualities (e.g., performance)
3. Experimental	Controlled Experiment: Study artifact in controlled environment for qualities (e.g., usability)
	Simulation – Execute artifact with artificial data
4. Testing	Functional (Black Box) Testing: Execute artifact interfaces to discover failures and identify defects
	Structural (White Box) Testing: Perform coverage testing of some metric (e.g., execution paths) in the artifact implementation
5. Descriptive	Informed Argument: Use information from the knowledge base (e.g., relevant research) to build a convincing argument for the artifact's utility
	Scenarios: Construct detailed scenarios around the artifact to demonstrate its utility

Figure 5: Design Science (Hevner & Chatterjee, 2010, p.280)

2. Literature review

In this chapter the most important terms, concepts as well as connections and contents are explained in detail. These include the concepts of formal, non-formal and informal learning as well as lifelong learning and the associated process of validation of formal, non-formal and informal learning. In addition, relevant IT tools for the validation process are briefly described.

In order to map the diversity of literature sources for these different subject areas, a systematic methodology is needed to perform this literature analysis. A very well-known and at the same time effective method is the Structured Literature Review (SLR) by Tranfield et al. (2003). However, this method is mainly used for larger works, such as a doctoral thesis or dissertation. Therefore, in this master thesis the method of the Rapid Structured Literature Review (RSLR) by Armitage and Keeble-Allen (2008) is used, which can be used especially for smaller work such as bachelor and master thesis. The RSLR is divided into three main phases. First, the conceptualization is started, the definition of needs and problems. Why is it important to study the topic at all? In this phase a so-called topic map or mind map is created. The map shows the different terms or topics and their interaction. The conceptualization is then followed by the literature search, which can be seen as the core operational aspect in the thesis. Subsequently the structuring and reporting, the writing and analysis of the literature follows.

Since this master thesis deals with the problem of how to validate acquired qualifications and competences, learning and the corresponding validation of the acquired knowledge are the most important and central topics of this literature review. It is therefore important to identify and understand the different types of learning. Figure 6 shows the corresponding topic map of this master thesis. The map starts with the topic area learning and the different types of learning. This learning then generates so-called learning outcome. But not only "normal" learning, but also learning at the workplace leads to these learning outcomes. The concept of learning and the corresponding learning outcomes both flow into the broad concept of lifelong learning. This concept uses a corresponding qualification framework. The achieved learning outcomes then lead to the process of validation of learning outcomes. This process is defined by the European guidelines for validation and also requires certain quality characteristics. Finally, the Process of Validation uses tools for support. The literature analysis is structured according to the topic map.

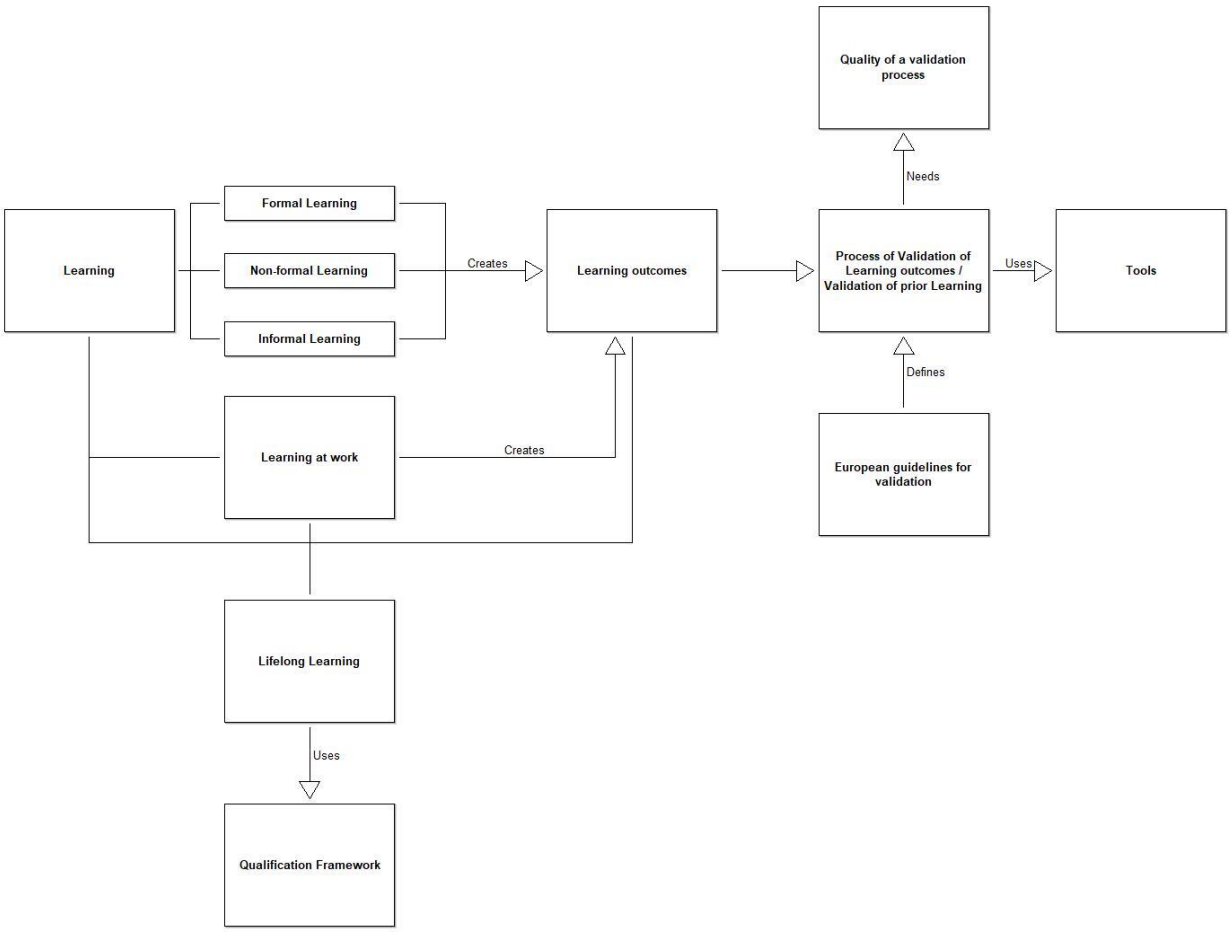


Figure 6: Topic Map

After the topic areas have been defined, the literature search is carried out. Literature databases are searched with the help of keywords. The keywords are, besides some others, as follows: Learning, formal learning, informal learning, non-formal learning, competencies, learning outcomes, learning pathways, workplace learning, lifelong learning, lifelong education, qualification framework, flexible learning, lifeplace learning, employability, accredidation of prior learning, recognition of prior learning, validation of learning. After checking the quality of the literature found, the most important findings are analyzed and the differences between the views of the authors will be addressed.

2.1. Formal, non-formal and informal learning

There are many different definitions for formal, non-formal and informal learning in the literature, practice and politics (Cedefop, 2008; OECD, 2007; UIL, 2012). The distinction between the terms is very important, because although they all have "learning" as a basis, the learning itself is achieved in different ways and contexts.

The Terminology of European education and training policy (Cedefop, 2008, p.99f) provides the following definitions:

- ***Formal learning:*** *Learning that occurs in an organized and structured environment (e.g. in an education or training institution on the job) and is explicitly designated as learning (in terms of objectives, time or resources). Formal learning is intentional from the learner's point of view. It typically leads to validation and certification.*
- ***Non-formal learning:*** *Learning which is embedded in planned activities not explicitly designated as learning (in terms of learning objectives, learning time or learning support). Non-formal learning is intentional from the learner's point of view.*
- ***Informal learning:*** *Learning resulting from daily activities related to work, family or leisure. It is not organized or structured in terms of objectives, time or learning support. Informal learning is in most cases unintentional from the learner's perspective.*

The OECD (2007, p.25f) defines the three different types of learning as follows:

- ***Formal learning:*** *Formal learning can be achieved when a learner decided to follow a program of instruction in an educational institution, adult training center or in the workplace. Formal learning is generally recognized in a qualification or a certificate*
- ***Non-formal learning:*** *Non-formal learning arises when an individual follows a learning program but it is not usually evaluated and does not lead to certification. However, it can be structured by the learning institution and is intentional from the learner's point of view.*
- ***Informal learning:*** *Informal learning results from daily work-related, family or leisure activities. It is not organized or structured (in terms of objectives, time or learning support). Informal learning is in most cases unintentional from the learner's perspective. It does not usually lead to certification*

Another definition is formulated by and used in the UNSECO Guidelines on the Recognition, Validation and Accreditation of the Outcomes of Non-Formal and Informal Learning (UIL, 2012, p.8):

- *Formal learning takes place in education and training institutions, is recognized by relevant national authorities and leads to diplomas and qualifications. Formal learning is structured according to educational arrangements such as curricula, qualifications and teaching-learning requirements.*
- *Non-formal learning is learning that has been acquired in addition or alternatively to formal learning. In some cases, it is also structured according to educational and training arrangements, but more flexible. It usually takes place in community-based settings, the workplace and through the activities of civil society organizations. Through the recognition, validation and accreditation process, non-formal learning can also lead to a qualification and other recognitions.*
- *Informal learning is learning that occurs in daily life, in the family, in the workplace, in communities and through interests and activities of individuals. Through the recognition, validation and accreditation process, competencies gained in informal learning can be made visible and can contribute to qualifications and other recognitions. In some cases, the term experiential learning is used to refer to informal learning that focuses on learning from experience.*

Taking into account the various definitions it becomes clear that informal learning is rather an unplanned or implicit process. In most cases the results are not really predictable. Informal learning is never organized or intentional from the learner's point of view. Mostly it happens through interactions with others. There are not really fixed goals regarding learning outcomes, and informal learning usually happens spontaneously and unconsciously. Learners usually do not notice that they have just learned something (Kyndt & Dochy, 2009; Singh, 2015). Non-formal learning was actually developed in order to further classify or describe the different categories of learning, since the difference between formal and informal learning was not enough (Werquin, 2007). A precise definition of non-formal learning is not so simple, as can be seen from the three different definitions given in figure four. It is somehow between formal learning and informal learning giving the *"advantages in establishing degrees of formality rather than fixed definitions"* (figure 7) (Werquin, 2010). Basically, non-formal learning refers to learning that usually takes place outside a formal education system. Compared to informal

learning, non-formal learning very often has learning objectives. Moreover, this learning happens mostly in an organized way (Cedefop, 2015). In most cases, non-formal learning is rather a process in which the learner learns because of his own interest or takes part in organized activities that have the underlining goal of learning (Kyndt & Dochy, 2009). Knowledge and competences resulting from non-formal learning are mostly the result of participation in society. Bjornavald (2001), on the other hand says, that even in non-formal learning learners do not always know that they have acquired competences at all. Therefore, also for non-formal, and of course for informal learning, it is very important to find a suitable way to assess these competences (Björnavald, 2001).

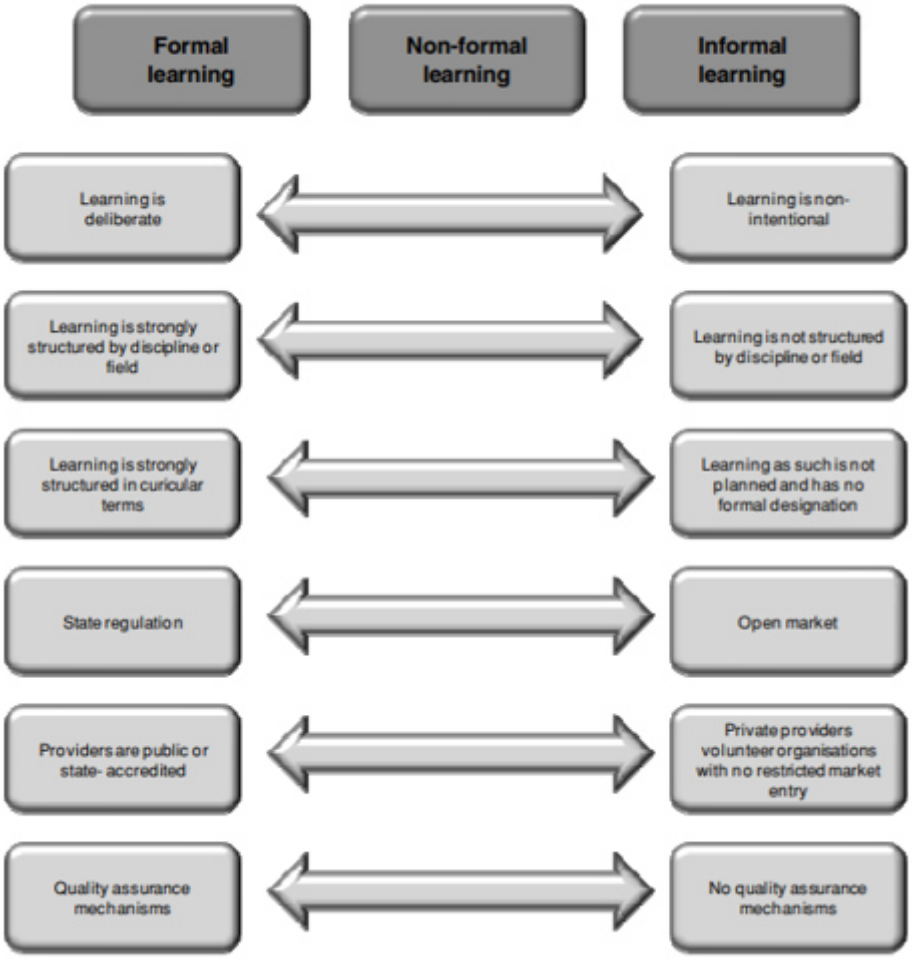


Figure 7:Learning (Werquin, 2010, p.25)

To sum up, table one provides a synopsis of the different approaches (Werquin, 2010). Formal learning is organized, has learning objectives and is intentional. Informal learning is not organized, does not have any learning objectives and is not intentional. Non-formal learning is

in the middle and is sometimes organized, has sometimes learning objectives and is sometimes intentional.

	Organised	**Learning Objectives**	**Intentional**	*Duration*	*Leads to a Qualification*
Formal Learning	Yes	Yes	Yes	*Rather long and/or full-time*	*Yes*[1]
Non-formal Learning	Yes or No	Yes or No	Yes or No	*Rather short, or part-time*	*No*[2]
Informal Learning	No	No	No	*NA*	*No*

Notes:
1. "Almost always" would be more accurate
2. "Usually no" would be more accurate

Table 1: Synopsis of learning (Werquin, 2007, p.4)

As said, there are many different definitions for the three different categories of learning. Basically, strict definitions are not really needed, because every country or institution might interpret it a little bit different. However, the definitions are important so that countries, policymakers and researchers can speak the same language in order to work and research (Werquin, 2010).

It is also very important to understand that these three different learning categories do not lead to different competences, skills or knowledge. The knowledge, skills and competences which are gained are usually the same, no matter in which context or environment the learning took place. The distinctions between the forms of learning, therefore, relate mainly to the environment in which it took place and not to the outcome. The distinction only becomes essential when identification, documentation, assessment and certification of these knowledge, skills and competences takes place (Werquin, 2010).

2.1.1. Learning outcomes

When people learn, this learning usually produces a result, the so-called learning outcomes. As already described, these learning outcomes are structured in knowledge, skills and competences. According to the Recommendation of the European Parliament and of the Council of 23. April 2008 in the establishment of the European Qualifications Framework for lifelong learning outcomes are defined as follows: *"learning outcomes means statement of what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and competence"* (European Parliament & Council, 2008, p.4).

Accordingly, there is not only one central learning outcome but several. It is important to distinguish between knowledge, skills and competences. According to the Terminology of European education and training policy (2008, p.47f), the three terms are defined as follows:

- *Knowledge: The outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of study or work.*
- *Skill: The ability to perform tasks and solve problems.*
- *Competence: The ability to apply learning outcomes adequately in a defined context (education, work, personal or professional development).*

Knowledge thus includes the underpinning of theory and concepts, but also tacit knowledge acquired through experience or execution of certain tasks. Knowledge is also often divided into general knowledge, for example independent knowledge from a professional context, and knowledge that is specific to a particular sector or occupational group. Skills refer primarily to concrete learning such as writing, reading and arithmetic. These skills are usually mechanized to such an extent that they can also be executed unconsciously. These skills can then be used to perform tasks and solve problems (Winterton et al., 2006; European Centre for the Development of Vocational Training, 2008; Bohlinger, 2008). Competences, on the other hand, are the ability of a person to fulfill a problem or a requirement based on experience, knowledge and ability. Competences enable people to act in a self-determining way in everyday life and at work (Deist & Winterton, 2005).

2.1.2. Learning at work

The balance between formal and informal learning also plays an important role in working life. Knowledge and competences of employees are one of the largest and most important resources for a company. In order to remain competitive, a company's aim must be to employ people with a large set of skills and knowledge. On the other hand, these competences must always remain up-to-date and should be further developed and improved. This is precisely why learning in the environment of a workplace is so important (Grip, 2015). However, this learning should not only include formal learning, for example official courses, but should also concern informal learning. Many companies are aware that informal learning should play an important role inside the company. Not only formal learning at the workplace, but also informal learning has a positive influence on the financial performance of a company (Park & Jacobs, 2011). However,

many do not succeed in exploiting or optimizing this potential. One reason for this is that many companies do not have adequate human resource management strategies (Grip, 2015; Berglund & Andersson, 2012).

On the other hand, a lot of different learning happens in the work area. Through the validation process, these unrecognized knowledge or skills can be made openly accessible. This allows the staff to see and use them. However, although there are already many different types of learning in the workplace, knowledge and skills developed are rarely documented or officially recognized (Grip, 2015). The most obvious reason for this non-recognition is that investment in education and skills would be lost if employees would leave the organization. It must also be taken into account that skills acquired through informal learning in a company are less transparent to other employees than those acquired through formal training or learning. (Berglund & Andersson, 2012; Romaniuk & Snart, 2000).

Grip (2015) notes that workers are confronted with informal learning in the workplace almost every day. This concerns in particular learning by doing, learning from superiors and learning from colleagues. Grip (2015) also shows that informal learning in the workplace is much more important than formal training, especially for the development of workers' skills. This suggests that informal learning in the workplace should be given a higher priority. In particular, the skills and competences of an employee should always be kept up to date.

Berglund & Andersson (2012) examined four different organizations and found that knowledge and skills are conceived and evaluated in these organizations. This assessment, however, was more based on spontaneous activities. The researchers found that the main focus was on evaluating knowledge and skills that could be used in activities within the organization. They did not only refer to skills that had been developed through internal training, for example, but also to knowledge and skills that came into the organization when recruiting new staff.

Eraut (2004) also dealt with informal learning in the workplace and found that workplace learning very often takes place on the job and not off the job. According to Eraut (2004) there are several problems that arise when dealing with informal learning. These problems relate not only to working life, but also to the general characteristics of informal learning. The main problems identified by Eraut (2004) are the following:

- *Informal learning is largely invisible, because much of its is either taken for granted or not recognized as learning; thus, respondents lack awareness of their own learning;*

- *The resultant knowledge is either tacit or regarded as part of a person's general capability, rather than something that has been learned;*
- *Discourse about learning is dominated by codified, propositional knowledge, so respondents often find it difficult to describe more complex aspects of their work and the nature of their expertise* (Eraut, 2004, p.249).

Learning in the workplace, no matter in which form it takes place, should therefore have a high priority for every company or organization. Even if there is a risk that what has been learned will not remain in the organization forever, investments should be made to ensure that the workforce can develop and thus improve the company's performance (Eraut, 2004; Berglund & Andersson, 2012).

2.2. Lifelong learning

Europe has for some time been moving towards a knowledge-based society and economy. Information and knowledge are becoming increasingly important in today's society. To strengthen society, access to and intelligent use of this information is a key issue. Through the efficient use of these resources, Europe will achieve better competitiveness, improved employability and adaptability of its workforce. In addition, the individuality of each human is becoming increasingly important and everyone wants to plan and control his or her own life and also contribute something to society. These are all challenges that can be met with a high level of education so that people are independent and at the same time able to master their life. That is why lifelong learning is a current and very important topic (European Commission, 2000). The concept of lifelong learning of the European Commission has two central objectives: Promoting active citizenship and promoting employability. Active citizenship goes in the direction of whether people belong to society and accordingly also contribute something to it. Employability is the result of active citizenship and is particularly important for strengthening Europe's competitiveness. In the Memorandum on Lifelong Learning, the European Commission has formulated six basic messages which should help to pursue lifelong learning. (European Commission, 2000; Colardyn, 2001). These six basic messages are the following:

1. New basic skills for all
2. More investment in human resources
3. Innovation in teaching and learning
4. Valuing learning

5. Rethinking guidance and counseling
6. Bringing learning closer to home (European Commission, 2000, S.10).

The European Commission (2000, p.3) defines lifelong learning as "*all learning activity undertaken throughout life, with the aim of improving knowledge, skills and competences within a personal, civic, social and/or employment-related perspective".* It is therefore a comprehensive concept that includes all types of learning. This learning begins in early childhood and accompanies a person throughout life. It is therefore also important that the knowledge or skills acquired are not valid throughout a person's entire life but must be regularly updated. It is also essential to stress that there are many different types of learning. These types include non-formal and informal learning.

Message 4 (Valuing learning) aims at: *„Significantly improve the ways in which learning participation and outcomes are understood and appreciated, particularly non-formal and informal learning" (*European Commission, 2000, p.15).

In today's knowledge society, certificates or qualifications are an important orientation for employers and employees. More and more qualifications and competences are expected as the demand for qualified workers increases. It must therefore be ensured that learning is visibly and appropriately certified. Important steps have already been taken in this direction, such as the mutual recognition of qualifications in higher education. Nevertheless, innovative forms of proof of qualification are important, especially in the area of non-formal and informal learning. Accreditation of Prior and Experiential Learning (APEL) systems are therefore particularly important. These systems evaluate and validate knowledge and competences acquired through formal learning on the one hand and non-formal and informal contexts on the other. Knowledge and competences from non-formal and informal learning are often not perceived as such or are unaware of them to the individual. The assessment can therefore help to disclose such knowledge (European Commission, 2000; Colardyn & Bjornavold, 2004).

Lifelong learning is a concept or theory that has not only existed in the last few years but has developed and crystallized over many decades. Not only in the European Union but all over the world scientists and politicians have developed and researched this topic. According to Bagnall (2000) there are three different progressive sentiments that have shaped theory in recent decades but have also steered it in a certain direction. These sentiments are the individual, the democratic and the adaptive sentiment. *"The individual progressive sentiment is defined by its programmatic commitment to individual growth and development"* (Bagnall, 2000, p.25). This approach is primarily concerned with the self-determination and development of an individual.

The main goal of education and lifelong learning is therefore individual growth and development. *"The democratic progressive sentiment is defined by programmatic commitment to social justice, equity and social development through participative democratic involvement"* (Bagnall, 2000, p.26). The democratic progressive sentiment is about education being seen as a public good. The purpose of education should therefore be to promote its social action for the development of a more humane and tolerant society. *"The adaptive progressive sentiment is defined by its programmatic commitment to cultural change. It seeks liberation from deprivation, poverty and dependence, through adaptive learning"* (Bagnall, 2000, p.27). This sentiment is about the fact that, as a result of constant cultural change, people should always be ready for something new and that the need for learning through adaptive learning is therefore increasing more and more (Bagnall, 2000; Bagnall, 2001; Johnson, 2002; Aspin et al., 2012).

2.2.1. Qualification framework

For the concept of lifelong learning to work, there must also be so-called qualification frameworks. The aim of such qualification frameworks should be that employers, but also educational institutions, recognize qualifications across national borders and create a common basis (Volles, 2016). Each country usually has its own qualifications framework. The development of a European qualification framework has set itself precisely this recognition across national borders as a goal. The recognition of non-formal and informal learning is particularly strongly linked to qualifications frameworks. To measure qualifications gained through non-formal and informal learning, there have to be uniform standards in order to treat these qualifications properly (Harris, 2012). The main purpose of the European qualification framework is therefore to make qualifications more comprehensible and comparable across Europe. This also promotes the mobility of learners and workers between countries. Such qualifications frameworks are a very important instrument for lifelong learning. The main objective of the European qualifications framework is to apply it to all learners and to adapt the system to integrate validation of non-formal and informal learning. Furthermore, the European qualification framework is applicable to all types of qualifications (OECD, 2007; Harris, 2012). Countries introducing a qualifications framework are trying to make their education systems more transparent, innovative and competitive. This is also the fundamental aim of the European Union with the European qualifications framework. Another objective of a qualification

framework is, for example, broader access to education opportunities or more opportunities to acquire qualifications (Bohlinger, 2008; Young, 2008).

According to the European Union as mentioned above in 2.1.1, learning outcomes are specified in three categories: knowledge, skills and competence. This means that qualifications cover a very broad spectrum of learning outcomes. This includes not only theoretical knowledge, technical and practical skills, but also social competences such as the ability to work with others. Learning outcomes therefore determine knowledge, skills and competences. These can be described within the European qualifications framework by so-called descriptors. Descriptors are generally abstract descriptive features or keywords that refer to the knowledge, skills and competence associated with a level. Each knowledge, skill or competence consists of eight levels. These eight levels are defined by a series of descriptors. Table two shows how this qualification framework can look like. (European Commisson, 2008; Méhaut & Winch, 2012). Knowledge, skills and competences are divided into four different levels. Each level is defined by a certain intellectual level.

Level	Knowledge	Skill	Competence (autonomy and responsibility)
Level 1			
Level 2			
Level 3			
Level 4 ... 5 ... 6			
Level 8 (doctoral)			

Table 2: European Qualification Framework (Méhaut & Winch, 2012)

A qualification framework is part of a qualification system. A qualification system *"includes all aspects of a country's activity that result in the recognition of learning"* (OECD, 2007, p.22). A qualification framework is *"an instrument for the development and classification of qualifications according to a set of criteria for levels of learning achieved…All qualification frameworks, however, establish a basis for improving the quality, accessibility, linkages and public or labor market recognition of qualifications within a country and internationally"* (OECD, 2007, p.22), and is therefore a component of a qualification system.

Figure 8 shows four different effects of a qualification system on lifelong learning. These four effects are:

- *Quantity of learning opportunities*

- *Quality of lifelong learning provision*
- *Equity of access to learning*
- *Efficiency of the lifelong learning processes* (OECD, 2007, p.26)

The effect quantity of learning opportunities is for example maintaining transparency for users or minimizing the cost of qualifications. Quality of lifelong learning provision is for instance clarifying the outcome of learning or involving stakeholders in qualification design. The effect of equity of access to learning is for example removing barriers to provision for specific groups or also focusing on outcomes of learning whenever possible. The efficiency of lifelong learning processes is for instance maintaining a clear structure of qualifications or maintaining stability in the system (OCED, 2007).

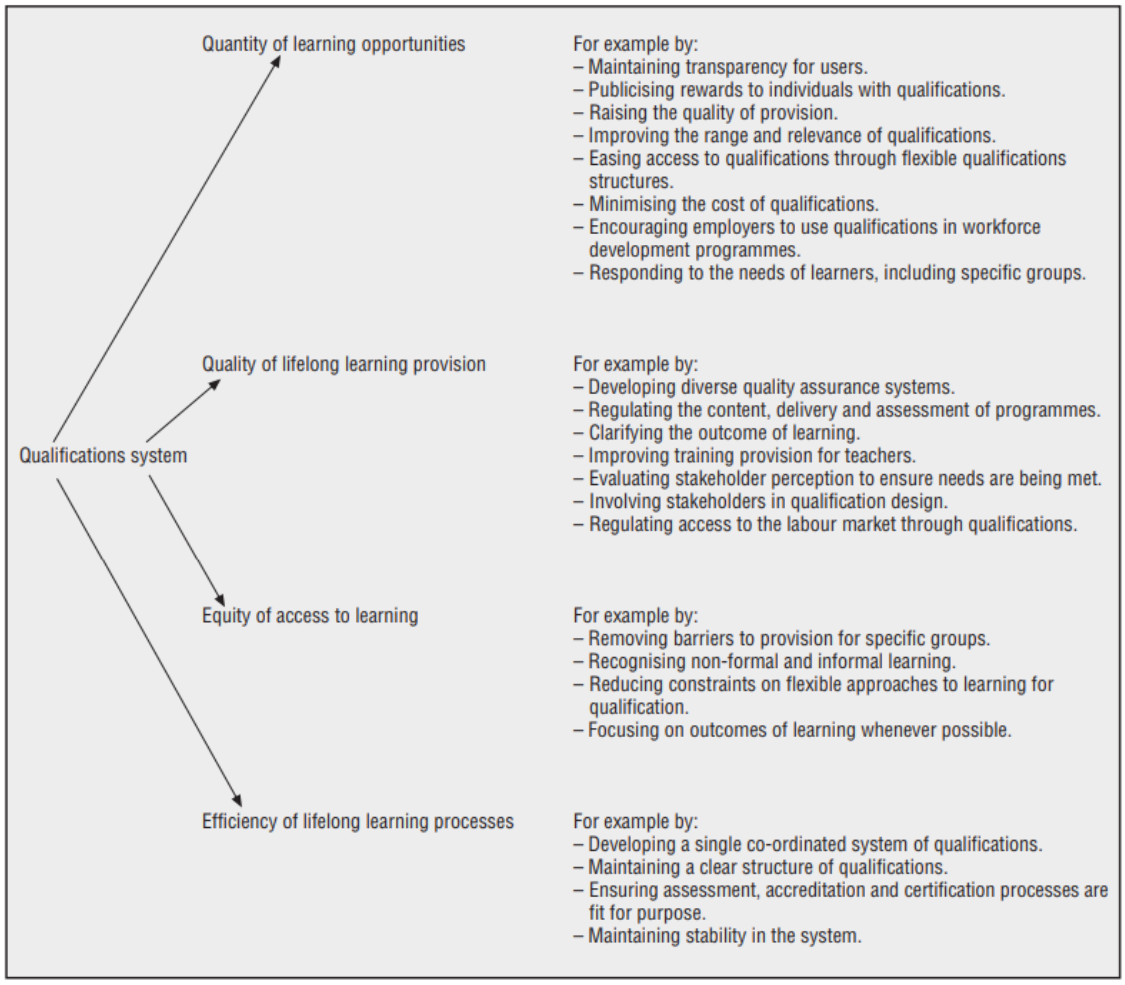


Figure 8:Effect of a qualification system (OECD,2007, p. 27)

2.3. The process of validation of formal, non-formal and informal learning

Validation of formal, non-formal and informal learning is basically about making the learning of an individual visible and usable. This learning does not only take place in formal institutions but also at home, at work, during leisure activities and also during voluntary work. Besides the visibility, the valued attached to what has been learned is of great importance. This is one of the most important goals of a validation process, regardless of the context or environment in which this learning took place. Through the process the learner is able to exchange his results for future learning or employment opportunities. In any validation process, the main requirements are reliability, validity and quality assurance (CEDEFOP, 2015).

There are many different approaches to a validation process in the literature. One of the most prominent approaches comes from the "European guidelines for validating non-formal and informal learning". This approach emphasizes that the process is not bound to a specific institutional context. It is not only used in the education and training sector, but also outside, for example by labor market authorities, companies or voluntary organizations. The common feature is that the learning, that takes place outside schools and classrooms is made visible. The EU Council (2012) divides the validation process into four basic steps. These are as follows:

- *Identification of an individual's learning outcomes acquired through non-formal and informal learning*
- *Documentation of an individual's learning outcomes acquired through non-formal and informal learning*
- *Assessment of and individual's learning outcomes acquired through non-formal and informal learning*
- *Certification of the result of the assessment of an individual's learning outcomes acquired through non-formal and informal learning in the form of a qualification, or credits leading to a qualification, or in another form, as appropriate* (Council of the EU, 2012, p.3).

It always depends on the context how the different phases are weighted. If a formal qualification is the goal, the evaluation phase is particularly important. In other contexts, such as volunteering, identification and documentation could be more important. However, the aim of validation is always to provide evidence of learning outcomes that can be used in the labor market or in further training.

Diedrich (2013) examined validation as a tool for integrating immigrants into the labor market in Sweden. Validation is seen as a instrument to design the labor market more flexible, to promote equality and to promote integration, especially for immigrants. According to the Swedish government, validation is "a process that involves the structured assessment, valuation, documentation, and recognition of the knowledge and competence than an individual possesses independently of how these were acquired" (Swedish ministry of Education, 2003 in Diedrich, 2013, p.554). The Swedish national commission for validation developed a model of validation consisting of four steps. These four steps, shown in figure 9, are as follows:

- Step 1: Explorative mapping of skills and knowledge
- Step 2: In-depth mapping of skills and knowledge
- Step 3: Assessment of skills and knowledge (certificate)
- Step 4: Assessment of skills and knowledge (grades, license).

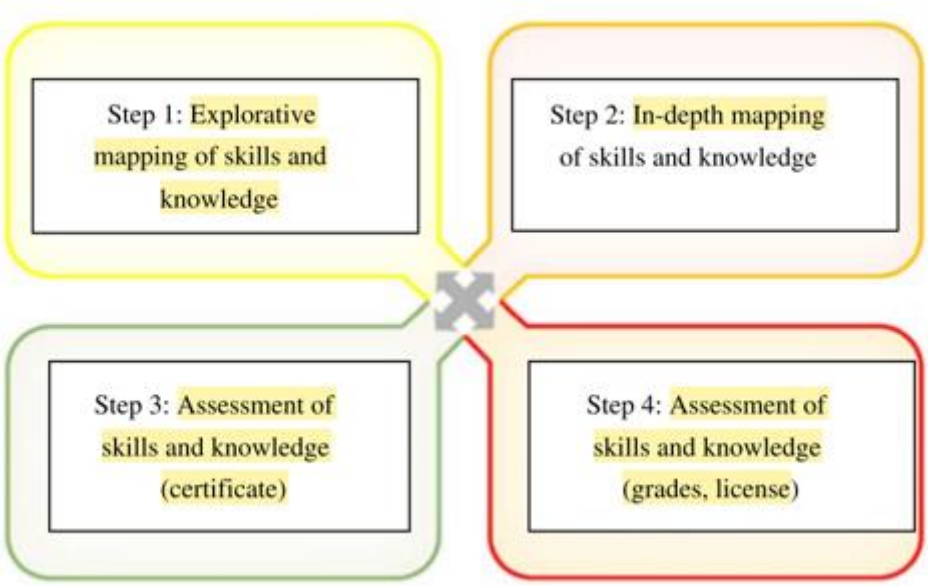


Figure 9: Model of validation (Diedrich, 2013, p. 555)

In the first process step, **explorative mapping of skills and knowledge**, the individual first explores alone or with a guide knowledge and skills. Interviews and also self-assessment tools are used in this step, in order to get a more diverse picture. After the first exploration a decision has to be made if the validation process will be continued or not. In the second step, **in-depth mapping of skills and knowledge**, specialists help the individual with an in-depth exploration of the knowledge and skills. After that the third step, **assessment of skills and knowledge (certificate**), consists of an assessment of skills of established skills, course objectives or

certificates. In the last step, **assessment of skills and knowledge (grades, license)**, the focus lies on verification. The goal is to produce documentation in the form of a relevant legal document (Hawley & Roy, 2007).

This model also emphasizes that these steps are not sequential, but that each step is a self-contained process and the model can be used individually or in any order. This approach is very similar to that of the European council, since skills and knowledge are also first mapped before they are evaluated or certified (Diedrich, 2013).

The validation process of non-formal and informal learning also plays an important role in adult education. This is especially true for adults who want to learn or study at an advanced age. Qualified employees, who professionally support adults in their learning, are of great importance. The qualification of such trainers is one of the key prerequisites for quality in adult education (Sava & Lupou, 2009).

According to Sava & Lupou (2009) many adult educators work with adults in a variety of ways without having an explicit qualification. Many have acquired their psycho-pedagogical competences through working with adults, through general work experience but also through volunteer work or similar activities. This is precisely why the validation of non-formally and informally acquired competences is also of great importance in the field of adult education. The two authors have started the so-called "Validation of Informal and Non-Formal Psycho-Pedagogical Competencies of Adult Educators VINEPAC" to develop measures and strategies for recognition, validation and certification in adult education. In this project they have also developed a validation process consisting of the following three steps:

- Step 1: Self-evaluation of competences
- Step 2: External evaluation
- Step 3: Consolidation of the results

The first step, self-evaluation of competences, is for learners to identify their own competences through reflection. In addition, all relevant documents that interact with these competences are to be added. The aim is to create a clear picture of the competences. This first step is comparable to the first two steps, identification and documentation, in the process of the European council. The only difference is that in the VIEPAC project this is done in one step. The second step, external evaluation, is to increase the objectivity of the validation results. The adult educator is evaluated by experts. In the final step, the consolidation of the results, all results are summarized and presented as a validation result. This last step is carried out by officially recognized

institutions. In the end the adult educators receive a validation sheet that proves the competences for external authorities or companies. Step two and three can be compared with the assessment and certification of Cedefop (Sava & Lupou, 2009).

The validation process of non-formal and informal learning plays a role not only in adult education but also in university education. Joosten-ten Brinke et al. (2009) use the term "Assessment of prior learning" (APL) to identify and recognize non-formal and informal learning experiences. They used the APL process to evaluate the first APL procedures in academic institutions. A computer science program and a pedagogical master's program were used for this study. In this approach, the APL process also consists of four different steps (Joosten-ten Brinke et al., 2008):

- Learner profiling (or identification and initiation)
- Gathering and presenting the evidence (also documentation and preparation)
- Assessing the evidence
- Accreditation or recognition

The first step, learner profiling, is about the respective educational institute collecting information, such as personal data or the needs of learners. The phase serves above all as information for learners on how to proceed. In addition, the collected data is often the basis that helps the respective institutes to select learners for the procedure (Joosten-ten Brinke et al., 2009). What is interesting about this approach is that the institutions first collect information and independently select persons for the procedure. This has not been seen in previous approaches. However, this is mainly due to the fact that the procedure takes place at the university level. In the second step, gathering and presenting the evidence, the main aim is to gather evidence of their previous qualifications and experience in order to have some kind of proof. Certain assessment standards should therefore be available. The collection and presentation steps are usually executed in the form of a portfolio. In the third step, an assessor evaluates the portfolio on the basis of the given evaluation standards to determine if accreditation of prior learning should be considered. In the final step, the responsible department is involved with the verification of the candidate's knowledge (Joosten-ten Brinke et al., 2009). The authors expected that the evaluation of previous learning in relation to educational programs would increase the motivation of the candidates. The candidates who took part in the study were typical candidates for such programs. They do have several years of professional experience and have got a very positive attitude towards learning. According to

the authors, such a validation process motivates candidates by offering them the opportunity to combine work and study and thus shorten the duration of study (Joosten-ten Brinke et al., 2009).

Sandberg and Andersson (2011) also assume that many students have already learned a lot before they start a formal education at university. The university of Lund, Linköping university and two trade unions in Sweden were surveyed using the concept of recognition of prior learning. According to the authors, these surveys concerned on the one hand competences from a possible previous job, but also things learned outside of educational settings. The aim of their work is to see how previous learning can be recognized as academic achievement at university level, so that certain courses no longer need to be attended. The developed model, however, aims exclusively at previous formal knowledge. When evaluating their model, the authors quickly notice that not only previous formal knowledge is important, but that some participants also possess a so-called "practical wisdom". This wisdom is, on the one hand, long-term experience in dealing with people and, on the other hand, certain work experience. The problem with the model, however, was that accreditation could only be granted in connection with a specific previous curriculum. Nevertheless, the authors come to the conclusion that informal learning processes also have a very strong influence on previous learning or competences (Sandberg & Andersson, 2011).

The validation process of previous learning has so far been very strongly related to non-formal and informal learning. However, such a process is also strongly related to processes related to formal education or training. According to Bjornavold and Mouillour (2009) learners choose different ways to gain competences. Which path they choose depends on their current life and work situation, but also on their current needs. As already described, a validation process has different phases. According to Bjornavold and Mouillour (2009), qualifications can basically be awarded in two ways (see figure 10).

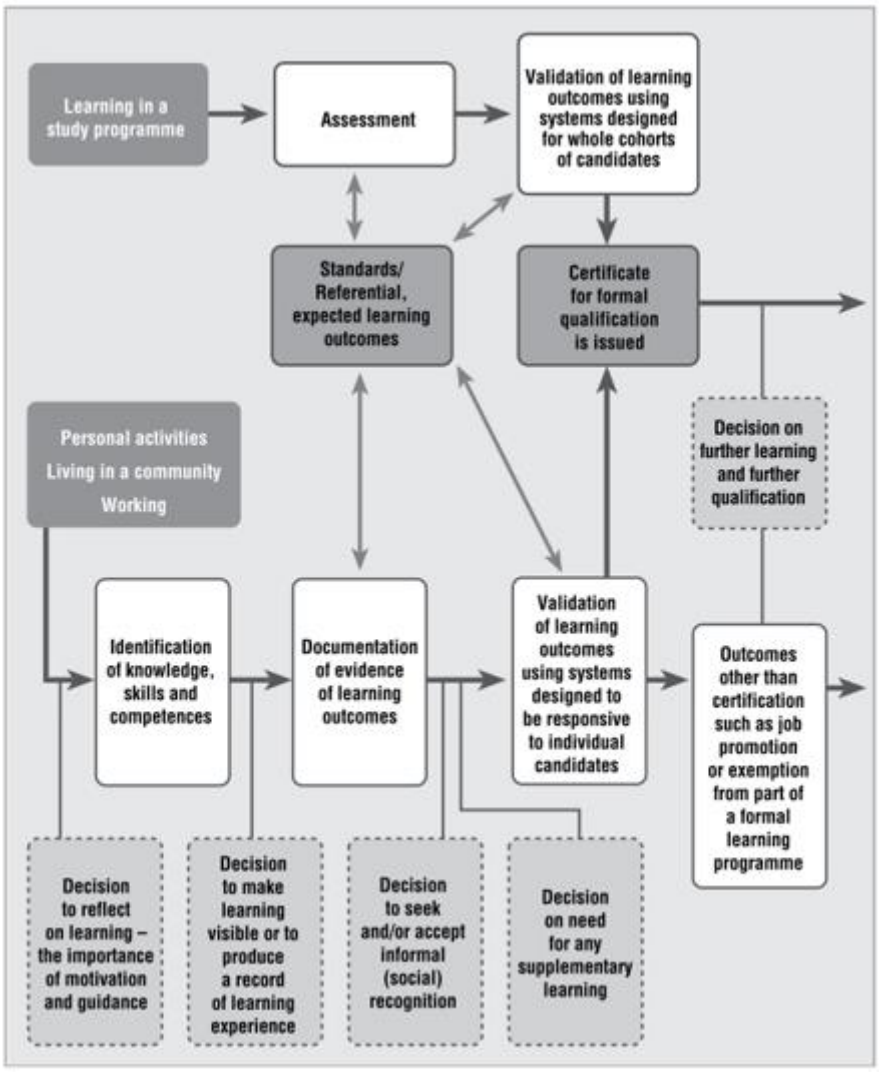


Figure 10:Routes from learning to certification (Bjornavol & Mouillour, 2009, p. 32)

In the upper part of figure 10, the process "Learning in a study program" leads to recognition of a certificate for a formal qualification. This process is therefore a normal formal learning process in which the learner learns in a study program and finally finishes with a certificate. The lower process contains several possibilities. Learning happens, for example, in personal activities, living in a community or at work. This process basically offers many more possibilities for the individual. The process varies depending on the goal of the individual. For example, a goal could be to simply identify prior knowledge. Another goal could be a certificate or diploma, but also a job promotion or exemption. With these different possibilities it becomes visible that there are different ways in this process and there is no standard learning path. The central element in this figure are the standards/referential and expected learning outcomes. No matter which validation process is chosen, the expected learning outcomes must be the same

(Bjornavold & Mouillour, 2009). Therefore, according to Bjornavold and Mouillour (2009), the validation of learning outcomes must actually be discussed (chapter 2.1.1.). The difference between the certification of formal learning and the validation of informal or non-formal learning should not have priority.

In summary, it can be said that there are many different processes and approaches involved in identifying and certifyin formal, non-formal and informal learning. According to Joosten-ten Brinke et al. (2008), such procedures have seven main characteristics:

- Different types of learning are recognized
- The procedures have a clear structure and time schedule
- The outcome of each procedure can differ
- The procedures are beneficial for the learner, the educational institution and the community
- A combination of methods (simulations, knowledge tests, performance assessments, interviews) is used to provide evidence of prior learning
- The procedures require a high level of responsibility from learners and a sufficient level of support
- The procedures are time-consuming (Joosten-ten Brinke et al. 2008).

2.3.1. European guidelines for validation of non-formal and informal learning

The most widely used approach in practice and in the literature is the approach of the European Union with its "European guidelines for validating non-formal and informal learning". This approach consists of four process steps: identification, documentation, assessment and certification. Since this approach will be used later in this master thesis, it is important to analyze the individual process steps in more detail. The four process steps can also be seen in figure 11.

Identification:

A validation must always begin with the determination of the acquired knowledge, skills and competences. In most cases, this determination takes place in the form of self-discovery. Here, different learning outcomes are determined in different contexts - at home, at work or through

voluntary work. In many countries, the identification phase is supported by standardized IT tools for self-assessment. On the one hand, this form can reach many people. Private and personal counseling, on the other hand, may be able to identify skills and competences that may not be possible from self-assessment using IT tools (Cedefop, 2015). Identification often also aims to make tacit knowledge or competences collected in formal, non-formal or informal settings explicit (Bjørnavold, 2000; Eraut, 2000).

Documentation:

In the documentation phase, evidence must be provided for the learning outcomes acquired. This can take the form of a portfolio or a CV. A portfolio usually contains a curriculum vitae as well as documents and work samples as proof of learning achievements. This evidence can be in the form of written documents, work samples or practical demonstrations. They must provide enough insight into learning outcomes. Common formats for presenting these learning experiences, such as Europass, would improve and facilitate the transferability of evidence (Cedefop, 2015; Bohlinger, 2017).

Assessment:

In the assessment phase, learning outcomes are measured against specific reference points and standards. The documented evidence can be either in writing or in some other form. The assessment of learning outcomes is of great importance for the credibility of validation. It is therefore important that standards or points of reference are used. The focus is more on what a learner knows and is able to do and less on the input factors such as duration or place of learning. This makes it easier to consider individual variations in one's own learning (Cedefop, 2015; Council of the European Union, 2012).

Certification:

The final step concerns the certification and evaluation of the learning outcomes identified, documented and evaluated. This usually takes the form of a formal qualification. In companies or in public organizations, this can also be done by means of a license, which entitles the person concerned to carry out certain activities. It is very important and decisive that this certification is carried out by a credible authority or organization. The importance of validation depends very much on the legitimacy of the awarding authority (Cedefop, 2015; Bjørnavold, 2000).

It is important to say, that the four phases are mixed and balanced in different ways depending on the goal of the validation process. In addition, the individual process steps do not necessarily have to run in a particular sequence.

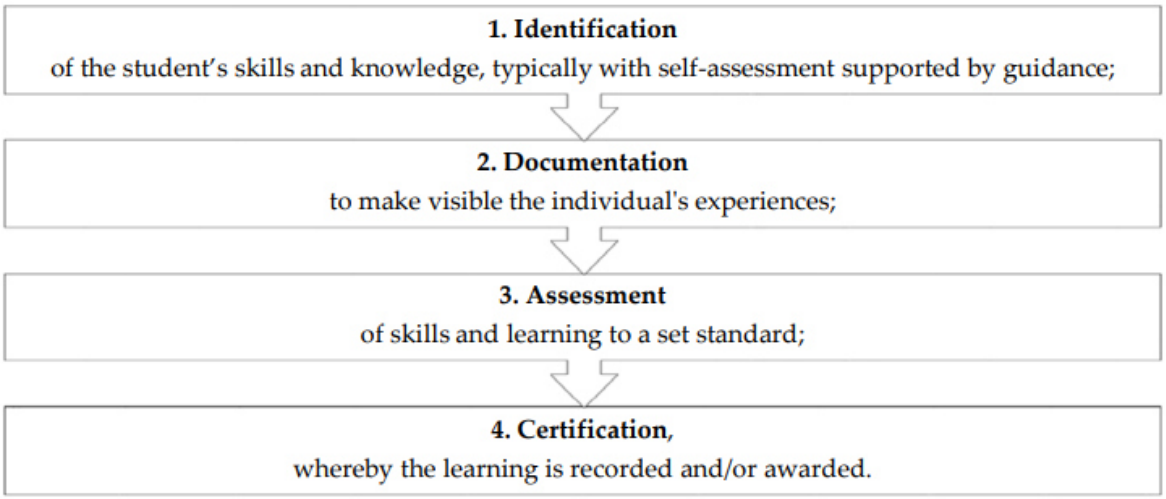


Figure 11: Validation process (Tuomainen, 2015, p. 20)

2.3.2. Quality of a validation process

Whether and how good a validation process really is, can only be seen from the quality of the process. Quality can be checked by validity and reliability. Reliability refers to whether the results can be reproduced in a new test. The validity of a process is given when the process really measures or "does" what was supposed to measure (Andersson et al., 2017; Bjornavold & Mouillour, 2008; Stenlund, 2010). According to Andersson et al. (2017), the goal of the validation process is important to determine the quality of a validation process. There are four different types of objectives in a validation process:

- Formative: Formative validation helps to monitor student learning and gives feedback. This feedback helps the teacher to teach better and the student to learn better. This can reveal difficulties or deficits (Björnavald, 2001; Andersson et al., 2017).
- Summative: Summative validation aims to evaluate the student at the end of the learning process by comparing him or her to a standard or benchmark (Björnavald, 2001; Andersson et al., 2017).

- Predictive: A predictive goal is a prediction of who is most likely to succeed (Andersson et al., 2017).
- Transformative: The goal here is a transformation of the candidate (Andersson et al., 2017).

Andersson et al. (2017) and Dahler and Grunnet (2012) have developed the so-called "Nordic Model for quality in the validation process". The nordic model is a generic model and can be used by educational institutions and everyone who is involved in a validation process. One of the main objectives is to ensure a transparent, reliable and fair process. (Andersson et al., 2017). The model is also concerned with the fact that its structured method is to evaluate and identify the current status of the validation or validation process.

The identified quality model consists of eight different factors and each factor consists of different indicators. The selected factors are responsible for ensuring an awareness of the entire validation process and the essential characteristics in such a process. The aim is to reflect and evaluate a validation process using these eight factors and then identify improvements or changes. The model used includes three different perspectives on quality. These are organizational quality, assessment quality and procedural quality. The quality model refers primarily to work in educational institutions. Nevertheless, it can also be used by various other institutions. It is mainly a tool for the employees who work with validation in practice and for the people who are responsible for the whole process. The eight factors in this model are as follows (Andersson et al., 2017; Grunnet & Dahler, 2012):

- Information
- Preconditions
- Documentation
- Co-ordination
- Guidance
- Mapping
- Assessment
- Follow-up

Information:

Information is one of the most important factors for the development of quality in a validation process. This applies not only to information for the potential target group but also to information for other stakeholders or collaborators. Information mainly concerns the who,

what, why, how, where and when in relation to the validation process. Possible quality indicators for the information factor are, for example, that information is comprehensible and prepared for the target group. In addition, the information should be accessible for validation via the Internet, but also in other forms. Validation costs should also be made transparent and it should be obvious for whom the validation is relevant (Andersson et al., 2017; Grunnet & Dahler, 2012).

Preconditions:

The framework conditions, e.g. national or local guidelines, are important for any validation process. These include the financial framework, how the cooperation is organized with other interest groups and whether certain standards or competence criteria are used as a basis for validation. Basically, the framework conditions, such as guidelines, cannot really be designed or changed differently. However, they can be evaluated to determine to what extent they influence the quality of the validation process. A possible quality indicator, for example, would be the legal basis for carrying out the validation (Andersson et al., 2017; Grunnet & Dahler, 2012).

Documentation:

The documentation factor refers primarily to the internal documentation of the executing institution. The documentation helps to coordinate the process and supports a proper one. Possible quality indicators would be, for example, that every single step of the validation process is documented, and that this documentation is clear and unambiguous (Andersson et al., 2017; Grunnet & Dahler, 2012).

Co-ordination:

Coordination refers to the fact that the methods, assessments and decisions in the validation process take place in a professional environment. The goal is a high level of competence and compliance with all legal requirements. Quality indicators for coordination are, for example, existing coordinators for validation. Coordination should also be transparent, with a clear distribution of roles within the process (Andersson et al., 2017; Grunnet & Dahler, 2012).

Guidance:

The consulting or guidance factor also plays a very important role. The guidance should be an integral part of validation and should also support people through all processes. Possible quality indicators are, for example, that the consultants are trained to carry out the validation or that

the guidance helps to visualize the competences of the individual (Andersson et al., 2017; Grunnet & Dahler, 2012).

Mapping:

The mapping of competences is another important factor. The aim is to get a complete picture of the competences using the existing methods and related guidelines. Possible quality indicators would be, for example, full clarity as to what is considered mapping at all. Accordingly, documentation standards must be made visible. In addition, advice and support for the documentation process should be provided, as each individual is responsible for the process (Andersson et al., 2017; Grunnet & Dahler, 2012).

Assessment

One of the most important factors is the assessment of learning outcomes. The assessment should have legal force and impact on further education or working life. Reliability, impartiality and above all the competences of the validation staff determine the quality of the assessment. Quality indicators, for example, provide transparency and openness in evaluation. Clear and comprehensible criteria should also be used for evaluation (Andersson et al., 2017; Grunnet & Dahler, 2012).

Follow-up

The follow-up refers to the individuals who go through the validation process. Furthermore, it also concerns the improvement of the whole process. Every person has a right to possible complaints after the process. In addition, the process should be continuously evaluated and improved as part of quality assurance. Possible quality indicators include, for example, the existence of a complaints system or a succession plan (Andersson et al., 2017; Grunnet & Dahler, 2012).

Using the Nordic model, it is possible to see the whole picture of a validation process and on the other hand it also illustrates very well the purpose of such a process. "The model was very useful to understand the complexity of the VPL process, and the different actors involved in the quality work and their roles and responsibilities" (Andersson et al., 2017).

Joosten-ten Brinke et al. (2008) chose a quite similar approach. With the help of the quality framework of Baartman et al. (2006) they try to elaborate the quality criteria for the procedures for assessing and crediting prior learning (APL). Accordingly, there are twelve different quality criteria as can be seen in figure 12.

Quality criteria	Definition
Fitness for purpose	The assessment fits the educational purpose and objectives of the educational program
Transparency	The assessment method and criteria are clear to all the participants—learners, staff members, program management, examination committee, and the labor market
Acceptability	Participants' acceptance of the assessment method and instruments
Reproducibility of decisions	The assessment program has several assessment moments and should use different perspectives to make a final decision
Comparability	The assessment is consistent, standardized and comparable for all learners
Fairness	Bias does not influence the assessment process
Cognitive complexity	Learners prove their acquisition of higher cognitive skills, which represent the level of the educational program
Fitness for self-assessment	The assessment stimulates self-assessment and reflection
Meaningfulness	The assessment has a surplus value for both the educational institution and the learners
Authenticity	The tasks that a learner has to fulfill should have a direct link with future practice (Gulikers et al., 2004)
Educational consequences	The assessment is implemented only if positive effects are expected and negative aspects can be minimized
Costs and efficiency	The assessment is feasible in terms of costs and time investment

Figure 12: Quality criteria (Joosten-ten Brinke et al., 2008, p. 53)

In the framework, a total of four different levels with different criteria are distinguished. The first level is "fitness for purpose" and is, so to speak, the basis for the development of competence assessment programs. The second level consists of the criteria "transparency", "acceptability", "reproducibility of decisions", and "comparability". The criteria are primarily used to evaluate assessments. The third level consists of the quality criteria "fairness", "cognitive complexity", "fitness for self-assessment", "meaningfulness" and "authenticity". The last level consists of the criteria "educational consequences" and "costs". If an assessment is negative on the basis of one of these criteria, implementation is not recommended (Joosten-ten Brinke et al., 2008; Baartman et al., 2006).

According to Joosten-ten Brinke et al. (2008) every process should be designed to take account of these twelve quality criteria. However, the authors also come to the conclusion that some criteria are more relevant than others.

2.3.3. Benefits for recognizing non-formal and informal learning

There are many different players who can take advantage when non-formal and informal learning is recognized. The most important group that benefits from this is the individuals. The benefits of this group can be divided into economic, educational, social and other personal benefits. The economic benefits mainly concern saving time and money. Learners no longer have to attend different courses or seminars in order to gain official competences (Werquin, 2007; Cedefop, 2015). By becoming visible and recognizing non-formal and informal learning,

these competences can be identified and no longer need to be demonstrated through formal courses. The educational benefit refers mainly to the context of lifelong learning. The educational benefit is considered above all as a factor that motivates people to return to learning, regardless of the context in which it took place. Social cohesion is also strengthened by the recognition of non-formal and informal learning. Indeed, equal access to qualifications is a major component of social cohesion. Another personal benefit, for example, is the psychological aspect. This is especially true for people who are least qualified. These people see an opportunity to acquire competences that they might have never achieved in this way. Another personal benefit also involves gaining self-esteem and trust (Werquin, 2010; Smith & Clayton, 2009).

Another group that benefits from the recognition of non-formal and informal learning are employers and the business world. They are also particularly interested in the economic aspect. When employees have more and better competences, this does not only increase their self-esteem, but also their morale at work. This enables individual companies to achieve better results and to be better equipped for future tasks. Above all, increasing competitiveness, but also increasing economic growth has economic advantages for a government (Werquin, 2010; Werquin, 2007).

2.3.4. Criteria for implementing validation systems/processes for formal, non-formal and informal learning

There are many different approaches and processes to the validation of formal, non-formal and informal learning. There is also a high heterogeneity and complexity of approaches around the world (Bohlinger, 2017). There are very several criteria for the implementation of validation systems. These are as follows:

- *To promote lifelong learning*
- *To foster individual employability and meet labor market demands*
- *To strengthen countries competitiveness*
- *To improve social inclusion and social justice (mainly by improving labor market inclusion)*
- *To better link labor markets and education and training systems* (Bohlinger, 2017, p.10)

2.3.5. Overview of definitions, concepts and terms

In the literature, in politics and in many countries, there is more than one term that defines the validation process of prior learning. The European union and the Swedish government use the term validation (CEDEFOP, 2015; Diedrich, 2013). But also, the terms recognition, assessment or certification are used (Smith & Clayton, 2009; Björnavald, 2001). UNESCO, for example, often uses the term recognition, validation and accreditation to describe outcomes of non-formal and informal learning (RVA). In the USA and the United Kingdom, the terms prior learning assessment (PLA) and accreditation of prior learning (APL) or accreditation of prior experiential learning (APEL) are more commonly used (Singh, 2015). Until now, terms such as recognition, validation or certification have been used almost exclusively in environments that deal with formal learning. However, a rethinking is slowly beginning that these terms can also be used outside of a formal framework. In principle, recognition is about identifying skills, knowledge and competences that are already known. The terms validation and recognition must be distinguished, since in some country's validation involves granting rights to individuals (Werquin, 2007). Thus CEDEOP (2015) also assumes that validation entitles some rights in the labor market, but also in connection with secondary education. Validation very often leads to certification. In order for certification to be successful, standards must be in place to test and validate non-formal and informal learning.

Many concepts and terms deal with formal, non-formal and informal learning. For a definition of terms, it is also very important to understand that in some countries "prior learning" or "acquired skills and/or competences" is used. In principle, these terms are to be understood in the same way as non-formal and informal learning. In principle, the term "prior learning" makes sense when it comes to recognition. It is therefore a matter of learning that took place before recognition. The persons who undergo these recognition programs are basically not only learners, but above all applicants as well, in order to recognize their earlier learning, no matter where it took place.

The validation process plays a role in almost every country in the world. In particular, the validation of non-formal and informal learning has moved to the center of attention. Since many different political, but also economic systems all over the world use different terms, it is important to classify these terms or to bring them to a common denominator. Werquin (2007) analyzed in an OECD document the different approaches to the recognition of non-formal and informal learning in some countries.

In Austria the term "recognition of non-formal and informal learning" is mainly used. In Australia, on the other hand, the term "recognition of prior learning (RPL)" is used. RPL is an assessment process that assesses non-formal and informal learning. RPL does not refer to the basis of prior formal learning. South Africa also uses the term "recognition of prior learning (RPL)". In contrast to Australia, however, formal learning is recognized here in addition to non-formal and informal learning. Ireland also uses RPL and also includes formal learning. The following definition of RPL was elaborated in Ireland: "Recognition is a process by which prior learning is given a value. It is a means by which prior learning is formally identified, assessed and acknowledged. This makes it possible for an individual to build on learning achieved and be formally rewarded for it. The term prior learning is learning that has taken place, but not necessarily been assessed or measured, prior to entering a program or seeking an award. Prior learning may have been acquired through formal, non-formal, or informal routes" (Werquin, 2007). The term RPL in Ireland includes other definitions used in various circumstances. These definitions are for example Accreditation of Prior Experiential Learning (APEL), Accreditation of Prior Certificated Learning (APCL) or Accreditation of Prior Learning and Achievement (APL&A). In Canada, the term "prior learning assessment and recognition (PLAR)" is used. While in the USA the term "prior learning assessment (PLA)" is mainly used (Andersson et al., 2004; Werquin, 2007).

This shows that there are many different definitions, but that they have a very similar meaning and therefore a certain degree of consistency within the terms is given. It should be noted that non-formal and informal learning refers mainly to these skills, knowledge and competences acquired outside the formal education and training sector. Recognition and validation are then about making these knowledge, skills and competences visible. The results of this "making visible" are then the so-called "learning outcomes". In the remaining parts of the thesis the validation process of the European guidelines is named **“validation process of prior learning”** and is used as the standard process.

2.4. IT tools for the validation process

To enable validation of prior learning, appropriate tools are needed to support this process. These tools are particularly important for transparency and recognition. There are several tools that support the different steps of identification, documentation, evaluation and certification. For example, the EU Council (2012, p.3) says: *"The use of Union transparency tools such as the Europass Framework and the Youth Passport will be encouraged to facilitate the documentation of learning outcomes".* As there are many different tools, users and evaluators in particular must consider which tools are appropriate or useful. It is therefore particularly important to check the reliability and validity of a tool, as each validation tool has an impact on the results of a validation process (CEDEFOP, 2015; Werquin, 2010).

When classifying such tools, a distinction can be made between methods for obtaining evidence and methods for documenting and presenting evidence. Methods for obtaining evidence are, for example, tests, examinations, simulations or self-evaluation tools. Methods for documenting and presenting evidence are, for example, CVs or portfolios. The methods for documentation and presentation mainly concern the process step documentation within the validation process. The methods for obtaining evidence, on the other hand, concern the identification process step (Björnavald, 2001; CEDEFOP, 2015).

Björnavald (2001) asks whether the evaluation of non-formal learning requires the same approaches or practices as formal learning, or whether new tools or instruments need to be found. Of course, especially with summative assessment, it must also be ensured that the assessment produces a kind of "proof" that is also legally and politically recognized, so that it can also be used in the labor market or at the university. Not only in the evaluation of non-formal learning, but also in identification and recognition, the question arises as to which methods are suitable and should be used. Björnavald (2001) thinks that in any case the experience of formal education or formal learning should be built upon. However, these methods cannot be used one-to-one because non-formal learning is much more complicated and complex. In addition, reliability and validity are more difficult to assess in non-formal learning. Björnavald (2001) suggests, for example, to strive for an optimal transparency of the assessment process or an introduction of systematic and transparent quality assurance practices. But not only with regard to the methods there are certain requirements that should be considered so that evidence of non-formal learning is accepted as well as evidence of formal education. Since this evidence has a direct impact on the labor market, it is precisely these participants who need to

be involved in setting up non-formal learning systems. In addition, all relevant information should be included, and some transparency should be created. Acceptance and legitimacy can only be achieved through transparency (Björnavald, 2001).

For each individual process step within the validation process, there are different tools that support each step. On the other hand, there are also tools that support the entire process.

However, it is not always clear for what purpose the different tools are used. There are countless tools that claim to support the validation process. There are more than 370 different tools on the "DataBase of Effective opportunities in the field of Validation of non-formal and Informal learning" (BEVIN). As a result, there is often disagreement as to whether the respective IT tools really fulfill the purpose they are intended to fulfil. That's why it's important to find out whether the respective IT tools are really suitable for the validation of prior learning process, or whether they might have a different purpose or additional purposes that have not yet been identified.

2.4.1. ProfilPass

The ProfilPass assumes that people not only learn something in formal contexts, but also at work, in the family or in the leisure time and thus in a wide variety of different contexts. In addition, ProfilPass argues that people need more than just specialist knowledge in their daily work. The competences to apply this specialist knowledge are also needed. Competences such as the ability to work in a team and learn, creativity, adaptability or the ability to work under pressure are competences that people often learn of the job and unconsciously in their daily work but also in their leisure time (Harp et al., 2010). The ProfilPass has set itself the goal of systematically identifying and presenting the competences of the users. Not only the vocational career is considered, but also the roles in family, spare or volunteer time. The result of the ProfilPass is a personal competence profile. The ProfilPass should help people in planning their professional development, preparing for (re-)entry into working life, professional and personal (re-)orientation and in planning future learning projects (ProfilPass; Bosche & Seusing, 2011).

The ProfilPASS has several essential characteristics.

- Cross educational approach

- Cross-target approach

- Biographical-systematic approach

- Development-oriented approach

- Mediation of self-reflection

- openness to results

- voluntariness

- Sole availability

- Openness for self-evaluation and external evaluation

- Professional advice (Harp et al., 2010).

The ProfilPass is basically constructed in two different columns: The ProfilPass portfolio and the ProfilPass consultation. The portfolio offers a structured collection of materials for the reflection of previous professional and life experiences and is available as a printed workbook in a digital version. The ProfilPass consultation accompanies the users on their way to systematically determine their competences and interests and to plan their goals (ProfilPass, Harp et al. 2010). The ProfilPass consists of five different areas:

- My life

- My fields of activity

- My competences

- My goals

- Collect evidence

“My life” begins with a review of the previous life, what has already been learned or what experiences have been made so far. In the “fields of activity”, professional qualifications, but also activities in leisure time or voluntary work are described, summarized and evaluated by the user himself. The aim is to find out what the user likes to do and what he does well. This documentation is based on a self-assessment process to encourage the user to discover learning experiences that have not yet been identified. The “my competences” chapter will create a short summary. An overview of the respective competences and their characteristics is created. In “my goals, future wishes and personal goals are defined. In the chapter “collect evidence”, users are given information on how they can systematically collect personal certificates and other evidence (ProfilPass; Harp et al., 2010).

The ProfilPass Tool is supposed to be used in the steps “Identification” and “Documentation” in the process of validation of prior learning. The target groups are especially adults entering a new profession or those who are interested in another education.

2.4.2. AiKomPass

The AiKomPass is a tool for the recognition of informal competences acquired in the metal and electrical industries. The concept has been translated into a web-based tool for activity-based self-assessment for employees in the metal & electrical industry (AiKomPass; Fischer et al., 2017). The aim of the AiKomPass is to record and document informal as well as non-formal competences. These competences were acquired not only during work but also through leisure activities. By the recording and documentation of such competences, this knowledge can be used by employees in the metal and electrical industry within the framework of competence recognition. The focus is on semi-skilled and unskilled persons and the group of skilled workers in the metal and electrical industry (Fischer et al., 2019; AgenturQ, 2015).

Within the scope of the AiKomPass, not only personal data, but also biographical stations and extra-occupational activities and experiences are recorded. The AiKomPass has a structured task inventory as a basis, from which the respective users can select tasks from their special work area, which they can master themselves. This results in individual task profiles that provide detailed information on work experience. In addition, these task profiles also map competence bundles. Not only activities from typical work activities are collected, but also competences that have developed from leisure activities (AgenturQ, 2015).

Operation, use and functionality of AiKomPass

The tool is based on a database with typical work tasks from the areas of work preparation, production, maintenance, as well as production and warehouse logistics in the metal and electrical industry. Users are systematically guided through the process using queries. This results in a profile of work tasks that have been processed in the course of the career or can still be processed successfully. The tool can be used to prepare for one's own professional development. However, it also serves as a source of information that can be enclosed to applications (Fischer et al., 2019; AgenturQ, 2015).

At the beginning the user has to fill out a CV. On a total of five pages, important information should be provided. All areas that are also contained in a typical tabular curriculum vitae are covered. The curriculum vitae can then also be created and printed. In order to create an own

professional task profile, the user selects tasks in four different steps. The selection will happen by using a mouse pointer. After the selection has been completed, the user is led to a page where the entire profile with all tasks is displayed. The same process is repeated when the interdisciplinary task profile is queried. Here not only activities concerning the working life are queried, but also activities from the spare time. Language and computer skills are also recorded in a separate area. Activities from leisure and voluntary activities are also selected. The overall profile is therefore made up of the following areas: Curriculum vitae, technical job profile in the metal and electrical industry, non-technical job profile outside the metal and electrical industry, language and computer skills as well as leisure and voluntary activities. Finally, the user can print out his overall profile as a print version (PDF) or save it locally on his computer. The AiKomPass is freely available on the Internet for every single person. The user just needs an appropriate internet connection and a suitable browser. Since the online tool is only used for identification or documentation purposes, it must be validated by technical experts. Figure 13 and 14 show the areas of the AiKomPass as well as the steps for competence recording in compact form (AgenturQ, 2015; AiKomPass).

Above all the AiKomPass helps workers and job seekers to assess their abilities and competences themselves. It primarily serves people who lack formal qualifications for the labor market. The identification and visualization of non-formal and informal competences could compensate the lack of formal qualifications (AiKomPass; Fischer et al., 2017).

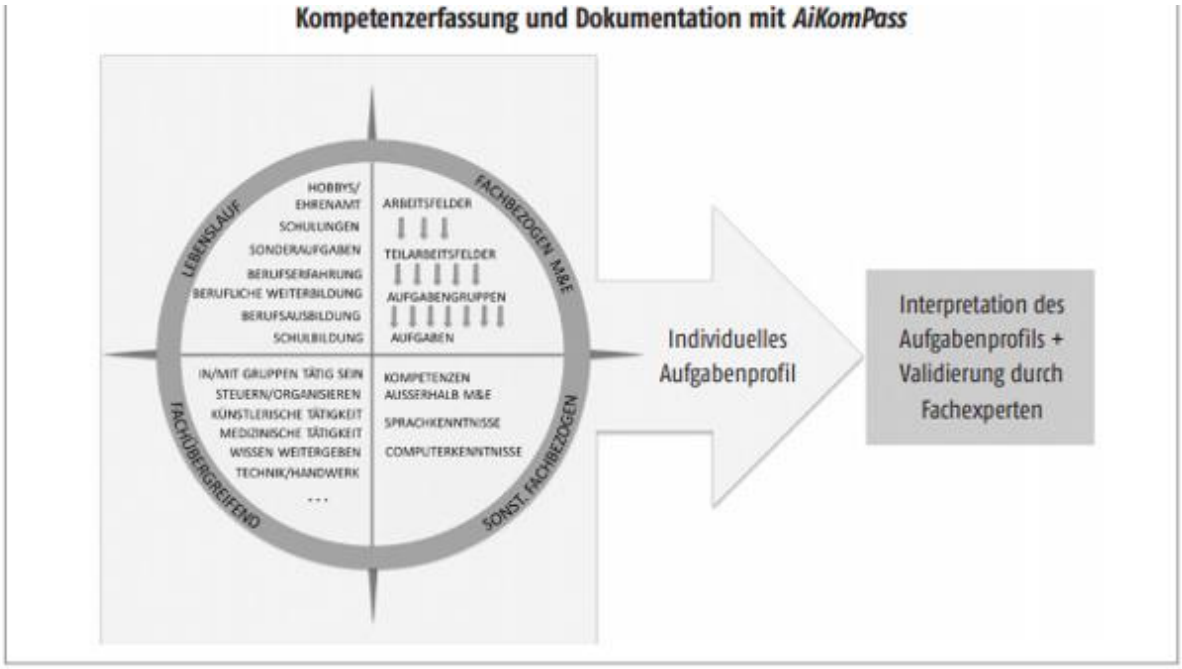


Figure 13: AiKomPass (AiKomPass)

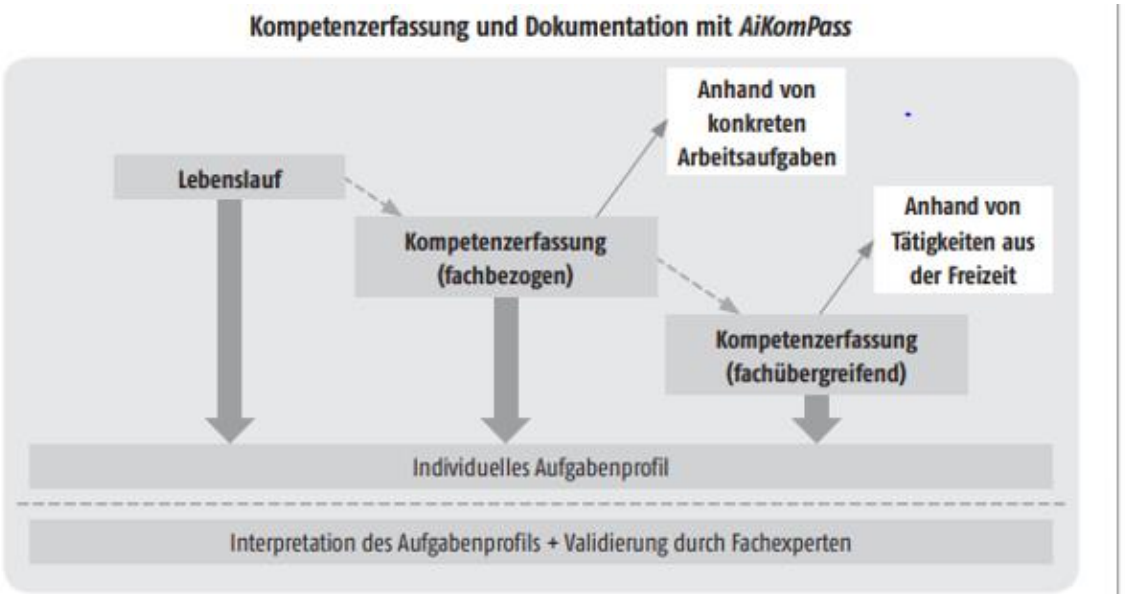


Figure 14:Process of AiKomPass (AiKomPass)

The AiKomPass Tool is supposed to be used in the steps "Identification" and "Documentation" in the process of prior learning and the target groups are people who work in the metal and electric industry.

2.4.3. Validation tool for volunteers

"The aim of this project is visualization, documentation and recognition of formally, non-formally and informally acquired competences in the field of volunteering and developing an online tool for validation of volunteering competences" (Destination e-Validation 2015).
The online tool is designed to give people, who have worked in any way in the field of volunteering, the opportunity to create an individual profile. This profile can also be linked to other social media tools such as Facebook or Xing. Users can fill out a form that leads to a statistical result and shows a personal profile. In addition, users can write individual texts about themselves or their experiences. Volunteer facilities can also be linked (Destination e-Validation, 2015).

In the first step, the online tool offers a surface on which the user's own profile is displayed. Now four different areas can be used. The first area is the activity area. Users can enter and describe their activities. In the next step, the user can reflect on the respective activities by himself. All abilities can be mentioned, which the user has used or developed during the

volunteer work. These skills are divided into several areas: Communication, social skills, initiative or entrepreneurship skills, IT skills, mathematical skills or cultural awareness or expression skills. It is also aimed at how far the developed skills can help in personal, professional or social life. The next step is a self-assessment where the user has to answer questions about his voluntary work. As a final step, a peer assessment is also possible, but another person must be invited (Destination e-Validation, 2015).

These four areas will then give a complete profile showing the user's skills and activities as part of their volunteering. Figure 15 shows how the online tool looks like.

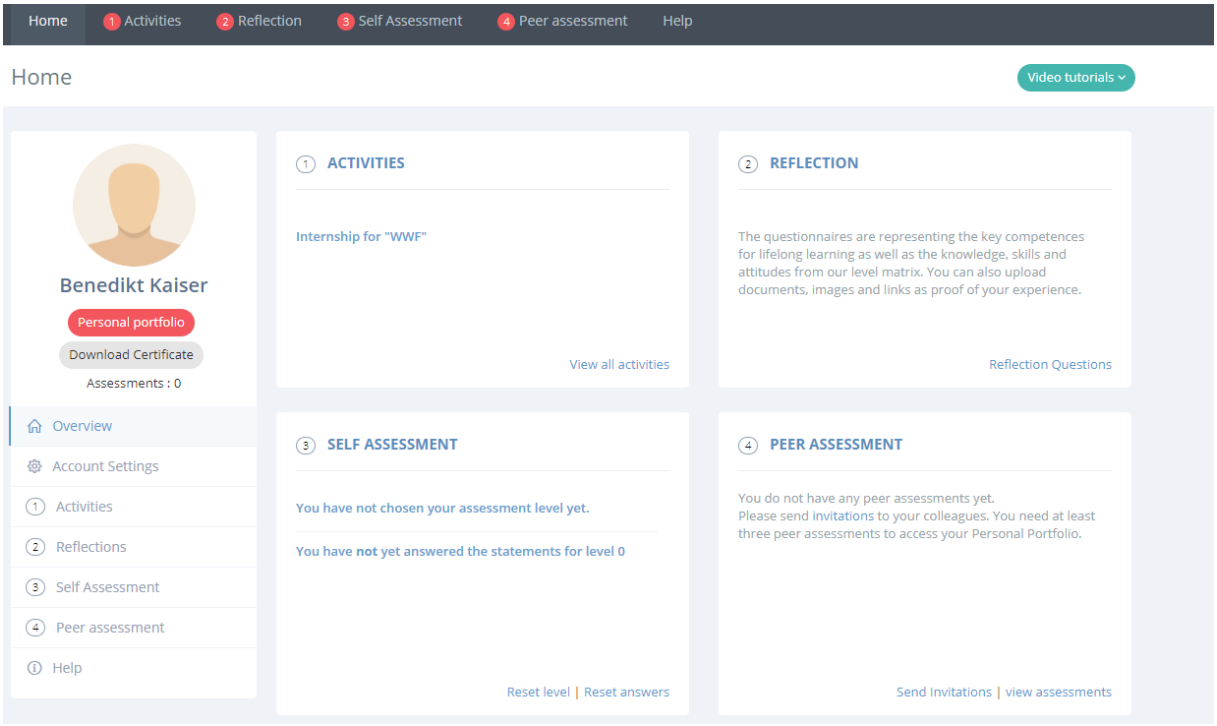


Figure 15: Validation tool for volunteers (Destination e-Validation, 2015)

2.4.4. YouRock

YouRock is a free, multi-language, employability networking tool for young people. It has various functions which are the following:

- *Designed for people 16-30+ across Europe to improve their employability*
- *Helps the user build a public employability profile and identify pre-existing work skills*
- *User makes links to existing content showing their skills, which trusted adults can endorse*

- *Encourages ICT career choice and will be promoted to industry HR as a new talent pool*
- *Users' profiles can be viewed in any of the system languages*
- *A resource for pan-European skills, employment or youth campaigns* (YouRock, 2017)

Each user has his own YouRock page. The diamond, shown in figure 16, is the center and the most important building block of the own page.

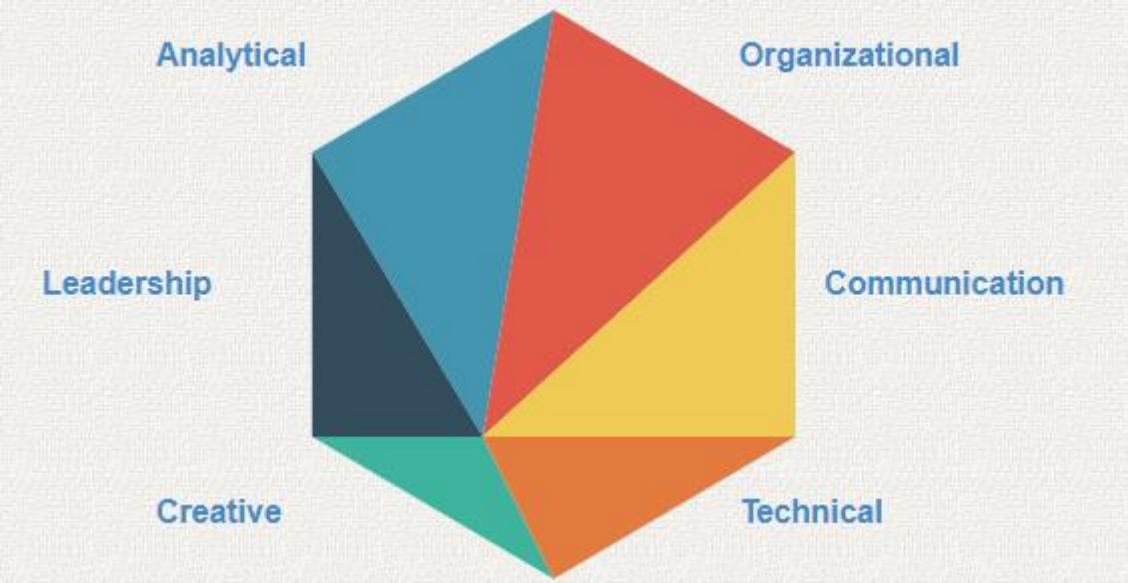


Figure 16: Diamond of YouRock (YouRock, 2017)

It is divided into six different parts: Creative, Communication, Organisational, Leadership, Analytical and Technical. At the beginning you start with an empty diamond. The diamond changes constantly as the user adds activities to the skill section of his page, as shown in figure 17 (YouRock, 2017).

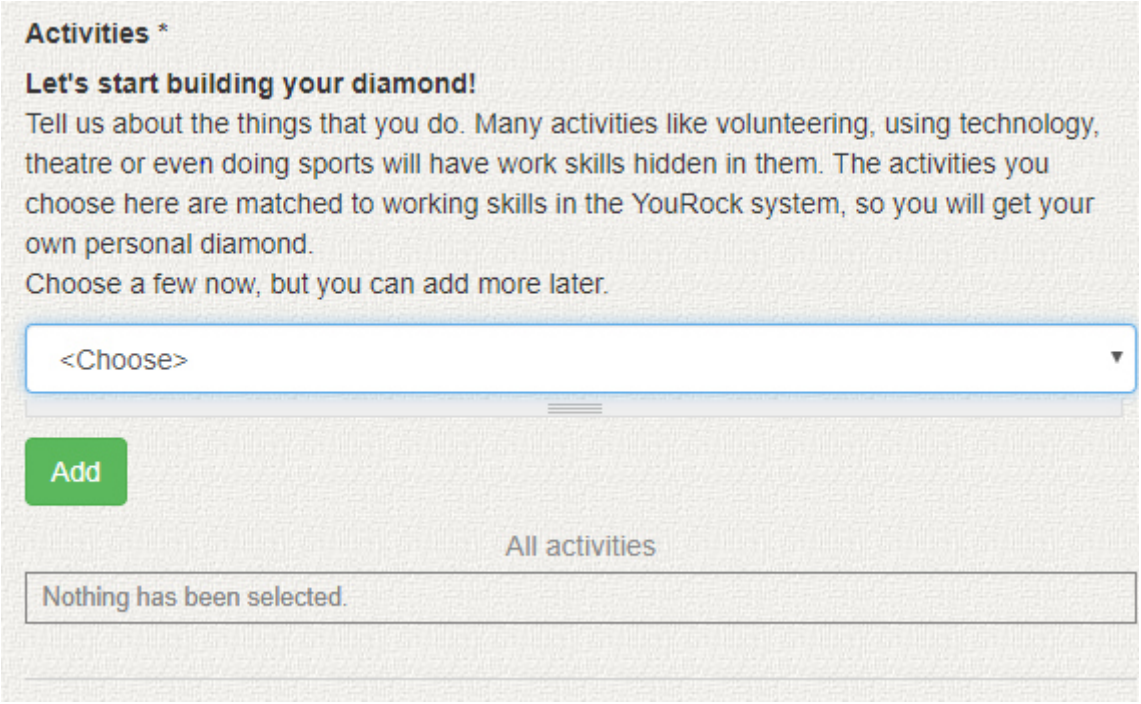


Figure 17:YouRock Activities (YouRock, 2017)

When activities are added that involve creative skills, the creative part of the diamond is extended. For example, if activities are added that require communication skills, then the communication part of the diamond fills. The diamond and the associated areas change when users enter their activities and skills. (YouRock, 2017).

When the user clicks on the different areas of the diamond, he can see what skills have been extracted out of his experience. These skills vary depending on the experience.

In summary, the process is as follows:

1. Identify unrecognized pre-existing business/work skill
    a. System helps the user to see the work skills they may already have
2. Endorse each skill by trusted adult/educators
3. Create links to online content showing each skill
    a. Potentially creating content elsewhere that shows those skills (YouRock, 2017)
4. Filling out a CV
5. Download and examine the finished diamond

This process creates a clear profile with the respective skills and experiences of a user. The profile is then visible to employers on the platform. This allows employers to look at skills that are not really visible in the CV. It also helps young people to identify their professional skills. It can also create a dynamic profile that shows the primary qualifications and skills (YouRock, 2017).

2.4.5. Self-evaluate your language skills' game

The language skills self-assessment tool helps to assess a person's language skills according to the six levels of the Common European Framework of Reference for Languages (CEFR). The CEFR exists in 39 languages and is used worldwide in many contexts. The tool is based on the Self-Assessment Grid contained in the CEFR and describes the language activities and was developed by the European Centre for Foreign Languages, an institution of the Council of Europe (European Centre for Modern Language).

The process is as follows:

- Self-assessment
- 10 to 20 questions to assess language ability in the following 5 areas: listening, reading, participating in conversations, speaking contextually and writing self-assessment (Yes I can, No I can't)
- Result in the form of CEFR (Common European Framework of Reference for Languages)
- Download the result in PDF format (European Centre for Modern Language).

In summary, there are many different tools for the validation of prior learning process. The five tools described represent only a brief insight into countless tools.

3. Characteristics of the validation process and IT tools

In order to carry out the matching with the help of an algorithm a reference frame has to be developed. This reference frame consists of several characteristics. The following chapters are going to describe these characteristics.

3.1. Reference frame

Before going into detail, it first must be explained how this reference frame was developed. The reference frame was developed using the qualitative content analysis of Mayring (2004). First of all, the general subject areas were defined, and the relevance was checked. The four-step validation process (Cedefop, 2015) and the closely related knowledge spiral of Nonaka (1994) were identified as the subject areas. For these subject areas, a literature search was made for suitable literature to be used for the analysis. In the selection of literature, the main focus was placed on literature with information and communications technology. But also general literature about the validation process and the knowledge spiral was used. Additionally, certain validation tools were selected and analyzed. For example, Cedefop (2015), Bohlinger (2017) or Diedrich (2000) deal with the validation process and Nonaka (1994) with the knowledge spiral. Authors such as Rice and Rice (2005), Natek (2016), Lee and Kelkar (2011), Davidekova and Hvorecky (2016), Sencioles et al. (2016) or Mustapha (2016) deal with the knowledge spiral of Nonaka (1994) with reference to information and communications technology.

After the literature has been selected and analyzed, four different categories have been defined. These categories are the four steps of the validation process and the knowledge spiral. The four categories are as follows: Identification/Socialization, Documentation/Externalization, Assessment/Combination and Certification/Internalization. These categories are then described with characteristics derived from the literature. The same is done with the selected tools.

The actual qualitative content analysis is then carried out. The identified characteristics are abstracted to a next higher level and summarized. This abstraction represents the final characteristics.

3.1.1. Validation of prior learning – implicit learning and tacit knowledge

Knowledge, skills or competences originate from three different ways of learning: formal, non-formal and informal learning. Resources of knowledge can be divided into either tacit or implicit or codified or explicit (Polany, 1967). Explicit knowledge is transferable in the form of formal or systematic language (Nonaka & Takeuchi, 1995). Explicit knowledge is therefore knowledge that is easily transferable. Implicit knowledge, on the other hand, cannot be passed on through language or words. So tacit knowledge is knowledge "that we know but cannot say" (Polanyi, 1967). Above all, non-formal and informal learning is very often of an inarticulate and tacit nature. At work or in leisure time, implicit knowledge is often accumulated. The validation of prior learning process often also has the goal of making this implicit learning or the resulting tacit knowledge explicit in order to bring it to bear. The aim of the validation process is also to enable people to learn what they already know. This means that they must find a way to express their tacit knowledge (Sandberg & Andersson, 2011, Toynton, 2005, Wheelahan, 2003). Implicit learning very often leads to explicit knowledge. However, the opposite may also be the case where explicit learning leads to tacit knowledge. An example of this has been described by Eraut (2000): *"For example, a person may be very aware of being able to ride a bicycle and able to describe how he learned to do it, without being able to describe critical aspects of the knowledge gained, such as rapid responses to a sense of impending imbalance, while other relevant knowledge, such as the steadying effect of the gyroscopic motion of the wheels, would almost certainly never be acquired."*. (Eraut, 2000, p.118).

One process that deals with the transformation of implicit knowledge into explicit knowledge or with knowledge generation in general is the knowledge spiral (SECI - Socialization, Externalization, Combination and Internalization) by Nonaka (1994). This knowledge spiral identifies four different patterns of interaction between explicit and implicit knowledge (Nonaka, 1994). The first pattern, the socialization phase, enables the production of implicit knowledge through interaction and exchange of experience. It is very important in this phase that implicit knowledge can also be acquired without language, for example through observation or imitation. The second pattern is used to externalize implicit knowledge. The implicit knowledge is externalized by means of work processes or linguistic metaphors. In the third pattern, the combination, explicit knowledge is connected. In the fourth and final step, explicit knowledge is internalized. This process, seen in figure 18, is very similar to the idea of learning (Nonaka, 1994).

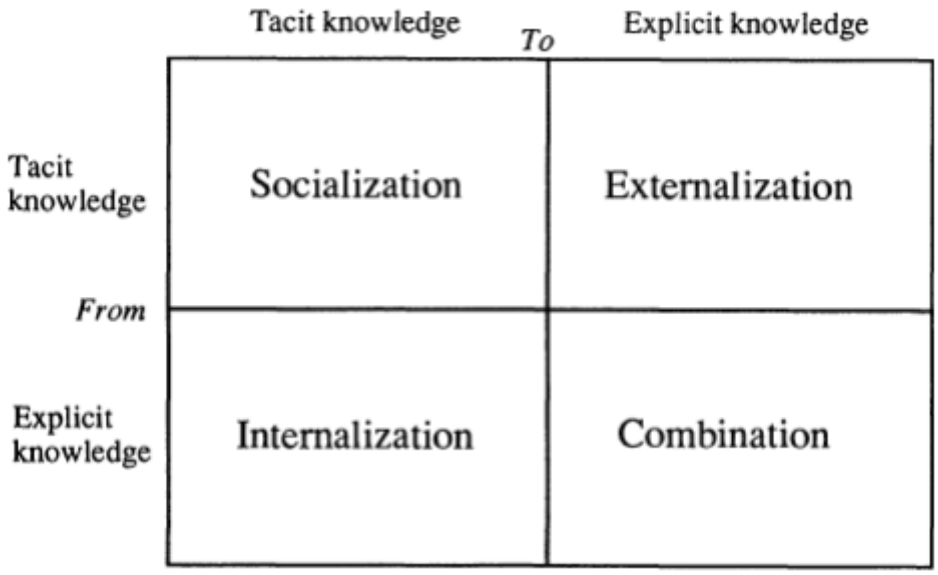


Figure 18: Knowledge spiral (Nonaka, 1994, p. 19)

One of the main goals of the validation process is to make knowledge explicit in order to bring it into the form of a qualification. Therefore, the knowledge spiral of Nonaka (1994) and the general validation process are very similar.

3.1.2. Characteristics of the knowledge spiral

In the following, the different characteristics of the knowledge spiral are described. These characteristics will be used later for the validation of prior learning process.

Socialization: In the first pattern, socialization, tacit knowledge is converted through interaction between individuals. As already mentioned, this can also take place without language. Much knowledge is passed on through observation, imitation and simple practice. The key to acquiring tacit knowledge is experience. Without a common experience, it is very difficult to process or classify information (Nonaka, 1994). Tacit knowledge is often very difficult to formalize and can usually only be acquired through shared experience. Socialization often takes place in traditional education where students learn the implicit knowledge, they need through practical experience rather than through written textbooks. However, socialization can also take place in informal social meetings (Nonaka et al., 2000). The process of creating tacit knowledge through shared experience is thus called socialization.

Externalization: Externalization concerns the transformation of tacit knowledge into explicit knowledge. Externalization is basically the process of articulating tacit knowledge into explicit

knowledge (Nonaka, 1994). Silent knowledge is made explicit so that it can be shared by others and used as a basis for new knowledge. An example would be the creation of concepts in the development of new products (Nonaka et al., 2000).

Combination: The third pattern of the knowledge spiral involves the use of social processes to combine different knowledge. Individuals exchange knowledge and combine it through meetings and telephone conversations, for example. In combination mode, explicit knowledge is transformed into more complex and systematic explicit knowledge. For example, if the accountant from one company collects information from the entire company to create a financial area, then this report is new knowledge. It has brought together knowledge from many different sources into one context (Nonaka, 1994; Nonaka et al., 2000).

Internalization: Internalization concerns the transformation of explicit knowledge into tacit knowledge (Nonaka, 1994). In the mode of internalization, the embodiment of explicit knowledge into tacit knowledge happens. Above all, the concept of "learning by doing" is closely linked to internalization. When knowledge is internalized, it becomes a very valuable capital. This tacit knowledge can then trigger a new spiral of knowledge formation (Nonaka et al., 2000).

3.1.3. Learning and knowledge management

Learning and knowledge management are very similar in terms of input, results, processes, activities, but also tools, concepts or terminologies. A learning process, similar to the process of knowledge generation, involves more than just the acquisition of knowledge. It is a dynamic process and also deals with the transformation of tacit and explicit knowledge (Chatti et al., 2007). Knowledge management (KM) and validation of formal, non-formal and informal learning can be viewed from different perspectives. The most commonly used and most important perspectives are the personal perspective and the information technology (IT) perspective. Today, information and communications technology (ICT) is used in almost every field (Natek, 2016). Many companies, scientists and politicians have used various IT systems to develop Knowledge Management Systems (KMS). In order for this work to become even more efficient and successful, the perceptions of ICT use in knowledge management are very interesting and important for future projects (Lee & Kelkar, 2011; Rice & Rice, 2005). Basically, there is a very positive attitude towards the use of ICT. Especially with regard to the

four different phases of the SECI model, there are already many different approaches. The use of ICT to support knowledge management is particularly important as it can influence the work and the outcome. For example, ICT is used as a tool to support some parts of the SECI model (Mustpaha, 2016). Today, digital information and communication technology enables the creation and exchange of information and knowledge over much longer distances than before. This technological change therefore leads to a broad application of virtual presence. (Dávideková & Hvorecký).

The characteristics, with regard to ICT, of the individual process steps are of great importance in the SECI- model but also in the validation process of formal, non-formal and informal learning.

3.1.4. Analysis of the validation process

In the scientific area of the validation process there are not many papers yet (Cedefop, 2015; Diedrich, 2000) dealing with the use of ICT in relation to the validation process. Nevertheless, certain characteristics or approaches or properties emerge that are important for the individual phases with regard to the use of ICT. According to Cedefop (2015) the use of self-assessment is particularly important in the identification pattern. People must learn to assess themselves in order to identify their competences. In addition to self-assessment, tests, observations or simulations will also be used to identify knowledge, skills or competences (Cedefop, 2015). According to the Berlin Declaration on Validation of Prior Learning (2019) at the beginning of a process it is very important that the process or the associated tool is accessible online and that there is also a clear entry point. Not only Cedefop (2015) but also Diedrich (2000) say that social interaction in the identification phase is very important. According to Cedefop (2015) in the second step, the documentation, it is important that a profile is created that can then be used for subsequent work. In addition, written documents, but also work samples or work demonstrations are of great importance. One of the most important tools for documentation is the CV and the portfolio (Cedefop, 2015). According to Bohlinger (2017) a portfolio is an "organized collection of (written) materials (either in paper and/or digital) that presents and verifies learning outcomes acquired through experience". According to Cedefop (2015) and Bohlinger (2015) in the third phase of the validation process, the assessment, there is a very central characteristic. Standards or reference points must be used in this phase. Only then a certain level can be reached, which can then be reused. The EU Council (2012), on the other

hand, says that the assessment phase can also be supported by self-assessment. In the last phase, certification, the main purpose is that a license or certificate can be created. However, according to Cedefop (2015) and Bjornavold (2000), this can only happen through credible and competent authority or organization. Accordingly, only those can issue a certificate that have the official authority to do so.

3.1.5. Analysis of the SECI model

In the following, the characteristics of the four different modes of the knowledge spiral, socialization, externalization, combination and internalization, are defined and analyzed with regard to the use of ICT. In addition, concrete examples are given of how this use or the corresponding tool can look like.

A personal meeting or interaction is a very important building block within the socialization pattern in order to establish the fundamental exchange of tacit knowledge (Rice & Rice, 2005). The essence of socialization is knowledge sharing. Natek (2016) also says that the exchange and creation of tacit knowledge happens primarily through direct experience. For example, social networks, forums, groupware, conference systems or chat groups are used (Natek, 2016). The results of Lee and Kelkar (2011) show that ICTs primarily support externalization. In addition, different types of ICT mixes are used to support the modes of the SECI model. The socialization pattern mainly uses email, instant messaging, people finder, e-collaborative systems or podcasting (Lee & Kelkar, 2011). According to Davidekova & Hvorecky (2016) in the socialization pattern mainly formal and informal talks on strategy take place. But brainstorming and the exchange of experiences also play a role. This happens mainly through video conferencing with, for example, Skype. But desktop sharing, instant messaging or digital discussion platforms are also used. The role of ICT in the socialization pattern is mainly supportive (Davidekova & Hvorecky, 2016). The socialization mode also begins with the construction of a "field" or "space" of social interaction. For this development of social interaction, social media instruments in particular are a great possibility (Chatti et al., 2007). The socialization pattern is also about sharing methods, understanding and skills within different social communities. This happens through online information, culture of trust but also coherent repository information (Sencioles et al., 2016). Mustapha (2016) assumes the following activities in computational form in the socialization pattern: Building user profiles,

creating special interest groups and ice-breaking sessions, watching user-generated content video, video exchanges, relayed audio recorded discussion.

The **externalization** pattern also includes creative reporting and compilation of systems (Rice & Rice, 2005). In other words, externalization is also the articulation of tacit knowledge through dialogue and reflection. A symbolic language is used and the tacit knowledge is transformed into a concept or a prototype, so to speak. This happens with the help of expert systems, blogs, wikis, questions and answers or cognitive mapping tools (Natek, 2016). According to Lee and Kelkar (2011), blogs or podcasting or people finder are also used in the externalization pattern. The collected tacit knowledge is codified into unambiguous concepts containing instructions, procedures, schemes, drawings and diagrams (Davidekova & Hvorecky, 2016). According to Chatti et al (2007), externalization is the process of articulating tacit knowledge into explicit concepts based on metaphors, analogies, concepts, hypotheses, or models. Blogs, for example, support the externalization process by giving everyone a voice and space to capture personal knowledge (Chatti et al., 2007). Externalization is also the pattern of representation. This representation takes place music in different platforms and languages using words, images, videos and. Emails, tagging or instant messages were used (Sencioles et al., 2017). For Mustapha (2016) and Haag and Duan (2012), externalization occurs primarily through participation in discussions in one form or through the creation and expansion of the content of a public channel (wikis, blogs).

The third pattern, **combination**, is the systematization, application and preparation of explicit knowledge and information. Among others, content management systems, databases, document systems, knowledge maps, web portals and machine learning are used here (Natek, 2016), but also repositories, emails, blogs or people finder (Lee & Kelkar, 2011). According to Davidekova & Hvorecky (2016), knowledge is systematically processed in the combination pattern and then transformed into more sophisticated systems. The combination is also the systematization of concepts into a knowledge system. Blogs and wikis, for example, create distributed community information stores with up-to-date content (Chatti et al., 2007). A platform is also needed that combines several components of explicit knowledge and systematizes it afterward (Sencioles et al., 2016). File-sharing based on the relevant content and distribution to the relevant group is also possible in the combination pattern (Mustapha, 2016). According to Haag and Duan (2012), self-assessment quizzes are also applied in this pattern.

The **internalization** pattern concerns the learning and acquisition of new implicit knowledge in practice through e-learning, wikis, social networks, forums or repositories (Natek, 2016; Lee

& Kelkar, 2011). Internalization is also the process of embodying explicit knowledge in individualized tacit knowledge (Davidekova & Hvorecky, 2016). For example, multi-player games, multi-user simulations and also trial and error are used in this pattern. According to Sencioles et al (2016), internalization is the process of systematic reflection through actions and practices.

3.1.6. Analysis of the characteristics of selected tools for validation of prior learning

For the four phases, identification, documentation, assessment and certification, there are, as already mentioned, many different tools. These tools can also be used to derive the characteristics for the validation of prior learning process. For example, there are tools such as the AiKomPass, YouRock, Validation Tool for volunteers and also the ProfilPass, which are used for the **identification** phase. The characteristics are derived from the various activities and activities that can be carried out using these tools. For example, YouRock and AiKomPass need to select activities or tasks that fit the person. In addition, the AiKomPass, ProfilPass and the Validation Tool for volunteers work with users being able to describe their activities, knowledge and skills themselves. This happens mainly through reflection and self-assessment. For the **documentation** phase, the tools YouRock, AiKomPass, Validation Tool for volunteers and ProfilPass are also used for analysis. The user has to create an online profile for YouRock as well as for the Tool for volunteers. This profile can also be linked to social media. The AiKomPass and ProfilPass work with PDF documents, which can either be saved locally or printed. For the **assessment** phase the tools IT-Barometer and Game for Self-Assessment are used for analysis. The main focus here was on the fact that users had to answer certain questions. The result of the questions is obtained in the Game for Self-Assessment in the form of the CEFR. For the **certification** phase there are no suitable tools yet, since the subsequent certificate must be issued by a competent and credible organization in order to be allowed to use it officially.

3.1.7. Analysis of the roles inside the validation process

When analyzing the specific tools, there are basically three essential roles that are used. The first role is the simple user, the user who uses the specific tool to identify his formal, non-formal and informal knowledge. The second role concerns the evaluator, the persons who evaluate the identified knowledge and initiate the further process. By analyzing the last step of the validation process, the certification, it becomes apparent that there must be a third role in the validation process. In addition to the simple user and the evaluator, there must also be an authority, for example a government or a credible organization, which is allowed to officially certify the knowledge of the user.

The whole analysis was done using excel. In the following page the excel sheet is provided (table 3).

Identified characteristics for the Validation of prior learning process								
Identification								
Process step	**Characteristic**	**Reference**	**Process st**	**Characteristic**	**Reference (Tool)**	**Process step**	**Characteristic**	**Reference**
Identification	Self-Assessment (--> Interact	Cedefop, 2015	Identification	Select activities	YouRock	Socialization	Interaction important component	Rice & Rice, 2005
Identification	Tests/Observations/Simulatic	Cedefop, 2015	Identification	Select tasks	AiKomPass	Socialization	Direct experience (Social network, forums, groupware)	Natek, 2016
Identification	Accessible locally and online	VPL-Biennale	Identification	Describe activities, knowledge, sk	AiKomPass	Socialization	E-collaborative systems	Lee & Kelkar, 2011
Identification	Clear entry point	VPL-Biennale	Identification	Describe activities	Validation Tool	Socialization	Digital discussion platforms, exchange of experience	Davidekova & Hvorecky, 2016
Identification	Social interaction	Diedrich, 2000	Identification	Reflection, Self-Assessment	Validation Tool	Socialization	Building a "field" or "space" of social interaction (social media), information sharing, online information, observation	Chatt et al., 2007
			Identification	Describe tasks/activities/etc	ProfilPass	Socialization	Share methods, understanding, experience, skills, information sharing, online information, culture of trust, coherent repository	Sencioles et al., 2016
						Socialization	Building user profile, creating special interest group	Mustapha, 2016
Documentation								
Process step	**Characteristic**	**Reference**	**Process st**	**Characteristic**	**Reference (Tool)**	**Process step**	**Characteristic**	**Reference**
			Documentati	Online Profile	YouRock	Externalization	Reporting and compiling of systems	Rice & Rice, 2005
Documentation	Building a profile	Cedefop, 2015	Documentati	Download the diamond	YouRock	Externalization	Essence of externalization is writing (codification)	Natek, 2016
Documentation	Writting documents	Cedefop, 2015	Documentati	Print PDF	AiKomPass	Externalization	Using symbolic language	Natek, 2016
Documentation	Work samples/demonstration	Cedefop, 2015	Documentati	Online Profile	Validation Tool	Externalization	Translating tacit knowledge into concept or prototype (blogs, questions and answers, cognitive mapping tools)	Natek, 2016
Documentation	Portfolio	Cedefop, 2015	Documentati	Connect profile to social media	Validation Tool	Externalization	Blogs	Lee & Kelkar, 2011
Documentation	Portfolio - "organized collection of (written) materials (either on paper and/or digital) that presents and verifies learning outcomes	Bohlinger, 2017	Documentati	PDF document	ProfilPass	Externalization	Putting down instructions, procedures ,schemes, drawing, graphs, ch	Davidekova & Hvorecky, 2016
						Externalization	Based on metaphors, analogies, concept, hypotheses and models, mobile technologies, blogs, email	Chatt et al., 2007
						Externalization	Mode of representation including words, images, video and music in different platform and different languages	Sencioles et al., 2016
						Externalization	Online information, Availability	Sencioles et al., 2016
						Externalization	Creating and enhancement to the public channel content, participation in forum discussion	Mustapha, 2016
						Externalization	Discussion forum, blog, wiki	Haag & Duan, 2012
Assessment								
Process step	**Characteristic**	**Reference**	**Process st**	**Characteristic**	**Reference (Tool)**	**Process step**	**Characteristic**	**Reference**
Assessment	Standard or reference points	Cedefop, 2015	Assessment	Answer questions	IT-Barometer	Combination	Systemizing and applying explicit knowledge and information, knowledge maps, web portals, machine learning, neural networks	Natek, 2016
Assessment	Standard or reference points	Bohlinger, 2017	Assessment	Answer questions	Game for self	Combination	Repositories, blogs, email	Lee & Kelkar, 2011
Assessment	Self-Assessment	Council EU, 2012	Assessment	Result in form of CEFR	Game for self	Combination	Systematically process and then converted into more sophisticated systems, databases, data warehouses ,respositories	Davidekova & Hvorecky, 2016
						Combination	Systemizing concepts into a knowledge system, blogs and wikis, reviews,	Chatti et al., 2007
						Combination	Platform combines several components of explicit knowledge to systematize it, information sharing	Sencioles et al., 2016
						Combination	File sharing based on the relevant content and distribution to the relvent group, searching for content on the web and place in the right	Mustapha, 2016
						Combination	Watching videos, self-assessment quizzes	Haag & Duan, 2012
Certification								
Process step	**Characteristic**	**Reference**				**Process step**	**Characteristic**	**Reference**
Certification	Issuing a licence/certificate	Cedefop, 2015				Internalization	Learning and acquring new tacit knowledge in practice	Natek, 2016
Certification	Credible authority or organiza	Cedefop, 2015				Internalization	Repositories	Lee & Kelkar, 2011
Certification	Competent authority	Bjørnavold, 2000				Internalization	Process of embodying explicit knowledge into individualized tacit knc	Davidekova & Hvorecky, 2016
						Internalization	Multi-player games, multi-user simulations, trial and error, performing	Chatt et al., 2007
						Internalization	Process of systematic reflecton through actions and practices	Sencioles et al., 2016
						Internalization	Measuring the density of the participation of every individual against the contemporary participants	Mustapha, 2016
						Internalization	No technology is mentioned, apply survey question to check on application of knowledge, self-assessment, skill improvement	Haag & Duan, 2012

Table 3: Analysis of the characteristics

3.1.8. Content analysis of the identified characteristics

Based on the content analysis about the characteristics of the SECI-spiral and the validation process, I identified several key-characteristics which will therefore be used for the modelling language for the process of validation of prior learning. The identified characteristics will be the classes of the modelling language in order to use every important aspect.

In the content analysis, each specific characteristic was analyzed and abstracted to a higher level. Thus, the individual terms were generalized so that they can be used for all tools. The content analysis was also carried out in excel (table 4):

Content analysis of the identified charcateristics			
Identification		Documentation	
Identified characteristics	**Abstraction**	**Identified characteristics**	**Abstraction**
Self-assessment → Interaction system	*Interact*	Building a profile	*Online profile*
Tests/Observations/Simulations	*Work samples*	Writing documents	*Codify*
Accessible locally and online	*Online entry point*	Work samples/demonstration/CV	*Collection of (written materials)*
Clear entry point	*Online entry point*	Portfolio	*Collection of (written materials)*
Social interaction	*Interact*	Online Profile	*Online Profile*
Select activities	*Select*	Download the diamond	*Collection of (written materials)*
Select tasks	*Select*	Print PDF	*Collection of (written materials)*
Describe activities, knowledge, skills	*Describe*	Online Profile	*Online profile*
Describe activities	*Describe*	Connet profile to social media	*Online profile*
Reflection	*Reflect*	PDF document	*Codify*
Self-assessment → Interaction system	*Interact*	Essence of externalization is writing (codification)	*Codify*
Describe tasks/activities/etc	*Describe*	Using symbolic language	*Codify*
Interaction important component	*Interact*	Translationg tacit knowledge into concept or prototype	*Present information*
Direct experience (Social Network, forums, groupware)	*User profile*	Blogs	*Present information*
E-collaborative systems → Engage people in collective reflection	*Reflect*	Putting down instructions, procedures, schemes, drawing, graphs, charts based metaphors, analogies, concept, hypotheses and models	*Codify*
Digital discussion platforms → Engage people in collective reflectic	*Reflect*	Mobile technoliges, blogs, email	*Present information*
Exchange of experience	*Interact*	Mode of representation including words, images, video and music in different platforms and different languages	*Present information*
Building a "field" or "space" of social interaction (social media → Interaction	*User profile*	Creating and enhancement to the public channel content, participation in forum discussion	*Present information*
Information sharing, online information, observation	*Work samples*	Discussion form, blog, wiki	*Present information*
Online information	*Describe*		
Building user profile	*User profile*		
Assessment		Certification	
Standard or reference points	*Standard of reference point*	Issuing a license/certificate	*Certificate*
Self-assessment	*Interact*	Credible authority or organization	*Authority*
Answer questions	*Answer*	Competent authority	*Authority*
Result in form of CEFR	*Standard of reference point*	Roles	
Systemizing and appying explicit knowledge and information, knowledge maps, web portals, machine learning, neural networks	*Applying knowledge*	User	
Repositories, blogs, email	*Present information*	Evaluator	
Systematically process and then converted into more sophisticated systems, databases, data warehouses, repositories	*Applying knowledge*	Authority	
Platform combines several components of explicit knowledge to systematize it, information sharing	*Applying knowledge*		
Watching videos, self-assessment quizzes	*Interact*		

Table 4: Content analysis

3.2. Matching concept

The identified characteristics are used in the matching concept. But how does this matching concept work in general and why are exactly these characteristics used?

The basis of the matching is the four step validation process. For this process, the characteristics for each step of the process were identified by means of the knowledge spiral. The process or the individual process steps can therefore be described with the help of these characteristics. The tools used for the validation process can also be described. The tools are divided into process steps and each individual step is described and explained in more detail. Between the process and the tools there is an algorithm, which is described in more detail in chapter 4. This algorithm supports the actual matching. The keywords that were used to describe the tool are compared with the characteristics of the validation process. The keywords are converted into vectors with the vector space model. Word vectors are a way to represent words as numerical vectors in a multidimensional space. Using these vectors, a similarity between the keywords of the tool and the characteristics of the process is calculated. Synonyms are also recognized, because similar words have similar vectors. The final result of the matching process is a percentage.

The vector space model is a model within information retrieval (Salton et al., 1975). Information retrieval can be defined as a procedure finding relevant information out of unstructured data and information (Manning et al., 2008). This information could then be processed and used. One of the fields of application is the so-called "similarity matching in texts" (Corley and Mihalcea, 2005). This is mainly about finding similarities between two or more text documents. One of the most prominent examples for this matching is the vector space model (Silva et al., 2004; Salton et al., 1975). Other examples are the boolean search or probabilistic models like the inference network model (Kuropka, 2004). Boolean search mainly works with the operators and, or and not. Searching with these operators limits the result to a certain range (Arnold and Voss 2004). Inference network models can handle probabilistic and Boolean queries and thus combine results from multiple queries (Turtle and Croft, 1989)

"The vector space model is a mathematical-based model that represents terms, documents and queries by vectors and provides a ranking" (Silva et al., 2004, p.97). The vector space model therefore transforms a document into a vector. This enables it to be compared with other documents and also with various queries. The documents and queries are represented as points in a vector space (Silva et al., 2004; Salton et al., 1975) This vector space is an n-dimensional

space and each dimension is a property of the documents. An example of a property would be how often a certain term occurs in the document (Salton et al., 1975). The vector of a document provides information about the relative frequency of terms and indicates which terms the document contains at all. This simplified representation of documents makes it possible to compare these documents (Salton et al., 1975; Lowe, 2001). Search queries are also transformed into vectors. For example for the search query "X Y", the vector has the value 1 in the dimensions X and Y, and the value 0 in all other dimensions. In other words, each word *wi* within the document set has a dimension *I* (Look, 2003). If the word *wi* does not appear in the document, a 0 appears at the *i*-th position of the vector. If the word *wi* appears in the document, a 1 appears. In a query, the vectors from the query are compared with the vectors in the documents. A similarity comparison can therefore be made between the vectors of the documents and the query (Look, 2003, Lee et al., 1997).

3.3. Requirements

Based on the literature review, the reference frame, the associated characteristics and the general matching method, requirements for the method can now be derived. On the one hand, functional requirements can be defined. These describe desired functionalities and behavior. The following functional requirements were identified:

- The IT artifact must provide the user with the ability to model any IT tool that is suitable for the validation of prior learning process
- The IT artifact must create the assessment matrix based on the reference frame
- The IT artifact must tell the user whether his modeled tool support one or more phases of the validation of prior learning process

In addition to the functional requirements, non-functional requirements can also be derived for the developed matching method. The following non-functional requirements were identified:

- The matching method must be supported by a procedure model.
- The matching method must allow self-administration.
- For the matching method, relevant characteristics must be identified in order for this matching to be possible.

4. Prototypical evaluation

In the course of the prototypical evaluation the developed artifact is evaluated as a prototype. In this way it is checked whether it can be implemented at all or whether a technical possibility exists. According to Sonnenberg and Vom Brocke (2011), the goal of the prototypical evaluation is *"Implement an artefact design as a generic solution to demonstrate the artefact's suitability"* (Sonnenberg & Vom Brocke, 2011, p.81). The point is therefore that the artefact design is operationalizable and feasible.

In this case, the prototypical evaluation will be done with the ADOxx Development Toolkit, Python and Natural Language Processing (NLP).

4.1. Awareness of the problem

As has been identified in the literature, the validation process is not a simple process, but a very complex and demanding one. There are many factors that have to fit in order for such a process to be successful. There are also some approaches in the literature that have different approaches to this process. The best known and most widely used is the cedefop validation process (Cedefop, 2015). In addition, there are countless different tools that all claim to support the whole validation process or just one or more steps. Users are often overwhelmed with this oversupply and don't really know which tool to use for which step or which task. For example, the AiKomPass, the ProfilPass or the Game for self-assessment are all to be used for the identification and documentation phase. It is therefore not always clear which tool serves which purpose and for which phase within the validation process it can or should be used.

Therefore, the way in which IT tools are described in terms of the validation process is formalized. This results in a specific metamodel and guidance on how to describe IT tools. This is achieved with the help of a domain-specific modelling language. The respective IT tool can be modeled by this modeling language in ADOxx to see what purpose the tool really serves.

4.2. Modelling framework

The work and the modelling are based on the framework (see figure 19) by Karagiannis and Kühn (2002). According to the authors, a modeling method consists of a modeling technique and mechanisms and algorithms. The modelling technique is further subdivided into a modelling procedure and a modelling language. The modelling language contains the elements that can be used to describe a model. The modeling language is described by its syntax, semantics and notation. The semantic schema is either formally defined or exists in the form of informal text descriptions (Karagiannis & Kühn, 2002; Fill & Karagiannis, 2013). The notation, syntax and semantic of a modeling language have the following meanings:

- **Notation**: the representation of a modelling construct (e.g. graphical)
- **Syntax**: the specification of a modelling construct
- **Semantic**: the definition of the meaning for a modelling construct (Karagiannis & Kühn, 2002)

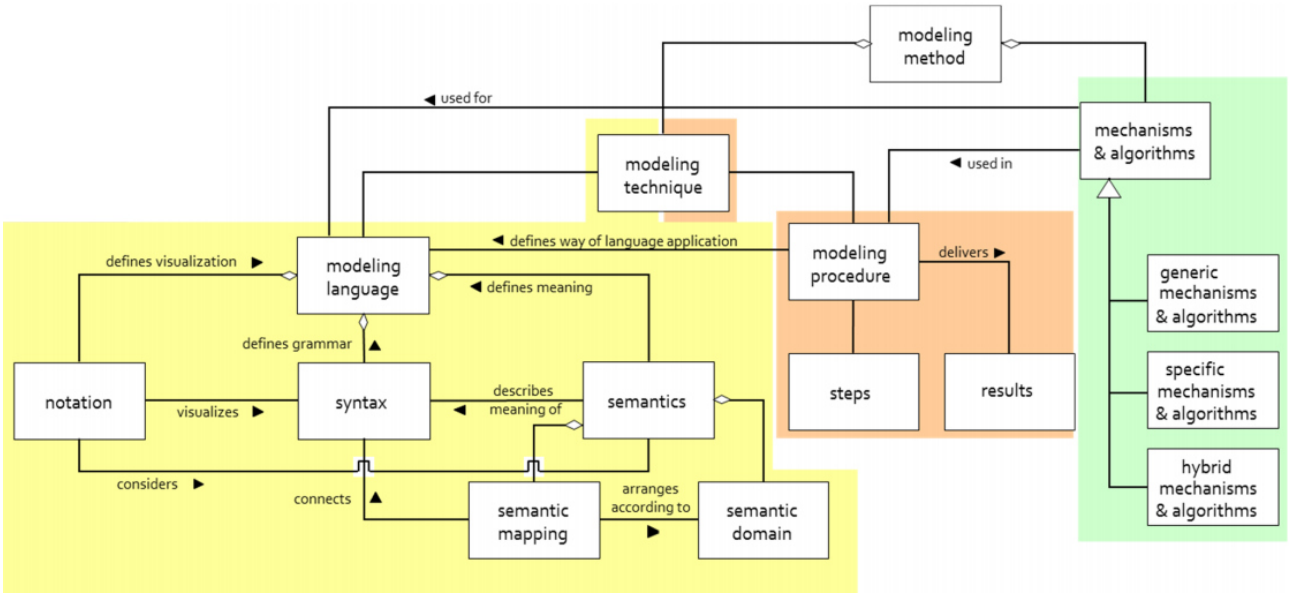


Figure 19: Modelling framework (Karagiannis & Kühn, 2002, p. 3)

The master thesis was designed using this modelling framework. In this thesis, several parts of the framework are selected and implemented: On the one hand, the modelling procedure using

individual steps and associated results. In addition, a meta model is developed and defined. The third part of the framework that is used is mechanisms and algorithms.

4.2.1. Modelling procedure

The modelling procedure of the developed IT artifact is essential so that the user knows which steps to take in order to come to a result. The modelling procedure looks like this and is also presented in figure 20:

- Step 1: Determined the starting point of the tool to be modeled for the **tool activity sequence Model**.
    - How is the tool started? Do I have to register or create a profile? Do I just start working without registering? Is the tool started online or do I have to download documents (pdf, etc...)?
    - Is the tool started without a specific starting point?
- Step 2: Identify the activities carried out in the specific tool.
    - Which activities must be carried out in the tool in order to achieve a result?
- Step 3: Create a logical chronology of the selected activities.
    - Must the selected activities be performed in a logical order or is the timing not important for the final result?
- Step 4: Describe each activity using keywords.
    - Which attributes can be assigned to the activities? Which attributes can be used to describe the details of the activity?
- Step 5: Determine the endpoint of the tool to be modelled for the tool activity sequence Model.
    - What event does the tool end with? Is an external document/file/etc. created that will be used further?
- Step 6: Identify which resources are used in the specific tool.
    - Which resources are used in the tool?
- Step 7: Create the **resource model** with the identified resources.
- Step 8: Describe each resource using keywords.
    - Which attributes can be assigned to the resources? Which attributes can be used to describe the details of the ressource
- Step 9: Identify which roles are used in the specific tool.

    - Which roles are used in the tool?
- Step 10: Create the **role model** with the identified roles.
- Step 11: Identify which resources and roles are used in which activity.
    - Are the resources/roles used within a particular activity? Do the resources/roles have to be linked to an activity?
- Step 12: Reference the identified resources and roles in the individual activities.
- Step 13: Push export-button, processing-button and info-button to generate the results

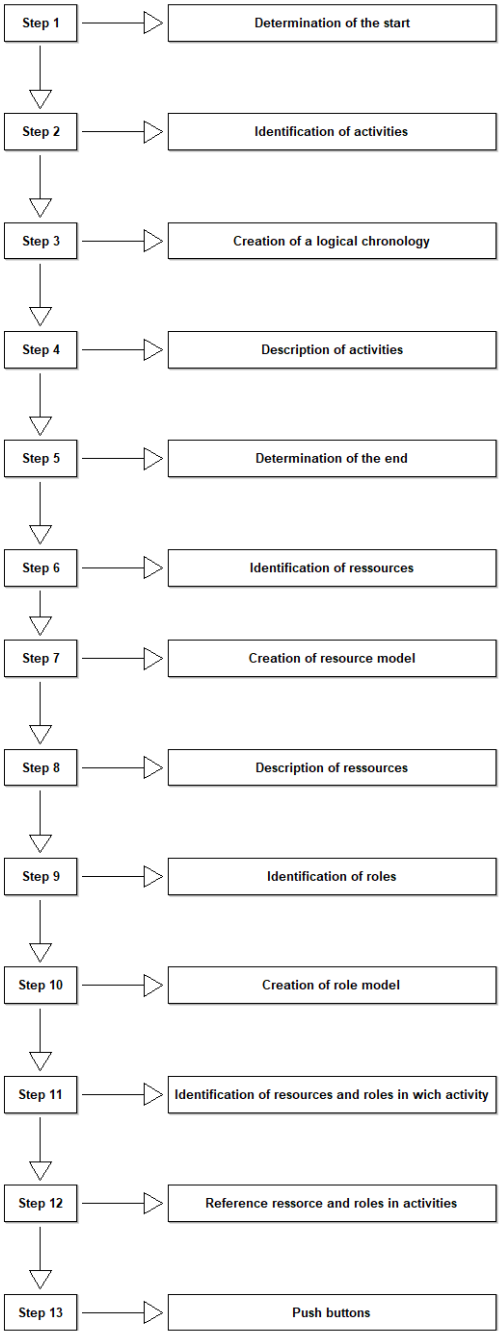


Figure 20: Modelling Procedure

According to the modelling procedure, a total of three different models are created. The tool activity sequence model is the main model. The other two models, the Resource Model and the Role Model, are linked at the end with the Tool activity sequence Model. Thus, all results are visible in a single model. The role model and the resource model are nevertheless two independent models. It can happen that a resource or a role is used that cannot be assigned to a single activity.

4.2.2. Metamodel, modeltypes and classes of the artifact

Figure 21 shows the dynamic meta model for the developed modelling tool. Since the modelling language is based on the ADOxx Meta modelling platform, there are some predefined abstract classes of ADOxx in the meta model.

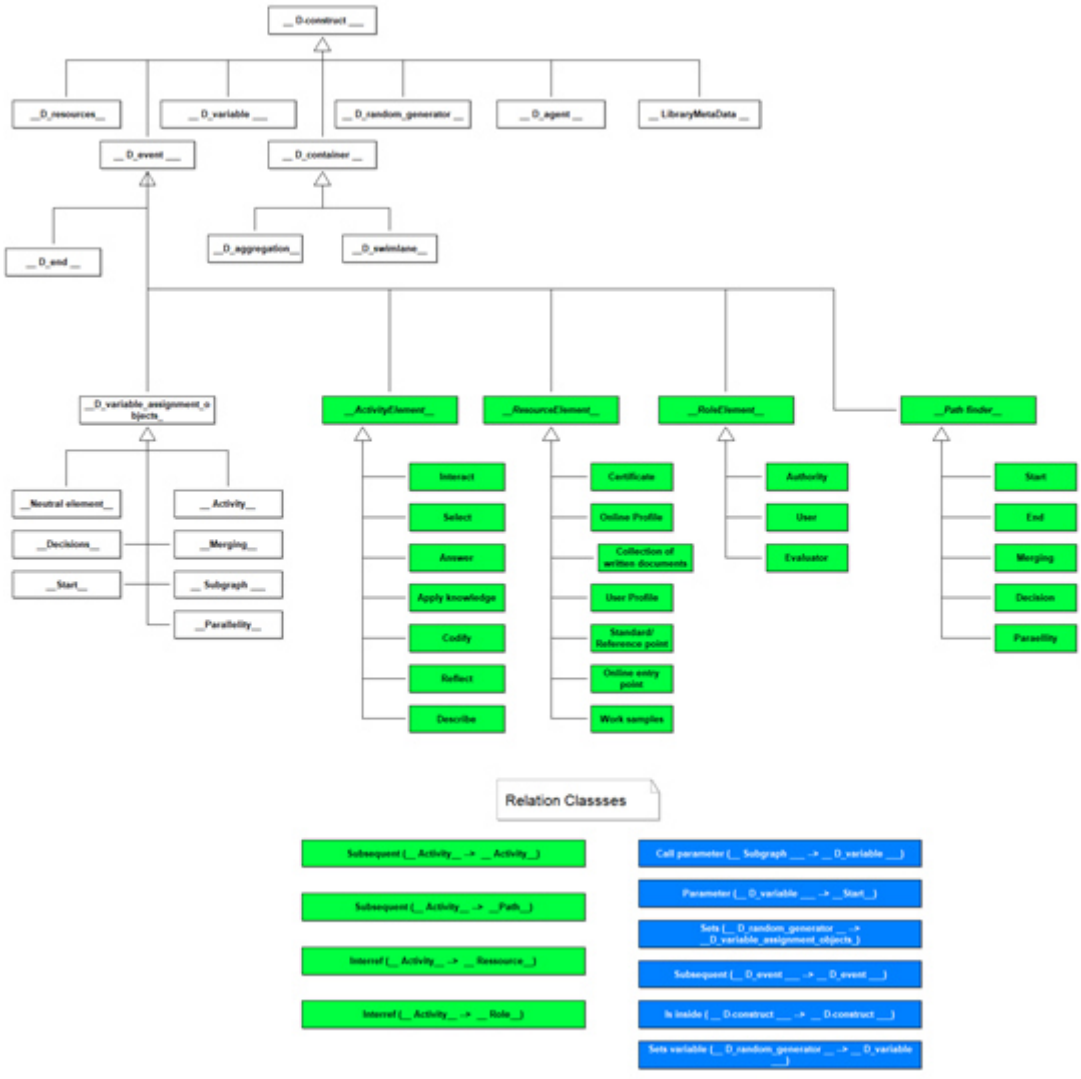


Figure 21: Dynamic meta model

These predefined classes are represented in the figure by the white squares. The green squares were added during development and analysis. These represent the concrete classes that are also used in modeling. All classes that have two underscores at the beginning and at the end are abstract classes and cannot be instantiated. As can be seen in the figure, all classes have a superclass, namely "__D-construct__". All classes, whether existing or self-added, inherit predefined attributes that cannot be deleted.

The blue rectangles represent the predefined relation classes in the dynamic meta model. The green rectangles were added during development and analysis. Basically, there are two four different relation classes. Relation classes from the class activity to activity and from the class activity to path finders. Furthermore, there are also two interRef relation classes. InterRef is a special configuration of a relationship class and describes the relationship between two objects from two or more classes. The relationship can exist within models but also between different models.

Figure 22 shows the conceptual meta model.

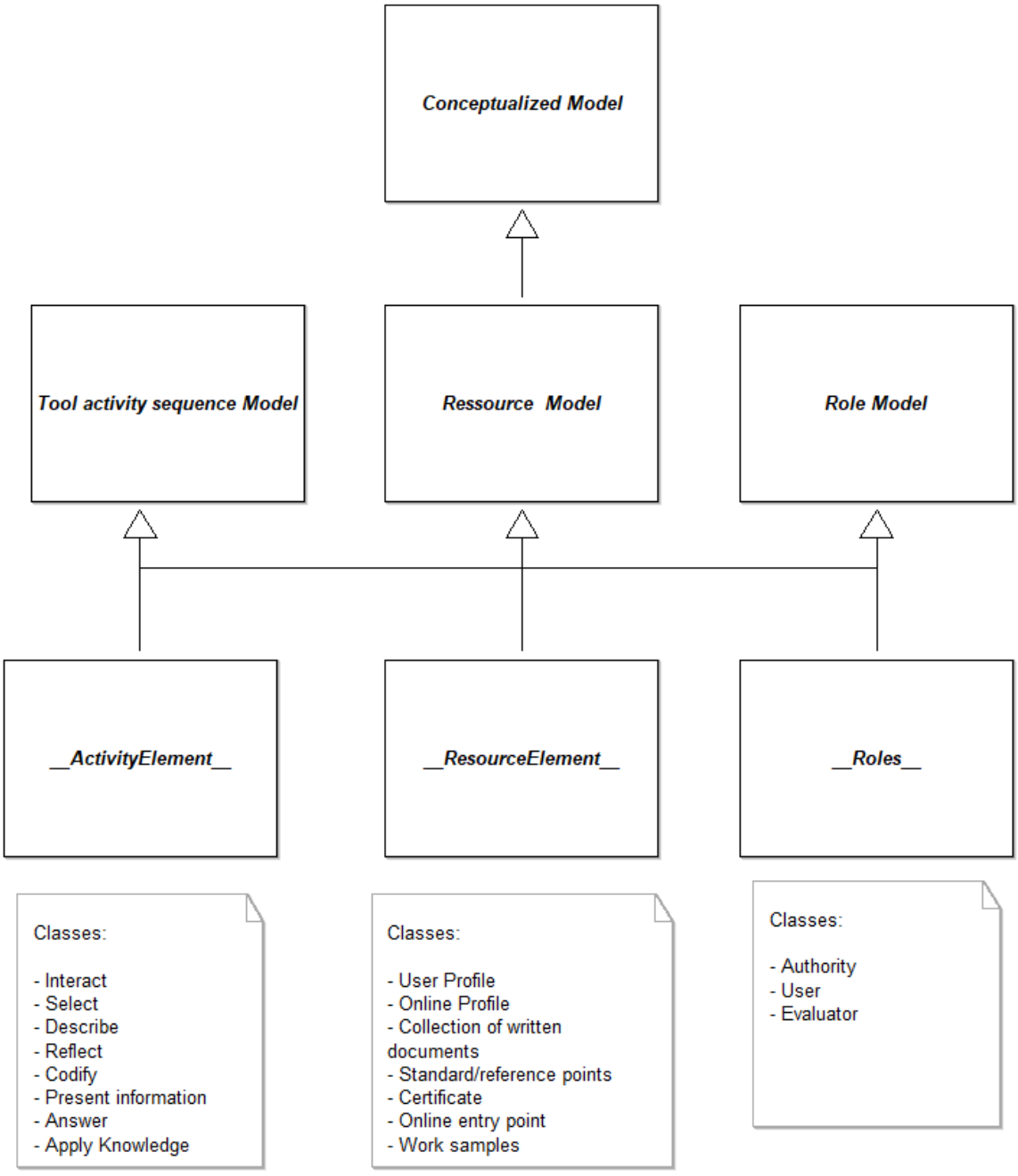


Figure 22: Conceptual meta model

4.2.3. Mechanism and algorithm

Before the algorithm is implemented in Python in Chapter 4.4., it must first be described generically so that it can be understood afterwards. Furthermore, generic concepts like Natural Language Processing and the programming language Python must be explained.

4.2.3.1. Natural Language Processing (NLP) and Python

The tool is not only developed with the ADOxx interface, but also with Python. Python is a programming language with which you can write your own programs. In my written python script also Natural Language Processing (NLP) is used. Natural language processing is a subfield of artificial intelligence and a research and application area that deals with the interaction between computers and human language. NLP deals with different techniques and methods to machine natural language. The goal is a direct communication between humans and computers. NLP thus describes the ability of a computer program to understand human language as it is written and spoken (Liddy, 2001; Collobert et al., 2011; Chowdhury, 2003). There are different levels of natural language processing. The most important are, among others, the syntactic and semantic levels. The syntactic level mainly refers to the analysis of words in a sentence. Here it is about recognizing the grammatical structure of a sentence. The result of such an analysis is the representation of a sentence, which recognizes the structural dependency relations between the words. The semantic level, on the other hand, refers to the possible meaning of a sentence. Here NLP concentrates mainly on the interactions between the meanings in the sentence (Liddy, 2001).

4.2.3.2. Generic algorithm

Basically, the algorithm runs in such a way that at the beginning an XML file is imported into Python. This XML file was generated using ADOxx and the modeling method developed. In this file all modeled models with their properties are contained. After the file has been imported, the file is analyzed using a library and the desired information is extracted. This extracted information is finally written into a new text file. This text file must then be cleaned up and slightly modified so that it can used working with it afterwards. This is followed by the process

of Natural Language Processing (NLP). This process makes the content of the text file readable for the computer. Afterwards the generated text file and the reference frame, which was also written in a text file, are compared with each other. This is done with the vector-based approach described above. The algorithm then presents a final result in the form of a percentage.

4.3. Implementation of the meta-model

The next phase concerns the implementation of the meta-model, which will be done with the help of the ADOxx Development Toolkit. *„ADOxx is the meta-modelling development and configuration platform for implementing modelling methods. Implementation of full-fletched modelling methods can be realized using the platform, consisting not only of a modeling language, but also of modelling procedure and the corresponding functionality on the form of mechanisms and algorithms. The implementation result, using ADOxx, are modelling toolkits (in contrast to model editors) following a configuration approach on the platform level (re-use of existing implementations and functionality on platform level indifferent“* (ADOxx). The ADOxx Modelling Toolkit is used to enable the modeling. Using the platform, the user can use all developed concepts.

4.3.1. ADOxx

The ADOxx metamodeling platform has some important features needed for metamodeling (Karagiannis & Kühn, 2002):

- *Extensible, repository-based metamodelling platform*
- *Three-step modelling hierarchy with a rich meta-metamodel*
- *Can be customized using metamodeling techniques*
- *Extendable with custom specific components*
- *Platform kernel provides basic modules for managing models and metamodels*
- *Graphical and tabular model editing*
- *Scripting language for defining mechanisms and algorithms* (Karagiannis & Visic, 2011, p. 33)

The meta-metamodel is an important part of the ADOxx metamodelling platform. Figure 23 shows an extract of this meta-metamodel. The core are the classes, relationship classes, model types and attributes. In ADOxx there is an Application Library that summarizes all developed artifacts for use. The library contains the definitions of model types, classes and relationship classes. A distinction is made here between abstract and concrete levels. All concrete classes and relationship classes are visible and are made available to the user as model types (ADOxx; Karagiannis & Kühn, 2002; Fill & Karagiannis, 2008).

- *Types: A model type is a well-defined sub-collection of classes and relation classes of a meta model.*
- *Classes: A class is construct that is used as a template to create objects of that class. The objects of a class are alternatively called "instances".*
- *Attributes: An attribute is a property of a modelling construct such as model, object or relation. Each attribute has type and a value.*
- *Relations: A relation class is a construct that is used as a template to create relations between objects. A relation class is defined between classes. A relation is always a directed connection between objects, i.e. each relation has a from-side and a to-side (ADOxx).*

Class attributes are one type of attributes. On the one hand, there are the notebook definitions for attribute display definitions in the ATTRREP grammar. They determine which attributes are visible in the modeling objects. There is also the possibility of a graphical representation. These are defined in the GRAPHREP grammar. The ADOxx meta-metamodel represents a high adaptability for metamodels (Fill & Karagiannis, 2013).

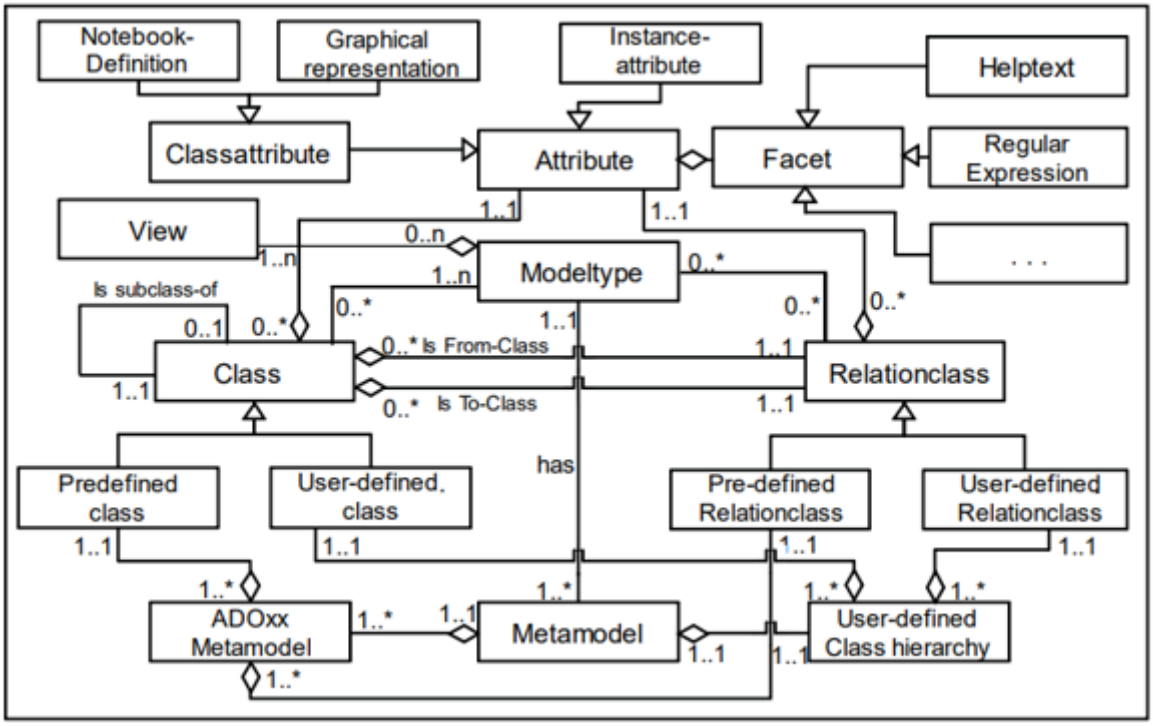


Figure 23: ADOxx meta-meta model (Fill & Karagiannis, 2008, p. 8)

4.3.2. Development of the modelling tool

Before going into detail about the different model types, classes, relations and attributes, I will first give an overview and a short description of the user interface of the developed tool. Figure 24 shows the Explorer window where all model groups are listed. By right-clicking on "Models" and selecting the option "New" all available model types appear. The first model type, "Resource Model", provides an overview of the resources used in the specific tool. The second, "Role Model" gives an overview of which roles can be assigned to the tool. The third, "Tool activity sequence Model" represents the most important model type. The chronological or logical activities that have to be performed in the specific tool in order to achieve a result are modelled here.

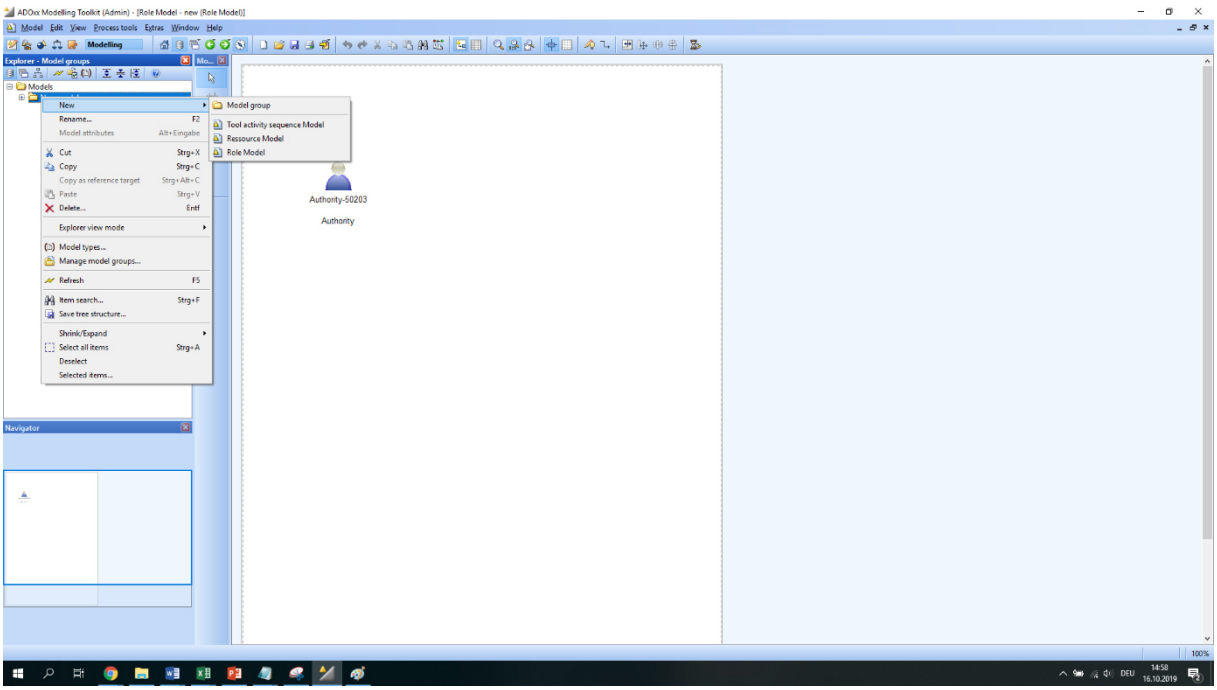


Figure 24: Explorer window of the modelling tool

4.3.2.1. Tool activity sequence model

The model type *Tool activity sequence model* is the main part of the tool. All activities that are carried out in the tool are modelled here. The model type contains a total of fourteen classes that allow you to model the activities of a tool. Of these fourteen classes, a total of eight classes are marked as activities. There is also a "note" class for any notes or annotations. There are also so-called "path finder" classes consisting of start, end, merging, parrallelity and decision. These classes mark the start and end points as well as possible branches or parallels within the model.

In the following, each individual class is described and its meaning as well as its properties are described.

Activity classes:

The eight different activity classes are all very similar in structure. The classes are used to model the various activities that are performed within a tool. Each class contains a notebook that is divided into chapters. The notebook is not itself an instant of a class but helps to display different attributes of an object. These attributes can be of different types, such as enumeration, string, or integer. The attributes can be edited in the notebook and provide information about the particular class or object. It is also possible to refer to other objects using the properties.

Attributes that refer to other objects can be displayed directly on the object itself. This enables faster access to these objects on the one hand and provides a better overview on the other. Each notebook of each class contains at least one chapter, the Description. General attributes such as name, comments and open questions are displayed here. With these attributes you can specify and name the object according to your requirements. All eight activity classes as well as the start and end classes additionally have the attributes "Referenced resources" and "Referenced roles". These two attributes can be used to reference other objects. "Referenced resources" refers to the resources used in the tool. "Referenced role" refers to the roles available in the tool. The most important attribute is the description which is display by **"Please describe it with keywords separated by semicolon".** Here the user has to describe each step in the modelling tool. This description is later used to assess his modeled tool.

The resources and roles will be discussed in more detail in a later chapter.

- **Class: Interact**
- Semantic:
    - Interact takes place primarily in the identification phase and in the assessment phase of the validation of prior learning process. This is mainly about interactions with other people, but also about interaction with the system. This interaction makes it possible to identify experiences that may not have been visible before. In ADOxx, this activity is mapped using "Interact".
- Notation:

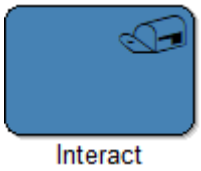


Figure 25 is an example of how the notebook of the different classes looks like in ADOxx.

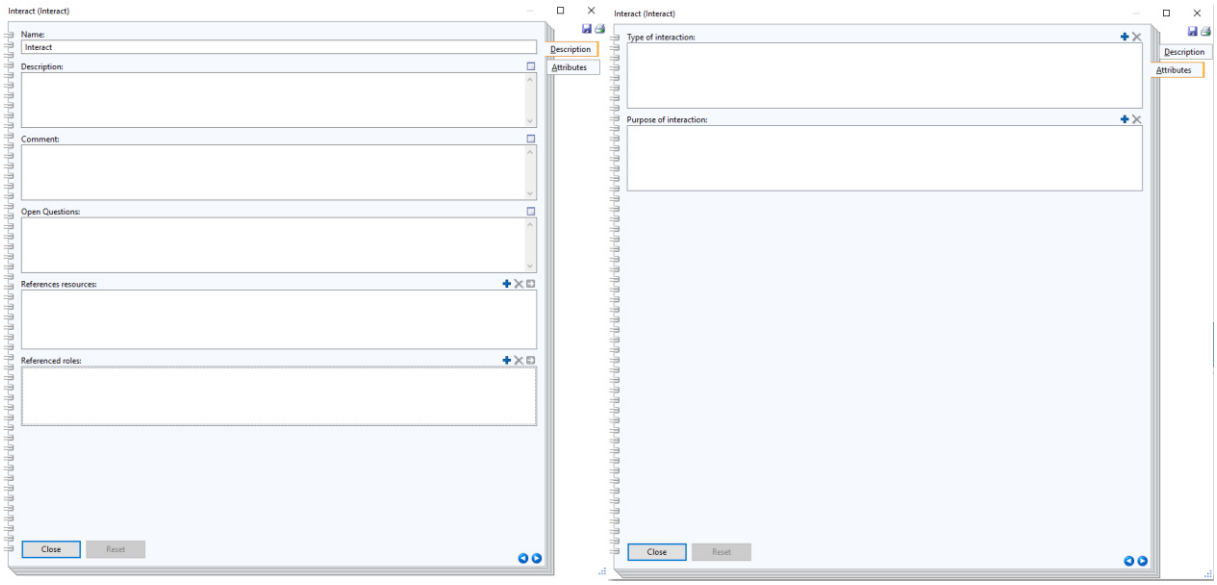
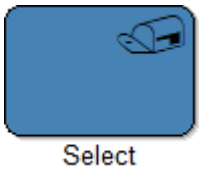
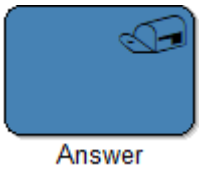


Figure 25: Notebook of interact

- **Class: Select**
- Semantic:
    - Select is mainly used in the identification phase and aims to allow users of a tool to select certain activities or tasks that are specified by the tool. There is a selection within the tool where the user has given different options. In ADOxx this activity is mapped using select.
- Notation:

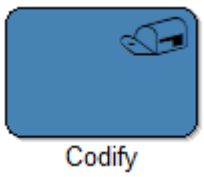


- **Class: Answer**
- Semantic:
    - Answer is mainly used in the assessment phase but also in the identification phase. The main point here is that questions are asked of the user and the user has to answer them. In ADOxx this answer is represented by "answer".
- Notation:



- **Class: Apply knowledge**
- Semantic:
    - Appy knowledge occurs primarily in the assessment phase. The main focus here is on the systematisation and application of knowledge and information, which is checked in a further step. In ADOxx this is mapped using "Apply knowledge".
- Notation:

- **Class: Codify**
- Semantic:
    - Codify is mainly used in the documentation phase. This is mainly about the use of symbolic speech encoding. Information and knowledge are written or codified. In ADOxx this activity is represented by "codify".
- Notation:

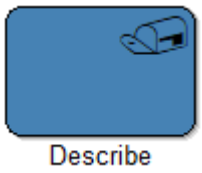


- **Class: Present information**
- Semantic:
    - Present information is mainly used in the documentation phase. Among other things, this involves the conversion of knowledge into concepts and prototypes.

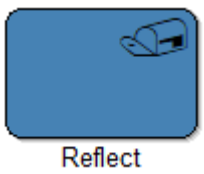
Information and knowledge are displayed so that they can be further processed. In ADOxx this activity is represented by "present information".

- Notation:

- **Class: Describe**
- Semantic:
    - Describe is mainly used in the identification phase. This is mainly about describing activities, knowledge or skills that users have, so that they can be documented afterwards. In ADOxx this activity is represented by "describe".
- Notation:



- **Class: Reflect**
- Semantic:
    - Reflect is used in the identification phase. This activity is about users thinking about what skills, knowledge or information they already have from a tool. In ADOxx this activity is represented by reflect.
- Notation:



- **Class: Start, End, Merging, Parallelism and Decision**
- Notation:
  - Start: 
  - End: 

4.3.2.2. Resource model

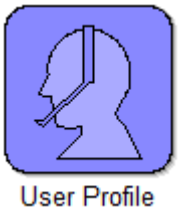
With the model type "Resource Model", all resources that are used in the tool are modelled. The model type has a total of seven classes, which represent all resources. Each resource class, like each activity class, is equipped with a description adapter in the notebook. It also contains the three properties, "Name", "Comment", and "Description" for further information and descriptions. Each resource class also has another property. Using this property, files such as Excel, PowerPoint or PDF files can be referenced and displayed. The following resource classes have this property: "Certificate", "Collection of written documents", "Standard/Reference point" and "Work samples". On the other hand, it is also possible to enter and reference urls. These urls are then opened with a browser. The following resource classes have this property: "User Profile", "Online entry point" and "Online Profile". All classes in the "Resource Model" also have the attribute description with the display **"Please describe it with keywords separated by semicolon".**

In the following, the semantics and notation of the individual classes are briefly discussed.

- **Class: Certificate**
- Semantic:
  - Certificate is used in the Certification phase. The only purpose here is to obtain an official certificate at the end of the validation process. In ADOxx this object is represented by "Certificate".
- Notation:

- **Class: Collection of written documents**
- Semantic:
    - Collection of written documents is used in the documentation phase. The main purpose here is to enable users to document and store their knowledge, skills and abilities. Written documents are, for example, PDF documents, CVs or portfolios. In ADOxx this object is represented by collection of written documents.
- Notation:

- **Class: User Profile**
- Semantic:
    - User profile refers, among other things, to whether the user must create a profile for the tool or not. With the help of this profile, a "field" or "space" of social interaction is created.
- Notation:



- **Class: Online entry point**
- Semantic:
    - Online entry point is used in the identification phase and aims to ensure that all tools for the validation process are accessible and available online. In ADOxx this subject is represented by online entry point.
- Notation:

Online entry point

- **Class: Online profile**
- Semantic:
    - Online profile is very similar to the user profile class. However, the online aspect is very important here. For example, it may be that the profile can be viewed online or that it can be linked to social media accounts.
- Notation:

Online Profile

- **Class: Standard/Reference point**
- Semantic:
    - Standard/reference points are used in the assessment phase. These clearly indicate the standards against which knowledge should be assessed. In ADOxx this object is represented by Standard/reference point.
- Notation:

Standard/Reference point

- **Class: Work samples**
- Semantic:
    - Work samples are mainly used in the identification and documentation phases. The main purpose here is to provide evidence of various work processes or general knowledge and then use it in a further step.
- Notation:

4.3.2.3. Role model

With the model type "Role Model", all roles that occur in the tool are modelled. The model type has a total of three classes. All three classes have a description adapter with the property Name, Comment and Description. In addition, the authority class has an attribute adapter where you can select the type of authority. Here you can choose either a government or an organization. In the following, the semantics as well as the notation of the three classes will be discussed briefly.

- **Class: User**
- Semantic:
    - The user is the person who uses the tool and works with it.
- Notation:

- **Class: Evaluator**
- Semantic:
    - The evaluator is the person who checks or analyses any results from the user.
- Notation:

Authority

- **Class: Authority**
- Semantic:
    - The Authority role is used exclusively in the certification phase. This role represents either an organization or a government that is officially empowered to issue official certificates.
- Notation:

4.3.2.4. ADOxx implementation

After the user modelled his tool and also described each step, he has to push at first the button seen in figure 26. With this button the user is able to save all three models in a XML-file which is then used for further processing. After this step the user is able to push another button which will trigger a python script (figure 27). The python script will process the modelled tool.

Figure 26: Export Button

Figure 27: Button for the python script

4.4. Implementation of mechanism and algorithm

In the following chapter the implementation of the mechanism and algorithm, which was done with the help of Natural Language Processing (NLP), SpaCy and python, is described.

4.4.1. SpaCy

SpaCy was used for this master thesis. "*Spacy is a free, open-source library for advanced Natural Language Processing (NLP) in Python. It's designed specifically for production use and help you build applications that process and "understand" large volumes of text. It can be used to build information extraction or natural language understanding systems, or to pre-process text for deep learning"* (Explosion).

SpaCy also offers statistical models for some languages. These models can be installed as python modules. These models typically contain the following content:

- *Binary weights for the part-of-speech tagger, dependency parser and named entity recognizer to predict those annotation in context.*
- *Lexical entries in the vocabulary, i.e. words and their context-independent attributes like the shape or spelling.*
- *Data files like lemmatization rules and lookup tables.*
- *Words vectors, i.e. multi-dimensional meaning representations of words that let you determine how similar they are to each other.*
- *Configuration options, like the language and processing pipeline settings, to put spaCy in the correct state when you load in the model* (SpaCy)

With spaCy it is possible to analyze different texts of whole documents. With the function “nlp” a text is tokenized in spaCy. This means that the whole text is divided into single linguistic units. These individual units are then processed by a given language processing pipeline. The processing pipeline of each pretrained model in spaCy consists of a PoS-tagger, a dependency parser and an entity recognizer.

A Part-of-Speach (PoS) tagger or part-of-speech tagging is a process of converting a sentence into documents. It therefore has the task of understanding the words in a text with its part of the language. Parts of language is a category of words with similar grammatical properties as verbs, adjectives or subjects. Each word is marked with its part. One of the main problems with POS tagging is the existing ambiguity. Especially in the English language many words have several meanings. A POS tagger thus has the task of eliminating this ambiguity (Moon & Baldridge, 2007; Marquez & Rodriguez, 1998). A dependency parser aims to analyse the grammatical structure of sentences. The parser also provides relationships between words and assigns a syntactic structure to a sentence (Chen & Manning, 2014). In almost every text document there are words or terms that represent certain units and that are more informative than other words. Named Entity Recognition (NER) is a process that localizes and classifies these units (Marrero, 2013).

Similarity:

After tokenizing a document with SpaCy, it is now possible to check the similarity of two documents using word vectors or so-called "word embeddings". According to SpaCy *"word embeddings are multi-dimensional meaning representations of a word"* (Spacy). The selected model (en_core_web_lg) has 685,000 vectors in 300 dimensions. In the context of this master

thesis, the comparison is made on the basis of the following two documents: On the one hand there is a so-called reference document. This document contains all the characteristics and properties that were worked out in chapter three. The other document contains a description that the user must enter within the framework of the ADOxx program. The user must not only model his modelled tool, but also describe the properties of the individual steps or the resources used. Using my written code, this document is prepared accordingly so that it is then available in the same form as the reference document. This way it is possible to find the similarity between the two documents. Furthermore, it is now possible to state how similar the modelled tool is to the reference frame that has been worked out. For this purpose, three different thresholds were defined in form of percentages:

- Between 85% and 100% similarity: The modeled tool is very well suited as a tool for the validation of prior learning process.
- Between 70% and 85% similarity: The modeled tool is well suited as a tool for the validation of prior learning process.
- Smaller than 70% similarity: The modeled tool is not really suited as a tool for the validation of prior learning process.

4.4.2. Code description

After pressing the button shown in figure 26, all 3 models are saved in an XML file. XML or Extensible Markup Language is a language used to structure, store or transfer data between two systems.

Import the XML file and create a new filled text file

```
import xml.etree.ElementTree as ET
tree=ET.parse(r"C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Activity.xml")
```

Figure 28: Import XML-file

After the file has been saved, the module "xml.etree.ElementTree" is called in python. ElementTree is a python library with which you can analyze an XML file. In the code the import command *"import as"* is used. This makes it possible to give the module a simplified name in the code. In this case the module was called ET. An XML file has a hierarchical data format. Therefore, the use of ElementTree splits the XML document into a simple tree structure. ElementTree has two different classes. First, ElementTree, which represents the entire XML file as a tree. The class Element represents a single node in this tree. If interactions are

performed in the entire file, this usually happens at the ElementTree level. Using the function "parse" this tree structure is created and stored in the variable tree. These two operations can be seen in figure 28.

```
with open(r"C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Activity.txt", "w")as f:

    for instance in tree.findall(".//ATTRIBUTE"):
        if instance.get("type")== "LONGSTRING":
            f.write(f"{instance.text}\n")
```

Figure 29: New text-file

The next step is to create an empty text file (Activity.txt) "with open as f". Then a For-loop is used. With this For-loop the function "findall" is used to search for all "ATTRIBUTE elements" in the XML file within the previously created variable tree. Therefore, the variable "instance" is created. An IF statement is also used within this For-loop. These IF statements are used to search for all "ATTRIBUTE elements" with the attribute "LONGSTRING" and then write the text to the newly created text file. So that a new line is opened after each iteration, the command "/n" is appended, by means of which a new paragraph can be created in python (figure 29).

Data cleaning

The text file was successfully created with the descriptions entered in ADOxx. However, the text file must now be cleaned up.

```
with open(r"C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Activity.txt", "r") as f:
    lines = f.readlines()

with open(r"C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Activity.txt", "w") as f:
    for line in lines:
        if line.strip("\n").startswith("iVB") is False:
            f.write(line)
```

Figure 30: Data cleaning1

The six lines in figure 30 open and read the text file. Then a For-loop is used. The aim of this For-loop is to delete all words that start with "iVB" from the text file. The created XML file from ADOxx still contains certain data, which start with "iVB", but are not needed.

```
infile = r"C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Activity1.txt"
outfile = r"C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Activity_Cleaned.txt"

delete_list = ["not specified", "none"]
fin = open(infile)
fout = open(outfile, "w+")
for line in fin:
    for word in delete_list:
        line = line.replace(word, "")
    fout.write(line)
fin.close()
fout.close()
```

Figure 31: Data cleaning2

When creating a text file a few data have to be deleted or changed. At the beginning the variables "infile" and "outfile" are created. Infile is the old text file and outfile will be a new cleaned text file. Then a list (delete_list) will be created containing the words to be deleted from the text file. After the two text files are opened with "open(file)", two For-loops are used. With these For-loops, all words to be deleted are replaced by a space. The newly generated data is then written to a new text file. In addition, the final text file was already converted to lowercase letters in the previous section by the command "s.lower()". This operation is seen in figure 31.

```
s=open(r"C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Activity_Cleaned.txt").read()
s=s.replace("\n", "").lower()
f=open(r"C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Activity1.txt", "w")
f.write(s)
f.close()
```

```
x=open(r"C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Activity1.txt").read()
x=x.replace(";", "\n").lower()
y=open(r"C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Activity1_Cleanedd.txt", "w")
y.write(x)
y.close()
```

Figure 32: Data cleaing3

Then the cleaned text file is opened with the command "open()" and read with ".read()". The following ten lines in figure 32 have the following goal. In the first operation, the text file is opened, and all line breaks are replaced with a space. This is done because there are still unnecessary line breaks in the text file. Then the text file is opened one last time and all semicolons are replaced by a line break. This results in a final cleaned file which can now be used for further work.

Natural Language Processing

```
import spacy
nlp= spacy.load('en_core_web_lg')
```

Figure 33: Natural language processing1

With the command "import spacy" the library is loaded and with "spacy.load('en_core_web_lg') the pre-trained model is loaded (figure 33).

```
import re
from spacy.tokenizer import Tokenizer
from spacy.util import compile_prefix_regex, compile_infix_regex, compile_suffix_regex

def custom_tokenizer(nlp):
    infix_re = re.compile(r'''[.\,\?\:\;\...\‘\`\“\”\"\'~]''')
    prefix_re = compile_prefix_regex(nlp.Defaults.prefixes)
    suffix_re = compile_suffix_regex(nlp.Defaults.suffixes)

    return Tokenizer(nlp.vocab, prefix_search=prefix_re.search,
                                suffix_search=suffix_re.search,
                                infix_finditer=infix_re.finditer,
                                token_match=None)


nlp.tokenizer = custom_tokenizer(nlp)
```

Figure 34: Natural language processing2

After the model has been loaded, the module "Regular expression operations (re)" and the SpaCy Tokenizer are also loaded. The function in this model allows you to check whether a particular string matches a particular regular expression. This is important because the user can also enter words separated by hyphens, for example. The keyword "def" is now used to create its own function. This function is used to separate all words that contain a punctuation mark. Since the hyphen was not included in this function, hyphen words are displayed as a single token. This process is seen in figure 34.

```
def get_file_contents(filename):
  with open(filename, 'r') as filehandle:
    filecontent = filehandle.read()
    return (filecontent)

fn1= r"C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Activity_Cleaned.txt"
fn2=r"C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Masterarbeitt.txt"

fn1_doc=get_file_contents(fn1)

fn2_doc=get_file_contents(fn2)

doc1 = nlp(fn1_doc)
doc2 = nlp(fn2_doc)
```

Figure 35: Get file content

Now that all preliminary work has been completed, a final program will be created. This program (get_file_contents) has the task to read and display all contents of a document. "Fn1" is the document that was created and edited by the user in ADOxx. "Fn2" is the document containing the reference frame. At the end these two documents are tokenized by the command "nlp". Now the already described process is executed in the processing pipeline and afterwards each word is provided with several vectors which are used for the comparison (figure 35).

```
result = (doc1.similarity(doc2))
result_final= round(result,2)*100
print (result_final)
```

Figure 36: Similarity

Using the function "doc1.similarity(doc2)) as seen in figure 36, the degree of similarity of these two documents is now determined. The round function rounds the final result to an integer number.

```
sehr_gut= "Your modeled tool is very well suited as a tool for the validation of prior learning process. The achieved similarity
mittel = "Your modeled tool is well suited as a tool for the validation of prior learning process. The achieved similarity resul
schlecht= "Your modeled tool is not really suited as a tool for the validation of prior learning process. The achieved similarity
```

```
if result >0.85 and result <1:
    print (sehr_gut + str(result_final) + "%")
elif result >0.7 and result >0.85:
    print (mittel + str(result_final) + "%")
else:
    print (schlecht + str(result_final) + "%")
```

```
Your modeled tool is very well suited as a tool for the validation of prior learning process. The achieved similarity result is
91.0%
```

```
with open(r'C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Ergebnisss.txt', 'w') as file_out:
    if result >0.85 and result <1:
        file_out.write(sehr_gut + str(result_final) + "%")
    elif result >0.7 and result >0.85:
        file_out.write(mittel + str(result_final) + "%")
    else:
        file_out.write(schlecht + str(result_final) + "%")
```

```
import os
os.startfile(r"C:\Users\benni\Google Drive\MASTER\Masterarbeit\Coden\Ergebnisss.txt")
```

Figure 37: Final output

Three different variables with different outputs are now created for the final output. These relate to how well the modelled tool fits to the reference frame. Using an IF function, the different thresholds are defined and at the end the respective variable is saved in a text document. With the command "os.startfile" this text file is opened and the result is presented (figure 37).

In summary, it can be said that the described concept is technically feasible. This implementation was carried out with ADOxx on the one hand and with the vector-based approach, python, and Natural Language Processing (NLP) on the other hand.

5. Case-based evaluation

One of the methods proposed by Hevner and Chatterjee (2010) and by Sonnenberg and Vom Brocke (2011) is used to evaluate the artifact with a cased-based evaluation. This evaluation method is used to check whether the artefact is applicable in practice and at the same time useful (Sonnenberg and Vom Brocke, 2011).

A total of three different scenarios are carried out for the case-based evaluation. The result of each evaluation is the degree of equality resulting from the modelled tool, its description and the associated reference framework. The descriptions of the tool are particularly important because they are compared with the reference framework. The following three different data are simulated:

- Data and descriptions from the tool called YouRock. This tool is likely suitable for the Validation of prior learning process, as this tool is also used in the literature.
- Data and descriptions from Moodle. Although Moodle is a tool within learning it should have nothing to do with validation of prior learning
- Data and descriptions from a fictive tool. The descriptions are not real words, they are just random "words". These words therefore do not exist in a conventional dictionary. This tool should therefore have nothing to do with the validation of prior learning process.

In each of the three scenarios, the respective tool is compared to the validation of prior learning process and the characteristics of this process. Figure 38 shows again the validation process and selected characteristics of the individual process steps. Based on these characteristics, the modelled tools are compared. The characteristics of the validation process are compared with the keywords of the modelled tools.

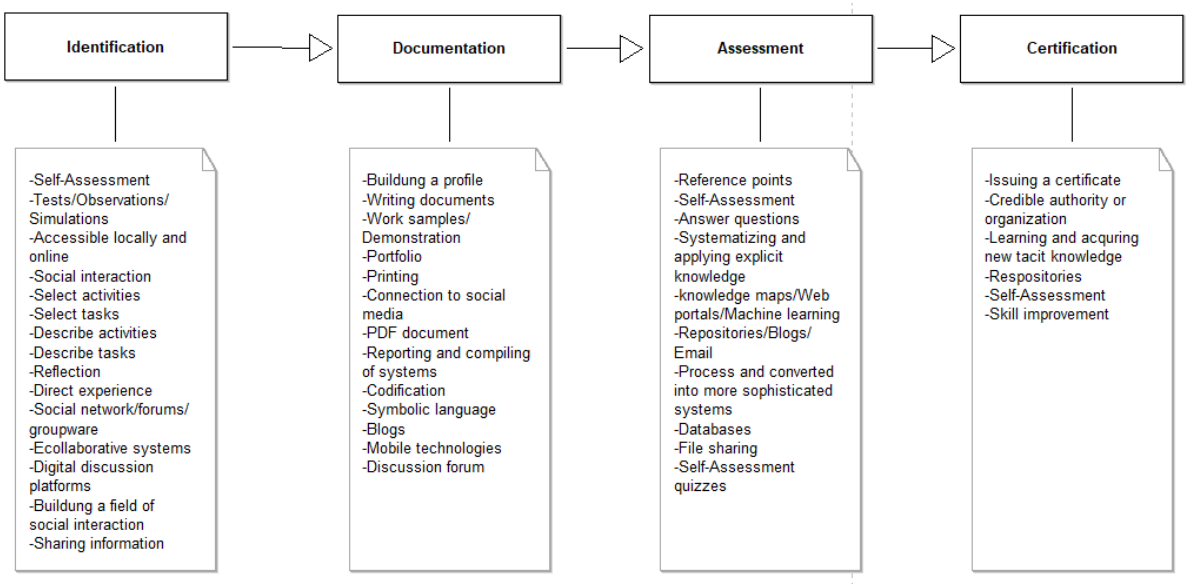


Figure 38: Validation Process and characteristics

YouRock:

YouRock is, as described in chapter 2.4.4., a networking tool with which young people can find out their competences and skills and can be searched and found by recruiters. The first step is to find out the starting point of the tool according to the modelling procedure developed. At YouRock you first have to register with an email address and then log in with it. Then you have to interact with the tool itself. On the one hand, personal data is entered, and the user profile is created. On the other hand, the user also has the possibility to upload a profile picture. In the next step, activities are selected from a dropdown menu. An example would be "Volunteers at a local community organization". After all suitable activities and language skills have been selected, the different skills related to the selected activities are displayed. The user then has the option of having his skills confirmed by a third party. Thus, an external reflection takes place. In a further step, the user can now design his profile more precisely. For this purpose, external links can be inserted, for example, which say something about the user. In addition, the user must also describe his aspirations. In the next step, the user can fill in his CV and link it to other social media. In the last step the user can download his finished "Diamond". This shows all his skills and competences. The described process can be seen in figure 39.

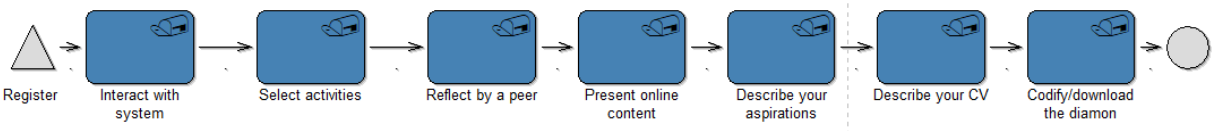


Figure 39: Process of YouRock

The process was modeled in ADOxx and the individual process steps or classes were described with specific keywords as seen in figure 40. Using the Python script described in chapter 4.4.2, this process and the associated descriptions are compared using the reference frame. The result results in a degree of equality of 94% (figure 41). Thus, YouRock clearly provides a tool that can be used for the Validation of prior learning process.

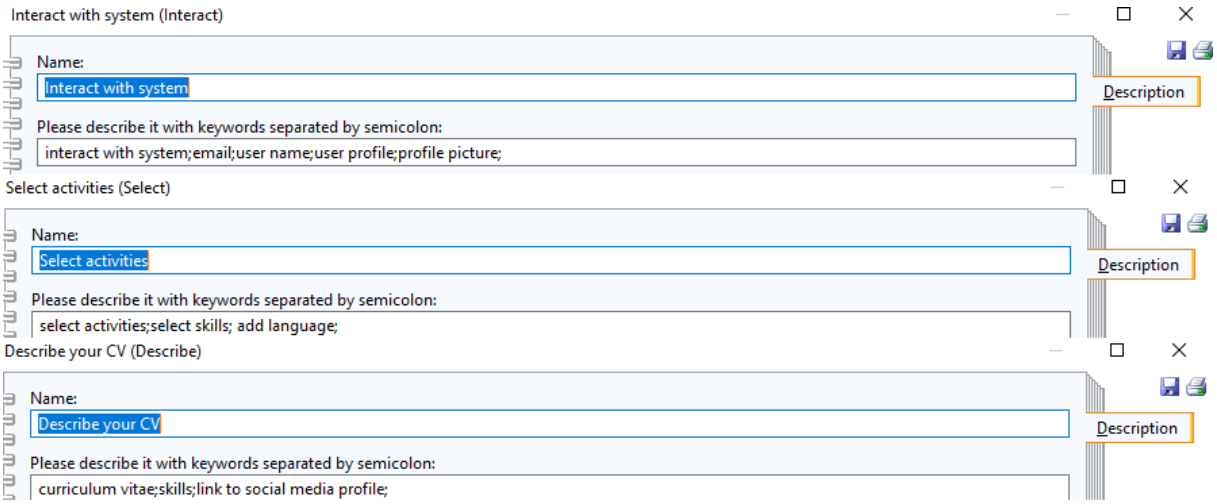


Figure 40: Description with keywords

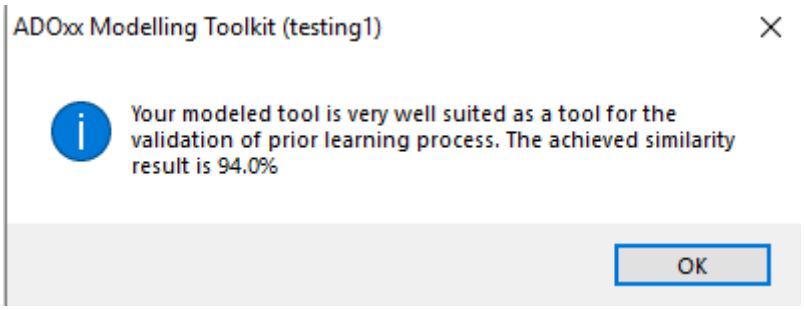


Figure 41: Similarity result YouRock

Moodle:

Moodle is a software package for developing and running internet-based courses. With this software it is possible to offer cooperative teaching and learning methods. Moodle is mainly used in schools and universities and provides an interface where students can interact with teachers.

At the beginning the user has to register on the website and create an online profile. This is followed by some kind of interaction with the system. This can consist of several steps and does not necessarily have to be done in order. The user can read announcements from teachers. Furthermore, the individual courses in which the user is enrolled can be selected. In these courses instructions can be read. In addition, teaching materials can be downloaded or homework or theses can be uploaded. Furthermore, the user can chat with colleagues, use his calendar or search for different things. This described process is shown in figure 42.

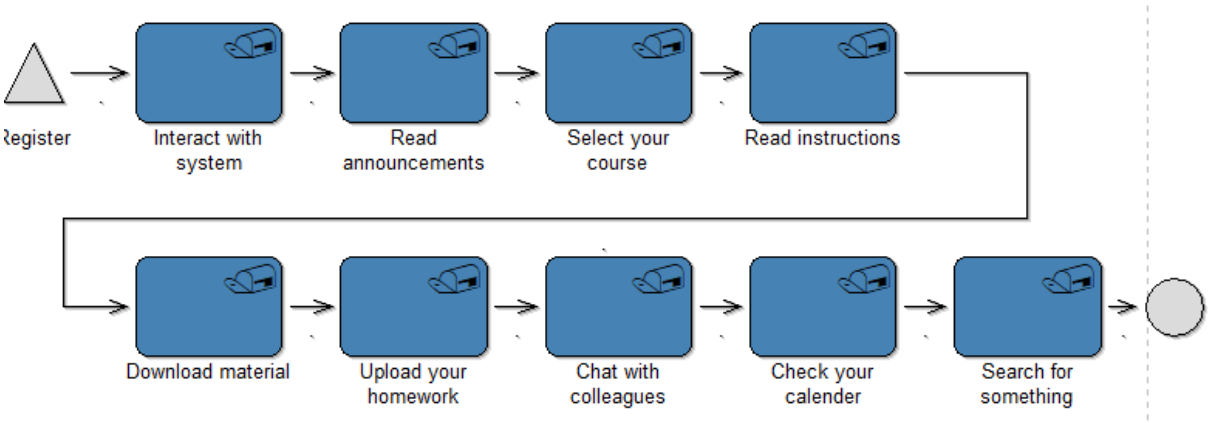


Figure 42: Process of Moodle

The process was also modelled in ADOxx and the individual classes and steps were described with specific keywords (figure 43). Now that the Python script has been executed, there is a degree of equality of 46% (figure 44) with the reference frame. Moodle therefore does not provide a practical tool to be used for the Validation of prior learning process.

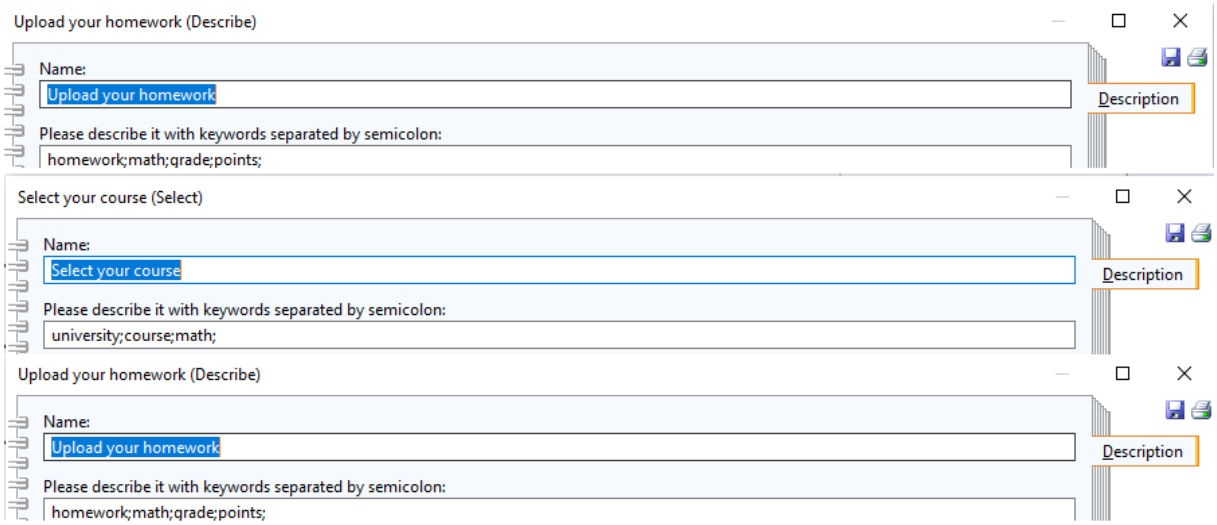


Figure 43: Description with keywords

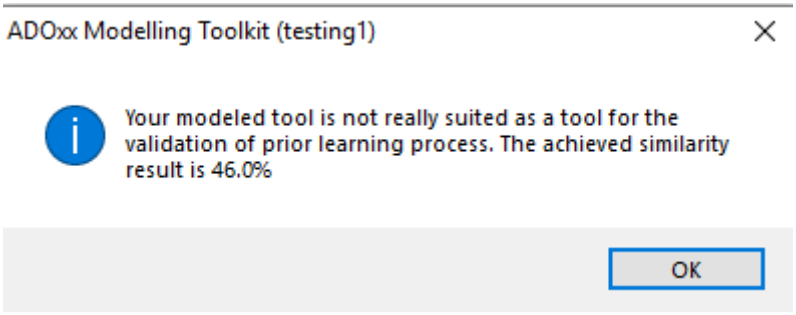


Figure 44: Similarity result of Moodle

In order to interpret this result correctly, it must first be said that the three different thresholds were deliberately chosen in such a way that a tool is only suitable for the validation of prior learning processes from a degree of equality of 70%. In the process described by Moodle, there are a few steps or descriptions that basically fit together with the reference framework. This concerns above all the necessary online profile or the general interaction with the system. Since a kind of codification also takes place at the end of the process, there are isolated similarities here. Therefore, the result of 46% is completely plausible and justifiable.

Fictive tool:

The scenario for a fictive tool represents the third and final scenario of the evaluation. It is simply a question of checking the tool developed to see whether a modelled fictitious tool with descriptions that do not consist of official words produces the correct result. The correct result in this case would be a degree of equality of 0%, since words that do not exist cannot be assigned vectors and therefore no comparison is possible. The tool simply assumes a random process (figure 45).

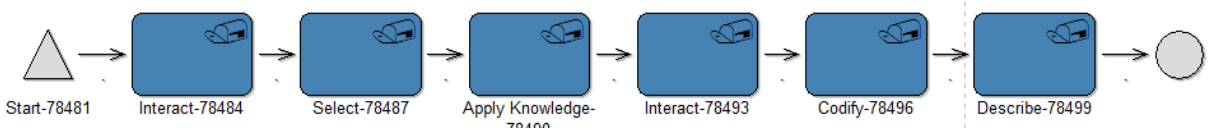


Figure 45: Process of a fictive tool

The corresponding descriptions of the classes and individual process steps are, as already mentioned, not real words (figure 46). After the execution of the Python script this results in a degree of equality of 0.0% (figure 47).

Figure 46: Description with keywords

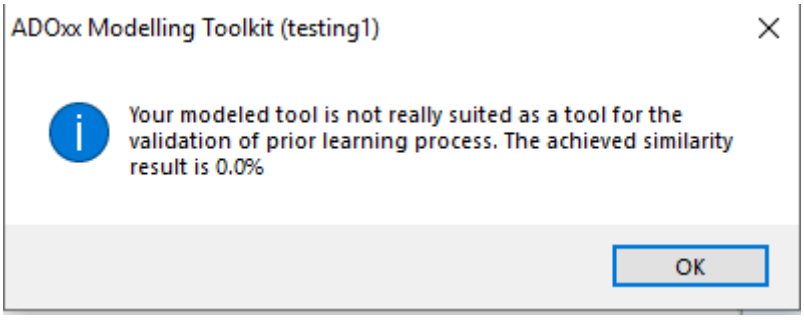


Figure 47: Similarity result fictive tool

In summary, the evaluation has produced plausible results based on the three scenarios. A tool which, according to the literature and practice, fits very well for the validation of prior learning process achieves a degree of equality of 94%. A tool used for a completely different task achieves a degree of equality of 49%. This value results on the one hand from descriptions,

such as real estate or apartment, which have little to nothing to do with the validation of prior learning process. On the other hand, there are also certain features, such as an online profile or a PDF document, which are also perfectly suited to the process. Finally, a fictitious tool with unofficial words is described, which results in a degree of equality of 0%.

6. Conclusion

The following chapter presents a conclusion of this master thesis and concludes with the existing limitations.

6.1. Summary

The aim of this master thesis was to develop a method that checks whether given IT tools support or match with the validation of prior learning process or not. It has to be said that only IT tools that are close to the validation of prior learning process can be evaluated. The developed method is therefore of no use if a tool completely alien to the validation process is to be evaluated. The Validation of prior learning process consists of the four process steps Identification, documentation, assessment and certification and aims at making non-formal, informal but also formal learning visible. Subsequently, this learning outcomes, i.e. knowledge, skills and competences, will be recognized. In order for this method to be developed, the relevant literature first had to be analyzed and then applied. A reference framework was developed to provide a basis on which the individual tools can now be evaluated.

It can also be said that the method or concept was shown in a particular domain. The domain concerns the validation of prior learning process. Basically, it can be said that this would also work elsewhere. With the help of similarity matching against a reference framework, a generalist concept was developed which is also generalist in its applicability. Thus, an innovative and modern concept was developed how similarity matching can work on a concept level. The concept does not necessarily have to be tailored to learning but can also be applied in other areas.

6.2. Contributions and limitations

Although the developed concept delivers the desired results, there are of course limits that can influence the results of this work. The most important limitations are briefly discussed below. Before going into the strengths and weaknesses of the developed concept, the technical limitations are briefly explained.

One of the most important limitations relates to the overall result output by the tool. The percentage output refers to the comparison of the whole modelled tool with the frame of reference. Thus, it is not possible to compare the individual modelled classes. In the future, it would be desirable if the degree of equality of the individual classes were also compared. Thus, it would be possible to see which step in the modelled tool is particularly important for the validation of prior learning process. On the other hand, it would also be obvious which steps in the tool might have a negative influence on the overall result. For this to be possible, the written Python script would have to be extended in a few lines and functions, which would go beyond the scope of this master thesis. It must also be said that at the time of writing only Python beginner knowledge was available. In order to program even more functions and a sophisticated comparison, much better Python knowledge is required. There is also a limitation regarding the vectors assigned by the spaCy model to each word. With this method the vectors are only assigned to the single words. Therefore, the description in ADOxx is only possible with single keywords. In order to enable an even more precise comparison, it would be desirable to be able to use whole sentences so that an even better semantic comparison is possible. This would give an even more precise insight into how well the modelled tool is suitable for the validation of prior learning process.

The most important strengths and weaknesses of the concept are briefly discussed using the SWOT (Strengths, Weakness, Opportunities, Threats) – Analysis by Hill & Westbrook (1997), as seen in figure 48.

Figure 48: SWOT-Analysis

The strength of the developed approach is that the concept can not only be used for learning or for the validation of prior learning process, but that the concept is a generic concept of how to connect and match tools and processes. Therefore, it is also applicable to other domains. The opportunities of the concept mainly concern its future use. So it can be further developed to be used at higher levels of the organization. This would mainly concern companies but also governmental institutions.

The biggest weakness of the concept concerns the evaluation. In this master thesis a qualitative assessment was carried out. No quantitative comparison was made and therefore it is of course not possible to say if the developed concept will always lead to the "right" results. There is also the risk that the literature used will influence the output and thus the concept.

7. List of references

AgenturQ: AiKomPass. Handbuch. Ein Instrument zur Sichtbarmachung und Dokumentation von Kompetenzen für Beschäftigte der Metall- und Elektroindustrie. 1. Auflage. Stuttgart 2015. Retrieved from: https://www.agenturq.de/wp-content/uploads/Handbuch_AiKomPass_final.pdf

AiKomPass. Retrieved from https://www.aikompass.de/index.php

Andersson, P., Halttunen, T., & Nistrup, U. (2017). Quality in Validation of Prior Learning: Experiences from Work with the Nordic Model for Quality in Validation of Prior Learning.

Armitage, A., & Keeble-Allen, D. (2008, June). Undertaking a structured literature review or structuring a literature review: tales from the field. In Proceedings of the 7th European Conference on Research Methodology for Business and Management Studies: ECRM2008, Regent's College, London (p. 35).

Arnold, J. F., & Voss, L. L. (2004). U.S. Patent No. 6,745,161. Washington, DC: U.S. Patent and Trademark Office.

Aspin, D. N., Chapman, J., Hatton, M., & Sawano, Y. (Eds.). (2012). International handbook of lifelong learning (Vol. 6). Springer Science & Business Media.

Baartman, L. K., Bastiaens, T. J., Kirschner, P. A., & Van der Vleuten, C. P. (2007). Evaluating assessment quality in competence-based education: A qualitative comparison of two frameworks. Educational research review, 2(2), 114-129.

Bagnall, R. G. (2000). Lifelong learning and the limitations of economic determinism. International Journal of Lifelong Education, 19(1), 20-35.

Bagnall, R. (2001). Locating lifelong learning and education in contemporary currents of thought and culture. In International handbook of lifelong learning (pp. 35-52). Springer, Dordrecht.

Ball, Claudia. (2016). 2016 update to the European inventory on validation of non-formal and informal learning. Country report Germany. Retrieved from: https://cumulus.cedefop.europa.eu/files/vetelib/2016/2016_validate_DE.pdf

Berglund, L., & Andersson, P. (2012). Recognition of knowledge and skills at work: in whose interests?. Journal of Workplace Learning, 24(2), 73-84.

Berlanga, A., Sloep, P., Brouns, F., Bitter-Rijpkema, M., & Koper, R. (2008). Towards a TENCompetence eportfolio. International Journal of Emerging Technologies in Learning (iJET), 3(2008).

Bjørnavold, J (2000). Making learning visible: Identification, assessment and recognition of non-formal learning in Europe. CEDEFOP reference document, Luxembourg: Office for Official Publ. of the Europ. Communities,

Bjornavald, J. (2001). Making learning visible: identification, assessment and recognition of nonformal learning. Vocational Training: European Journal, 22, 24-32.

Bjornavold, J., & Le Mouillour, I. (2009). Learning Outcomes in Validation and Credit Systems. European journal of vocational training, 48(3), 27-47.

Bohlinger, S. (2008). Competences as the Core Element of the European Qualifications Framework. European journal of vocational training, 42(1), 96-112

Bosche, B., & Seusing, B. (2011). der ProfiLPass in Unternehmen. Einsatz und Nutzen in der Ausbildung der Deutschen Telekom. In: Berufsbildung in Wissenschaft und Praxis. Bielefeld: Zeitschrift des Bundesinstituts für Berufsbildung (BIBB), 40, 48-49.

Cedefop. (2008). Terminology of European education and training policy. Luxembourg: Office for Official Publications of the European Communities.

Cedefop (2015). European guidelines for validating non-formal and informal learning. Luxembourg: Office for Official Publications of the European Communities

Cedefop (2017). European inventory on validation of non-formal and informal learning – 2016 update. Synthesis report

Chatti, M. A., Klamma, R., Jarke, M., & Naeve, A. (2007). The Web 2.0 driven SECI model based learning process. In Seventh IEEE International Conference on Advanced Learning Technologies (ICALT 2007) (pp. 780-782). IEEE.

Chen, D., & Manning, C. (2014). A fast and accurate dependency parser using neural networks. In Proceedings of the 2014 conference on empirical methods in natural language processing (EMNLP) (pp. 740-750).

Chowdhury, G. G. (2003). Natural language processing. Annual review of information science and technology, 37(1), 51-89.

Corley, C. D., & Mihalcea, R. (2005, June). Measuring the semantic similarity of texts. In Proceedings of the ACL workshop on empirical modeling of semantic equivalence and entailment (pp. 13-18).

Colardyn, D. (2001). College of Europa. “Lifelong learning: Which ways forward? “

Colardyn, D., & Bjornavold, J. (2004). Validation of Formal, Non-Formal and Informal Learning: policy and practices in EU Member States 1. European journal of education, 39(1), 69-89.

Collobert, R., Weston, J., Bottou, L., Karlen, M., Kavukcuoglu, K., & Kuksa, P. (2011). Natural language processing (almost) from scratch. Journal of machine learning research, 2493-2537.

Council of the European Union (2012). Council recommendation of 20 December 2012 on the validation of non-formal and informal learning. Official Journal of the European Union, C 398, 22.12.2012, pp. 1-5

Dahler, A. M., & Grunnet, H. (2012). Quality in validation in the Nordic Countries. Final report for “Quality in the Nordic Countries–A Mapping Project.

DataBase of Effective opportunities in the field of Validation of non-formal and Informal learning (BEVIN). Retrieved from: http://bevin.eu/database/

Dávideková, M., & Hvorecký, J. (2016). Collaboration tools for virtual teams in terms of the SECI model. In International Conference on Interactive Collaborative Learning(pp. 97-111). Springer, Cham.

De Grip, A. (2015). The importance of informal learning at work. IZA World of Labor.

Destination e-Validation , 2015. Retrieved from: http://tool.validationforvolunteers.eu/intro

Diedrich, A. (2013). Translating validation of prior learning in practice. International Journal of Lifelong Education, 32(4), 548-570.

Eraut, M. (2000). Non-formal learning and tacit knowledge in professional work. British journal of educational psychology, 70(1), 113-136.

Eraut, M. (2004). Informal learning in the workplace. Studies in continuing education, 26(2), 247-273.

European Centre for Modern Language. Retrieved from: https://edl.ecml.at/LanguageFun/Selfevaluateyourlanguageskills/tabid/2194/Default.aspx

European Centre for the Development of Vocational Training. (2008). Terminology of European education and training policy: a selection of 100 key terms. Office for Official Publ. of the Europ. Communities.

European Commission. 2000. “A Memorandum on Lifelong learning”. Retrieved from: https://uil.unesco.org/i/doc/lifelong-learning/policies/european-communities-a-memorandum-on-lifelong-learning.pdf

European Commission. 2008 “The European Qualifications Framework for Lifelong Learning (EQF). Retrieved from: http://ecompetences.eu/wp-content/uploads/2013/11/EQF_broch_2008_en.pdf

European Inventory on Validation (2016). 2016 Update. Retrieved from: https://www.cedefop.europa.eu/en/events-and-projects/projects/validation-non-formal-and-informal-learning/european-inventory

European Parliament Council (2008) Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning, 2008/C 111/01.

Explosion. Retrieved from: https://explosion.ai/

Fill, H. G., & Karagiannis, D. (2013). On the conceptualisation of modelling methods using the ADOxx meta modelling platform. Enterprise Modelling and Information Systems Architectures (EMISAJ), 8(1), 4-25.

Fischer, M., Follner, M., Rohrdantz-Herrmann, I., & Sandal, C. (2019). AiKomPass–Ein Instrument zur Sichtbarmachung informellen Lernens in der Metall-und Elektroindustrie. Zeitschrift für Weiterbildungsforschung, 42(1), 133-149.

Fischer, M., Röben, P., & Sandal, C. (2017). Erfassung informell erworbener Kompetenzen und Weiterbildungsplanung für Geringqualifizierte auf Basis von AiKomPass. Berufsbildung für Geringqualifizierte–Barrieren und Erträge, 111-130.

García-Peñalvo, F. J., & Conde, M. Á. (2014). Using informal learning for business decision making and knowledge management. Journal of Business Research, 67(5), 686-691.

Griffiths, D., & García-Peñalvo, F. J. (2016). Informal learning recognition and management.

Haag, M., & Duan, Y. (2012). Understanding Personal Knowledge Development in Online Learning Environments: An Instrument for Measuring Externalisation, Combination and Internalisation. Electronic Journal of Knowledge Management, 10(1).

Harp, S., Pielorz, M., Seidel, S., & Seusing, B. (2010). Praxisbuch ProfilPASS. Ressourcenorientierte Beratung für Bildung und Beschäftigung. Bielefeld: W. Bertelsmann.

Harris, M. S. (2012). Fulfilling a European vision through flexible learning and choice. European Journal of Education, 47(3), 424-434.

Hawley, J., & ROY, S. (2007). » European inventory on validation of informal and non-formal learning: France «. Birmingham: ECOTEC Research & Consulting Ltd.

Hevner, A. R. (2007). A three cycle view of design science research. Scandinavian journal of information systems, 19(2), 4.

Hevner, A., & Chatterjee, S. (2010). Design research in information systems: theory and practice (Vol. 22). Springer Science & Business Media.

Hill, T., & Westbrook, R. (1997). SWOT analysis: it's time for a product recall. Long range planning, 30(1), 46-52.

Johnson, I. (2002). The application of Buddhist principles to lifelong learning. International Journal of Lifelong Education, 21(2), 99-114.

Joosten-ten Brinke, D., Sluijsmans, D. M. A., Brand-Gruwel, S., & Jochems, W. M. G. (2008). The quality of procedures to assess and credit prior learning: Implications for design. Educational Research Review, 3(1), 51-65.

Joosten-ten Brinke, D. J. T., Sluijsmans, D. M. A., & Jochems, W. M. G. (2009). Quality of assessment of prior learning (APL) in university programmes: Perceptions of candidates, tutors and assessors. Studies in Continuing Education, 31(1), 61-76.

Karagiannis, D., & Kühn, H. (2002, September). Metamodelling platforms. In EC-Web (Vol. 2455, p. 182-196).

Kuropka, D. (2004). Modelle zur Repräsentation natürlichsprachlicher Dokumente: Ontologie-basiertes Information-Filtering-und-Retrieval mit relationalen Datenbanken. Logos-Verlag.

Kyndt, E., Dochy, F., & Nijs, H. (2009). Learning conditions for non-formal and informal workplace learning. Journal of Workplace Learning, 21(5), 369-383.

Le Deist, F. D., & Winterton, J. (2005). What is competence?. Human resource development international, 8(1), 27-46.

Lee, D. L., Chuang, H., & Seamons, K. (1997). Document ranking and the vector-space model. IEEE software, 14(2), 67-75.

Liddy, E. D. (2001). Natural language processing.

Look, P. (2003). DAFFODIL: Übersicht und Entwicklung von möglichen Algorithmen für Recommendation (Doctoral dissertation, Master's thesis, Universität Dortmund, FB Informatik).

Lowe, W. (2001). Towards a theory of semantic space. In Proceedings of the Annual Meeting of the Cognitive Science Society (Vol. 23, No. 23).

Manning, C. D., Raghavan, P., & Schütze, H. (2008). Introduction to information retrieval. Cambridge university press.

Mayring, P. (2004). Qualitative content analysis. A companion to qualitative research, 1, 159-176.

Màrquez, L., & Rodríguez, H. (1998). Part-of-speech tagging using decision trees. In European Conference on Machine Learning (pp. 25-36). Springer, Berlin, Heidelberg.

Marrero, M., Urbano, J., Sánchez-Cuadrado, S., Morato, J., & Gómez-Berbís, J. M. (2013). Named entity recognition: fallacies, challenges and opportunities. Computer Standards & Interfaces, 35(5), 482-489.

Méhaut, P., & Winch, C. (2012). The European Qualification Framework: skills, competences or knowledge?. European educational research journal, 11(3), 369-381.

Moodle. Retrieved from: https://moodle.univie.ac.at/

Moon, T., & Baldridge, J. (2007, June). Part-of-speech tagging for middle English through alignment and projection of parallel diachronic texts. In Proceedings of the 2007 Joint Conference on Empirical Methods in Natural Language Processing and Computational Natural Language Learning (EMNLP-CoNLL) (pp. 390-399).

Mustapha, S. S. (2016). Towards Building Monolithic Computational Platform for SECI Model. International Journal of Intelligence Science, 6(October (4)), 29-41.

Natek, S., & Zwilling, M. (2016). Knowledge Management Systems Support SECI Model of Knowledge-Creating Process. In Joint International Conference (pp. 1123-1131).

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. Organization science, 5(1), 14-37.

Nonaka, I., & Takeuchi, H. (1995). The knowledge-creating company: How Japanese companies create the dynamics of innovation. Oxford university press.

Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and leadership: a unified model of dynamic knowledge creation. Long range planning, 33(1), 5-34.

Organisation for Economic Co-operation and Development (OECD) (2007) Qualifications Systems: bridges to lifelong learning. Paris: OECD.

Park, Y., & Jacobs, R. L. (2011). The influence of investment in workplace learning on learning outcomes and organizational performance. Human Resource Development Quarterly, 22(4), 437-458.

Per Andersson, Andreas Fejes & Song-Ee Ahn (2004) Recognition of prior vocational learning in Sweden, Studies in the Education of Adults, 36:1, 57-71,

Polanyi, M. (1967). The tacit dimension. London: Routledge and Kegan Paul

ProfilPass. Stärken kennen – Stärken nutzen. Retrieved from: https://www.profilpass.de/

Rice, J. L., & Rice, B. S. (2005). The applicability of the SECI model to multi-organisational endeavours: an integrative review. International Journal of Organisational Behaviour, 9(8), 671-682.

Romaniuk, K., & Snart, F. (2000). Enhancing employability: the role of prior learning assessment and portfolios. Journal of Workplace Learning, 12(1), 29-34.

Salton, G., Wong, A., & Yang, C. S. (1975). A vector space model for automatic indexing. Communications of the ACM, 18(11), 613-620.

Sandberg, F., & Andersson, P. (2011). RPL for accreditation in higher education–As a process of mutual understanding or merely lifeworld colonisation?. Assessment & Evaluation in Higher Education, 36(7), 767-780.

Sava, S., & Lupou, R. (2009). The adult educator in Europe–professionalisation challenges and the alternative of validation of learning outcomes. Procedia-Social and Behavioral Sciences, 1(1), 2227-2232.

Sencioles, S. V. O., Santoyo, A. H., & Strauhs, F. D. R. (2016). Use of wikis in organizational knowledge management. Social Networking.

Sian Lee, C., & Kelkar, R. S. (2013). ICT and knowledge management: perspectives from the SECI model. The Electronic Library, 31(2), 226-243.

Silva, I. R., Souza, J. N., & Santos, K. S. (2004, July). Dependence among terms in vector space model. In Proceedings. International Database Engineering and Applications Symposium, 2004. IDEAS'04. (pp. 97-102). IEEE.

Singh, M. (2015). Global perspectives on recognising non-formal and informal learning: Why recognition matters. Springer Science+ Business Media.

Smith, L., & Clayton, B. (2009). Recognising Non-Formal and Informal Learning: Participant Insights and Perspectives. A National Vocational Education and Training Research and Evaluation Program Report.

Sonnenberg, C., & Vom Brocke, J. (2011, October). Evaluation patterns for design science research artefacts. In European Design Science Symposium (pp. 71-83). Springer, Berlin, Heidelberg.

SpaCy. Industrial-Strenght Natural Language Processing. Retrieved from: https://spacy.io/

Stenlund, T. (2010). Assessment of prior learning in higher education: A review from a validity perspective. Assessment & Evaluation in Higher Education, 35(7), 783-797.

Swedish Ministry of Education. (2003). Validering m.m. - fortsatt utveckling av vuxnas la¨rande. Depart- mental Report. Stockholm: Ministry of Education.

Toynton, R. (2005). Degrees of disciplinarity in equipping mature students in higher education for engagement and success in lifelong learning. Active Learning in Higher Education, 6(2), 106-117.

Tranfield, D., Denyer, D. and Smart, P. (2003) “Towards a methodology for developing evidence-informed management knowledge by means of systematic review”, British Journal of Management, Vol. 14, No.3, pp.207-222.

Tuomainen, S. (2015). Recognition and student perceptions of non-formal and informal learning of English for specific purposes in a university context (Doctoral dissertation, Doctoral dissertation, Publications of the University of Eastern Finland. Joensuu, University of Eastern Finland

UNESCO Institute for Lifelong Learning (UIL)(Germany). (2012). UNESCO Guidelines for the Recognition, Validation and Accreditation of the Outcomes of Non-Formal and Informal Learning.

University of Lapland (2010). Recognition and Accreditation of prior learning (RPL) at the university of Lapland. Retrieved from: https://www.ulapland.fi/loader.aspx?id=3f3115fa-3dc2-49e5-bde8-57ad26894d73

Volles, N. (2016). Lifelong learning in the EU: changing conceptualisations, actors, and policies. Studies in higher education, 41(2), 343-363.

Werquin, P. (2007, October). Terms, concepts and models for analyzing the value of recognition programmes. In Report to RNFIL: Third Meeting of National Representatives and International Organisations

Werquin, P. (2010). Recognising non-formal and informal learning outcomes, policies and practices: Outcomes, policies and practices (Vol. 2009, No. 35). OECD publishing.

Wheelahan, L. (2003, April). Recognition of prior learning and the problem of 'graduateness'. In sixth Australian VET Research Association Conference, Sydney, Australia (Vol. 911).

Winterton, J., Delamare-Le Deist, F., & Stringfellow, E. (2006). Typology of knowledge, skills and competences: clarification of the concept and prototype. Luxembourg: Office for Official Publications of the European Communities.

Young, M. (2008). Towards a European qualifications framework: some cautionary observations. Journal of European Industrial Training, 32(2/3), 128-137.

YouRock, 2017. Retrieved from: http://yourock.jobs/en

YouRock, 2017. Retrieved from:http://yourock.jobs/sites/default/files/images/english_support_guide_2017.pdf

8. Appendices

8.1. Progamming Code

```
#!/usr/bin/env python
# coding: utf-8

# In[21]:


import xml.etree.ElementTree as ET
tree=ET.parse(r"C:\Users\benni\Google
Drive\MASTER\Masterarbeit\Coden\modelidsout.xml")


# In[22]:


with                                              open(r"C:\Users\benni\Google
Drive\MASTER\Masterarbeit\Coden\Activity.txt", "w")as f:

    for instance in tree.findall(".//ATTRIBUTE"):
        if instance.get("type")== "LONGSTRING":
            f.write(f"{instance.text}\n")


# In[23]:


with                                              open(r"C:\Users\benni\Google
Drive\MASTER\Masterarbeit\Coden\Activity.txt", "r") as f:
    lines = f.readlines()

with                                              open(r"C:\Users\benni\Google
Drive\MASTER\Masterarbeit\Coden\Activity.txt", "w") as f:
    for line in lines:
        if line.strip("\n").startswith("iVB") is False:
            f.write(line)


# In[24]:


infile                          =                          r"C:\Users\benni\Google
Drive\MASTER\Masterarbeit\Coden\Activity.txt"
outfile                          =                         r"C:\Users\benni\Google
Drive\MASTER\Masterarbeit\Coden\Activity_Cleaned.txt"

delete_list = ["not specified", "none", "None", "Not specified"]
fin = open(infile)
fout = open(outfile, "w+")
for line in fin:
    for word in delete_list:
        line = line.replace(word, "")
    fout.write(line)
fin.close()
fout.close()
```

```
# In[26]:


s=open(r"C:\Users\benni\Google
Drive\MASTER\Masterarbeit\Coden\Activity_Cleaned.txt").read()
s=s.replace("\n", "").lower()
f=open(r"C:\Users\benni\Google
Drive\MASTER\Masterarbeit\Coden\Activity1.txt", "w")
f.write(s)
f.close()


# In[28]:


x=open(r"C:\Users\benni\Google
Drive\MASTER\Masterarbeit\Coden\Activity1.txt").read()
x=x.replace(";", "\n").lower()
y=open(r"C:\Users\benni\Google
Drive\MASTER\Masterarbeit\Coden\Activity1_Cleanedd.txt", "w")
y.write(x)
y.close()


# In[29]:


import spacy
nlp= spacy.load('en_core_web_lg')


# In[30]:


import re
from spacy.tokenizer import Tokenizer
from    spacy.util    import    compile_prefix_regex,    compile_infix_regex,
compile_suffix_regex

def custom_tokenizer(nlp):
    infix_re = re.compile(r'''[.\,\?\:\;\...\’\`\“\”\"\'~]''')
    prefix_re = compile_prefix_regex(nlp.Defaults.prefixes)
    suffix_re = compile_suffix_regex(nlp.Defaults.suffixes)

    return Tokenizer(nlp.vocab, prefix_search=prefix_re.search,
                                suffix_search=suffix_re.search,
                                infix_finditer=infix_re.finditer,
                                token_match=None)


nlp.tokenizer = custom_tokenizer(nlp)


def get_file_contents(filename):
  with open(filename, 'r') as filehandle:
    filecontent = filehandle.read()
    return (filecontent)

fn1=                                                r"C:\Users\benni\Google
Drive\MASTER\Masterarbeit\Coden\Activity1_Cleanedd.txt"
fn2=r"C:\Users\benni\Google
```

```
Drive\MASTER\Masterarbeit\Coden\Masterarbeitt.txt"

fn1_doc=get_file_contents(fn1)

fn2_doc=get_file_contents(fn2)

doc1 = nlp(fn1_doc)
doc2 = nlp(fn2_doc)


# In[31]:


result = (doc1.similarity(doc2))
result_final= round(result,2)*100
print (result_final)


# In[32]:


sehr_gut= "Your modeled tool is very well suited as a tool for the validation
of prior learning process. The achieved similarity result is "
mittel = "Your modeled tool is well suited as a tool for the validation of
prior learning process. The achieved similarity result is "
schlecht= "Your modeled tool is not really suited as a tool for the validation
of prior learning process. The achieved similarity result is "


# In[33]:


if result >0.85 and result <1:
    print (sehr_gut + str(result_final) + "%")
elif result >0.7 and result >0.85:
    print (mittel + str(result_final) + "%")
else:
    print (schlecht + str(result_final) + "%")


# In[34]:


with                          open(r'C:\Program                          Files
(x86)\BOC\ADOxx15_EN_SA\Ergebnisssse_adoxx.txt', 'w') as file_out:
    if result >0.85 and result <1:
        file_out.write(sehr_gut + str(result_final) + "%")
    elif result >0.7 and result >0.85:
        file_out.write(mittel + str(result_final) + "%")
    else:
        file_out.write(schlecht + str(result_final) + "%")


# In[35]:

import os
os.startfile(r"C:\Program                                                  Files
(x86)\BOC\ADOxx15_EN_SA\Ergebnisssse_adoxx.txt")
```

8.2. Abstract English

As people learn in different ways throughout their whole lives, this learning and the associated outputs must be supported. This happens with the validation of prior learning process. Therefore, the research goal of this master thesis is to develop a concept or method that assesses whether given IT tools are consistent with and support the validation process. First, an overview of the existing literature and tools is given. Then, using a developed framework, characteristics for the validation process and tools are developed and defined. These characteristics then form the basis for the compliance check. Then the general concept is defined and described. This is followed by a prototypical evaluation to ensure that the developed concept is technically feasible. The concept is implemented using ADOxx, the vector-based approach, Python and Natural Language Processing (NLP). Finally, the concept will be tested and evaluated using three different scenarios. The purpose of this work is to develop an innovative concept of how similarity matching can work on a concept model level.

8.3. Abstract German / Kurzfassung

Da Menschen ihr ganzes Leben lang in verschiedenen Formen lernen, muss dieses Lernen und auch die damit verbunden Outputs unterstütz werden. Die passiert mit dem Prozess der Validierung von Lernergebnisse. Daher ist das Forschungsziel dieser Masterarbeit die Entwicklung eines Konzepts beziehungsweise einer Methode, die bewertet, ob gegebene IT-Werkzeuge mit dem Validierungsprozess übersteinstimmen und diesen unterstützen. Zunächst wird ein Überblick über die vorhandene Literatur sowie vorhanden Tools gegeben. Anschließend werden mithilfe eines entwickelten Frameworks Charakteristika für den Validierungsprozess sowie für Tools entwickelt und definiert. Diese Charakteristika bilden anschließend die Basis für die Prüfung der Übereinstimmung. Dann wird das generelle Konzept definiert sowie beschrieben. Anschließend folgt eine prototypische Bewertung, die sicherstellen soll, dass das entwickelte Konzept auch technisch umsetzbar ist. Umgesetzt wird das Konzept mithilfe von ADOxx, dem vektorbasierten Ansatz, Python sowie Natural Language Processing (NLP). Als Abschluss wird das Konzept mittels drei verschiedener Szenarien getestet und evaluiert. Der Zweck dieser Arbeit besteht darin, ein innovatives Konzept zu entwickeln, wie ein Ähnlichkeitsabgleich auf einer Konzeptmodellebene funktionieren kann.