UTQ Portfolio

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Chapter 1

UTQ

This is my University Teaching Qualification (UTQ) portfolio.

About me

I am Breno Alves Beirigo, an Asst. Prof. in Stochastic *Operations Research (OR)* working at the University of Twente in the *Industrial Engineering and Business Information Systems (IEBIS)* department. For the last six years, I have worked at TU Delft (NL) in the *Transport Engineering and Logistics (TEL)* section of the *Maritime and Transport Technology (MTT)* department, where I carried out my postdoc and Ph.D. research. Previously, I pursued a BSc and MSc degree in Computer Science at the Federal University of Viçosa (BR).

Research

My interest in the optimization field was sparked in 2011 when I first moved to the Netherland for a one-year exchange program at the Hanze University of Applied Sciences in Assen. By then, besides following the "Advanced Sensor Applications" program, I was puzzled by a classical optimization problem when planning my summer vacations: visiting as many western European cities as possible within a month under my meager student budget. In the end, the travel was terrific (my friends and I visited about thirteen destinations), but the planning phase was very laborious, and the itinerary was, most likely, far from optimal.

Going back to Brazil, I took advantage of my frustration to design and solve a travel planning problem, which became the topic of both my graduation project and my MSc dissertation thesis. In parallel with my master's degree, I worked as a lecturer at the Federal Center of Technological Education of Minas Gerais (CEFET-MG). By then, I was teaching IT-related topics (e.g., automation via web, android development, web design) daily for a BSc in Mechatronics Engineering and an IT technical degree.

At the end of 2016, I stop lecturing at CEFET-MG to pursue a Ph.D. at TU Delft. I worked within the "Dynamic Fleet Management" module of the Integrated Cooperative Automated Vehicle (I-CAVE) project, a multi-disciplinary and cross-university joint effort covering all research fields related to developing and deploying autonomous vehicles (AVs). My thesis, "Dynamic Fleet Management for Autonomous Vehicles: Learning- and Optimization-Based Strategies," focuses on addressing the logistical challenges and opportunities arising from adopting shared AV fleets in urban environments. It presents a series of strategies to guarantee service quality throughout operational scenarios throughout the timeline of AV technology deployment.

In my postdoctoral research, the focus has changed from surface streets to water: I worked on the Transportation and Logistics Over Water (TRiLOGy) project. This project aims at improving city livability by efficiently using urban waterways for mobility and logistics applications. My research was mainly concerned with designing optimization models that can leverage stochasticity in the demand and network conditions to route and schedule hybrid (over water and land) fleets of (autonomous) vehicles. Also, we worked closely with Amsterdam Municipality to design dynamic stochastic algorithms for managing fleets of autonomous vessels to (partially) carry out the city's day-to-day logistics services, such as waste collection and freight delivery.

Education

> I enjoy teaching because it allows me to witness first-hand students' skill acquisition process (improving how they solve problems) while honing my skills as an educator, presenter, and researcher.

Throughout my work as a:

- full-time lecturer at the Federal Center of Technological Education of Minas Gerais (CEFET-MG) in Brazil,
- supervisor of master students at TU Delft, and
- mentor of an early-stage Ph.D. student at TU Delft,

I earned extensive pedagogical experience in the design and conduct of a range of different courses and daily interaction with a diverse body of students from different educational backgrounds.

Teaching

Before starting my doctoral studies, I worked for 1.5 years (40h/week) at CEFET-MG in the Department of Informatics, teaching computer science disciplines for a BSc in Mechatronics Engineering (4 one-semester courses) and a career-focused IT technical degree (2 one-year courses). Teaching day-by-day to 50+ students at different levels (high-schoolers and bachelors) taught me that fulfilling the learning objectives is rooted in organization, clarity, and, most importantly, contextualization.

I foster student engagement by tailoring the content to guarantee that they quickly recognize its relevance and applicability. For example, the lessons of my "Web Development" course focused on recreating the features of students' everyday social networks, such as Instagram photo filters or Facebook-inspired databases and user interfaces. Further, when teaching "Automation via Web," I assisted student groups in designing practical projects that embodied all the learning objectives. This way, they could use their creativity to develop applications appealing to them (e.g., a web-controlled home automation system) while practicing the course's concepts.

To improve content retention, I seek to include plenty of examples and eye-pleasing visualizations in my lectures. I painstakingly prepare slides to ensure a clear and intuitive message gets across and design interactive assignments to illustrate concepts vividly. Still, I am aware these are supportive materials and regard my teacher role as a "tour guide" that enthusiastically contextualizes the content. My students have always deemed me friendly and rigorous, with high standards and expectations. This attitude translates to being approachable and providing detailed feedback in reports and assignments, both in the classroom and as a supervisor.

Supervision

At TU Delft, I proposed and supervised MSc graduation projects and literature/research assignments spun off from my work on transportation and, more recently, working as a teaching assistant in the course "Machine Learning for Transport and Multi-Machine Systems." As a supervisor, I seek to tailor the topic and the approach to fit the students' aspirations and preferences, helping them develop a feasible plan to achieve their goals while delivering quality work that complies with the program's requirements. To ensure they are on track and focused, I adopt an Agile methodology of continuous and iterative improvement through constant feedback.

Teaching and supervision at UT

As a teacher at UT, I am responsible for two *Industrial Engineering and Management (IEM)* courses: *Warehousing* (MSc - 4th quarter) and *VBA/Excel* (BSc - 1st quarter and Pre=MSc - 2nd quarter). These courses have a wealth of legacy material, having been lectured for experienced teachers for 5+ years, and present different challenges. While *VBA/Excel* is (mainly) lectured to first-year students fresh from high school, *Warehousing* is geared towards last-year MSc students on the verge of entering the job market. Throughout this UTQ portfolio, I will show how I finetune my approach and materials to adequately cater to the needs and aspirations of these different student bodies.

Finally, as a supervisor, I am involved as a first/second supervisor in both BSc and MSc graduation projects. I supervise students whose project topics lie at the intersection of OR/ML (methods) and transportation/warehousing (context).

Part I

Designing or redesigning teaching

The design of education is the basis of all teaching and organized learning. Without a design teaching is random and not aimed at learning.

> "Teaching is the process of attending to people's learning needs, experiences and feelings, and making specific interventions to help them learn particular things".

Mark K. Smith, in What is teaching? A definition and discussion

Chapter 2

Warehousing in the MSc IEM curriculum

Warehousing is a mandatory course of the *Manufacturing Logistics (ML)* orientation within the *Production and Logistics Management (PLM)* specialization of the *Master (of Science) program Industrial Engineering and Management (M-IEM)* program[1].

The PLM specialization focuses on designing and managing logistics and supply chain processes.

The M-IEM degree has a study load of 120 ECs and comprises a set of mandatory courses/activities at program, specialization, and orientation levels. Table 2.1 presents such courses for M-IEM/PLM/ML (totaling 75 ECs). The rest of the study load is divided among elective courses (45 ECs) and the graduation thesis (30 ECs).

Table 2.1: Overview of mandatory courses for M-IEM's *Production and Logistics Management (PLM)* specialization and *Manufacturing Logistics (ML)* orientation[2].

Mandatory	Code	Course	Quartile	ECs	Test[3]
M-IEM	201700020	IEM research orientation	1 + 3	5	W
M-IEM	201400174	Data Science	1 + 2 + 3	5	W
M-IEM	202001464	Thesis Preparation	-	5	-
M-IEM	194100060	Thesis	-	30	-
PLM	201800003	Operations Research Techniques 1	1 + 3	5	W
PLM	201800004	Operations Research Techniques 2	4	5	P
PLM	191820210	Simulation	1	5	PW
ML	201800007	Planning & Scheduling	4	5	PW
ML	201800009	Advanced Inventory Management	2	5	PW
ML	191820120	Warehousing	4	5	W

[1]See M-IEM program-specific Education and Examination Regulations (EER)
[2]Source: Study Program for all specializations and orientations in M-IEM
[3]W=Written exam, O = Oral exam, P = Practical assignment

Table 2.2: M-IEM/PLM/ML recommended schedules.

(a) Starting in September (Q1) / (b) Starting in February (Q3)

Quartile	Activity	Quartile	Activity
Q1	Simulation, IEM Research Orientation, OR Techniques	Q3	IEM Research Orientation, OR Techniques 1, SMOM
Q2	Data Science, Advanced Inventory Management	Q4	Planning and Scheduling, OR Techniques 2, **Warehous**
Q3	SMOM	Q1	Simulation
Q4	OR Techniques 2, Planning and Scheduling, **Warehousing**	Q2	Data Science, Advanced Inventory Management
Q1		Q3	
Q2	Thesis Preparation	Q4	Thesis Preparation
Q3	Thesis	Q1	Thesis
Q4	Thesis	Q2	Thesis

2.1 Recommended course schedules

The first 1.5 years of M-IEM focus on teaching and learning activities, whereas the last semester is fully dedicated to the graduation project of 30 EC. Since efficient and cost-effective warehousing operations are frequently on-demand in industry, there is a wealth of opportunities to conduct the graduation project in several organizations (see a complete list of MSc theses on warehousing in Section 2.3.3).

Table 2.2 summarizes the recommended schedules for M-IEM/PLM/ML mandatory courses. Notice that students starting the program in September (Table 2.2a) will have already covered most of the program's disciplines by the time the **Warehousing** course starts.

2.2 Learning outcomes in the context of the program competences

The M-IEM program aims at educating students to become well-rounded industrial engineers and managers. M-IEM graduates can quickly identify, thoroughly comprehend, critically assess, correctly apply, and creatively integrate existing scientific knowledge to analyze problems and design solutions (see the detailed program ILOs in Section 7.1).

Table 2.3 shows how the **Warehousing** course learning outcomes underpin M-IEM competencies, providing quantitative and qualitative methods to design, manage, control, and evaluate contemporary warehouses.

Once the course is mandatory for M-IEM PLC urse within the PLC track, all its learning objectives are strongly related to the program's competency A7, which entails mastering M-IEM core disciplines. Also, since all course content is fine-tuned to real-world study cases, all learning objectives address competency A4 conceptually or through practical examples. In special, learning outcomes W1, W2, W3, and W4 entail mastering topics within Warehousing, a pre-requisite to critically analyzing and framing concrete situations.

Conversely, W5, W6, and W7 focus on learning state-of-the-art methods to optimize warehouses at different planning levels. W5 and W6 are strongly related to A3 and A5, respectively, focusing on implementing and evaluating quantitative methods, whereas W7 addresses the research components of the program (ILOs A1, A2, and A8).

Finally, contributing to meaningful research (A8) in the context of warehousing requires a grasp of all course ILOs, especially W7.

Table 2.3: MSc IEM program ILOs (top) covered by the **Warehousing** course ILOs (left). The symbols “ ” indicate the ltheLOs are associated (” ” = *not associated*, “ ” = *associated*, “ ” = *stongly associated*).

Warehousing ILOs / M-IEM ILOs	(A1) Apply research & design processes	(A2) Evaluate research & design processes	(A3) Model operational processes quantitatively	(A4) Leverage existing knowledge in concrete cases	(A5) Plan implementation methods and processes	(A6) Evaluate solution strategies' performance	(A7) Demonstrate mastery of M-IEM's core disciplines	(A8) Contribute to academic development
(W1) Explain the role of warehousing in supply chains and identify warehouse types, functions, and operations								
(W2) Discuss major planning, design, management, and control decisions in contemporary warehouses								
(W3) Discuss storage and material handling objectives, principles, and technology								
(W4) Discuss emerging warehousing challenges, trends, and innovations								
(W5) Implement quantitative methods to optimize distribution networks and warehouses' design, management, and operations.								
(W6) Analyze relevant data and evaluate performance metrics to support decision-making in a warehousing environment								
(W7) Synthesize and critically evaluate relevant warehousing research and literature to inform best practices								

2.3 Research and Industry

In recent years, the field of warehousing has been undergoing rapid change due to advancements in technology and increasing demand for efficient and effective supply chain management.

The MSc IEM's **Warehousing** course helps students stay up-to-date with the latest developments and prepare them to take on leadership roles in their future careers.

> Graduates are equipped with a thorough understanding of the latest research and best practices in the field and the knowledge and skills needed to analyze data, optimize warehouse operations, and make informed decisions.

They may work as logistics managers, supply chain analysts, operations managers, or warehouse managers, among other roles.

2.3.1 Warehouse research

Ongoing research in warehousing is focused on developing new and innovative solutions for optimizing warehouse operations, including the use of automation and artificial intelligence, the implementation of more sophisticated inventory management systems, and the adoption of sustainable practices.

In conclusion, an MSc course in warehousing provides students with a strong foundation in the field and prepares them for careers in an industry that is constantly evolving and offers many opportunities for growth and advancement. The course also helps students stay informed about the latest research and developments in the field, equipping them to make informed decisions and contribute to ongoing efforts to improve the efficiency and effectiveness of warehousing operations.

2.3.2 Warehousing industry

Graduates of the MSc course in warehousing are well-prepared to meet this demand. They are equipped with a thorough understanding of the latest research and best practices in the field and the knowledge and skills needed to analyze data, optimize warehouse operations, and make informed decisions.

They are also well-positioned to contribute to the ongoing efforts to improve the efficiency and effectiveness of the warehousing industry in the Netherlands. In conclusion, the MSc course in warehousing and its learning outcomes are directly relevant to the warehousing industry in the Netherlands, providing students with the knowledge and skills needed to succeed in a critical and rapidly evolving sector of the country's economy.

Warehousing in the Netherlands

The Netherlands is a major logistics and supply chain management hub with a well-developed warehousing industry that plays a critical role in the country's economy. Many companies in the Netherlands operate large warehousing facilities to support their supply chain operations, including major retailers, manufacturers, and logistics. Consequently, the demand for skilled professionals in the field of warehousing is high, and many companies are seeking individuals with advanced knowledge and skills in warehouse design, operation, and management.

> Given the diversity of the Dutch market, M-IEM students willing to carry out their graduation projects in warehousing related-subjects may choose from a wealth of companies.

The number of warehouses in the country has been consistently growing, to keep up with the latest trends towards online shopping, digitalization, and same- or next-day delivery. As can be seen in Figure 2.2, the take-up[4] rate for warehouses increased markedly since 2014, and is recently more prominent in the south of the country (Brabant province). For example, in 2022, bol.com has doubled the area of its fulfillment center in Waalwijk, Brabant.

[4] total floor space known to have been let or pre-let (planning/construction stage), sold or pre-sold to tenants or owner-occupiers

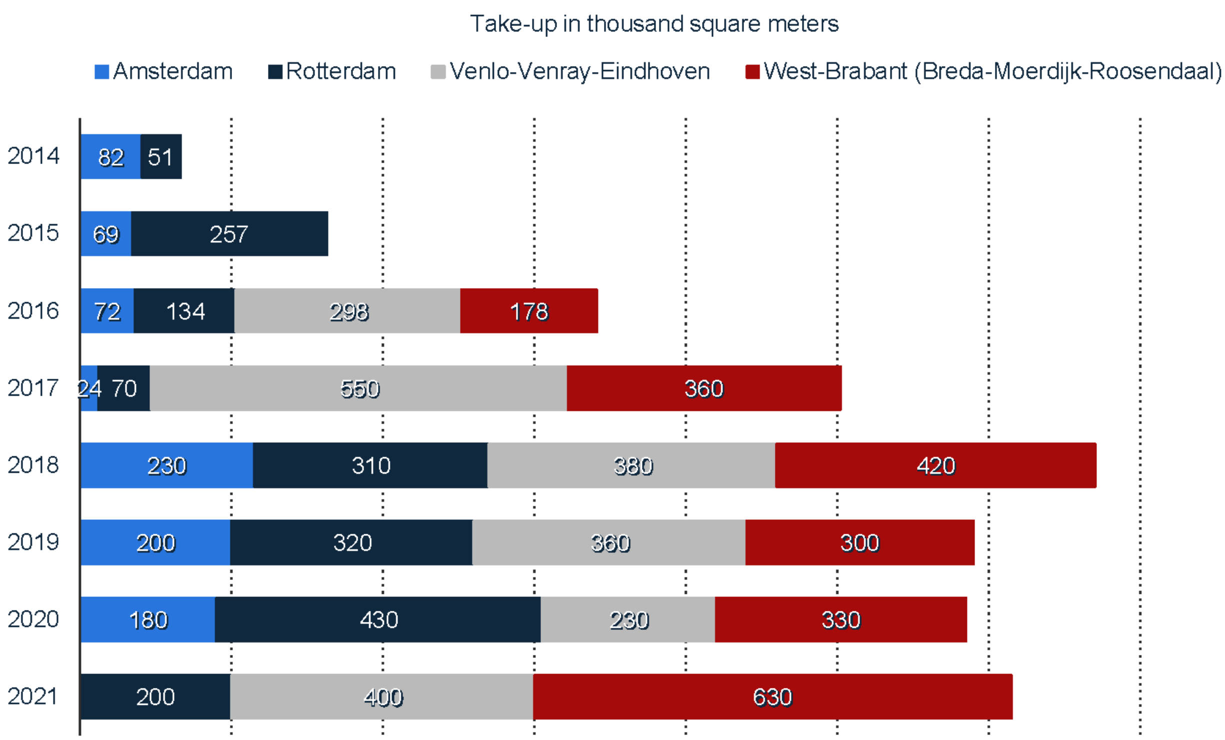

Figure 2.1: Dutch warehouse annual take-up rate in square meters.

Figure 2.2: Annual take-up rate for warehouses in the Netherlands from 2014 to 2021, by city (source: Statista).

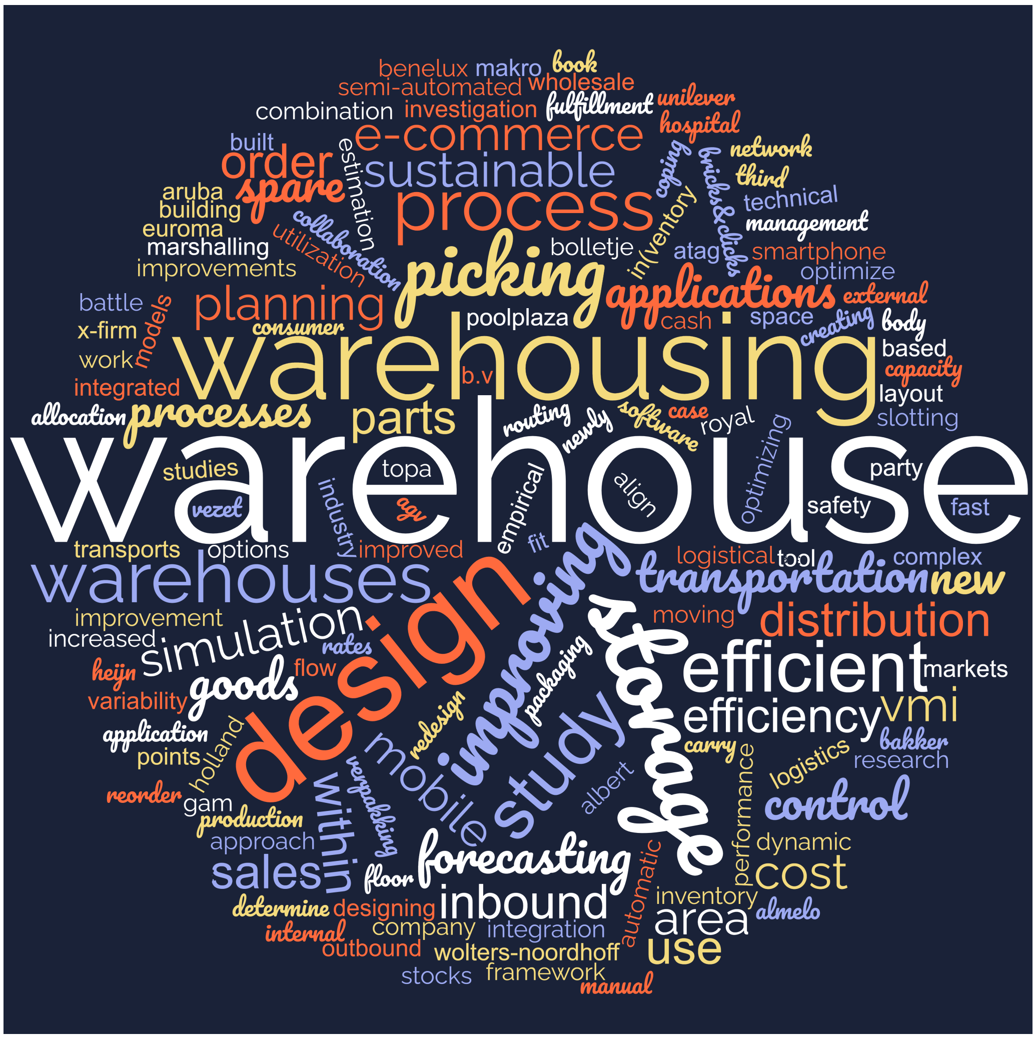

Figure 2.3: Word cloud produced using M-IEM theses titles. Research conducted within the program reflects the main literature topics (e.g., order-picking, design, storage).

2.3.3 M-IME theses on warehousing

- Beeldman, S. (2022). *Improving the internal warehouse logistics at Gam Bakker.*
- Berghuis, O. (2022). *Improving the outbound performance of a newly built semi-automated production and spare parts warehouse : A simulation study.*
- Kuipers, S.M. (2022). *Warehouse design for PoolPlaza.*
- Bergman, M.M.G. (2021). *Optimizing the transportation and external warehousing process of Euroma.*
- Rensen, J.J. (2021). *How to align storage and order picking in the VMI warehouse.*
- Hulshof, S.R. (2019). *Creating a more efficient flow of goods within the warehouse, through the improvement of storage and order picking.*
- Jansen, W. (2019). *Efficient Routing and Planning within the Complex Logistical Network : Based on the Integration of a New Warehouse, AGV Transports and Increased Transportation Rates.*
- Nijenkamp, B. (2018). *Designing the inbound warehouse process.*
- Looman, J.H.A. (2017). *Mobile applications on the work floor : The use of mobile applications in fast moving consumer goods warehouses.*
- Pieterse, R.G.M.G. (2017). *The use of a marshalling area in the warehouses of Albert Heijn.*
- Schutte, M. (2017). *Inventory)control of spare parts at the warehouse of the TD of Bolletje Almelo.*
- Vreriks, S.F. (2017). *New Integrated Warehouse Design Framework And its application at ATAG Benelux BV on the redesign of the distribution warehouse.*
- Wentzel, S.J. (2017). *Improving warehouse layout design : A study to optimize the warehouse of the hospital of Aruba.*
- Bijl, T. (2016). *Warehouse cost estimation.*
- Brummelhuis, Bob (2016). *Coping with Variability: Improving the Inbound Process of the VMI Holland Warehouse.*
- Land, G. (2015). *Forecasting the sales for Body & Fit : Automatic sales forecasting to determine the safety stocks and reorder points in an e-commerce warehouse.*
- Lugtig, J. (2015). *Improving warehousing control at Royal Vezet B.V. : A simulation study on dynamic warehouse processes.*
- Padmoes, T. (2014). *Improving storage cost allocation & warehouse space utilization at a third party warehouse.*
- Puspasari, K. (2014). *An Approach to Capacity Planning of Distribution Warehouses for X-Firm.*
- Reiche, P.J.J. (2014). *The combination of 'Bricks&Clicks': An investigation into warehousing efficiency improvements for the E-Commerce fulfillment processes at Makro Cash & Carry.*
- Mulder, S. (2013). *Sustainable warehousing; An empirical research at Unilever on building options and collaboration models in sustainable warehousing.*
- van Eijndhoven, F. (2012). *Inventory management of the technical warehouse.*
- Martens, J. K. J. (2005). *Smartphone software markets: The battle in case studies.*
- Stouwdam, G. (2010). *Warehouse efficiency at Topa verpakking.*
- Veldman, F.H.J. (2009). *Warehouse design for a wholesale company in the packaging industry.*
- Ruijter, H. de (2007). *Improved storage in a book warehouse : Design of an efficient tool for slotting the manual picking area at Wolters-Noordhoff.*

2.4 Institutional alignment

3. An explanation on how the education design fulfils the rules, institutional regulations and educational vision of the University or faculty.

Here you can refer to (for example) :

https://www.utwente.nl/en/tom/why-tom/

https://www.utwente.nl/en/ces/celt/toolboxes/student-driven-learning/

https://www.utwente.nl/en/organisation/about/shaping2030/

Also… are there any departmental or group regulations that are unique to your context? Share them.

2.4.1 Regulations

2.4.2 Educational vision

2.5 Aligning learning outcomes to MSc level

4. The level of the intended learning outcomes is appropriate to the place of the course in the program.

Write a short paragraph explaining Blooms Taxonomy. Then explain how you considered Blooms taxonomy when articulating your course's learning objectives.

https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

And how you were careful to make sure he levels were appropriate for your students (i.e. lower levels on pyramid for novices, higher up for M students).

Chapter 3

Teaching design and constructive alignment

3.1 Course redesign

Here, refer to your situation in the course. Maybe you inherited an outdated model, maybe you had bad feedback from SEQ. Tell us the reasons you identified a need to change, then tell what you changed and the intended effect it had. Reflect a bit on how you feel about the changes (are you proud etc?) Maybe make a table, show old vs. new parts and why they are better?

Look up the ADDIE cycle – you probably used something similar –

https://www.learnupon.com/blog/addie-5-steps/

Break down these step and explain your process fully.

3.2 Intended Learning Outcomes (ILOs)

After successful completion of the course, the student is able to:

1. Explain the role of warehousing in supply chains and identify warehouse types, functions, and operations.
2. Discuss major planning, design, management, and control decisions in contemporary warehouses.
3. Discuss storage and material handling objectives, principles, and technology.
4. Discuss emerging warehousing challenges, trends, and innovations.
5. Implement quantitative methods to optimize distribution networks and warehouses' design, management, and operations.
6. Analyze relevant data and evaluate performance metrics to support decision-making in a warehousing environment.
7. Synthesize and critically evaluate relevant warehousing research and literature to inform best practices.

3.3 Aligning modes of instruction and assessments to ILOs

How assignments, modes of instruction and assessments are related to the intended learning outcomes, and demonstrates that the intended learning outcomes are fully covered in a valid and reliable manner.

Constructive alignment is an educational approach that involves aligning learning outcomes, teaching methods, and assessment practices to ensure that students achieve the intended goals of a course. According to Biggs and

Tang (2011), it is imperative for learning because it helps to create a clear and focused learning experience for students by linking all aspects of the educational process, from the desired learning outcomes to the evaluation of student achievement. This helps to ensure that students have a clear understanding of what they are expected to learn and how their progress will be assessed, and it enables teachers to design more effective and engaging learning experiences.

Following Bloom's taxonomy, Section 3.2 presents the ILOs in an ascending level of complexity regarding order thinking skills. In summary, students are expected to be able to discuss relevant topics in the context of warehousing to support decision-making, apply quantitative optimization methods, analyze operational data to evaluate performance, and synthesize research to derive best practices.

Since assuming a direct correspondence between Bloom's Taxonomy action verbs and learning outcomes' complexity may be misleading (see Newton, Da Silva, and Peters (2020)), for clarity, Table Table 3.1 maps ILOs to assessment types, giving meaning to the outcome and determining its usefulness in the context of the course.

Table 3.1: Learning activities and assessment associated to ILOs.

Intended Learning Outcome	Importance	Quiz (15%)	Individual report (15%)	Group assignment (20%)	Exam (50%)	Learning activity
1. Explain the role of warehousing in supply chains and identify warehouse types, functions, and operations.	5%					Case studies, lectures, reading materials, think-pair-share, summarize
2. Discuss major planning, design, management, and control decisions in contemporary warehouses.	15%					Case studies, lectures, reading materials, think-pair-share, summarize
3. Discuss storage and material handling objectives, principles, and technology.	5%					Case studies, lectures, reading materials, think-pair-share, summarize
4. Discuss emerging warehousing challenges, trends, and innovations.	5%					Case studies, lectures, reading materials, think-pair-share, summarize
5. Implement quantitative methods to optimize distribution networks and warehouses' design, management, and operations.	40%					Case studies, lectures, calculate, problem-solving tasks, short answers, questionnaires
6. Analyze relevant data and evaluate performance metrics to support decision-making in a warehousing environment.	20%					Case studies, lectures, calculate, problem-solving tasks, short answers, questionnaires
7. Synthesize and critically evaluate relevant warehousing research and literature to inform best practices.	10%					Case studies, report, review paper, summarize

Chapter 4

Designing learning methods and materials

4.1 Activating instructional methods and assignments

A variation of activating instructional methods and assignments in the course that enable and support the student to reach the desired learning outcomes.

Here describe different methods of activating you use, for e.g. Asking open questions, thought provoking questions, using talk partners, embedding tech like wooclap polls/quiz in lessons, using short practise tasks to elicit performance etc.

You can refer to Gagnés events?

https://www.niu.edu/citl/resources/guides/instructional-guide/gagnes-nine-events-of-instruction.shtml

4.2 Guiding students through learning activities

An explanation of how the teacher provides guidance for students to give direction to their learning activities.

Describe how you guide learning in and out of the class. Formative assessment? Scaffolding in class? Clarifications on canvas?

4.3 Hybrid education

An argued blend of face-to-face teaching and digitally enhanced or online learning

Reflect a bit on how Covid changed things and what you'd like to keep from this experience.

Hybrid education is very much a hot topic – maybe mention if this is a good option for you? Tell us about how you can make it work and how it can be a benefit for you, the students and the UT.

https://www.utwente.nl/en/telt/online-lectures/Hybrid-education/

Chapter 5

Finetuning teaching design to students

5.1 Student entry level

The **Warehousing** course happens every Q4 of the M-IEM program (see the recommended course schedules). Therefore, students of the *Manufacturing Logistics (ML)* orientation within the *Production and Logistics Management (PLM)* specialization starting either in February (Q3) or September (Q1) will have already be familiar with the course pre-requisites, namely:

- *Elementary computer programming:* if-then-else statements, for/while loops, local/global variables, functions, and procedures. (part of IEMs' BSc and Pre-MSc program.)
- *Operations research techniques:* Mathematical programming/model formulation. (covered during Q1 or Q3 by the *Operations Research techniques I* of the M-IEMs program.)

Additionally, knowledge of handling and processing data is helpful in completing the assignments. Therefore, students starting the MSc program in Q4 would have already attended the *Data Science* course (lectured in Q2), having an edge on students starting on Q3. In order to make up for this knowledge gap, assignments are adequately scaffolded such that only the warehousing-related topics require work.

5.2 Student background

An explanation on how the diversity of backgrounds and the needs (e.g. culture, functional impairment, learning preferences) of the students is taken into account in the course design (e.g. in the modes of instruction, selected study materials/literature, composition of project teams, explicitness of expectations).

- Here, tell us about the variety of nationalities for example (in your class) and how you take care to make sure to consider cultural differences like some cultures not questioning teachers – therefore you set expectations early to encourage desired behaviour. Or, you ensure project groups are mixed so that all students get a multicultural perspective in their teamwork etc.
- Tell us how you consider your unique contextual situation and how you have adapted your course to best facilitate learning for the varied audience.
- Have a look into UDL and see if you can mention something about this. (https://teaching.cornell.edu/teaching-resources/designing-your-course/universal-design-learning#:~:text=Universal%20design%20for%20learning%20(UDL,hurdles%20in%20the%20learning%20process.)

5.3 Student development: independent learning and self-reflection

An explanation on how students are stimulated to develop themselves as independent learners / stimulated to think actively for themselves and develop critical self-reflection.

- Independent learning is when pupils set goals, monitor and evaluate their own academic development, so that they can manage their own motivation towards learning – how do you do this? Or how would you like to do this? Nice examples below: https://blog.irisconnect.com/uk/blog/9-tips-for-encouraging-students-to-become-independent-learners/
- Critical self-reflection refers to the process of questioning one's own assumptions, presuppositions, and meaning perspectives (Mezirow, 2006). How do you do this? Nice examples below: https://www.enhancementthemes.ac.uk/docs/ethemes/student-transitions/critical-self-reflection.pdf (see practical strategies)

Chapter 6

Practical and logistically feasible teaching design

6.1 Course practical details

Name: Warehousing **Level:** Master of Science **Faculty:** Behavioural, Management and Social Sciences (BMS) **Module:** 191820120 (see on Osiris) **Credits (ECTS):** 5

6.1.1 Teaching team

Lecturers

- Breno Alves Beirigo (b.alvesbeirigo@utwente.nl)
- Derya Demirtas (d.demirtas@utwente.nl)
- Lin Xie (l.xie@utwente.nl)

Student assistant

- Josien Mourik (j.b.mourik@student.utwente.nl)

6.1.2 Aims

This course aims to introduce the fundamental concepts and techniques for designing, managing, and operating contemporary warehouses.

6.1.3 Learning outcomes

After successful completion of the course, the student is able to:

1. Explain the role of warehousing in supply chains and identify warehouse types, functions, and operations.
2. Discuss major planning, design, management, and control decisions in contemporary warehouses.
3. Discuss storage and material handling objectives, principles, and technology.
4. Discuss emerging warehousing challenges, trends, and innovations.
5. Implement quantitative methods to optimize distribution networks and warehouses' design, management, and operations.
6. Analyze relevant data and evaluate performance metrics to support decision-making in a warehousing environment.
7. Synthesize and critically evaluate relevant warehousing research and literature to inform best practices.

6.1.4 Assumed previous knowledge

- *Elementary computer programming:* If-then-else statements, for/while loops, local/global variables, functions, and procedures.
- *Operations research techniques:* Mathematical programming/model formulation.

6.1.5 Participating study

- MSc Mechanical Engineering
- MSc Industrial Engineering and Management

6.1.6 Study load (ECTS)

The Warehousing course has a total study load of **5 ECTS**[1] (140h). Table 6.1 shows the estimated study load per activity (see reasoning behind estimates and workload estimator).

Table 6.1: Warehousing course study load.

Activity	Number	Duration (h)	Workload (h)
Lectures + Q&A	21	2	40
Practicals	10	2	20
Assignments	4	6	24
Required literature (slides, articles, book excerpts)	150 pages	5–10 pages/hour	~16[2]
Quizzes (preparation)	4	6	24
Written report	1	12[3]	12
Final Exam	1	3	3
		Total	**140**

6.1.7 Assessment

The assessment consists of four main activities:

- Individual report (15%)
- Group assignments (20%)
- Quizzes (15%)
- Final exam (50%)

The relative importance of each learning objective can be found in Table 3.1.

> **!** Students who followed the course last year do not need attend quizzes and assignments. Grades will be carried on.

6.1.7.1 Individual report (15%)

Each student is expected to write a 1000-word report (in the style of a blog post) on the warehousing operations of a company in the Netherlands. Companies will be initially assigned to students but they can change their target company later, provided that it does not coincide with other students' companies.

[1] ECTS: European Credit Transfer System. One ECTS is equal to 28 hours of study.
[2] 7 pages/hour (Page Density: 750 words/page, Purpose: Engage(1/3)/Survey(2/3), Difficulty: Many New Concepts).
[3] 500 words of genre "Research" equal on average 6 hours per page.

The final grade comprises two main parts.

6.1.7.1.1 * Part I - Research (10%)

Students will be asked to provide specific details on several aspects of their target company warehousing operations (e.g., location, industry type, distribution strategy, material handling system). These details must be referenced accordingly (e.g., company website, articles, books).

> If information on a certain warehousing category can not be found, students may consider the information of the "best-in-class" company in the same industry.

6.1.7.1.2 * Part II - Report (5%)

Using the information gathered in part 1, students should write a 1000-word report on the warehousing activities of their target company following a template provided by the teacher.

6.1.7.2 Group assignments (20%)

There are four group assignments (max. 3 students), each accounting for 5% of the final grade. Assignments aim at exercising the quantitative nature of the course main modules. Table 6.1 shows the assignments' estimated workload (viz., 6 hours per student).

> The practicals will be focused primarily on providing assistance to solve assignments' questions.

6.1.7.3 Quizzes (15%)

There are four 10-question multiple-choice quiz exams. Quizzes consist of three steps:

1. **Individual quiz-exam (20 min):** Each student work on quiz-questions individually.
2. **Team formation (5 min):** Students are (randomly) grouped in teams (5-7 students).
3. **Team discussion (25 min):** Each team considers the same questions again, negotiates the best alternative, and agrees on the final answer.

6.1.7.3.1 Grading policy

Quiz grades are calculated as the weighted sum of points earned individually and as a team:

$$\text{Quiz points} = 0.5 * \text{Individual points} + 0.5 * \text{Team points}.$$

Three out of the four quizzes will account for the final grade (the three highest outcomes will be considered). For example, in the example shown in Table 6.2, quiz 2 is eliminated, such that the final grade is 13.5 out of 15 quiz points.

Table 6.2: Example of grade calculation for quizzes. The highest three grades, namely, 1, 3, and 4 are used to compute final points.

# Quiz	Individual grade	team grade	Quiz grade	Points earned
1	10	10	10 (5 + 5)	5
~~2~~	~~5~~	~~7~~	~~6~~ (2.5 + 3.5)	*discarded*
3	8	8	8 (4 + 4)	4

# Quiz	Individual grade	team grade	Quiz grade	Points earned
4	7	3	7 (3.5 + 1.5)	3.5

! Students may miss a quiz: it will be automatically considered the lowest-grade quiz and not accounted in the final grade.

6.1.7.4 Final exam (50%)

The final exam covers the whole content of the course. It consists of a closed-book exam featuring multiple-choice questions and open questions.

6.1.8 Materials

Required

- John J. Bartholdi, & Steven T. Hackman. (2019). *Warehouse & Distribution Science*. (http://www.warehouse-science.com/).

Recommended

- Richards, G. (2021). *Warehouse management: The definitive guide to improving efficiency and minimizing costs in the modern warehouse* (Fourth edition). Kogan Page.
- Heragu, S. S. (2022). *Facilities design* (Fifth edition). CRC Press.
- Tompkins, J. A. (2010). *Facilities planning* (4th ed). J. Wiley.
- Ross, D. F. (2015). *Distribution Planning and Control: Managing in the Era of Supply Chain Management*. Springer US.
- Zijm, H., Klumpp, M., Regattieri, A., & Heragu, S. (Eds.). (2019). *Operations, Logistics and Supply Chain Management*. Springer International Publishing.
- Coyle, J. J., Langley, C. J., Novack, R. A., & Gibson, B. J. (2020). *Supply chain management: A logistics perspective* (11th edition). Cengage.
- Manzini, R. (Ed.). (2012). *Warehousing in the Global Supply Chain*. Springer London.
- Frazelle, E. (2016). *World-class warehousing and material handling* (Second Edition). McGraw-Hill Education.

6.1.9 Facilities

Lecture rooms are expected to feature blackboards and electric sockets and host 80-100 students (lectures, practicals) and 200 students (quizzes). The rooms for quizzes are required to be more spacious because students will work in groups to answer questions (see details on the quiz activity). More space allows adequate group separation and helps minimize cheating.

6.1.10 Course overview

The course spans ten weeks (see a weekly summary in Table 6.3). We are expected to have two 2-hour lectures (L) and one 2-hour practical (P) each week. The four quizzes will take place during lectures and will be hosted in more spacious lecture rooms.

Finally, we have two closing activities before the exam: the project presentations and a Q&A session.

Table 6.3: Warehousing (2023) course overview (*L = Lecture, T = Tutorial, A = Assessment, AS-N = Assignment N*).

Wk	Date & Time	Room	Type	Activity	Lecturer	Activity
17	Tue, Apr 24 10:45–12:30	SP 1	L	Syllabus/ Introduction	Breno	Report assignment online
	Tue, Apr 24 15:45–17:30	OH 113	L	Guest lecture 1 - Peter Schuur Read the on Facility Location	Breno, Peter S.	Read material on Facility Location
	Fri, Apr 24 13:45–15:30	SP 1	L	Distribution network design	Breno	
18	Tue, May 2 10:45–12:30	OH 218	L	Facility Location I	Derya	
	Tue, May 2 15:45–17:30	SP 1	L	Facility Location II AS-1 online	Derya	AS-1 online
	Thu, May 4 13:45–15:30	OH 218	T	Tutorial AS-1	TAs, Derya	
19	Tue, May 9 10:45–12:30	OH 218	A	*Quiz 1: Facility Location and Distribution Network Design*	TAs, Derya	
	Thu, May 11 13:45–15:30	SP 1	L	Warehouse performance optimization	Breno	
	Fri, May 12 10:45–12:30	SP 2	T	AS-1	TAs, Derya	AS-1 due
20	Tue, May 16 10:45–12:30	SP 1	L	Warehouse performance optimization	Breno	AS-2 online
	Tue, May 17 10:45–12:30	OH 218	T	AS-2	TAs, Breno	
		SP 1	L	Warehouse design: facility layout	TAs, Breno	
21	Tue, May 23 10:45–12:30	OH 218	L	Warehouse design: Unit-load warehouse layout	Breno	
	Wed, May 24 13:45–15:30	OH 211	P	Warehouse design: Unit-load warehouse layout	TAs, Breno	
	Thu, May 25 13:45–15:30	SP 1	L	*Quiz 2: Warehouse design*	TAs, Breno	AS-2 due
22	Tue, May 30 10:45–12:30	OH 218	L	Warehouse operation (storage): Inventory management	Breno	AS-3 online
	Wed, May 31 13:45–15:30	OH 211	L	Warehouse operation (storage): Slotting	Breno	

Wk	**Date & Time**	**Room**	**Type**	Activity	**Lecturer**	Activity
	Thu, Jun 1 13:45–15:30	SP 1	P	Warehouse operation (storage): Slotting	TAs, Breno	
23	Tue, Jun 6 10:45–12:30	OH 218	L	Warehouse operation (storage): Slotting	Breno	
	Wed, Jun 7 13:45–15:30	OH 211	A	*Quiz 3: Warehouse operation (storage)*	TAs, Breno	
	Wed, Jun 9 13:45–15:30	SP 1	L	Guest lecture 2 - Pieter Meints (Ahold Delhaize)	Breno	
	Fri, Jun 11, 17:00			Deliver AS-3		
24	Tue, Jun 13 10:45–12:30	OH 218	L	Warehouse operation (order-picking)	Lin	
	Wed, Jun 14 13:45–15:30	OH 211	L	Warehouse operation (order-picking)	Lin	
	Wed, Jun 15 13:45–15:30	SP 1	P	Warehouse operation (order-picking)	Lin	
25	Tue, Jun 20 10:45–12:30	OH 218		Warehouse operation (order-picking)	TAs, Lin	
	Wed, Jun 22 13:45–15:30	SP 1	A	*Quiz 4: Warehouse operation (order-picking)*	Breno	
	Wed, Jun 23 10:45–12:30	SP 1	L	Warehouse challenges, trends, and innovations	Breno	AS-4 due
26	Tue, Jun 27 8:45–11:45 (change to afternoon)		A	***Final exam***	TAs, Breno	
	Fri, Jun 30 17:00			Submit report		
27	TBD	TBD	A	***Resit***	TAs, Breno	

6.1.11 Content outline

Introduction

- History of warehouses
- Role of warehouses in supply chains
- Warehouse functions
- Warehouse classification and types
- Warehouse management systems (WMSs)
- Warehousing strategic, tactical, and operational planning decisions

Distribution network design

- *Distribution tradeoffs*
  - Ownership vs. Outsourcing (third-party logistics)
  - Centralized vs. decentralized

  - Number of facilities
- *Facility location*
  - Taxonomy of discrete location models (Daskin)
  - Median-based model formulation
  - Covering-based models' formulations and heuristic solutions

Warehouse performance evaluation

- Costs and trade-offs
- Performance metrics
- Activity profiling

Warehouse design

- Space requirement planning
- Facility layout problem
  - Quantitative/qualitative department relationship charts
  - Systematic layout procedure (SLP)
  - Mathematical formulation
- Unit-load warehouse layout
  - Aisle width optimization
  - Lane depth optimization

Warehouse operation

- *Receiving and put-away*
  - Cross-docking
- *Storage*
  - Inventory management
    - Safety stock and reorder levels
    - Economic order quantities (EOQs)
  - Pallet storage and handling systems
  - Zoning
  - SKU-department assignment
    - Fast-pick area design (fluid model)
  - Storage location assignment (slotting)
    - Storage policies (dedicated, random, class-based, etc.)
    - Cube-per-order index (COI)
- *Order-picking*
  - Order-picking systems
    - Case vs. broken-case picking systems
    - Robotized and automated systems (AGVs, RMF, AS/R)
  - Order picking schemes
    - Pick from primary (Batching, Zoning)
    - Pick from storage
  - Routing
    - Travelling salesman problem (TSP)
    - Routing in automated storage and retrieval (AS/R) systems
      - Travel time calculation (Chebyshev metric)
    - Routing in conventional warehouses
      - Ratliff & Rosenthal algorithm
      - Distance approximations for routing manual pickers (Hall algorithm)
- *Replenishment and shipping*
- *Support processes*
  - Inventory counting

  - Value-adding services
  - Reverse logistics

Warehouse challenges, trends, and innovations

- External change drivers
- The warehouse and the environment
- The warehouse of the future
  - Robotized and automated warehouses
  - Physical internet

6.1.12 Content sequencing

The content sequencing follows a modular structural logic, from external (distribution network design) to internal (warehouse design and operation) optimization problems arising on warehouse strategic, tactical, and operational planning levels. The following framework illustrates the interconnection between problems and main related sub-problems:

6.2 Teaching logistics

In the following sections, we describe the workload per activity of the educational team, which is comprised of three lecturers and three teaching assistants (TAs). Section 6.2.1 and Section 6.2.2 lay out the workload per activity and workload split of teachers and TAs, respectively.

Finally, Section 6.2.3 describes workload related to coordination activities.

> To estimate exam- and assignment-related activities, we assume the typical number of students (around **90**) enroll in the course. Additionally, we group the workload of administrative- and communication-related activities per week, such that these are always multiplied by **10** (the course duration in weeks).

6.2.1 Teaching workload

Table 6.4 shows the breakdown of the teacher workload per activity. Activities are grouped into five main clusters:

- Lecture
- Group assignment
- Quiz
- Exam
- Admin/Communication

Table 6.4: Teaching workload split per activity.

Activity cluster	Activity	Number	Duration (h)	Workload (h)
Lecture	Give lecture	20	2	40
	Prepare lecture materials	20	10	200
	Organize guest lecture	3	4	12
Group assignment	Design assignment	4	10	40
	Prepare for tutorial	8	1	8
	Conduct tutorial	8	2	16

Activity cluster	Activity	Number	Duration (h)	Workload (h)
Quiz	Design quiz	4	5	20
	Prepare for quiz	4	1	4
	Administer quiz	4	2	8
Exam	Design exam	2	15	30
	Create answer model	2	6	12
	Administer exam	2	2	4
	Review exam	2	4	8
Report	Design report assignment	1	10	10
	Grade report	90	0.1	9
Admin/Communication	Manage Canvas	10	1	10
	Answer student questions	10	2	20
			Total	459

In Figure 6.2, it can be seen that activities related to lecturing occupy most of the teacher time.

However, this prominence of lecturing-related activities is temporary: once the course is run for the second time, the prepared material can be re-used.

6.2.2 Teaching assistant (TA) workload

Table 6.5 shows the breakdown of the teaching assistance workload. To estimate exam- and assignment-related activities, we assume the typical number of students (around 90) enroll in the course. In total, we expect to request a maximum of **169 TA hours**, which will be divided among three TAs.

Table 6.5: Expected teaching assistant workload.

Activity	Number	Duration (h)	Workload (h)
Assist in practical lesson (in class)	8	2	16
Prepare for practical	8	2	16
Assist in quiz evaluation (in class)	4	2	8
Process quiz results	4	1	4
Grade assignment	120[4]	0.5	60
Answer assignment-related questions	10	1	10
Grade exam	90	0.5	45
Manage Canvas, buffer	10	1	10
		Total	**169**

Activities are divided according to TA's availability and aptitude (previous performance in the course). Table 6.6 shows the workload split among the three TAs.

In summary:

[4] Assignments are carried out by groups of 3 students, thus 4 assignments × 30 groups = 120

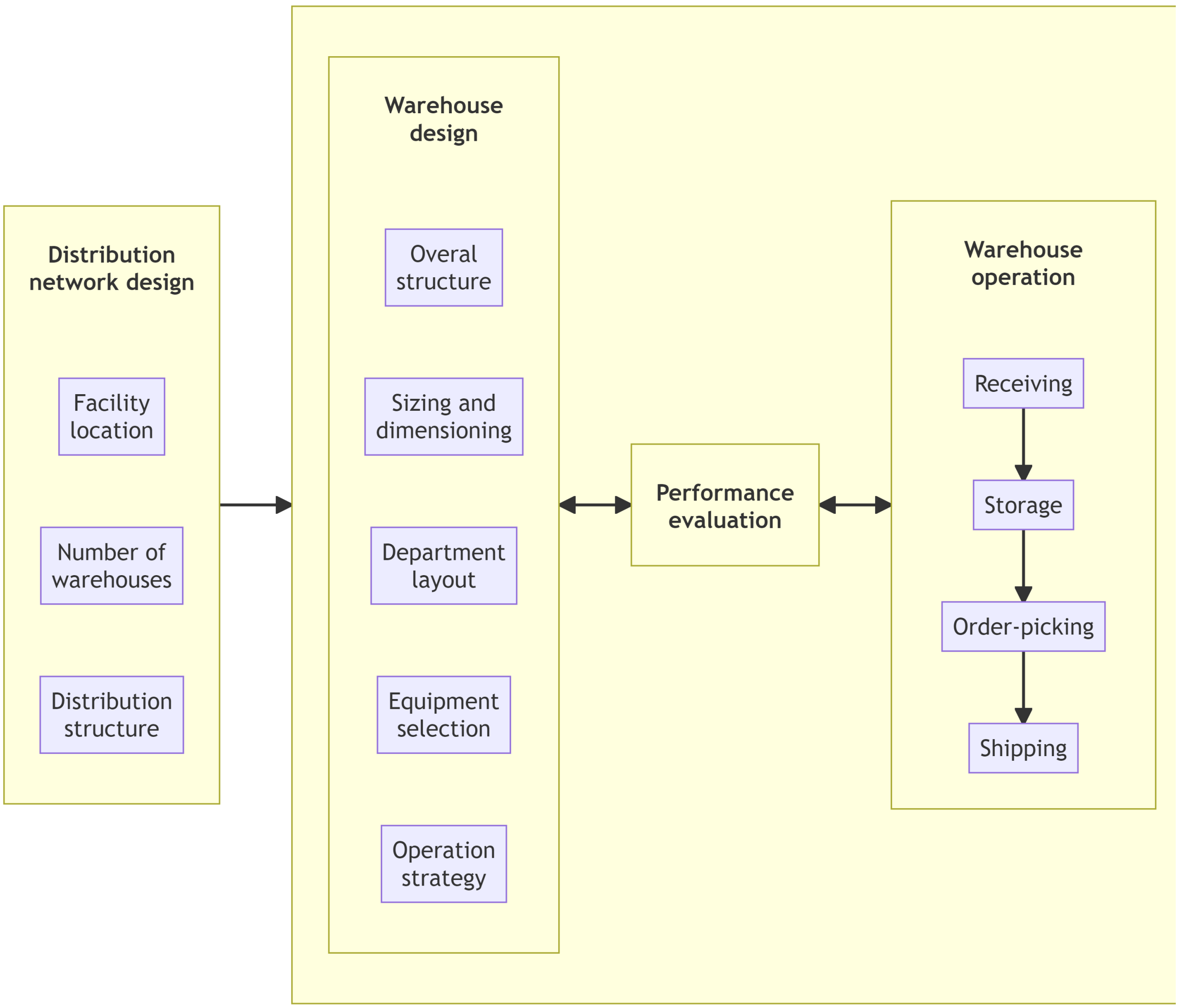

Figure 6.1: Warehousing course content sequencing.

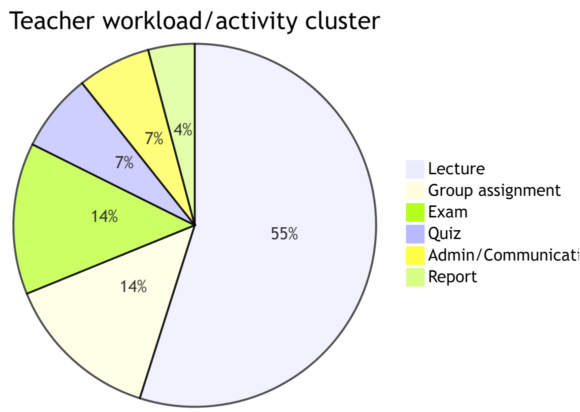

Figure 6.2: Activities related to lecturing feature the highest workload.

- **TA 1** assists in 2 practicals, grades 1 assignment, and grades the exams.
- **TA 2** assists in 6 practicals and grades 3 assignments.
- **TA 3** Assists in all quizzes and manages Canvas.

Table 6.6: Expected workload per TA.

Activity	TA 1 (h)	TA 2 (h)	TA 3 (h)
Assist in practical lesson (in class)	4	12	
Prepare for practical	4	12	
Assist in quiz evaluation (in class)			8
Process quiz results			4
Grade assignment	15	45	
Answer assignment-related questions	3	7	
Grade exam	45		
Manage Canvas, buffer			10
Total	71	76	22

6.2.3 Coordination workload

References

Newton, Philip M., Ana Da Silva, and Lee George Peters. 2020. "A Pragmatic Master List of Action Verbs for Bloom's Taxonomy." *Frontiers in Education* 5. https://www.frontiersin.org/articles/10.3389/feduc.2020.00107.

Part II

Appendices

Chapter 7

M-IEM ILOs

The ILOs of the M-IEM programme correspond to the requirements formulated by comparable programmes in the Netherlands and abroad, and by professional practice. We distinguish two groups of competences: *domain-specific* (Section 7.1) and *general competences* (Section 7.2).

7.1 Professional Academic Qualifications MSc

The graduate is able to quickly identify, thoroughly comprehend, critically assess, correctly apply, and creatively integrate existing scientific knowledge that can be used for analysing problems and designing solutions, in one of the domains of:

- Production and logistics;
- Finance and accounting;
- Health care.

A1) Apply research & design processes

The student has a thorough overview of the **structure of research and design** processes. The student is able to:

- Identify the various steps in performed research and design.
- Properly break up own research and design activities into sub-processes.

These processes are intertwined: Research is needed for producing knowledge that is used for designing solutions in a specific context. Such knowledge is produced in a purposeful and methodical way (using scientific research methods). It may or may not be generalizable knowledge.

A2) Evaluate research & design processes

The student has an overview of quantitative and qualitative **empirical research methods**. The student is able to:

- Critically analyse performed research as to the methodological aspects.
- Select an appropriate method and justify this choice for research to be performed.
- Apply this method in relatively complex cases.

A3) Model operational processes quantitatively

The student has a thorough overview of **quantitative modelling techniques** for operational processes in this domain. The student is able to:

- Select appropriate modelling techniques and justify this choice.
- Apply these techniques in relatively complex cases.
- Critically analyse the results of modelling activities.

A4) Leverage existing knowledge in concrete cases

Is able to **integrate** existing knowledge, modelling techniques, and research results for designing, validating, and selecting solutions in relatively complex cases. This is challenging, because existing knowledge may not fully apply to a specific situation, models are always stylized, empirical research always has limitations, and some aspects have been left out of scope from the beginning anyway.

A5) Plan implementation methods and processes

The student has an overview of **implementation methods and processes**. The student is able to:

- Critically analyse ongoing or finished implementation processes.
- Plan globally an implementation process in a relatively complex case.

A6) Evaluate solution strategies' performance

The student has an overview of **evaluation methods and techniques**. The student is able to:

- Critically analyse the results of performed evaluations.
- Select appropriate evaluation methods and justify this choice.
- Carry out an evaluation in relatively complex cases.

A7) Demonstrate mastery of M-IEM's core disciplines

In order to be able to meet these competencies, the graduate must have **mastered** a set of **core disciplines** in the specialisation domain.

A8) Contribute to academic development

The student is able to **contribute** to the development of the academic profession by identifying generic consequences and implications from professional cases (for example, general presentations, write papers about design solutions).

7.2 General Academic Qualifications MSc

The general competences have a specific operationalisation: reflection, working in (multidisciplinary) teams, the preparation of students lifelong learning, ethics and philosophy of science, and Corporate Social Responsibility.

B1) The student is able to work autonomously and is self-reliant

The student:

- Is able to work on complex assignments and conduct research projects without clear boundaries
- Can apply effective time management and is self-reinforcing

B2) The student is able to work in multidisciplinary teams

The student:

- Can form a team to work with based on what is required for the project or assignment
- Understands decision-making techniques and how to effectively organise meetings
- Can effectively make use of a supervisor and organise feedback

B3) The student is able to communicate properly (in oral and written form) with various stakeholders from different backgrounds

The student:

- Can write an academic text, based on clear questions or hypotheses.
- Is capable of designing, conducting and digesting interviews and other means of oral input and can identify argumentation fallacies and the like
- Is able to organise the preconditions for co-production of knowledge and interaction
- Can balance appropriate body language, content, and the use of audio-visual means on the basis of a good understanding of the audience

B4) The student is able to conduct a bibliographic search and knows how to reference correctly

The student:

- Can select and judge relevant scientific literature for projects and exams and has a pro-active attitude regarding acquiring and updating knowledge
- Is able to properly use quotation and paraphrases and compile a relevant reference lists in APA-style

B5) The student is able to reflect on ethical and societal aspects of the IEM domain and work field

The student:

- Can reflect on his behaviour in a professional context
- Can detect General Data Protection Regulation and confidentiality issues and analyse ethical implications of using research methods and technologies

B6) The student is able to reflect on and direct personal and professional behaviour and development

The student:

- The student is able to manage and concretize his own learning process in the context of "lifelong learning"
- Can create an innovative learning portfolio by selecting and describing learning and development goals he wants to pursue

B7) Has sufficient knowledge and competencies to pursue a PhD or PDEng, and work in the IEM domain