Fit For BIM

BGZ

Process proposal for the strengthening of permeability between vocational and higher education

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

The learning units are the result of the FIT for BIM project within the framework of the Erasmus+ programme.

Project Coordination

BGZ Berliner Gesellschaft
für internationale Zusammenarbeit mbH

www.bgz-berlin.de

www.fit4bim.eu

Information: Prof. Dr.-Ing. Jens H. Liebchen, jens.liebchen@htw-berlin.de

Berlin, 2020

Table of contents

For reasons of readability, no gender-specific formulations are used in this document. Insofar as personal designations are only given in masculine form, they refer to men and women in the same way.

1. Introduction

The political requirement to promote permeability in order to meet the increasing demand for skilled workers has been and is being accepted by the universities. As the Federal Minister of Education and Research, Johanna Wanka, noted at the BIBB Vocational Training Congress in Berlin as early as 2014, the rate of more than 50% of first-year students in an age cohort is viewed positively by the OECD. However, the Minister also points out what difficulties small and medium-sized enterprises face in finding suitable trainees. Furthermore, she also points out that the issue is about permeability between vocational training and academic education and in the opposite direction.[1] As far as the latter is concerned, her own research shows that there is no consistent strategy at many institutions. This paper aims to show a possible way of implementing permeability in the field of training in the Building Information Modeling (BIM) field.

With the publication of the step-by-step plan Digital Planning and Building in December 2015 by the BMVI, the process of using methods in building projects known as Building Information Modeling was accelerated. Until then, the dissemination of BIM was primarily driven by buildingSMART-Deutschland (bS). The globally operating umbrella organisation (hereafter abbreviated as bSi) and its regional chapters pursue with their activities the promotion of digitisationin the building industry and especially the exchange of information by means of open, manufacturer-neutral interfaces. For 20 years, the focus of these efforts has been on the organizational, procedural and technical support of digital processes in the entire construction value chain with the aim of an open, i.e. manufacturer and product-independent working method.[2] For the above-mentioned reason, the current development is also decisively influenced by the honorary members of bS.

As an obstacle to the use of BIM, practitioners have mentioned, among other things, the lack of specifications (models) in the area of technical processing by standards and guidelines and corresponding contractual structures. In response to this problem, working groups were set up in the BMVI and the institutions DIN, VDI and VBI, some of which had already been in existence before 2015, and some of which published standards and guidelines. The BMVI will probably publish a complete sample project template for BIM projects in the field of infrastructure in 2019, which should then dispel the criticism that has been voiced so far.

Since BIM is a methodology which partly redefines work processes, clear structures, which are generally laid down in regulations (for example DIN standards or VDI guidelines), are necessary. These are then also part of the training and further training. All occupational groups working in the construction industry are affected, according to their qualifications. In this context, VDI Guideline 2552 Sheet 8.1 ("Building Information Modeling - Qualifications - Basic Knowledge"), which was published in December 2017 and developed in close cooperation with bS, should be emphasized. The further training measures of the Federal Chamber of Engineers and the Federal Chamber of Architects or their state representatives are based on this guideline. This also sets the minimum standard for universities when developing course content.

[1] Cf. Wanka, J. (2014)
[2] Cf. https://www.buildingsmart.de/

The above-mentioned framework conditions define the environment in which the development of the "procedural proposal for strengthening the transparency of higher education institutions" is to be carried out.

2. Permeability in Germany

According to Gabler Wirtschaftslexikon (lexicon of economy), the term "permeability" in the education system is closely related to educational mobility in the political debate. A distinction can be made between horizontal and vertical mobility. Educational advancement and relegation are referred to as vertical mobility, changes within an educational stratum as horizontal.[3]Vertical mobility is also at the forefront of the debate.

As the Federal Institute for Vocational Education and Training (BiBB) notes under the heading "Interlocking: Cross-sectoral education formats", there are hardly any offers in the area of continuing education and training to date "which strengthen both vocational and higher education and which feature new forms of this type of interlocking. On the contrary, continuing vocational training and scientific continuing training are largely unrelated. Particularly following vocational training (journeyman level), there is thus a lack of flexible further training opportunities that not only combine elements of practical professional development and academic reflection, but also develop qualifications that are recognised by both sides".[4]

The BMBF-funded project "DQR-Bridge5" addressed the above-mentioned topic by developing exemplary concepts for the areas of information technology (IT) and the automotive industry (motor vehicles). Under the title "Promoting permeability to attract skilled workers - Development of cross-departmental training measures at Level 5 of the German Qualifications Framework (DQR)", cross-departmental training measures were developed at Level 5 of the DQR which are equally valid as advanced training at DQR Level 5 and in Bachelor's programmes. These measures contain additional educational options that integrate elements of academic and vocational education and training while facilitating reciprocal transitions between the educational sectors. The project was completed in 2016.[5]

As mentioned at the beginning, the further consideration will not only take into account advanced training but also the "educational decline" in the form of dropping out of university.

2.1 Qualification paths in the construction industry

The realisation that the qualification of employees is an important basis for sustainable competitiveness was already published by the construction industry associations in a joint declaration in 2003. With the ordinance on the examination for the recognised advanced training qualification of certified foreman in 2012, the advanced training of the construction industry was then defined via the levels foreman, works foreman and certified foreman. The foreman corresponds to the "industrial foreman" for the construction industry and is therefore classified in the DQR at level 6.[6]

[3]https://wirtschaftslexikon.gabler.de/definition/durchlaessigkeit-54045/version-277100; Revision von Durchlässigkeit vom 19.02.2018 - 15:58 und https://wirtschaftslexikon.gabler.de/definition/bildungsmobilitaet-54040/version-277095

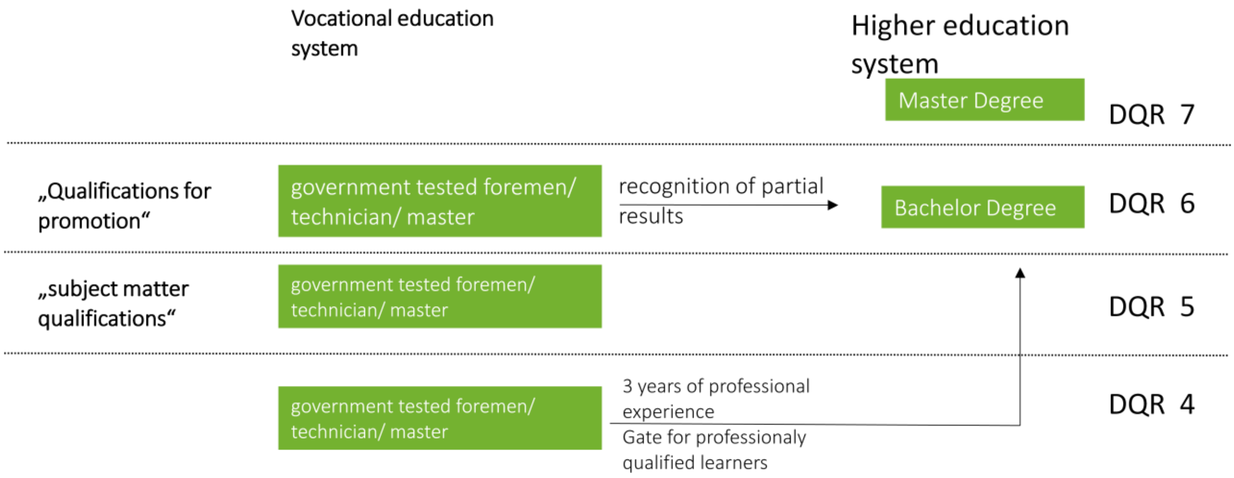
[4]https://www.bibb.de/de/64484.php

[5]https://www.bibb.de/de/64484.php, in Verbindung mit https://www.bibb.de/de/25789.php

[6]Cf. Zimmer, K. (2013), p. 49

In addition to the above-mentioned qualification path, a course of study at a technical college (duration full-time 2 years) after completion of vocational training and at least one year of professional experience can also lead to the qualification of a construction technician at level 6 DQR. This is used in lower and middle management levels of construction companies, architecture and engineering offices and building authorities.

A bachelor's programme is rarely taken up by professionally qualified students. The evaluation of the admissions figures at the HTW Berlin for the civil engineering course shows an application rate of less than 2%, based on the total number of applicants. The classic route into the higher education system is the Abitur or Fachabitur.



Vocational education system

Higher education system

„qualifications for promotion“ government tested foremen/ technician/ master→ recognition of partial results

„subject matter qualifications“ level of further education

Vocational education → 3 years of professional experience

Figure2.1:Qualification path and recognition between educational sectors in civil engineering [7]

The recognition of achievements acquired in the vocational education and training system is treated very differently by the universities, which also applies to the reverse route from the university system to vocational training. Chapter **Błąd! Nie można odnaleźć źródła odwołania.** describes which credit transfer systems exist and which of them have proven themselves in terms of permeability.

2.2 Dropping out of higher education - actual situation

The German Centre for Research on Higher Education and Science (DZHW GmbH) has conducted several studies to explain the causes and motivation for dropping out of university studies in Germany. According to these studies, the drop-out rate across all types of higher education institutions and subjects is 28%, based on first-year students in the 2012 and 2013 cohorts,

[7] See Hemkes, B. et al. (2015), p. 29

and 25% fortechnical colleges (cf. Figure2.2). Looking only at engineering sciences, the figure for universities rises to 35% and to 34% for technical colleges.[8]

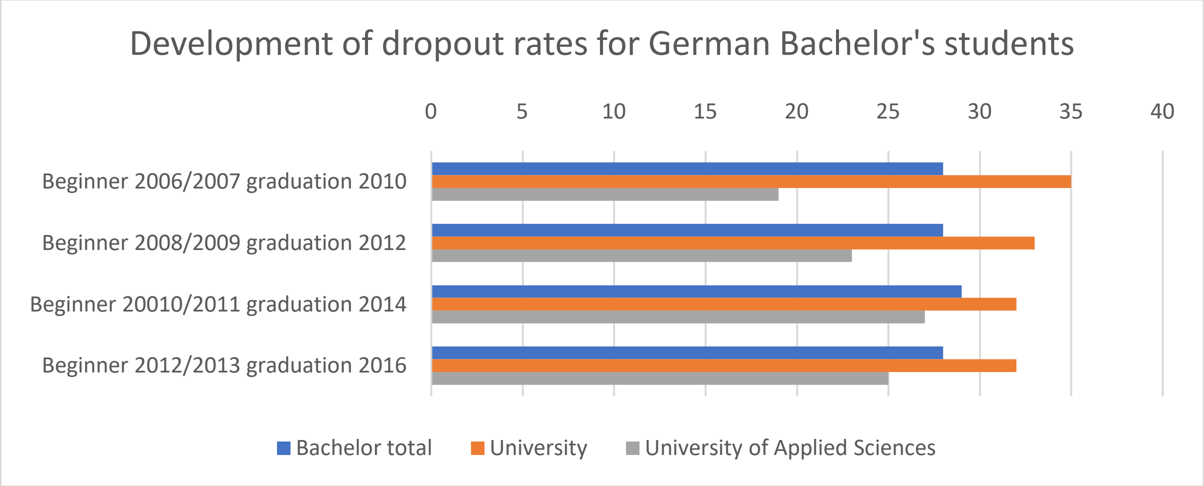


Figure2.2: Development of drop-out rates for German students in Bachelor's programmes by type of higher education institution Reference group Graduates 2010, 2012, 2014 and 2016, figures in percent (Source: Federal Statistical Office of Germany) Heublein, U., Schmelzer, R. (2018), Figure 2)

The reasons for discontinuing the study were determined by the DZHW in a 2016 study for the federal state of Baden-Württemberg (BW). As the study shows, performance problems (including too much study and examination material and too high study requirements) and a lack of study motivation (including false expectations with regard to the study) are decisive for discontinuation (Figure2.3).[9]For years, higher education institutions have reacted to this situation by describing study programmes comprehensively with regard to study content and later employment for those interested. In some cases, interested parties are also given the opportunity to check their suitability for the field of study by means of an online self-assessment. Performance problems are likely to be a result, among other things, of the political will to enable more citizens to obtain higher education. The extent to which this makes sense will not be discussed at this point.

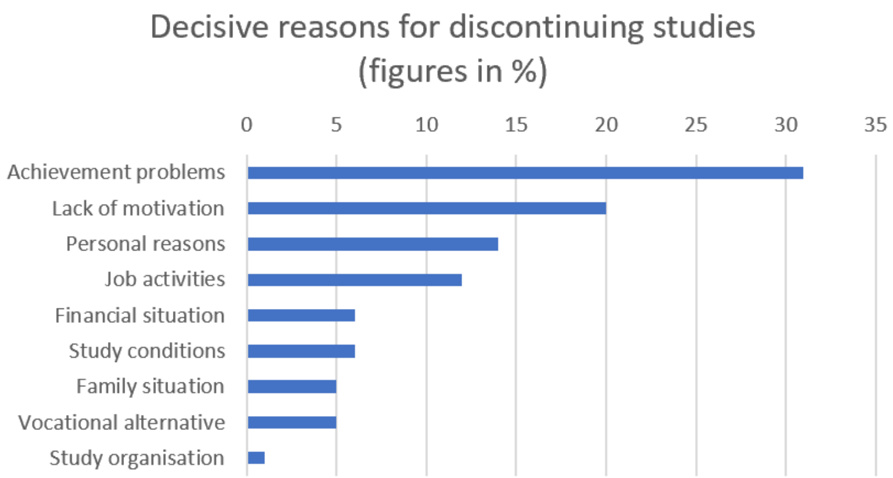


Figure2.3: Decisive reasons for dropping out of university, in percent (Source: Heublein, U. et. al. (2017), Figure 3.2)

[8]Cf. Heublein, U., Schmelzer, R. (2018), p. 5 ff
[9]Cf. Heublein, U. et al. (2017), p. 13 ff

Furthermore, the study examined which career path was taken by the dropouts after early termination of their studies. It is interesting to note that 44% of the dropouts in BW took up vocational training six months after dropping out of university, 14% of them in school and 30% in in-company vocational training. One out of every three dropouts (32%) went directly into employment.[10]The respondents primarily cited friends and acquaintances and company websites as sources of information when making a decision to pursue a particular occupation or undergo vocational training (see Figure2.4). Accordingly, student advisory services at universities play a subordinate role.

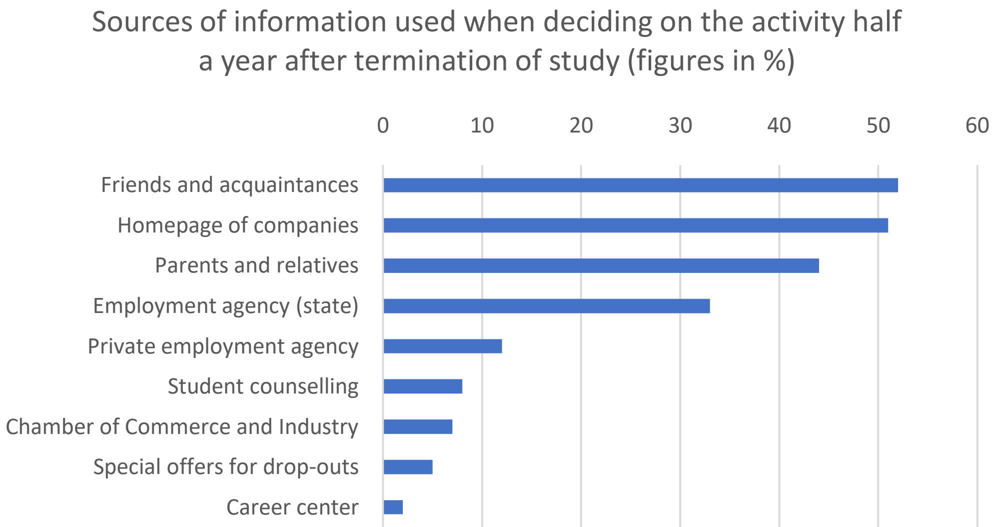


Figure2.4: Sources of information used in the decision to take up employment six months after dropping out of university (Source: Heublein, U. et. al. (2017), Figure 8.9)

The shortage of skilled workers that is becoming more acute from year to year has prompted the Federal Institute for Vocational Education and Training (BIBB) to conduct a survey of training enterprises regarding the target group of dropouts in 2015. The survey comes to the conclusion that from the enterprises' point of view, dropouts are becoming an increasingly important factor in filling training places and that companies are increasingly opening up to them. The main problem for integrating dropouts into dual vocational training appears to be primarily the establishment of contact with the target group. In addition, it is also necessary to convince them that this path is a good option for dropouts.[11]

2.3 Offers for dropouts

All universities have departments that provide comprehensive advice to students before and during their studies (student service). In addition, the universities maintain various interfaces with the business world in order to make it easier for graduates to enter the job market directly (Career Services). If the keyword "Dropout" is entered in the search fields of the respective homepages, you will often find references to psychological counselling. Only a few universities have a clear profile regarding an orderly withdrawal from studies. A distinction must be made here between those who, in addition to the "general" offer of advice on dropping out of a course of study, including links to services provided by the Agentur für Arbeit and the Chambers of In-

[10]Heublein, U. et al. (2017), Seite 200 ff
[11]Cf. Ebbinghaus, M. (2016), p. 13 f

dustry and Commerce[12], also address the deficit described in the previous chapter (lack of a network between drop-outs and companies) and offer solutions. The HS Wismar[13]and the HS Harz[14] belong to such HS.

The latter is working as a partner in a joint project on permeability with the Anhalt and Merseburg Universities of Applied Sciences on an orderly transition for dropouts into vocational training. Within the framework of the project "Scientific Continuing Education for SMEs in Saxony-Anhalt 2015-2017", the crediting of academically acquired competences towards initial or continuing vocational training was investigated. As a result, it was found that in Germany there is generally a potential for crediting prior learning outcomes from university studies towards vocational training. In addition, the thesis was formulated that, depending on the subject-specific orientation, the degree of coverage and scope of the potential varies from HS to HS and presumably even from subject to subject.[15]This assessment can be confirmed by practical experience in the field of civil engineering for the recognition of academic achievements at other HS.

On the homepage of the above-mentioned university network, drop-outs can find advice and further links, among other things:

- https://www.studienabbruch-und-dann.de/ (operated by BMBF)
- http://www.wegbereiter-studienabbruch.de (Operator TU Braunschweig)
- https://www.studienabbrecher.com/ (private operator)

While the public operators, such as the BMBF and the TU Braunschweig, limit their offer to consulting services, case studies and field reports, the private ones such as "studienabbrecher.com" also offer job search and job applications. An analysis of the list of job offers shows that the focus is on the commercial and IT sectors. For example, training courses are offered in media design (f/m), banking or insurance (f/m). More craft-oriented training courses are only found in isolated cases, e.g. automotive mechatronics technician. The building trade was not represented at the time of the research.

2.4 Recognition of (vocational) previous performance/competencies

With the ANKOM initiative, 20 projects were funded by the BMBF between 2011 and 2014 on the topic of "Transitions from vocational to higher education".[16]The results were published in several comprehensive articles. Building on this, the HS Harz University of Applied Sciences has investigated the possibilities of crediting vocational learning outcomes and developed a guideline[17]within the framework of the joint project "Scientific Continuing Education for SMEs in

[12]https://www.fh-bielefeld.de/zsb/studienabbruch-neustart
https://www.hs-neu-ulm.de/studium/studienberatung/studienzweifel/

[13]https://www.hs-wismar.de/studium/nach-dem-studium/karrierestart/studienabbruch/https://www.hs-harz.de/studienabbruch/

[14]https://www.hs-harz.de/studienabbruch/Cf. Koch-Rogge, M. (2016), p. 5

[15]Cf. Koch-Rogge, M. (2016), p. 5 I.e. Stamm-Riemer, I./Loroff C./Hartmann, E.A. (2011); Freitag, W./Buhr, R./Danzeglocke, E.-M./Schröder, S./Völk, D. Hrsg. (2015)

[16]I.e. Stamm-Riemer, I./Loroff C./Hartmann, E.A. (2011); Freitag, W./Buhr, R./Danzeglocke, E.-M./Schröder, S./Völk, D. Hrsg. (2015)

[17]Anrechnung non-formaler Lernergebnisse auf ein Hochschulstudium – Leitfaden für Studierende und Bewerber, Hochschule Harz, https://www.hs-harz.de/user-mounts/246_m1438/Hochschule_Harz_Anrechnung_Leitfaden_Portfolioerstellung.pdf

Saxony-Anhalt 2015 - 2017". Although this guideline considers the crediting of non-formal learning outcomes to university studies, the procedure can also be transferred to other forms of further education.

The crediting of learning outcomes generally requires a competence-oriented module description, which may have to be prepared by the applicants themselves. In addition to the certified learning outcomes achieved through formal learning (e.g. a Chamber of Industry and Commerce degree), non-certified learning outcomes can also be used for credit transfer. The latter include, for example, work experience and continuing education measures that do not end with a formal qualification. While a flat-rate crediting of certified learning outcomes is possible, non-certified learning outcomes must always be examined individually. Certified learning outcomes are, for example, examined in two stages at the HS Harz. A credit is awarded if at least 75% of the learning outcomes are the same and the level is comparable according to the descriptors (EQF/DQF).[18]

As shown in Figure2.5, credit is awarded either by means of a test procedure or a portfolio, which the applicant / student must create in conjunction with the relevant certificates of competence, if necessary, unless this has been confirmed by employers or training institutions. The HS Harz offers the students comprehensive templates for this purpose in order to be able to create a portfolio.[19]

The recognition of academic achievements is usually based on an individual assessment of learning outcomes using module descriptions, which corresponds to the portfolio procedure. Only in rare cases is there general recognition via equivalence tables. This is often practised by the HS when students switch between study programmes within the HS.

[18]Cf. Koch-Rogge (o.J.), p. 7f

[19]Cf. Hochschule Harz (o.J.), p. 7f.

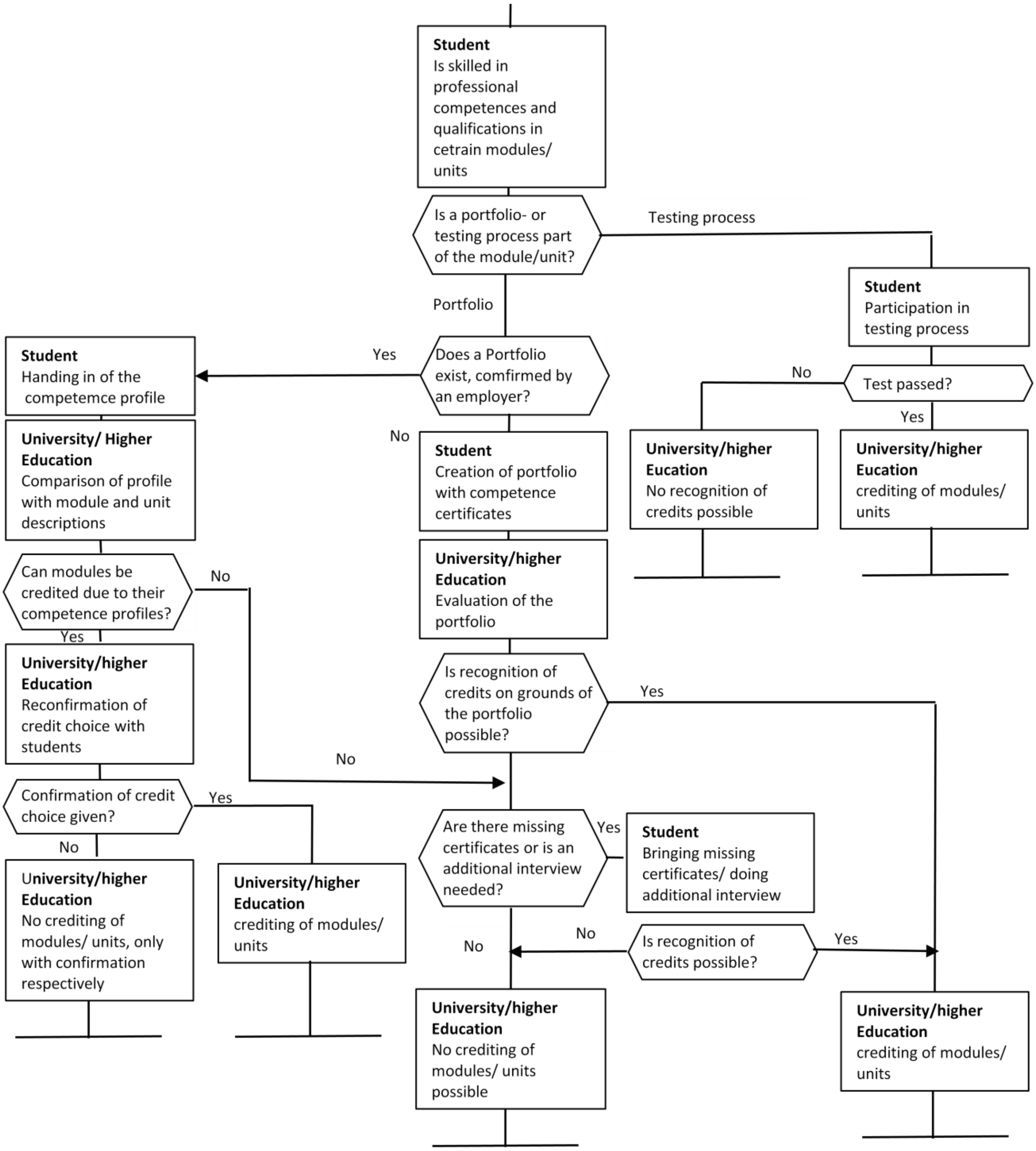


Figure2.5: Overview of credit paths for vocational competences and qualifications at the Harz University of Applied Sciences (Source: Harz University of Applied Sciences (n.d.), p. 4))

3. Permeability in the partner countries

3.1 Denmark

In Denmark standards are set by the Ministry of Higher Education and Science. The basic principles of the Danish education system are lifelong learning and the active participation of citizens. In addition, high standards and interdisciplinary activities as an integrated part of the respective educational levels in the form of project work are named as characteristic features.[20]

[20]Cf. https://ufm.dk/en/education/the-danish-education-system/principles-for-education-in-denmark

The structure of the school system is comparable to the German one. The classical school education, consisting of primary and secondary school, takes 9 and 10 years respectively. This is followed by vocational training or a higher-level school leaving certificate that directly entitles the holder to study at university (see Figure 3.1).

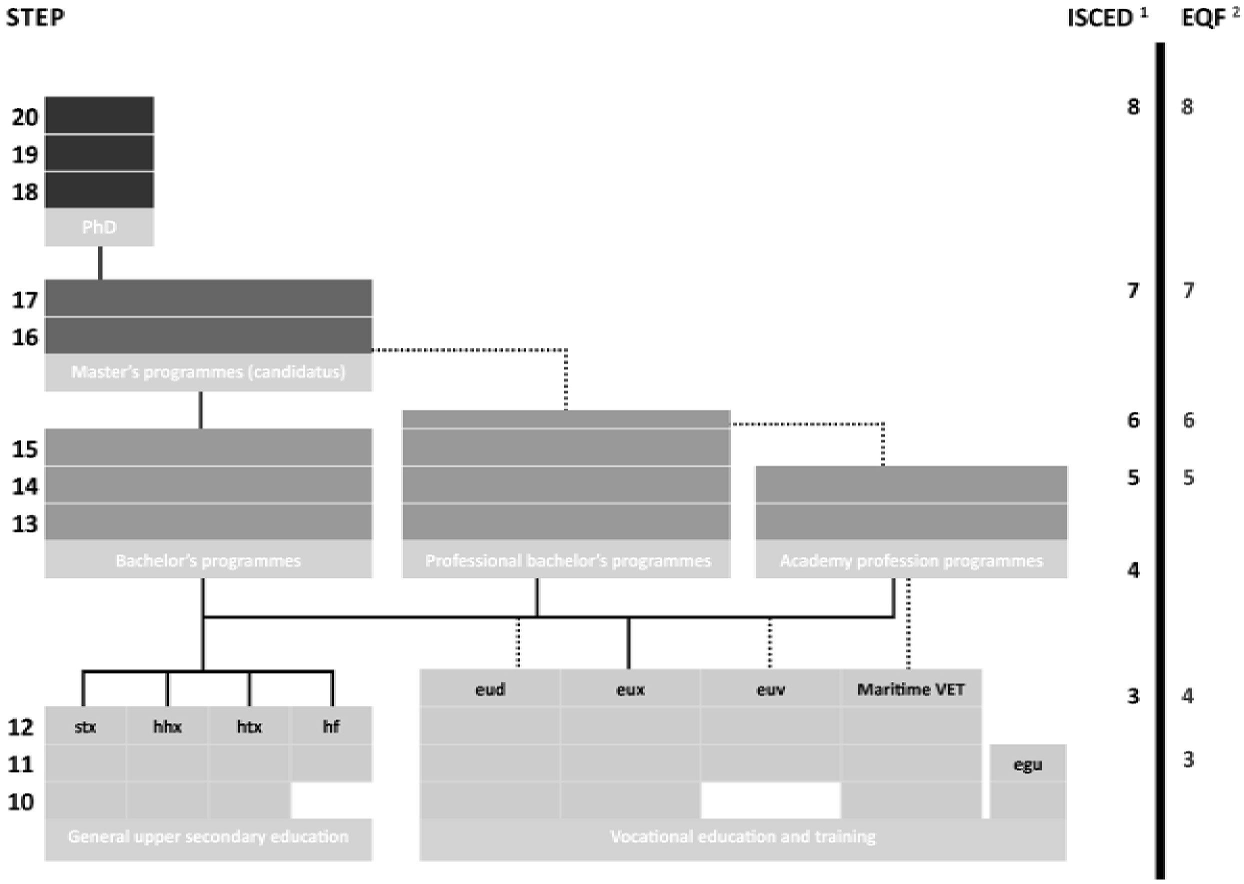


Figure 3.1: Overview of the Danish education system after attaining the intermediate school leaving certificate (source: https://ufm.dk/en/education/the-danish-education-system/overview/danish_education_system)

AsFigure 3.1shows, the system is consistent for both school-based and vocational training. The difference to the German education system is firstly the training at level 5 according to EQF, which is important in terms of permeability. The so-called "academy profession programmes" can be completed within the framework of 90-150 ECTS (with normal university entrance qualification) or 60 ECTS (further vocational training with proven work experience), depending on the educational path.[21]

At the partner university VIA University College, which is entitled to train at levels 5 and 6 according to EQF, a training path is offered which can be regarded as a model in terms of permeability. In addition to the 7-semester Bachelor's program "Architectural Technology & Construction Management (ATCM)", VIA also offers the 4-semester program "Construction Technology (CT)" (Academy Profession Degree, see Figure 3.1). The contents of the first three semesters are identical in both programs, so that students are flexible in both directions. At VIA,

[21]Cf. https://ufm.dk/en/education/recognition-and-transparency/transparency-tools/europass/diploma-supplement/standardbeskrivelse-danish-higher-education-system.pdf

the course content is taught in a project-oriented manner throughout, which can be seen as a fundamental difference to the formats in the partner countries (seeFigure3.2).[22]

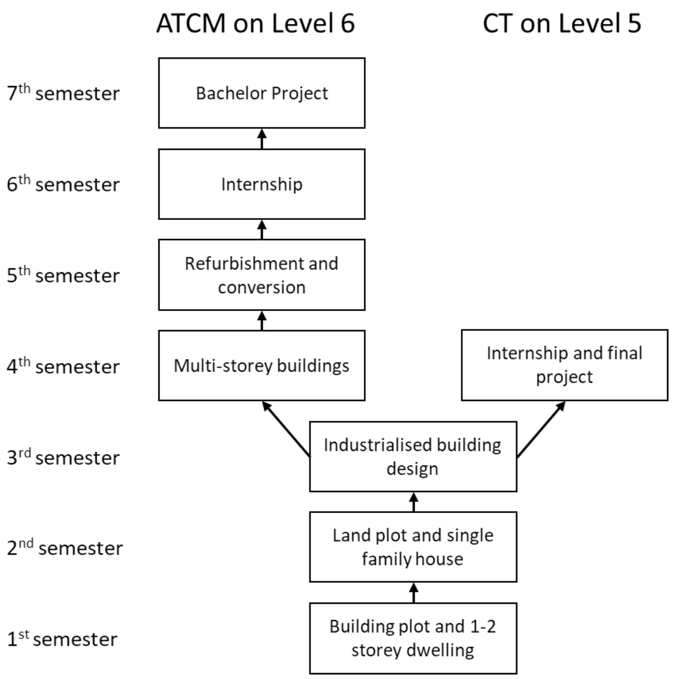


Figure3.2: Level 5 and 6 education at VIA University College (Y-Model)

There is no information available in Denmark on the whereabouts and careers of dropouts.

3.2 Poland

The Polish education system shows some differences from those described above. It is divided into three areas: primary, secondary and tertiary education. Primary education is similar to the 6-year German primary school. In Poland, all Polish pupils are then followed by three years of education on a gimnazjum (lower secondary level). A differentiation is then only made at upper secondary level:

- three-year general education and profiled lyceums (comparable to German grammar schools),
- four-year vocational schools (technical schools),
- supplementary lyceums and supplementary vocational schools (technical schools),
- as well as three or four-year vocational schools.[23]

After completion of an education at a general education or profiled lyceum or technical college (Technika), the students have the right of access to universities and universities of applied sciences. They can then complete Bachelor's and Master's programmes at levels 6 and 7 EQF.

In connection with the topic under consideration here, colleagues from the Poznan University of Technology (PUT) have stated that education at level 5 EQF does not exist so far, which also applies to the profession of architectural draftsman.

[22] Cf. https://en.via.dk/programmes/technology-and-construction/construction-technology-ap-degree, https://en.via.dk/programmes/technology-and-construction/architectural-technology-bachelor

[23] Cf. Institut für ökonomisch Bildung (IÖB), Das polnische Bildungssystem: http://www.ioeb.de/bildungssystem

The training of civil engineers follows curricula which are comparable to those in Germany (see Chapter 0). The same paths are open to dropouts in Poland as in Germany.

4. “Old" and "new" knowledge and qualifications in construction - selected learning outcomes

The subject of the Fit for BIM project is the development of learning models for vocational and higher education in the context of digitization in the construction industry. In order to be able to develop a proposal for strengthening permeability, the current training content of the relevant occupational groups must first be presented. The occupational groups "construction draftsman", "construction technician" and "civil engineer (Bachelor)" are considered relevant here.

4.1 Construction Draftsman

The training as a draftsman is usually 3 years (full-time school) and can be shortened to 2 years within the framework of a dual training if the university entrance qualification is available. The current framework curriculum was adopted by the Conference of Ministers of Education and Cultural Affairs on 14.06.2002.[24] This date implies that digital methods cannot be part of the framework curriculum at the current stage of development. The framework curriculum of the state of Berlin from 2008 includes drawing in 3D, which has become firmly established. The methodological approach of BIM and the more extensive use cases is not yet taught. In order to be able to delimit learning content later, the learning fields for the training occupation of draftsman are shown in the following table.

[24] Cf. Kultusministerkonferenz (2002)

Overview of learning areas for the vocational profession of draughtsmen				
Learning areas		Time guidelines		
No.		1st year	2nd year	3rd year
1	Participation in construction planning	40		
2	Recording of a building	60		
3	Open up/ develop a building site	60		
4	Planning of a foundation	60		
5	Planning of a basement	60		
6	Construction of a reenforced concrete beam		8060	
7	Contsruction of staircases		80	
8	Creation of a storey ceiling		60	
9	Planning of a rooftop support structure		80	
Focus point architecture				
10 (A)	Creation of a buiding application			60
11 (A)	Development of an outer wall			60
12 (A)	Planning of a hall/ hangar			40
13 (A)	Construction of a roof construction			60
14 (A)	Building of a storey			60
Focus point construction engineering				
10 (I)	Securing of a Building			40
11 (I)	Development of an outer wall			60
12 (I)	Planning of a hall/ hangar			60
13 (I)	Construction of a roof			60
14 (I)	Plannin of a reenforced concrete construction			60
Focus point civil engineering: underground construction, road building and landscaping				
10 (TSL)	Preparation of a road design			60
11 (TSL)	Construction of a surface road structure			60
12 (TSL)	Planning of water supply			40
13 (TSL)	Planning of water disposal			60
14 (TSL)	Planning of an outdoor facility			60
	Sum (840 hrs in total)	280	280	280

Abbildung 4.1: Übersicht Lernfelder Bauzeichner (Quelle: Kultusministerkonferenz (2002), S. 8)

4.2 Building technician

The advanced training to become a construction technician lasts 2 years full-time. Framework curricula are published by the federal states. A comparison of the curricula of the federal states of Hessen, North Rhine-Westphalia, Bavaria and Baden-Württemberg shows that digital methods - apart from CAD - have not yet been taken into account. Rather, education is very traditionally structured, as Figure4.2 shows for the state of Bavaria.

Subjects	Weekly hours	
	1st schoolyear	2nd schoolyear
Mandatory		
German	2	/
Englisch	2	2
Mathematics I	5	/
Mathematics II	/	2
Economics and Socal studies	2	/
Industrial psychology	2	/
Business management	/	2
Data processing	2	/
Construction physics	3	/
Buliding material technology	4	/
Building construction	4	/
CAD	2	/
Construction law and construction planning	2	4
Descriptive Geometry	2	/
Construction history	/	1
Structural analysis/ design	3	/
Measurement	2	/
	37	11
		+ 23 hours facultative subjects
	37	34

Figure4.2: Overview of the core subjects of construction engineering (Source: State Institute for School Quality and Educational Research (2011), p. 6)

The electives cited in the table include, for example, road and bridge construction, project management, structural design or technical expansion.

4.3 Civil Engineer (Bachelor)

The teaching content of civil engineering studies is developed by the Accreditation Association for Study Programmes in Civil Engineering (ASBau) e.V. and the Faculty Day (for universities) and the Fachbe-reichstag (for universities of applied sciences) for civil engineering. The Faculty Day had discussed the core contents of a civil engineering degree course in Leipzig in 2013 and published it in 2015. While working on work package O5, a new reference framework[25] was presented in November 2018.

A bachelor's degree in civil engineering at universities of applied sciences comprises at least 6 theory semesters and is also intended to provide initial practical work experience of at least 12 weeks (internship). This corresponds to 180 to 210 performance points. The core contents are

[25] Akkreditierungsverbund für Studiengänge des Bauwesens (ASBau) e.V., Referenzrahmen für Studiengänge des Bauingenieurwesens (Bachelor), Berlin 2018

specified in the current reference framework with 135 ECTS and are structured as shown in the following figure.[26]

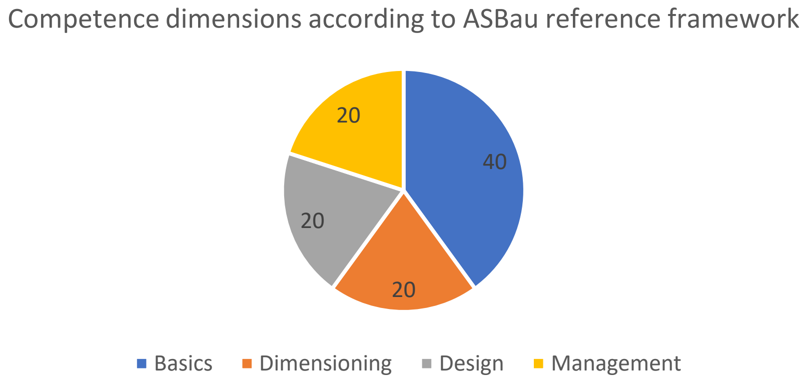


Figure 4.3: Competence dimensions according to ASBau reference framework (Source: ASBau (2018), page 9)

An analysis of the "module descriptions" or competence clusters shows that between 2015 and 2018 digital construction was newly included in the area of basic principles in addition to engineering informatics. The corresponding knowledge/skills/competences are shown in the following table.

Engineering informatics	· Functionality of higher programming language · Methods to exchange data vie networks · Construction specific software for different subject areas in construction · Computer-Algebra-Systems and their possibilities of use · Algorithms and data structures · Object oriented programming · Data security	· Choosing and deploying construction specific software for standard tasks · Describing framework and conditions unambiguously · Recognising calculation and measurement tasks and realizing their implementation by digital programming · Implementing algotithms in a higher programming language · Solving engineering tasks with support of spreadsheet calculations · Using Computer-Algebra-Systems to solve problems	· Independently preparing tasks from construction subject areas for the use of computer programs, to be able to complete the task with according software · Using and operating interfaces in programs · Evaluating and explaning clearly the results of computer based calculations
Digital construction	Basics: · Information, knowledge and data management · Digital technologies · Tracking systems for machines and tools · CAD-programs · Software · Robotics in construction · Principles and Application of Building Information Modelling (BIM) · Artificial Intelligence/big data	· Choosing and operating hard- and software · Processing data electronically	· Using current digital technologies independently · Evaluating and implementing digital technologies in planning and realization processes

Figure4.4: Information technology and digital construction according to the current ASBau reference framework (Source: ASBau (2018), page 15)

[26]ASBau (2018), p.9

The basics also include: mathematics, technical mechanics of elastic bodies, building construction, building physics, building materials science and geodesy. The principles and methods of BIM are an integral part of digital construction and therefore do not constitute a separate subject / module, which is important for further discussion and basic understanding. At many universities, BIM is still understood as an independent discipline and not as a link between planning, building and operation of structural facilities. This is represented in discreteCAD/BIM modules.

4.4 Schnittmengen der Lerninhalte

Wie die vorangegangenen Kapitel gezeigt haben, besitzen die hier untersuchten Bildungsbereiche bei den Lerninhalten Schnittmengen. Eine genauere Betrachtung auf der Ebene von Modulbeschreibungen zeigt für die hier im Fokus stehenden Bildungsebenen „Bauzeichner“ und „Bauingenieur (Bachelor)“, dass in Fächern, wie „Baukonstruktion“ und „Darstellungsmethoden/Technisches Zeichnen“ eine große Übereinstimmung bei den Lerninhalten besteht). Darüber hinaus werden im Rahmen der Ausbildung zum Bauzeichner auch einzelne Themen aus den Fachgebieten „Bauphysik“, „Vermessungskunde“ und „öffentliches Baurecht“ vertieft. Weitere kleinere Schnittmengen sind in der nachstehenden Grafik gelb markiert (vgl. Figure4.5).

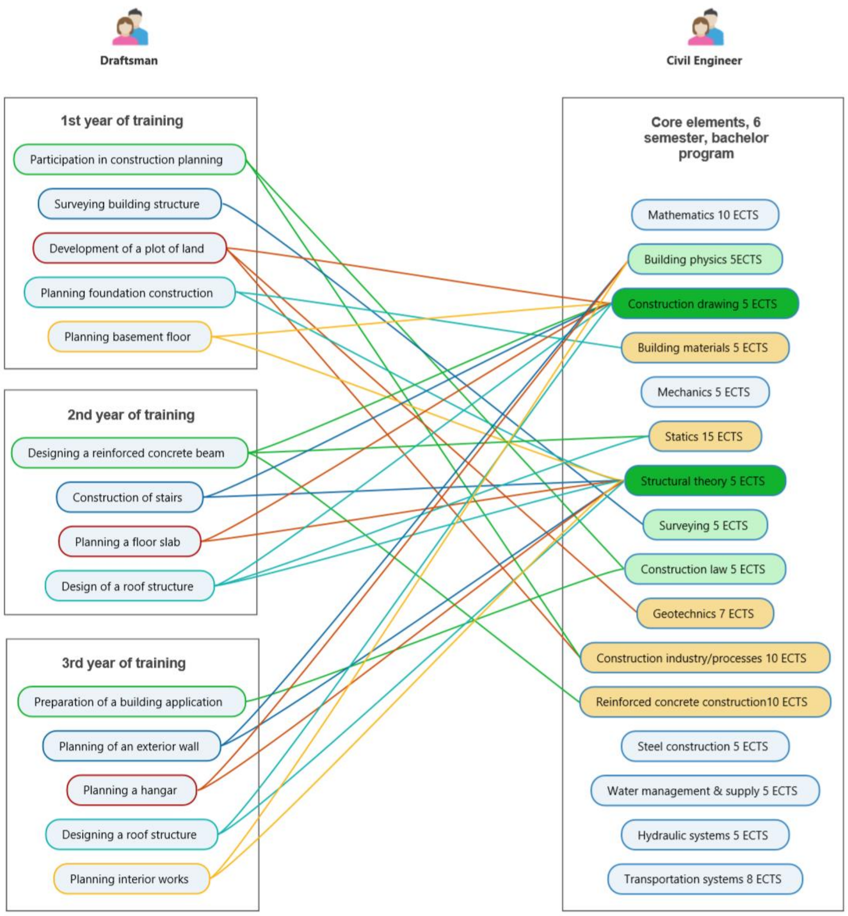


Figure4.5: Intersections in the learning contents architectural draftsman and civil engineer

4.5 BIM basic knowledge and course content

The guideline 2552 part 8.1 published by the VDI in January 2019 in cooperation with bS is intended *"to ensure the quality of training, further training and further education measures by set-*

ting out competences, qualifications and teaching content and by providing a framework for the course of training, further training and further education".[27] As mentioned at the beginning, the Federal Chamber of Engineers and Federal Chamber of Architects already orientate themselves towards this guideline within the framework of their further training measures. For this reason, the development of new teaching modules or job descriptions against the background of permeability is not meaningful without taking VDI 2552 Part 8.1 into account, which is why this chapter takes a closer look.*

Following the "openBIM Professional Certification Program" developed by bSi, the two phases "Individual Qualification" and "Professional Certification" have been adopted in Germany. In the draft guideline from 2017, the structure was still based on the fields of activity in the entire life cycle of real estate (planning, construction, operation and maintenance). This was abandoned in the adopted version, as Figure4.6 shows. In the second phase, specialisation is then carried out. For the latter, the learning objectives and contents are currently being developed. A publication is not expected before 2021.[28]

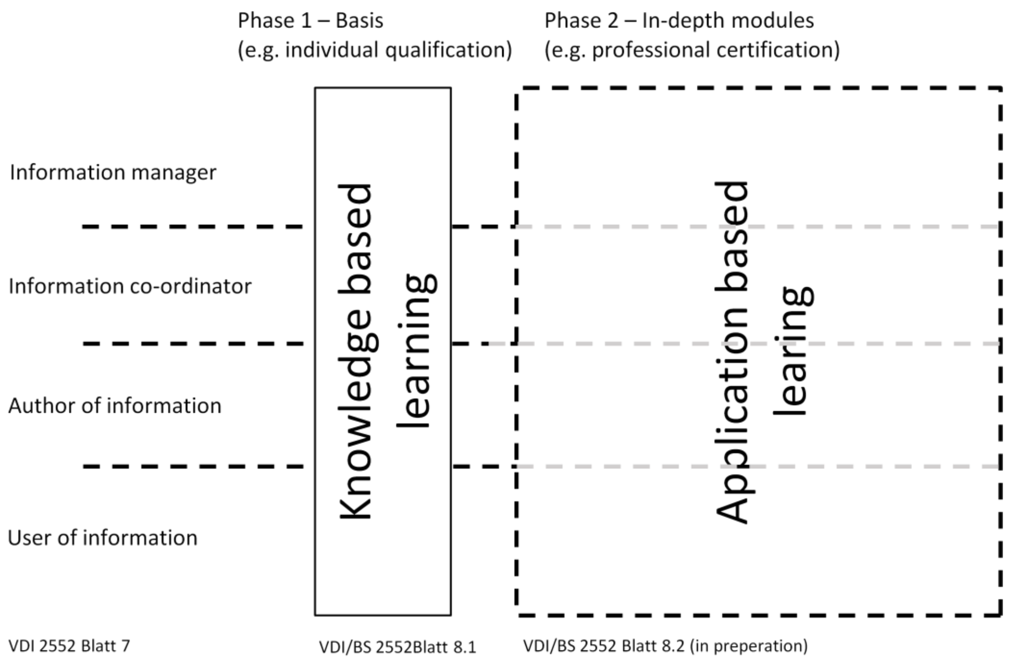


Figure4.6: Qualification structure (Source: VDI/bS 2552, 8.1 (2019), page 4)

"Basic knowledge within the framework of basic skills includes the definition and derivation of terms, technical terminology in the sense of a uniform vocabulary and the understanding of BIM as a methodology for cooperation, collaboration and co-creation. In this context, the differences between BIM processes and traditional processes as well as potential added value and challenges at project and organizational level are particularly relevant. Theoretical steps on the way to the implementation level include the knowledge of model construction, tools as well as structuring and running a BIM project.

The basic knowledge must be related to a dynamic system consisting of the five BIM factors "people", "processes", "data", "technology" and "framework conditions" as well as their interac-

[27] VDI/BS 2552, Blatt 8.1 (2019), p. 3

[28] https://education.buildingsmart.org/structure/, accessed on 2018-08-17

tion with their environment. In this respect, the necessary system thinking must be included in the basic knowledge.”[29]

In addition, the directive describes the following 12 topics with keywords/half sentences:

1. Introduction (among others development and background of BIM, differences between 2-D, 3-D and BIM, opportunities and risks, information models, information management)
2. Current standards and directives and those under development
3. Added value and challenge in the introduction and application of BIM
4. Forms of application of BIM (including the distinction between open BIM and closed BIM, Exchange formats, Information Delivery Manual, Model View Definition)
5. Object-oriented model structure (including the structure and linking of technical and sub-models, granularity, component libraries and product catalogues)

1. 6th BIM implementation company along the 5 BIM factors

6. BIM implementation in the project (BIM application fields and use cases, client information request, roles and responsibilities, BIM execution plan, modeling guidelines, data delivery points)
7. Overview BIM tools in local and networked systems
8. Coordination (including definition, set-up and structure of coordination models, coordination process, change management)
9. Handover (transfer and receipt of data and information to the following project phase of design, construction and operation)
10. Legal aspects
11. Perspectives

Due to the high level of acceptance among the chambers and associations, it is assumed here that VDI Guideline 2552 Part 8.1 defines the minimum standard with regard to learning content from the point of view of the construction industry. This minimum standard applies in any case to the training of civil engineers at level 6 of the DQR/EQF and also serves as a guideline for the learning content to be developed within the framework of work package O5.

5. Digital methods - current labour market and demands on employees

When developing learning contents and concepts, the needs of employers are also taken into account in addition to the above-mentioned VDI guideline. In order to derive the requirements for employees, continuous research was carried out in relevant job portals[30] with regard to the advertised job profiles in the period spring to autumn 2018. In addition, discussions were held with stakeholders from the construction and real estate industry.

In general, it can be said that in almost all job profiles in the fields of "Architecture", "Civil Engineering" and "Technical Drawing", the desire for initial experience with BIM has been expressed. However, only a few companies are able to precisely formulate the requirements. Thus, a search with the keyword "BIM" resulted in approx. 100 hits, compared to more than 1,000 for the keywords "civil engineer" or "architect". If one looks at the activity profiles associated with concrete BIM services, the following categories can be formed:

a) BIM modeller / 3D modeller (BIM)

[29] VDI/BS 2552, 8.1 (2019), p. 5

[30] stepstone.de, indeed.de, monster.de, arbeitsagentur.de

b) BIM Coordinator / Project Manager BIM Projects (m/f)

c) Other BIM specialists

Other BIM specialists (category c) include, for example, "BIM training and further education", "Product data digitization" or "BIM specialist (m/f) scheduling and cost planning", which are not considered here due to the very specific requirement profiles. The job profiles of categories a) and b) include in the rule:

a)

- Creation and editing of building models in all planning phases
- BIM modelling for calculation within the design phase
- Participation in the introduction of model-based calculation processing
- Creation and further development of component databases

b)

- Development of standards for BIM services
- Creation of basic documents, guidelines, specifications and processes in connection with the BIM implementation
- Coordination of the planning services with the BIM method
- Development of BIM project development plans
- Development of project-related BIM targets and use cases, establishment of client information requirements (AIA)
- Advice for users in the decision-making process regarding the selection of software for special tasks
- Concept and workflow development of BIM methods and quality standards
- Organization and implementation of knowledge transfer of BIM services

The descriptions show that the previous understanding of the role between engineer and technical draftsman is also adopted in BIM projects. The technical draftsman draws or models and the engineer does the rest.

6. Development of a new field of activity - "BIM Assistant“

6.1 BIM use cases and workload distribution

When handling construction projects using the BIM methodology, the client contractually determines the extent to which and for what purpose data (so-called use cases) are used. In practice, the use cases shown in Figure 6.1 are just some of them. The figure shows the qualitative workload for the occupational groups "draughtsman" and "engineer"[31] as a function of the respective use case in the levels 0/25/50/75/100. The distribution is based on the current training standards (cf. Chapter 3).[32]

	BIM-Anwendungsfall	**Workload**	
	Modellbasierte	**Bauzeichner**	**Ingenieur**
1	Bestandserfassung erstellen (3D-Scanning, Modellieren, Daten-	75	25

[31] Since architects are also engineers, we do not differentiate here.

[32] The evaluation was carried out by a working group at the HTW Berlin, which is involved in BIM research and teaching.

	sätze einpflegen)		
2	Raumprogramm erstellen	25	75
3	Planung erstellen	75	25
4	Kollisionsprüfung durchführen	25	75
5	Mengenermittlung erstellen	25	75
6	Performing tender procedure and allocation conduct		100
7	Performing planning coordination	25	75
8	Performing sampling	25	75
9	Performing change management	25	75
10	Creating and performing cost planning and control		100
11	Adhering to the schedule		100
12	Performing construction estimation		100
13	Performing logistical planning	25	75
14	Performing mobile quality control		100
15	Creating and mainatining site-/strucutal component descriptions	25	75
16	Creating documentation	50	50
17	Administering the integrationplattform	25	75

Figure6.1: Distribution of the workload between technical draftsmen and engineers for selected use cases

The table shows that the use cases (AF) in which drawing or modeling dominates (AF1 and AF3) also represent the proportionally largest workload for the technical draftsmen, which is not surprising. In all other AF the focus is on the engineers. However, many activities that are currently still performed by engineers do not require a classical civil engineering degree. Especially profound knowledge from subjects like mechanics, statics, structural engineering are not necessary for many AF. Rather, knowledge of how projects are realized in planning and on the constructionsite is required. In addition to knowledge of the processes, basic knowledge in the fields of building construction, building materials and building physics must be acquired so that AF can work on their own responsibility. Some of this basic knowledge is already imparted in the training as a draftsman, but is not sufficient to work on AF independently.

The following matrix shows qualitatively, which basic knowledge is necessary for the AF considered here. It is obvious that software products are used for all AF, which is why the term "applied construction informatics" is used here to describe the handling of data, for example databases.

BIM Use Case	Building construction	Building materials science	Building physics	Surveying	Project-/ Process Management	Construction operations and process engineering	applied construction informatics	Public procurement and building law
1 Create an inventory (3D scanning, modeling, ...)	X	X		X			X	
2 Create room program					X			
3 Create planning	X	X	X		X			
4 Perform collision detection	X	X	X		X	X	X	
5 Create quantity determination				X	X	X		X
6 Tendering and awarding of contracts					X	X		X
7 Carry out planning coordination	X	X	X		X			
8 Sampling carried out	X	X			X	X		
9 Perform change management					X	X		X
10 Create and carry out cost planning and control	X	X			X	X		
11 Carry out flow chart	X				X	X		
12 Conduct a building calculation	X	X	X			X		
13 Carry out logistics planning					X	X		
14 Carry out mobile quality assurance	X	X	X		X	X		
15 Create/maintain plant and component profiles	X	X	X		X	X	X	
16 Creating documentation				X	X	X	X	X
17 Administrate integration platform					X		X	X

Figure6.2: Required basic knowledge for selected applications

6.2 Changed workload distribution by introducing a "BIM Assistant”

Many AF can be processed by workers who have not completed engineering studies, as shown in Chapter 6.1. However, the technical competence of the draftsmen is not sufficient to do this work completely. This gap can be filled by a "BIM Assistant" who, building on the training as a draughtsman, has knowledge and skills in BIM methodology and concrete use cases. If these are available, the workload distribution is likely to shift, as shown in Figure 6.3. This would relieve the engineers and reduce costs.

The term "BIM Assistant" has been introduced here as a designation, since at the current time the service contents of the "BIM Coordinators" and "BIM Managers" have not yet been defined in a generally valid way.

	BIM-Use cases	Workload		
	Model based	Bauzeichner	Assistent	Ingenieur
1	Conduct inentory recording (3D-Scanning, modelling, in-putting data sets)	50	25	25
2	Create spatial program	25	25	50
3	Create a plan	75		25
4	Conduct a colision prevention	25	50	25
5	Create a quantity creation	25	50	25
6	Performing tender procedure and allocation conduct		25	75
7	Performing planning coordination		50	50
8	Performing sampling	25	25	50
9	Performing change management	25	25	50
10	Creating and performing cost planning and control		50	50
11	Adhering to the schedule		50	50
12	Performing construction estimation		50	50
13	Performing logistical planning	25	25	50
14	Performing mobile quality control		50	50
15	Creating and mainatining site-/strucutal component de-scriptions	25	50	25
16	Creating documentation	25	50	25
17	Administering the integrationplattform	25	50	25

Figure6.3: Changed workload distribution after introduction of a BIM Assistant

7. Further training to become a BIMAssistant

7.1 Concept

The recommendation issued by the Board of the Federal Institute for Vocational Education and Training on 12 March 2014 on key points for the structure and quality assurance of continuing vocational training[33] indicates that three levels are to be distinguished in the context of regulated continuing training which can be assigned to DQR levels 5 to 7 (cf. Figure7.1).[34]

BIBB's recommendations contain details on the occupational requirements and competences of the first level of continuing vocational training:

"Graduates of this continuing training level can perform functions in their occupational field such as consultant, supervisor, developer, project manager, tester or trainer. These functions are assigned complex tasks with budget responsibility or area responsibility, which are carried out responsibly and independently.

... have the skills to independently plan and work on comprehensive technical tasks in complex, specialised and changing fields of activity. They are able to assess the quality of their work

[33]Cf. Bundesinstitut für Berufsbildung (2014)
[34]Cf. Wilbers (2014)

themselves and to take responsibility for it, as well as to independently plan and implement the further development of their individual careers".[35]

The requirements fit the target group of draftsmen, civil engineers and drop-outs from civil engineering or architecture. These workers already have the basic knowledge that enables a compact further education in a time frame of 400 hours (attendance seminars + self-study), see also chapter 4.4.[36]

Levels of Qualification	Aims of qualification	Level DQR
First professional level of advanced education	Qualifications on this level enable the taking on of tasks which expand on and deepen the competences aquired in vocational education and ential new content.	DQR 5
Second professional level of advanced education	Qualifications of this level enable to take responsibility for subject matter - and management positions, in which performance processes of an area of operations or an enterprise are independently operates, realised and for which employees are instructed. Qualifications of this level expand on anf deepen the competences of the first professional level of advanced education.	DQR 6
Third professional level of advanced education	Qualifications of this level expand on the competences of the second professional level of advanced education and incorporate competences that are necessary to responsibly run organisations or to work on new complex tasks and problems. They entail the development of methods and products and the connected instruction of personell. The requirements are marked by frequent and unforseeable changes.	DQR 7

Figure7.1: Level model of regulated continuing vocational training (Source: Federal Institute for Vocational Education and Training (2014), p. 3)

Since drop-outs who have chosen to enter higher education via the Gymnasium and the Abitur do not have a vocational qualification, they cannot enter further vocational training directly. In this case, it is necessary to first complete training as a draftsman, which should be possible within one year due to the extensive previous knowledge that is usually available. This is then followed by further training as a BIM assistant (see Figure7.2).

[35]Bundesinstitut für Berufsbildung (2014), p. 3

[36]BIBB envisages an average learning time of 400 hours at this level and 1,200 hours at level two.

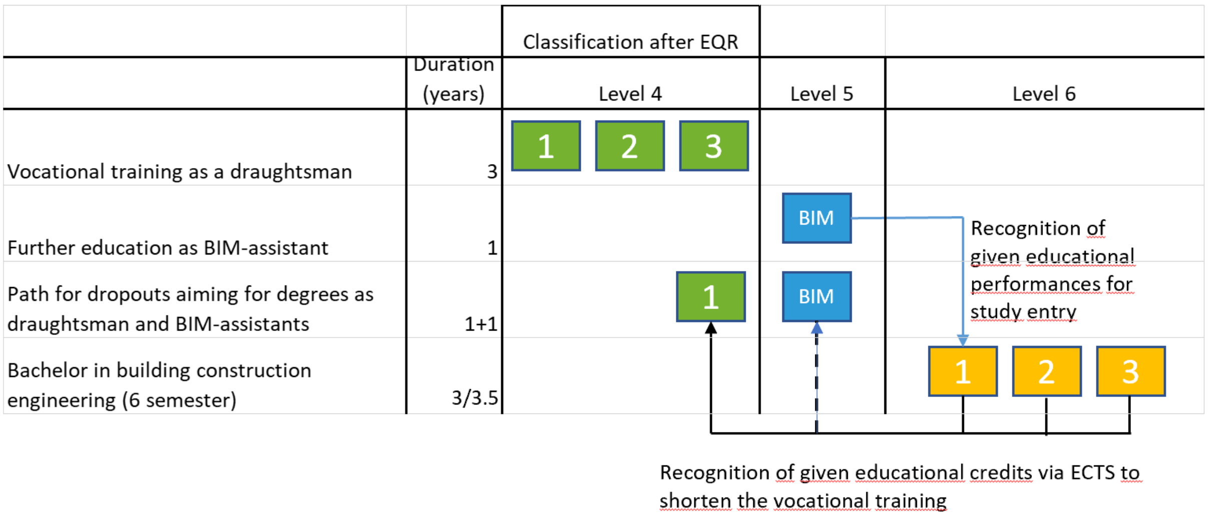


Figure7.2: Qualification path to BIM Assistant

As shown in Chapter 6.1 using BIM use cases, certain basic knowledge must be expanded within the framework of within the framework of further training. In contrast to the classic training as a draftsman, technician cian or civil engineer, the focus here is on the use of BIM methods. This means that all learning contents must have a direct reference to it. For example, this can be achieved by an integrated, cross-module project (see

Figure7.3). A single BIM module, as found in many curricula, is not part of the concept.

Assuming a total volume of 400 hours for classroom teaching and self-study, the workload could be distributed among the individual subject groups as shown in the following table (see Figure7.4). The 200 hours of classroom instruction and the project work, which would then be an elementary component of the examination, can be completed in a year while working. The total scope can be scaled according to requirements, whereby the specifications of the BiBB must be observed.

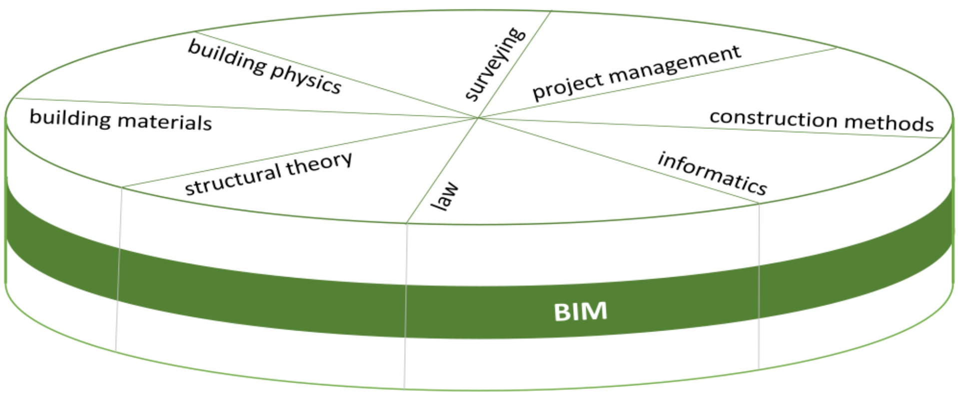


Figure7.3: Overview learning content BIM Assistant

Subject group	Attendance time **[%]**	**in hours**	**Self-study [%]**	**in hours**
Building construction	10	20		
Construction materials	5	10		
Construction physics	5	10		
Surveying/Measurment	5	10		
Project management	20	40		
Construction operati-ons and procedures	20	40		
Construction informa-tics	30	60		
Law	5	10		
Project			100	200
Sum	**100**	**200**	**100**	**200**

Figure7.4: Weighting of the learning content BIM Assistant

The learning unit A (Basic BIM) and the competence matrix developed within the project "Fit for BIM" can be used to define concrete learning content at level 5 EQF.

7.2 Permeability

As described in the introduction, the concept is also aimed at drop-outs from the civil engineering and architecture courses. Whether drop-outs from the field of technical building equipment/ supply engineering can also be trained as BIM assistants is still to be investigated. Many drop-outs have already successfully completed the basic modules. In this respect, the attendance time can possibly be shortened. Since the present concept provides for a final examination via a project work with defense and no module examinations in the classical sense are planned, recognition of modules is not mandatory. The same applies to technicians.

For draughtsmen or technical draughtsmen the learning contents are new, so that a recognition of achievements is not relevant. Also due to the continuing education format (voluntary participation in courses), the participants decide on the basis of professional practice to what extent the attendance time can be reduced if necessary.

With regard to a course of study at a university of applied sciences, it should be noted that training as a BIM assistant with 400 hours corresponds to a module with 14 ECTS. Recognition will be carried out individually by each university according to the portfolio procedure (cf. Chapter **Błąd! Nie można odnaleźć źródła odwołania.**). According to the current status of the curriculum, the HTW Berlin would, in the case of successful completion as a BIM assistant, recognise the modules:

- Presentation methods (5 ECTS)
- Building constructions (5 ECTS)
- Construction industry and construction operations 1 (5 ECTS)

These individual modules are then graded on the basis of the grade from the project work, if necessary with an additional explanation by the student (see Figure2.5).

References

ASBau (2018): Akkreditierungsverbund für Studiengänge des Bauwesens (ASBau) e.V., Referenzrahmen für Studiengänge des Bauingenieurwesens (Bachelor), Berlin 2018

Bundesinstitut für Berufsbildung (2014): Empfehlungdes Hauptausschusses des Bundesinstituts für Berufsbildung vom 12. März 2014für Eckpunkte zur Struktur und Qualitätssicherung der beruflichen Fortbildungnach Berufsbildungsgesetz (BBiG) und Handwerksordnung (HwO), Bundesanzeiger, veröffentlicht am 07.04.2014

Ebbinghaus, M (2016): Studienabbrecher/-innen: Als Auszubildende in Betrieben willkommen – aber möglichst ohne Extrabehandlung Ergebnisse einer Betriebsbefragung mit dem Referenz-Betriebs-System, BIBB-Report, Nr. 2, April 2016

Fachbereichstag Bauingenieurwesen (2015): Kenntnisse, Fertigkeiten und Kompetenzen im Kernstudium von Bachelorstudiengängen des Bauingenieurwesens an Hochschulen für angewandte Wissenschaften, April 2015, http://www.fbt-bi.hm.edu/fbt/veroeffentlichungen/fbt-bi-kerninhalte-broschure-web.pdf

Freitag, W.; Buhr, R.; Danzeglocke, E.-M.;Schröder, S.; Völk, D. *Hrsg.* (2015): Übergänge gestalten Durchlässigkeit zwischen beruflicher und hochschulischer Bildung erhöhen, Waxmann Verlag, 2015

Hemkes, B.; Wilbers, K.; Zinke, G.; Bednarz, S. (2015): Bereichsübergreifende Bildungsmaßnahmen als Brücke zwischen Hochschule und Berufsbildung, Hochschule und Weiterbildung (2015) 1, S. 27-31

Heublein, U.; Ebert, J.; Hutzsch, Chr.; Isleib, S.; König, R.; Richter, J.; Woisch, A. (2017):Motive und Ursachen des Studienabbruchs an baden-württembergischen Hochschulen und beruflicher Verbleib der Studienabbrecherinnen und Studienabbrecher, DZHW-Projektbericht, Juni 2017

Heublein, U., Schmelzer, R. (2018): Die Entwicklung der Studienabbruchquoten an den deutschen Hochschulen Berechnungen auf Basis des Absolventenjahrgangs 2016, DZHW-Projektbericht, Oktober 2018

Hochschule Harz (o.J.): Anrechnung non-formaler Lernergebnisse auf ein Hochschulstudium – Leitfaden für Studierende und Bewerber, o.J., https://www.hs-harz.de/user-mounts/246_m1438/Hochschule_Harz_Anrechnung_Leitfaden_Portfolioerstellung.pdf

Institut für ökonomisch Bildung (IÖB): Das polnische Bildungssystem, http://www.ioeb.de/bildungssystem, Juli 2018

Koch-Rogge, M. (2016): Untersuchung zur Deckungsgleichheit von Studiengängen der Hochschule Harz und Ausbildungsberufen, Zwischenergebnis zum Arbeitspaket 3: Verbesserung der Durchlässigkeit akademische-berufliche Bildung, Teilbereich: Anrechnung akademisch erworbener Kompetenzen auf eine berufliche Aus- oder Fortbildung, im Rahmen des Projektes: Wissenschaftliche Weiterbildung für KMU in Sachsen-Anhalt 2015-2017, Hochschule Harz, April 2016

Koch-Rogge, M. (o.J.):Rahmenbedingungen und Durchführung von Anrechnung beruflicher Lernergebnisse - Anrechnungswege an der Hochschule Harz, Präsentation, HS Harz, o.J.

Kultusministerkonferenz (2002): Rahmenlehrplan für den Ausbildungsberuf Bauzeichner/Bauzeichnerin, Beschluss vom 14.06.2002, https://www.kmk.org/fileadmin/Dateien/pdf/Bildung/BeruflicheBildung/rlp/Bauzeichner.pdf

Staatsinstitut für Schulqualität und Bildungsforschung (2011):Lehrpläne für die Fachschule für Bautechnik, München, 2011

Stamm-Riemer, I.; Loroff C.; Hartmann, E.A. (2011): Anrechnungsmodelle - Generalisierte Ergebnisse der ANKOM-Initiative, HIS-Forum Hochschule, Januar 2011

VDI /BS 2552 Blatt 8.1 (2019): Building Information Modeling – Qualifikationen Basiskenntnisse, VDI-Handbuch Bautechnik, Januar 2019

Wanka, J. (2014): "Berufsbildung attraktiver gestalten - mehr Durchlässigkeit ermöglichen", Rede der Bundesministerin für Bildung und Forschung, Johanna Wanka, anlässlich des 7. BIBB-Berufsbildungskongresses in Berlin, veröffentlich auf der Seite des BMBF, 18.09.2014, https://www.bmbf.de/de/berufsbildung-attraktiver-gestalten-mehr-durchlaessigkeit-ermoeglichen-1845.html

Wilbers, K. (2014): Das Niveau 5 des Deutschen Qualifikationsrahmens (DQR) als Plattform für die Gestaltung bildungsbereichsübergreifender Arrangements (Berichte zur Wirtschaftspädagogik und Personalentwicklung, 2014-3). Nürnberg: Universität Erlangen-Nürnberg, Lehrstuhl für Wirtschaftspädagogik und Personalentwicklung.

Zimmer, K. (2013): Das neue Aufstiegsfortbildungssystem in der Bauwirtschaft – eine Branche geht neue Wege, in: Zeitschrift BWP Berufsbildung in Wirtschaft, Heft 1, 2013, Seite 49-50

Contact to the partnership

Germany

BGZ Berliner Gesellschaft für internationale Zusammenarbeit mbH
Pohlstraße 67
DE – 10785 Berlin
Telefon: +49 (30) 80 99 41 11
Telefax: +49 (30) 80 99 41 20
info@bgz-berlin.de
www.bgz-berlin.de
www.fit4bim.eu

Hochschule für Technik und Wirtschaft Berlin
University of Applied Sciences
www.htw-berlin.de

Max-Bill-Schule
OSZ Planen | Bauen | Gestalten
www.max-bill-schule.net

Belgium

ROBERT-SCHUMAN-INSTITUT
www.rsi-eupen.be

ZAWM ST.VITH
www.weiter-mit-bildung.be

Denmark

AARHUS TECH
www.aarhustech.dk

VIA University College
www.via.dk

Poland

poznan university of technology
institute of structural engineering
www.put.poznan.pl

ZSB POZNAŃ Zespół Szkół Budowlanych
www.zsb.com.pl