

Turning learning data into meaningful Learning Analytics Dashboards

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Preface

“Non scholae, sed vitae discimus.”

We do not learn for school, but for life.

— Seneca, *Epistulae Morales ad Lucilium*, Letter 106

With this thesis, I conclude my studies in the Master of Applied Computer Science at KU Leuven. Yet, this is not the end of my learning journey—rather, it marks a new beginning. Information technology is, much like music, one of my greatest passions. It is more than a skill to be mastered; it is a creative process in which I can fully immerse myself, often losing track of time as I solve problems, build systems, or bring ideas to life.

Throughout this process, I have had the privilege of being surrounded by people who challenged and supported me in equal measure. I am especially grateful to Dr. ir. R. De Croon for his expert guidance, support, and coaching. It has truly been a pleasure to learn from you. I also want to sincerely thank my promotor, Prof. dr. K. Verbert, for offering me this opportunity and for the valuable learning moments along the way.

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Jonas Van Hove

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Abstract

As Flemish secondary schools increasingly adopt competency-based education (CBE), teachers face growing challenges in interpreting and acting on student data. This thesis explores how a learning analytics dashboard (LAD) can support teachers during class council meetings, where critical decisions about student progress and support are made.

Based on a participatory design approach, a proof-of-concept dashboard named CLAIRE was developed through multiple co-design sessions with teachers. The dashboard integrates key features of the Flemish competency framework and is built to work with Moodle, the learning platform used in the partner school. The design process focused on visual clarity, usability, and relevance for everyday teaching practice.

Teacher feedback emphasized the need for actionable insights, intuitive interface elements, and support for tracking student progress at multiple levels. While artificial intelligence was explored as a future extension, the final prototype prioritizes the clarity and interpretability of learning data.

Qualitative evaluation showed that teachers found the visual overview particularly useful and appreciated the clear structure of competencies per subject. Prototype iterations revealed the importance of minimal input, progress visualizations, and flexible filtering options to support meaningful daily use. The design of CLAIRE was well received during a school-based feedback session, with teachers recognizing its potential to simplify and support student data analysis.

This work contributes to the development of teacher-centered learning analytics tools and provides practical design guidelines to support data-informed decision-making in CBE settings.

Samenvatting

Competentiegericht onderwijs (CBE) wordt steeds vaker toegepast in het Vlaams secundair onderwijs. Voor leerkrachten brengt dit uitdagingen met zich mee bij het interpreteren van leerlinggegevens en het nemen van gepaste acties. Deze masterproef onderzoekt hoe een learning analytics dashboard (LAD) leerkrachten kan ondersteunen tijdens klassenraden, waar belangrijke beslissingen over leerlingen genomen worden.

Via een participatief ontwerpproces werd CLAIRE ontwikkeld, een proof-of-concept dashboard. Dit dashboard sluit aan bij het Vlaamse competentiekader en is technisch geïntegreerd met Moodle, het leerplatform van de partnerschool. Het ontwerp richtte zich op gebruiksvriendelijkheid, visuele helderheid en praktische toepasbaarheid in het dagelijkse lesgebeuren.

Feedback van leerkrachten wees op de nood aan duidelijke inzichten, intuïtieve interfaces en ondersteuning bij het opvolgen van leertrajecten op verschillende niveaus. Hoewel artificiële intelligentie werd verkend als mogelijke uitbreiding, ligt de focus in het uiteindelijke prototype op begrijpelijke en bruikbare visualisaties van leerdata.

Kwalitatieve evaluatie toonde aan dat leerkrachten het visuele overzicht erg nuttig vonden en de duidelijke structuur van competenties per vakgebied sterk waardeerden. Iteratieve prototyping bracht het belang aan het licht van minimale manuele input, voortgangvisualisaties en flexibele filters die aansluiten bij de dagelijkse praktijk. Tijdens een feedbacksessie op school werd het ontwerp van CLAIRE positief onthaald; leerkrachten gaven aan dat het dashboard het analyseren van leerlinggegevens aanzienlijk vereenvoudigt.

Deze thesis levert een bijdrage aan het ontwerpen van gebruiksvriendelijke dashboards voor leerkrachten en biedt concrete richtlijnen voor datagedreven besluitvorming binnen CBE-contexten.

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List of Abbreviations

AI	Artificial Intelligence
CBE	Competency-Based Education
CLAIRE	Competency Learning Analytics for Insights and Reflection in Education
EQF	European Qualifications Framework
HCI	Human-Computer Interaction
LA	Learning Analytics
LAD	Learning Analytics Dashboards
LISSA	Learning dashboard for Insights and Support during Study Advice
LLM	Large Language Model
LMS	Learning Management Systems
LTI	Learning Tools Interoperability
POC	Proof of Concept

Chapter 1

Introduction

In recent years, a growing number of secondary schools in Flanders have started to explore the implementation of Competency-Based Education (CBE). This approach shifts the focus from traditional grades to the assessment of clearly defined, subject-specific competencies. While promising, this transition introduces practical challenges for teachers, particularly in interpreting and acting on student data.

One of the key challenges teachers face in a CBE system is the interpretation of student data. To make informed decisions about student progress and support needs, teachers require accessible and structured overviews of each learner’s development across multiple competencies. This need arises not only during formal decision-making moments such as class councils, but also in everyday teaching practice—when planning lessons, giving feedback, or identifying students who are falling behind.

Currently, many teachers lack effective tools to support this kind of continuous data-informed monitoring [50]. The available systems often fail to present student information in a way that is both pedagogically meaningful and practically usable. For example, at the partner school, teachers use printed Excel sheets to track student performance. These sheets show daily work and exam scores per subject in plain black-and-white tables, without any color-coding, summaries, or visual elements to support interpretation. This results in an overly dry and fragmented view of student progress that makes it difficult to identify patterns or spot students at risk.

This thesis explores how a learning analytics dashboard (LAD) can be designed to help secondary school teachers more effectively interpret and respond to student data in a CBE context. The research specifically explores how the Flemish competency framework can be integrated into a dashboard that aligns with the digital learning environment used by the partner school. Rather than starting from a purely data-driven approach, this research adopts a co-design perspective, involving teachers throughout the process to ensure the tool responds to authentic classroom realities.

This thesis is guided by the following initial research question:

What design features should a dashboard have to effectively support secondary school teachers in interpreting competency-based student data?

To explore this question in depth, two sub-questions are formulated:

1. *What are the informational and functional needs of secondary school teachers during class councils when interpreting competency-based student data?*
2. *How can key student data be visualized to enhance clarity, accessibility, and actionable insights for teachers?*

The structure of this thesis is as follows:

Chapter 2 provides an overview of the current literature on learning analytics, dashboard design, and the use of CBE in secondary education.

Chapter 3 outlines the research trajectory, starting from an initial data-driven plan that evolved into a co-design-based development process in collaboration with teachers.

Chapter 4 presents the final dashboard design and evaluation, emphasizing which elements teachers found most helpful during class council simulations.

Chapter 5 details the technical implementation of the dashboard, including its integration with Moodle and the rationale behind key interface decisions.

Chapter 6 reflects on the broader implications of the work, lessons learned, and potential directions for future development.

Chapter 7 summarizes the thesis's main contributions and discusses its relevance in the context of Flemish secondary education.

1.1 Use of AI tools

While writing this master's thesis, I used ChatGPT (developed by OpenAI) and Grammarly (developed by Grammarly Inc.) as writing assistants. These tools helped improve sentence structure, phrasing, and clarity of complex ideas.

I used GitHub Copilot (developed by GitHub and OpenAI) to assist with code completion and syntax suggestions, especially during development. The generated code was carefully checked, adjusted to fit the context, and tested to make sure it was correct and easy to maintain.

In addition, selected visual elements in this thesis were created using image generation models such as GPT-4o and DALL·E, accessed via Microsoft Copilot [44]. These images are clearly marked and cited.

Their use complied with KU Leuven's guidelines on the responsible use of AI in education.¹ I remained fully responsible for the content, reasoning, and scientific quality of this work. No parts of the thesis were generated or copied without thorough critical review and revision.

¹<https://www.kuleuven.be/onderwijs/student/onderwijstools/artificiele-intelligentie>

Chapter 2

Literature study

To address the research problem, it is important to first examine the relevant literature. This chapter outlines the key concepts, insights, and challenges that define the field, with a particular focus on how learning analytics (LA) can support secondary school teachers in making informed decisions to benefit their students.

The chapter starts in Section 2.1 by exploring the growing importance of data-driven decision-making in education, focusing on secondary education. Section 2.3 examines the current state of LA tools for secondary schools, discussing their features and potential benefits for teachers. In Section 2.4, the focus shifts to the design principles for Learning Analytics Dashboards (LAD), emphasizing user-centered design and effective data visualization. Section 2.5 identifies important gaps in existing research on LADs, highlighting where further work is needed. Finally, Section 2.6 presents the research questions of this thesis and links them to the identified gaps. These questions aim to contribute to academic discussion and address real-world needs in education.

2.1 Data-driven decision-making in education

The COVID-19 pandemic forced secondary schools in Flanders to quickly switch to online learning in spring 2020 [37]. Later, a blended learning model was introduced that combines online and in-person classes [59]. This sudden change sparked larger discussions about the future of digital education. While blended learning has potential, its implementation comes with challenges [59]. The pandemic sped up the use of digital tools in Flemish secondary schools, encouraging deeper exploration of how technology can improve teaching and learning [59].

Learning analytics can help improve teaching by using student data, which is being generated daily as schools become more digital [1]. When analyzed properly, this data offers valuable insights to enhance both teaching and student outcomes [57]. However, while LA is common in higher education, it is not yet widely used in secondary schools [59]. Teachers in these schools face challenges such as limited time for data analysis, diverse student needs, and a lack of tools that fit their teaching styles (Figure 2.1)¹. This thesis aims to bridge the gap between the potential of LA and its practical application in secondary education, helping teachers make data-driven decisions to improve their teaching and support student success.

¹The image was generated with OpenAI's ChatGPT [43].



Figure 2.1: Conceptual illustration of a teacher reviewing a learning analytics dashboard with numeric and competency data. This image was generated with ChatGPT.

2.2 Competency-based education

In traditional education, students are often graded based on numerical scores, like a test grade out of 10 or 20. However, this system does not always measure the discrete skills and competences students need to succeed in their careers [50]. An alternative approach is Competency-Based Education (CBE), where students are assessed based on their ability to achieve specific skills, rather than grades [11]. Because CBE defines clear, measurable competencies, it generates fine-grained data on individual students' mastery levels. Learning analytics can leverage this competency data to provide actionable insights, such as visualizing progress trajectories and identifying skill-gaps early. For example, a dashboard might display each student's proficiency across core competencies in real time, enabling teachers to target interventions precisely where they are needed. By combining CBE's structured skill assessments with data-driven dashboards, teachers gain both the qualitative clarity of competencies and the quantitative rigor of learning analytics.

CBE has become increasingly popular recently, especially in fields such as healthcare and pharmacy. According to Rhoney et al. [50], CBE is a promising way to better prepare students for the challenges of their future careers, as it helps them develop not only knowledge but also problem-solving skills and lifelong learning abilities. The Flemish Qualifications Framework (Vlaams kwalificatieraamwerk) spans eight qualification levels and encompasses a comprehensive set of competences and performance descriptors, which adds significant complexity to the design and implementation of CBE in the Flemish educational context [3, 18]. For example, at GITO Overijse, students are assessed based on the demonstration of subject-specific competencies instead of traditional grades [11]. This competency-focused approach offers a more holistic view of learning and better prepares students for the future workforce [11].

However, teachers in secondary schools may face difficulties when interpreting CBE (Figure 2.9). Each subject involves a wide range of skills that students need to master. This can be overwhelming for teachers because it requires tracking and assessing many competencies over time.

The large amount of data can make it hard to understand how students are progressing in different competencies. Similar challenges occur in Graduate Medical Education, where

Clinical Competency Committees also struggle with data overload and combining various sources of evaluation to make informed decisions about trainees [9]. These challenges show the need for effective tools, like learning analytics, to help teachers manage and interpret competency data.

2.3 Learning analytics tools for secondary education

The increasing use of learning analytics and artificial intelligence (AI) in education offers significant opportunities to support teachers in their tasks [54]. However, to fully capitalize on these advancements, it is essential to consider the specific needs of secondary school teachers. These educators are tasked with managing a diverse group of students, each with unique learning styles and challenges. Therefore, any AI-driven tools or data analysis methods must not only provide insights but also be aligned with teachers' teaching methodologies and daily responsibilities. Understanding how teachers engage with technology and what support they require can help ensure that AI systems enhance, rather than complicate, their instructional practices [24]. This section delves into these needs and explores how AI and learning analytics can be implemented to better support secondary school teachers in their educational tasks.

2.3.1 AI: a potential extension to LADs

It is important to note that this thesis does not focus on the direct implementation of AI within a learning analytics dashboard. However, AI is worth mentioning as a potential future extension to the dashboard, offering the possibility of more advanced, automated insights and personalized recommendations for educators in the future.

Recent reports, such as the comprehensive review by Ahmad et al. on AI-driven data analytics in education [2] and VRT NWS on Smartschool [40, 41], show how AI can be used to analyze student data and provide useful insights for schools, teachers, and students. These insights can help track student progress, identify those who are struggling, suggest personalized learning paths, or predict future performance. This connects with recent research by Szymanski and colleagues [56], which explores how teachers use AI tools in education. The study found that teachers prefer feedback mechanisms that allow them to apply their knowledge and remain flexible, rather than relying solely on AI for control or explanations. The researchers also highlighted the need for more data-based insights, as these are often more helpful in real teaching situations.

For instance, a recommender system could suggest actionable steps for students to achieve specific competencies, while historical data analysis might help determine whether a student is on track or at risk of falling behind. Furthermore, advanced tools like large language models (LLMs) and trend analyses could explain why a student achieved a certain score or had a lower chance of attaining competencies [48]. Recent studies highlight the potential of AI to provide more personalized support in e-learning and LADs. For example, Ooge et al. [42] investigated how control mechanisms and visualizations of these controls can help adolescents better understand a recommender system and build trust in an educational platform. Their experiment showed that visualizing the impact of control not only increases transparency but also raises awareness of the underlying algorithm. These findings suggest that visual and interactive AI features can make the experience

clearer and help develop important self-reflection skills, such as thinking about personal learning goals.

These AI-driven mechanisms could enable teachers to gain deeper insights into student performance, helping them better understand and support individual learning journeys.

2.3.2 Challenges and concerns in the integration of AI in education

However, the integration of AI tools in educational platforms such as Smartschool [53] and Moodle [35], or other Learning Management Systems (LMS), is not without controversy. Smartschool's AI tool, developed to detect learning delays using data like student activity, grades, and attendance, has faced criticism. Stakeholders, including parents and Flemish Minister of Education Zuhair Demir, have raised concerns about data privacy and the ethical implications of private companies handling sensitive student information [41].

In response, Smartschool has paused the tool's rollout and will review it with an Independent Advisory Board. While the tool aims to support teachers in reducing school dropout, it has sparked debate about the ethical, legal, and educational challenges of using AI in schools [41]. This case highlights both the potential of AI in education and the need to address societal concerns before its full adoption.

2.4 Designing dashboards for educators: principles and considerations

When creating a LAD for secondary school teachers, it's crucial to select visualization methods that effectively communicate insights. Several LA tools are designed to support both teachers and students, such as Course Signals [5] (Appendix, Figure A.1), which uses traffic light signals to indicate risk levels, and IntelliBoard [26] (Figure 2.2), a Moodle plugin offering diverse visualizations and monitoring features.

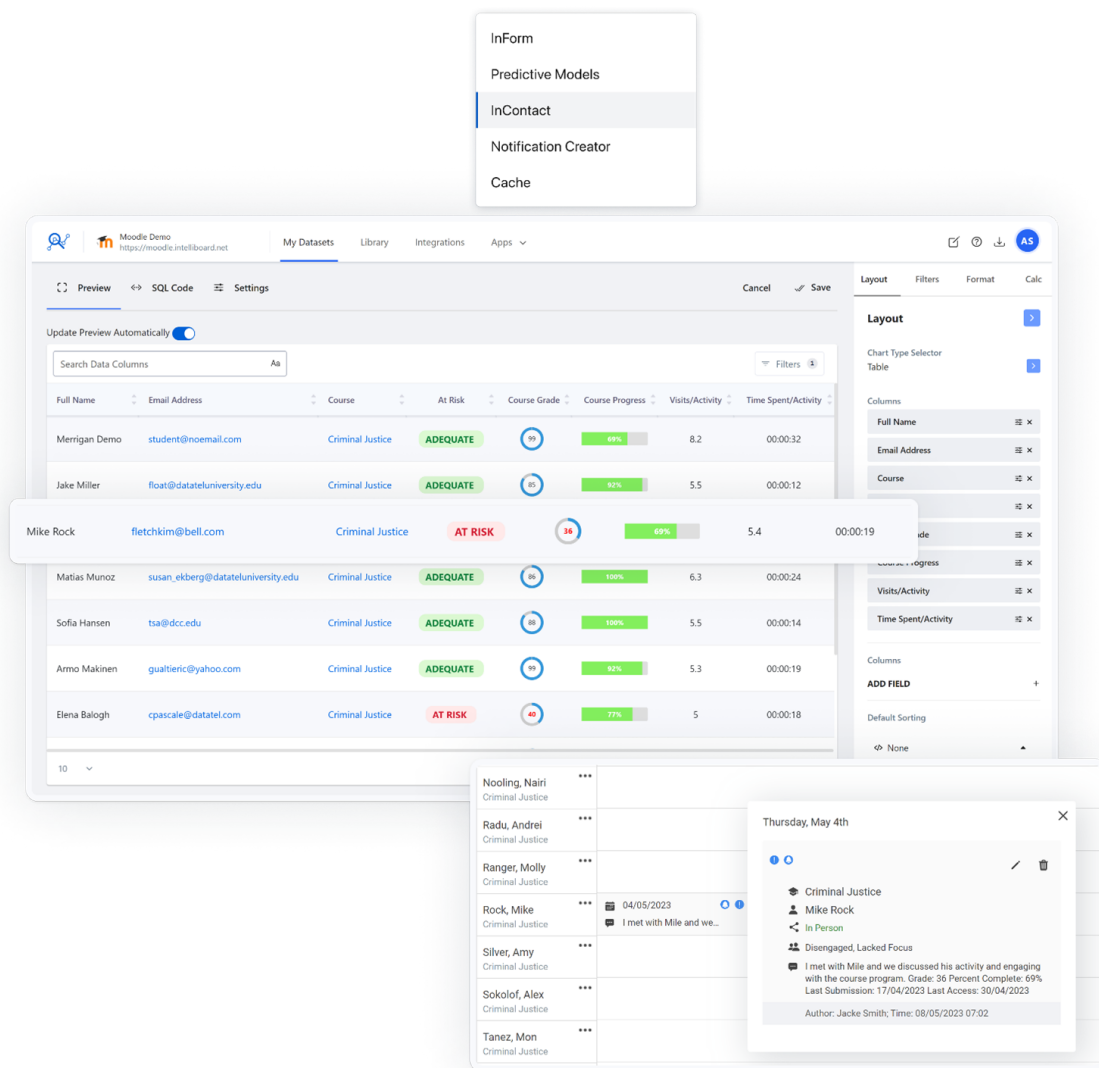


Figure 2.2: IntelliBoard [26] Moodle plugin's overview page, showing diverse data visualizations and monitoring tools for tracking student engagement and performance.

Tools like the EMODA system (multimodal and contextual emotional dashboard) [19] (Appendix, Figure A.2) analyze emotions using audio and video, while GISMO (Graphical Interactive Student Monitoring Tool) [32] (Figure 2.3) provides bar charts and scatter plots to track activities and assessments. These tools help educators tailor their teaching strategies and improve student outcomes by leveraging detailed and insightful data.

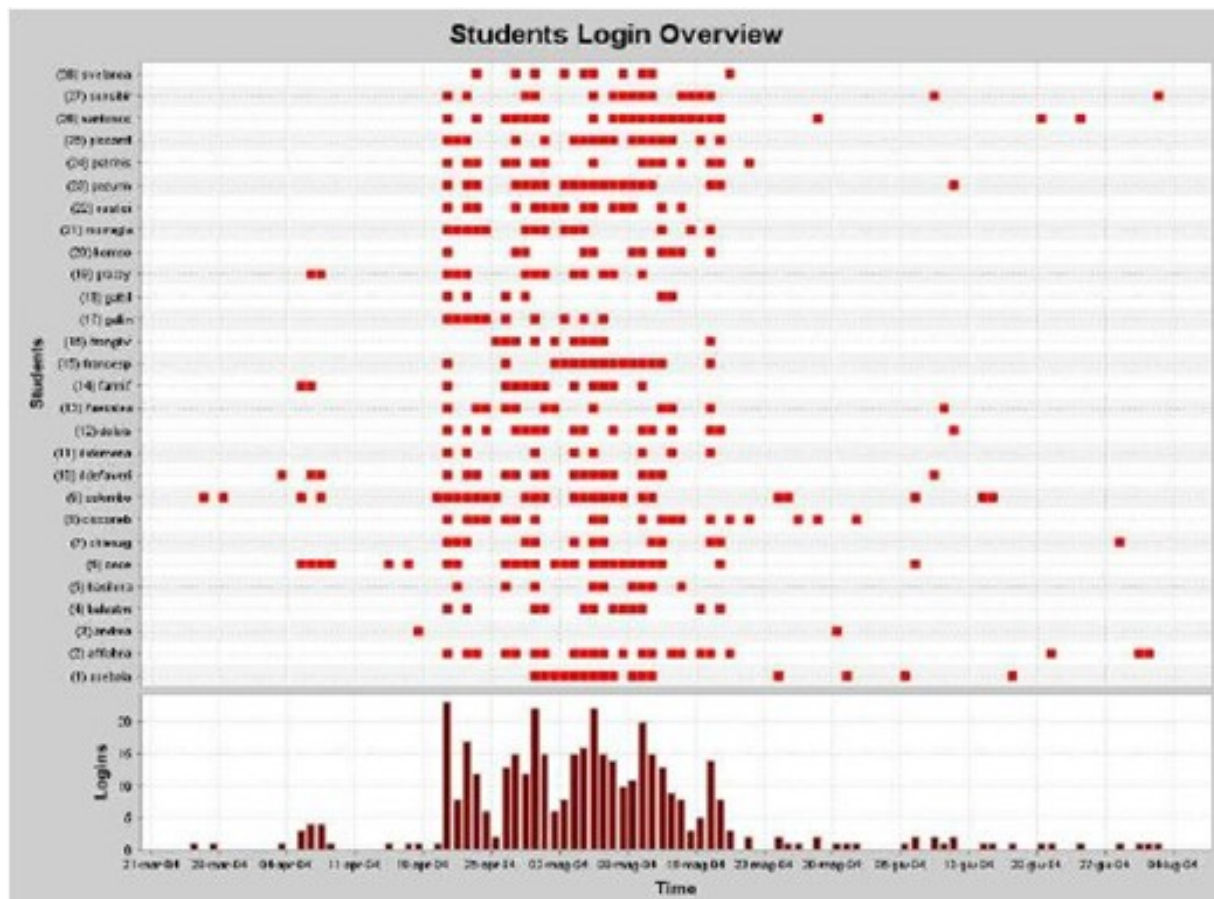


Figure 2.3: GISMO dashboard [32] displaying bar charts and scatter plots to track student activities and assessment performance over time.

The Content recommender (Figure 2.4) and skills recommender (Appendix, Figure A.3) [7] focuses on creating dashboards for students, providing dynamic recommendations based on their learning activities and performance.

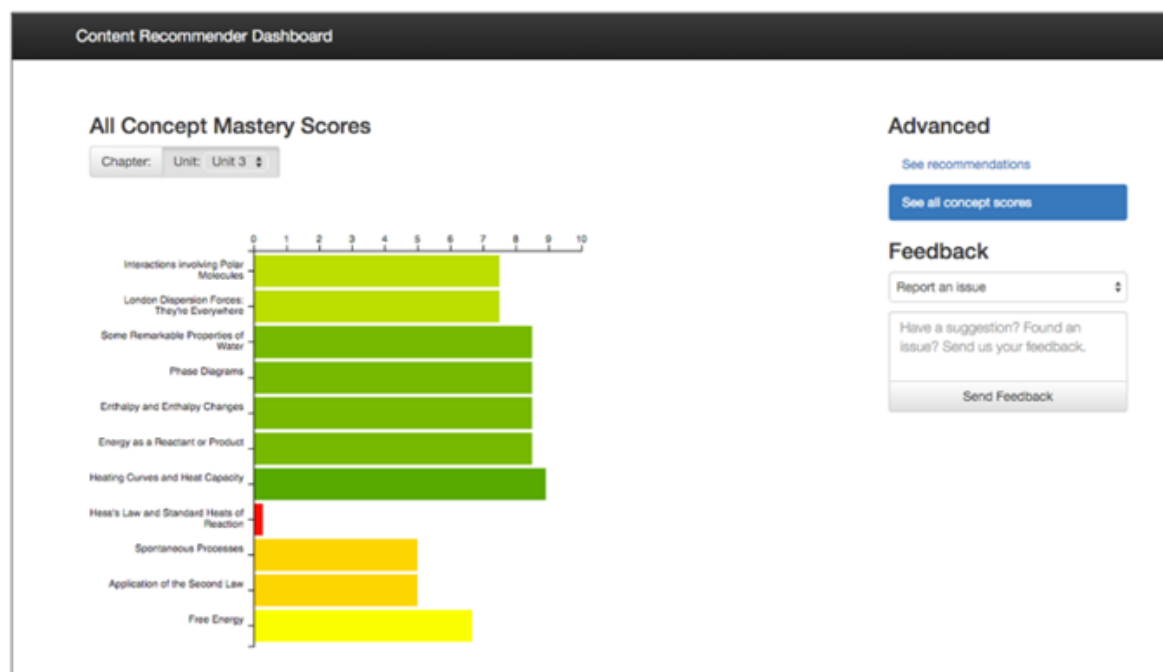


Fig. 2 The concept scores view of the content recommender version one

Figure 2.4: Content Recommender dashboard [7] displaying colour-coded horizontal bars for concept mastery scores, with dynamic filters for chapter and unit, and options for advanced recommendations and feedback.

Its visualizations include suggestions for learning materials and personalized study tips. The main goal is to give students clear insights into their progress and areas needing improvement. Instead of traditional graphs, the tool emphasizes informative summaries and tailored advice. The ICAP Technology Scale (ICAPTS) [4], on the other hand, focuses on how teachers integrate technology into learning activities. ICAP stands for Interactive, Constructive, Active, Passive. While it does not provide a specific dashboard, it supports visualizations that highlight interactive behavior, such as how students engage with technology. The emphasis is on measuring and improving the use of technology in education rather than on visualizing traditional data charts like bar or pie charts.

Several tools designed for Moodle environments provide integrated dashboards tailored to course management and outcome tracking. LAD-S [46] (where the “S” stands for “Students”) and the Learning Outcome Analytics Dashboard [61] both offer visual feedback based on course data and assessments. They use line graphs, bar charts, and pie charts to show learner performance and progress over time. While LAD-S emphasizes usability and continuous refinement through evaluation, the Learning Outcome Dashboard focuses on aligning performance with learning outcomes, making it especially suitable for institutions applying outcome-based education.

Dashboards that support competency-based learning have a distinct emphasis on tracking skill acquisition rather than grades alone. MyCompetencies [22] provides heat maps, tables, and box plots to visualize individual competencies for IS students. It is specifically designed to track learning objectives and personal development within a pro-

gram. Similarly, the Teaching and Learning Content Analytics (TLCA) dashboard [12], developed by the European Commission, uses bar and donut charts to show progress toward predefined learning outcomes. Both tools align with frameworks like the European Qualifications Framework (EQF) and support a shift from summative assessment to skills-based evaluation.

Divers mobile or adaptive systems have emerged with a focus on individual learner guidance. The LearnSmart App [31] (Appendix, Figure A.4) and SmartBook [17] (Figure 2.5) combine mobile compatibility with adaptive learning. These tools present progress indicators through simple bar charts and tables, helping learners monitor their mastery of topics and review areas that need reinforcement. Their strength lies in usability and accessibility, especially for self-paced learning environments.

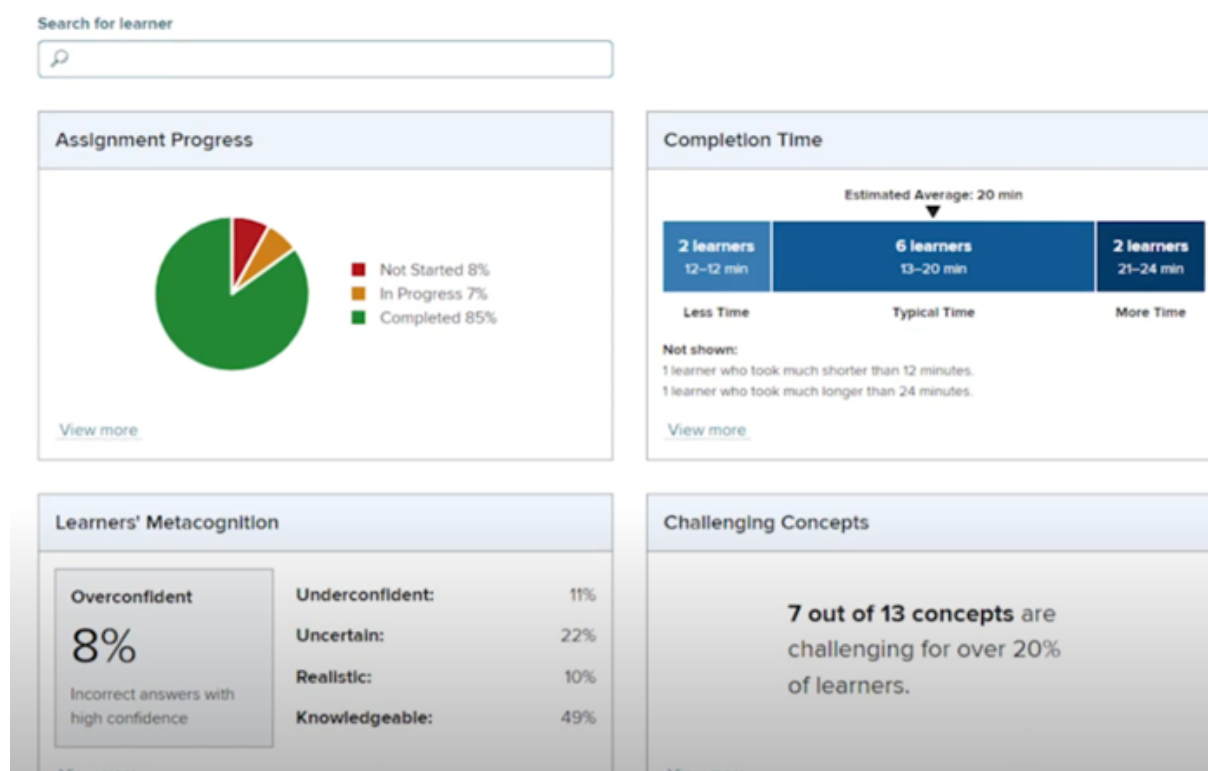


Figure 2.5: SmartBook interface [17] with adaptive reading content, showing progress indicators and summary tables that highlight areas requiring reinforcement.

SmartKlass [28] is a Moodle plugin designed to provide real-time insights into student engagement and learning progress. It offers a variety of visualization formats, including radial bar charts, gauge charts, line graphs, and tables. These visual elements help educators quickly identify trends and monitor individual or group performance over time. The tool emphasizes clarity and immediacy, making it suitable for both classroom-based and online learning environments that require timely interventions based on learner activity.

Plenty of dashboards target both students and educators by facilitating academic advising and support. The Results of Examinations (REX) [8] (Appendix, Figure A.5) combines a minimalist design with robust functionality, employing bar charts and emotive cues to present exam data. It is intended as a conversation starter to foster early interventions

in higher education. Similarly, Student Explorer [30] (Figure 2.6) presents performance data through tables and bar graphs to advisors working with large student populations. These tools prioritize simplicity and interpretability to support data-informed guidance.

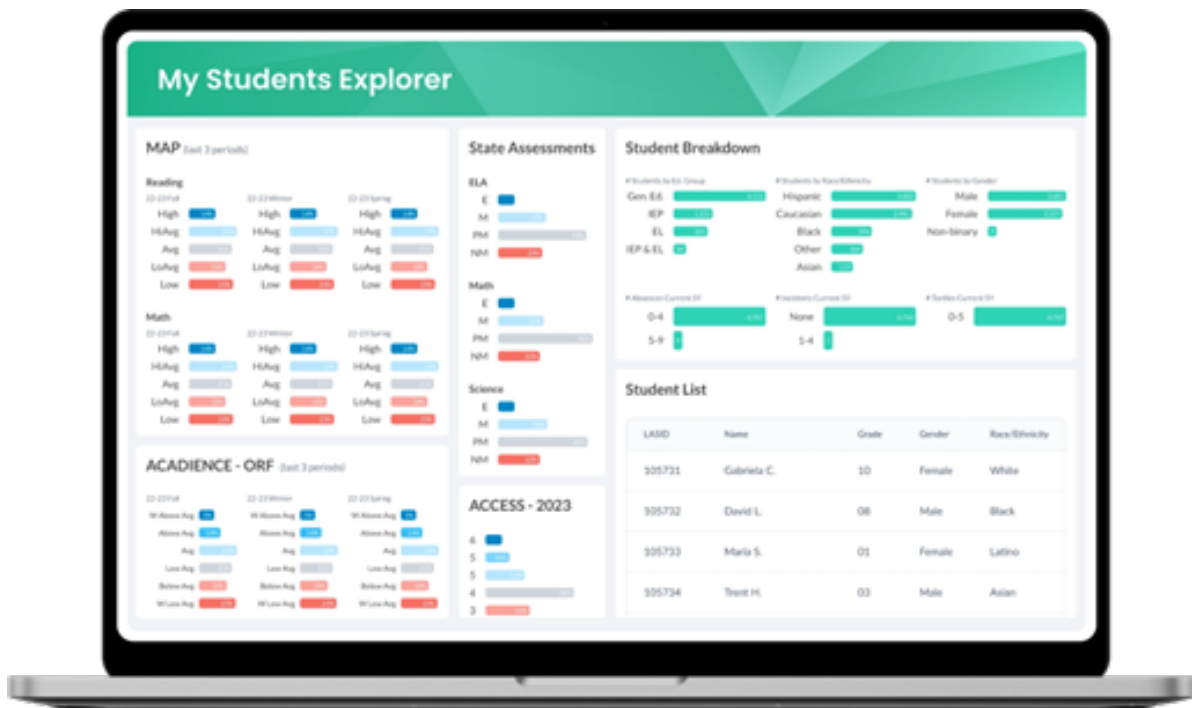


Figure 2.6: Student Explorer interface [30] showing tabular performance data and bar graphs for advisors managing large student cohorts.

StudentPulse [55] is a platform designed to provide insights into student well-being and engagement. Unlike traditional dashboards that rely on bar charts or performance graphs, StudentPulse focuses on interpretive feedback derived from student responses to periodic surveys. This approach allows educators to monitor emotional and motivational dimensions of learning, making it especially suitable for gauging learner satisfaction and classroom climate. While it does not visualize academic performance, its emphasis on student voice offers valuable qualitative data to support well-being-oriented interventions.

Smartschool [53] (Figure 2.7), which is widely used in secondary schools across Flanders, brings together various data sources in a single interface and offers visualizations such as pie charts and line graphs. Although the platform is well established and supports administrative and academic monitoring, it follows a more traditional approach. It lacks explicit support for competency-based learning, which makes it less or not suitable for schools that focus on personalized learning paths or skill development.

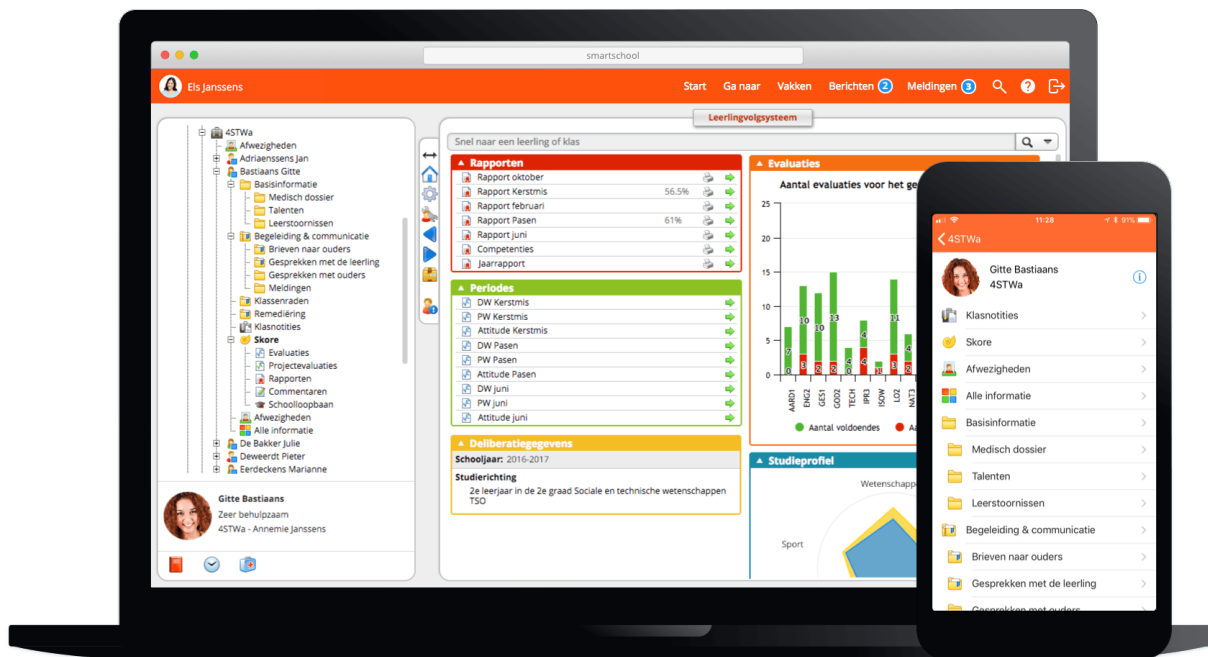


Figure 2.7: Smartschool dashboard [53], featuring a collapsible tree menu for student records, report and period listings, evaluation bar charts, and a radar-style study profile visualization.

The Learning dashboard for Insights and Support during Study Advice (LISSA) dashboard [10, 34] (Figure 2.8) offers the most comprehensive and effective visualizations for teachers and advisors. It displays data such as student grades, peer comparisons, and predictions about study duration in a clear and insightful way. This tool stands out because it simplifies complex information, helping educators and advisors make better decisions. However, a key limitation is that this dashboard is not tailored to the competency frameworks. The focus of LISSA is primarily on academic results and general progress without considering the specific needs of competency-based education. While LISSA is highly effective, it may not fully meet the requirements of schools that use a competency-focused approach.

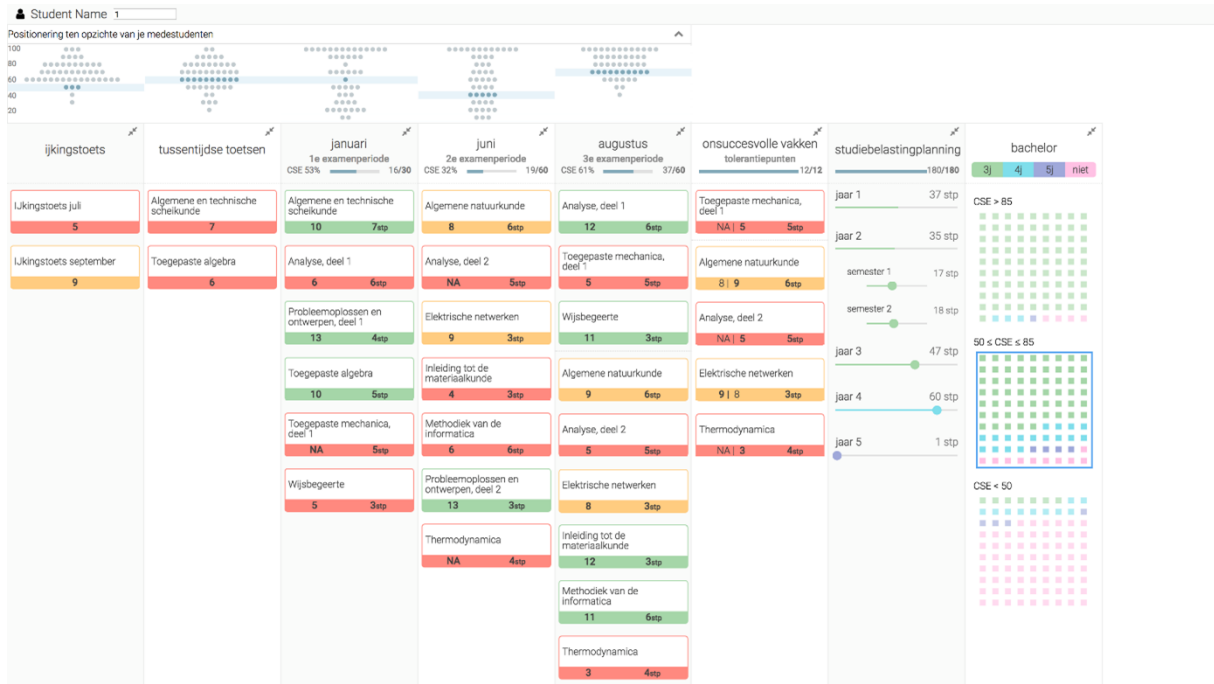


Figure 2.8: LISSA dashboard displaying student grades, peer comparison metrics, and estimated study duration predictions in an integrated interface for educators and advisors.

A recent contribution by Dourado et al. [14] offers a promising direction by introducing a teacher-facing LAD specifically designed to support process-oriented feedback in online learning. The dashboard was co-designed with teachers and visualization experts, emphasizing both empirical grounding and usability. Their iterative design approach and focus on actionable feedback highlights the potential for dashboards that go beyond grades and traditional metrics, aligning more closely with the principles of competency-based education.

An important aspect of dashboard development is the design process itself. Using a participatory design approach [49], where teachers and other stakeholders are actively involved in shaping the tool, can significantly improve both usability and educational relevance. This ensures that the resulting dashboard aligns with real-world classroom practices and teacher needs.

According to Hill [23], the choice between pie charts, donut charts, and bar charts depends on the specific analytical task and the nature of the data. Bar charts are especially effective for comparing individual values or ranking elements, making them suitable for showing differences in performance across students or subjects. In contrast, pie and donut charts are more appropriate for illustrating proportional relationships, such as the distribution of students across grade bands. While bar charts offer greater precision for comparison tasks, pie and donut charts provide a compact and visually engaging way to communicate part-to-whole relationships. In the context of a Learning Analytics Dashboard (LAD), this distinction is important: bar charts can support detailed comparisons and trend identification, whereas pie or donut charts may enhance quick comprehension

and user engagement, especially when space is limited and the goal is to highlight distributional patterns rather than precise values.

Table 2.1 provides a comprehensive overview of various LA tools, detailing their primary users, types of visualizations they offer, and the types of data they utilize (AL = Activity Logs, AD = Assessment Data, CT = Completion Tracking, CD = Course Data, FD = Forum Data.). The tools are categorized based on their intended users (students or teachers) and the visualizations they provide, such as bar charts, scatter plots, etc. Additionally, the table highlights the specific types of data each tool uses, including activity logs, assessment data, completion tracking, course data, and forum data. This information is crucial for understanding the functionalities and applications of different LA tools in educational settings. Building on a participatory design approach, the dashboard developed in this thesis aims to respond swiftly to teacher needs by incorporating multiple data sources in a later phase, to provide a holistic and timely view of student engagement and performance.

LA Tool	Users	Visualization	AL	AD	CT	CD	FD	ref.
Content recommender	Students	bar chart, scatter plot	x	x	x	x		[7]
Course Signals	Teachers	traffic lights: red, orange, green	x	x		x		[5]
EMODA	Teachers	audio, video, self-reports and interaction traces	x			x		[19]
GISMO	Teachers	bar chart, scatter plot, heat map	x	x	x			[32]
ICAPTS	Teachers	scatter plot	x			x		[4]
IntelliBoard	Teachers	bar chart, pie chart, table	x	x	x		x	[26]
LAD-S	Teachers, Students	line graph, bar chart	x	x				[46]
Learning Outcome	Teachers	line graph, bar chart, pie chart	x	x	x	x		[61]
LearnSmart	Teachers, Students	bar chart, line graph, table	x	x	x	x		[31]
LISSA dashboard	Students	bar chart, line graph, table...	x			x	x	[10, 34]
MyCompetencies	Teachers, Students	bar chart, heat map, table, box plot			x			[22]
REX-dashboard	Student	bar chart, mood					x	[8]
Skills recommender	Students	simple view, skills graph, line graph (time)	x	x	x	x		[7]
SmartBook	Teachers, Students	bar chart, line graph, table	x	x	x	x		[17]
SmartKlass	Teachers, Students	line graph, gauge chart, radial bar chart, table	x	x				[28]
Smartschool	Teachers, Students	line graph, bar chart, pie chart, table...	x	x	x	x	x	[53]
Student Explorer	Teachers	line graph, bar chart, table...	x	x	x	x		[30]
Student Pulse	Teachers	explanation of scores	x					[55]
TLCA	Teachers, Students	line graph, bar chart, donut chart	x	x	x	x		[12]
Participatory design	Teachers	line graph, bar chart, donut chart, skills graph...	x	x	x	x	x	[49]

Table 2.1: Overview of Learning Analytics Tools and Their Features, including Activity Logs (AL), Assessment Data (AD), Completion Tracking (CT), Course Data (CD), Forum Data (FD), and their Reference keys.

2.5 Addressing research gaps

2.5.1 Research gaps

Many existing learning analytics tools are not adequately aligned with the needs of secondary education institutions implementing CBE. These tools are frequently grounded in traditional grading models, which limits their ability to support meaningful tracking and assessment of student competencies [27]. Dashboards often lack contextual relevance and are not designed with the practical needs of educators in mind [20]. Furthermore, their complexity and technical requirements pose usability challenges, particularly for teachers who may lack advanced digital skills [47]. In addition, concerns regarding data privacy, transparency, and ethical use of student data have emerged as significant barriers to the broader adoption of learning analytics in CBE settings [45].

2.5.2 Future directions

To address these gaps, current research should focus on designing user-friendly dashboards aligned with CBE frameworks, incorporating actionable insights, and ensuring ethical and secure data use. This will better support teachers in making data-driven decisions for their students.

2.6 Research questions

A key context in which student-related decisions are made in Flemish secondary schools is the class council (klassenraad) (Figure 2.9²). A class council in Flemish secondary schools is a formal meeting where teachers and school staff jointly evaluate a student's academic performance, behavior, and overall well-being. These councils are crucial decision-making moments where teachers provide study advice, discuss interventions, and determine promotion to the next grade.



Figure 2.9: Conceptual illustration of a Flemish class council meeting. This image was generated with ChatGPT.

²The image was generated with OpenAI's ChatGPT [43].

This thesis aims to address a key gap in learning analytics research by exploring the following central research question:

What design features should a dashboard have to effectively support secondary school teachers in interpreting competency-based student data?

To guide this investigation, the following sub-questions are formulated:

1. *What are the informational and functional needs of secondary school teachers during class councils when interpreting competency-based student data?*
2. *How can key student data be visualized to enhance clarity, accessibility, and actionable insights for teachers?*

The goal of this research is to design a dashboard that better supports teachers during these meetings by:

- Identifying students who may require additional support through patterns and trends in their data.
- Presenting key insights into individual student performance and broader class dynamics in an accessible way.
- Facilitating informed and timely pedagogical decisions based on accurate and relevant information.

This research responds to persistent challenges in educational dashboard design. Existing tools are often overly complex, insufficiently actionable, or poorly integrated with the systems teachers already use. By tackling these shortcomings, this study aims to create a practical, teacher-friendly dashboard that strengthens data-informed decision-making in everyday school practice.

Chapter 3

Research process and dashboard development

This chapter outlines the research process that guided the development of a Learning Analytics Dashboard (LAD) tailored to the needs of Flemish secondary school teachers.

Initially, the thesis was conceived as a data-driven study that would analyze real usage data to derive insights into student learning patterns. However, due to limited access to such data in the school context, the research approach was reoriented early in the process.

Instead of focusing on quantitative analysis or AI integration, the project shifted toward an iterative, design-based methodology. The dashboard was developed through multiple co-design sessions and feedback loops with teachers from the partner school, GITO Overijse. The process was highly participatory, placing end users at the center of each iteration.

This chapter documents the evolution of the dashboard through various stages: from the initial plan to the co-design workshop, and from the development of Prototypes 1 and 2 to the final concept that is elaborated in Chapter 4. It also highlights key insights and decisions that shaped the current version of the dashboard.

3.1 Initial research plan

The research commenced with a thorough review of relevant literature and consultations with teachers and domain experts to clarify objectives and requirements. Through iterative dialogues and feedback sessions, the dashboard concept was refined via successive low-fidelity prototypes. All designs were initially sketched and then digitally refined with the goal of producing a working Proof of Concept (POC) that runs locally on a standard computer. This lightweight POC enables rapid setup and early-stage testing without complex infrastructure. Following prototype development, semi-structured interviews with a cohort of teachers will be conducted to collect rich qualitative insights on usability, interpretability, and instructional value. The findings from these interviews will inform the data analysis and underpin the thesis's conclusions. For my research, I will employ the Design Activity Framework for Visualization Design by McKenna et al. [33]. This framework organizes the visualization design process into four interconnected phases: Understand, Ideate, Make, and Deploy. By adhering to this methodology, I will iteratively develop and assess the Moodle plugin concept, ensuring each design choice aligns with

teacher needs and data characteristics. The framework will guide activities ranging from domain analysis and sketching to formal deployment and user evaluation.

All ethical and practical preparations for the field study were submitted to the KU Leuven Social and Societal Ethics Committee (SMEC) under approval number G-2024-8842. The documents related to this process can be found in Appendix B. These include the approved ethics application, the information brochure for participating teachers, the consent confirmation, and the questionnaire used for data collection.

3.2 Design process progression

The design process of the learning analytics dashboard followed an iterative, user-centered design process. Each phase combined prototype development with direct engagement of teaching staff to ensure that the interface addressed real classroom needs. The timeline in Figure 3.1 summarizes the major milestones from September 2024 until February 2025. In October, Prototype 1 (Figure 3.3) introduced an initial “Recommendations per final term” view alongside a “Goals Path” screen, visualizing competency-based suggestions and student learning pathways. Also during October, a co-design workshop with seventeen GITO Overijse teachers (Section 3.4.1) generated key insights on structuring competencies, simplifying visual elements, and maintaining flexibility in exercise selection. These findings guided the creation of Prototype 2 (Figure 3.5) in December, which emphasized year-long student evolution and integrated actionable suggestions with impact scores for unachieved competencies.

Subsequently, the lessons learned from Prototype 1 and Prototype 2, together with feedback from Workshop 1 (Section 3.4.1), informed the development of Prototype 3, which focuses primarily on the competency framework while deferring further AI features (Section 3.6). A strategic meeting on 27 February 2025 with Eummena representatives, GITO Overijse and CVO Antwerpen management, and KU Leuven researchers aligned the dashboard’s technical implementation with existing competency frameworks. Finally, on 28 February 2025, a qualitative feedback session at GITO Overijse validated the refined interface in a real school context. This continuous, user-in-the-middle approach has been central to refining visual hierarchy and ensuring usability for class council decision-making; the final design of Prototype 3 is presented and validated in Chapter 4.

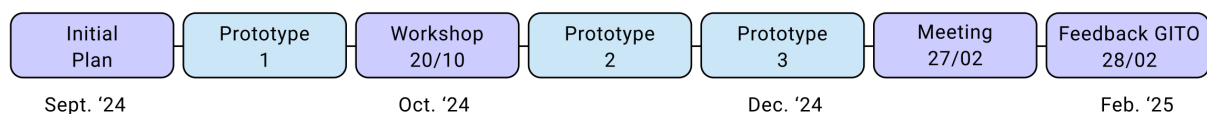


Figure 3.1: Timeline of the design and feedback process from September '24 until February '25

3.3 Designing prototype 1

The design of Prototype 1 emerged from a series of sketches, which are presented in Appendix D.1. This dashboard prototype is organized around two complementary views: “Recommendations per Learning Outcome” (Figure 3.2) and the “Goal Path” (Figure 3.3).

Selecteer
Klas: 2STEM
Leerling: Marc Vertongen

Aanbevelingen per eindterm

Eindtermen

II **06.40** De leerlingen lossen fysische problemen met en zonder formularium op.
Wiskunde, Exacte wetenschappen & technologie

III

1	Basisformules herhalen Impact: Verwachting 10-30%	Do	Done	Delete
2	Oefeningen zonder formularium maken Impact: Verwachting 20-40%	Do	Done	Delete
3	Bijles volgen in fysica Impact: Verwachting 20-50%	Do	Done	Delete
4	Samenwerken in studiegroep Impact: Verwachting 15-35%	Do	Done	Delete

05.01 De leerlingen gaan respectvol en constructief met anderen in interactie rekening houdend met elkaars grenzen.
Sociaal-relatieve competenties

Figure 3.2: Prototype 1: “Recommendations per final term” dashboard with a number of suggestions per competency to improve performance. I. Student selector II. Competence with related subjects III. Recommendation with impact score and action buttons

The “Recommendations per Learning Outcome” view (Figure 3.2) allows the teacher to select a student from a given class and displays all learning outcomes (competencies) that the student has not yet mastered. Each competency is accompanied by a set of suggested actions designed to support student success in that area. An impact score is provided for each action, estimating the expected percentage improvement in performance should the teacher or student implement the suggestion. Actions can be marked as “To Do” (planned), “Done” (completed), or “Delete” (not applicable), enabling the teacher to tailor recommendations to the individual learner’s context. Although this concept is straightforward, it can be extended to include richer metadata, such as prerequisite relationships, estimated time requirements, and resource links.

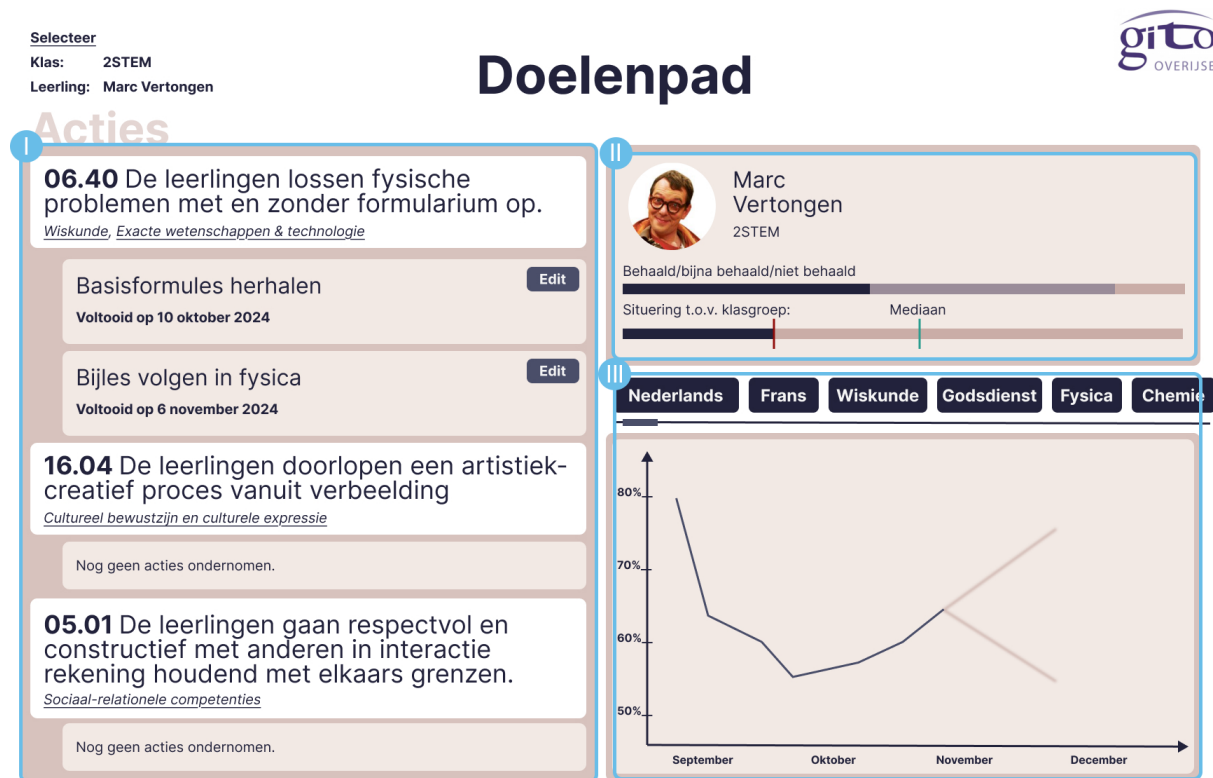


Figure 3.3: Prototype 1: “Goals Path” screen that lists the choices made for the selected student and provides an overview for student monitoring. I. “Action subject” with competencies and actions taken and status II. Student profile with parameters III. Subject selector with student evolution

The “Goal Path” view (Figure 3.3) functions as a detailed student-monitoring interface, tracing the history of all decisions and actions for the selected learner. On the left, the list of competencies is shown along with their current status and the dates of completion where applicable; ongoing competencies remain visible until mastery is achieved. On the right, the student’s profile summary presents an overview of mastered versus unmastered competencies and situates the learner’s progress relative to the class median. A filter at the bottom enables selection of individual subjects or displays all subjects simultaneously, allowing for temporal analysis of performance trends across domains. A shaded band indicates the target improvement range over time, guiding teachers in setting realistic goals. Although this prototype remains minimal, it offers a foundation for iterative refinement and usability testing.

Underpinning both views is a predictive model trained on historical student performance data to estimate the likely impact of each recommendation. User feedback on the quality and relevance of suggestions is incorporated into the model in a continuous feedback loop, improving the accuracy of the recommendations over time. Natural language processing powered by a large language model generates concise, context-sensitive explanations for each action, enhancing interpretability for teachers. Future enhancements may include real-time data streaming, adaptive thresholds for intervention alerts, and teacher annotation capabilities to further personalize the dashboard experience.

3.3.1 Lessons learned

During the development of Prototype 1, I gained valuable insights into the iterative nature of dashboard design. Sketching multiple variations on paper forced me to think through each interface element in its simplest form. Physically erasing and redrawing ideas highlighted that there are no wrong concepts—only hypotheses to validate with end users or peer researchers. These low-fidelity sketches enabled rapid feedback and helped uncover usability issues early, before investing in digital mockups. Later, translating paper sketches into digital prototypes (for example, in Figma [21]) proved essential for clearer communication and closer approximation of the final user experience.

Implementing the “Recommendations per Learning Outcome” view taught me the importance of balancing information density and clarity. I discovered that concise impact scores coupled with simple labels improved comprehension, whereas excessive detail overwhelmed teachers. In particular, the action states “To Do,” “Done,” and “Delete” were not immediately intuitive for all users, indicating a need for a unified overview screen that presents status, progress, and next steps in a single view.

Working on the “Goal Path” view reinforced the value of temporal context in student monitoring. Teachers found the visualization of student evolution highly informative, so I plan to prioritize richer trend-line visuals and more detailed impact estimation in future iterations. Although the initial impact scores provided a useful starting point, refining the underlying predictive model and augmenting the visuals will require further data collection and user testing.

Finally, the overall prototyping process underscored the principle that one learns by doing. Even though I was not entirely satisfied with the initial dashboard design, each round of sketching and feedback led to clearer decisions and a stronger foundation for subsequent versions. These lessons will guide the development of Prototype 2, with a focus on enhanced sketch-driven ideation, more intuitive status indicators, and deeper integration of student progress visualizations.

3.4 Workshop, meeting and feedback session

3.4.1 Co-design workshop (20/10/2024)

The workshop followed a structured co-design format commonly used in educational innovation research [51]. The session was designed to both collect insights and stimulate creativity among participants. The structure consisted of four main phases: (1) a short introduction and icebreaker to create a comfortable environment, (2) a discussion round with feedback on usability and areas for improvement, (3) a group voting exercise to highlight the most important elements, and (4) a hands-on design task where teachers sketched their own ideas for a LAD. This format supported both open and focused thinking that helps teachers reflect on current tools. It also helps them think about ways to improve them for their own teaching situation.

Seventeen teachers from GITO Overijse participated in the session. They were divided into five groups and engaged in guided discussions around proposed statements and visual mock-ups. The session aimed to gather perspectives on integrating a competency framework within Moodle, including its structure, use in grading, and visualization. The collected feedback offered concrete insights into desired system features and conditions

for adoption.

Since not all points were quantitatively voted on, estimated levels of agreement were derived from group discussion dynamics and qualitative notes. Table 3.1 gives an overview of key discussion topics, estimated level of teacher support, and their perceived importance for LAD integration.

Topic	Estimated support	Priority
Frustrations with current Moodle tools	All participants	High
Grading linked to competencies	All participants	High
Flexibility in selecting exercises	All participants	High
Structured planning of competencies	≈ 13 participants	High
Feedback on proposed visual designs	All participants	High
Overview of class progress	≈ 13 participants	Medium
Annotating competencies in assessments	≈ 10 participants	Medium
Complexity of some visual elements	≈ 10 participants	Medium
Involvement of parents	Divided opinion	Low

Table 3.1: Summary of key workshop insights with estimated support and priority

In addition to the group discussions, participants took part in a short voting exercise. They were asked to vote on the problems they considered most urgent and the features they found most useful for a future system. Table 3.2 shows how many teachers saw each problem as something that must, should, or can be solved. Table 3.3 presents the results of a feature voting round, in which participants allocated paper slips to their preferred ideas. Each teacher received up to ten votes, though not all used their full number.

Problem	Must be solved	Should be solved	Can be solved
Moodle is not user-friendly	16/17	1/17	–
Too many or vague competencies	13/17	2/17	–
Moodle lags behind Smartschool	13/17	3/17	–
Do students actually achieve the competencies?	1/17	12/17	1/17
Too many clicks and input fields	13/17	4/17	–

Table 3.2: Teacher-reported issues and their perceived priority levels

Feature or suggestion	Number of votes (paper slips)
Automatic linking of competencies	39
Hierarchy within competencies	33
Seeing evolution is useful	32
Visualization of (un)achieved competencies	20
Being able to customize dashboard view	10
Box plot is useful	4

Table 3.3: Voting results on proposed dashboard features (ranked by number of votes)

The voting results support several key points raised during the earlier group discussions. Teachers clearly prioritized ease of use, a well-structured competency framework, and fewer unnecessary administrative steps. The most pressing issues were related to Moodle’s poor usability and the lack of practical tools for working with competencies. Among the proposed features, automatic linking of competencies and visual support for tracking student progress received the most votes. Overall, the feedback shows a strong need for a system that combines structure with flexibility, and offers visual feedback that teachers can easily apply in their daily practice.

3.5 From workshop insights to prototype 2

The design of Prototype 2 builds upon the overarching concept of Prototype 1, shifting the focus from the individual student to the entire class (Figure 3.4).

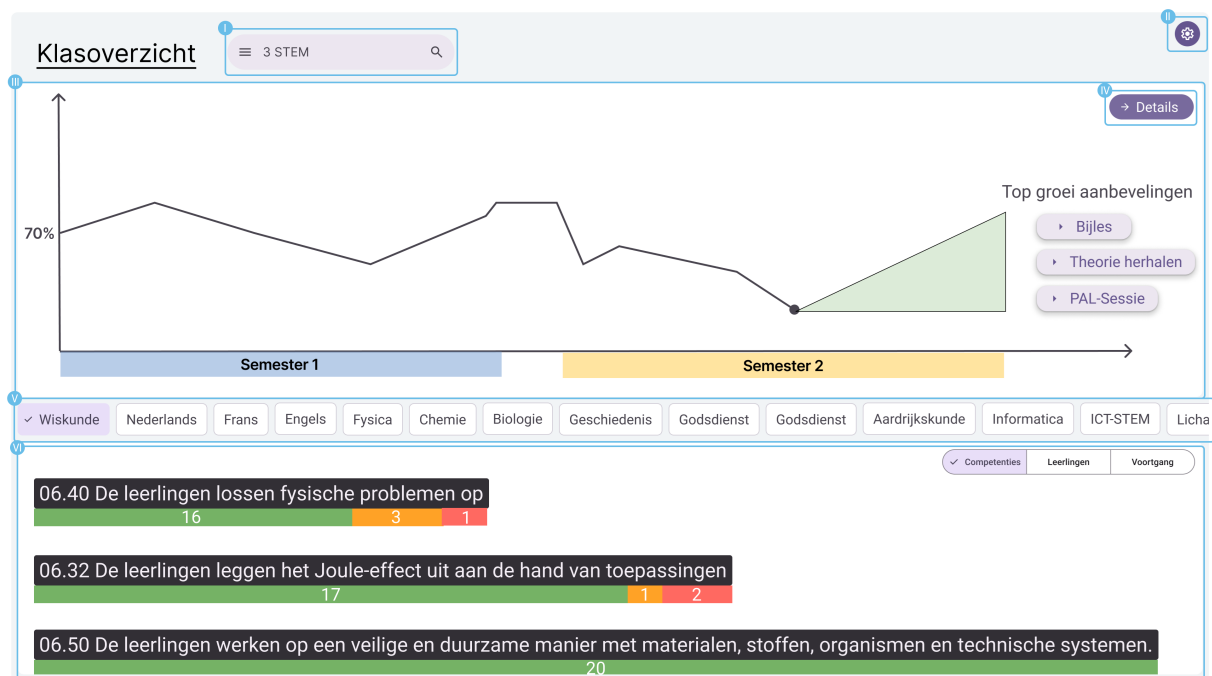


Figure 3.4: Prototype 2: Dashboard screen that focuses on the student’s evolution over the school year at the top, with more details on topics such as “competencies”, “students”, and “progress” at the bottom. I. Student selector II. Settings III. Evolution graph with “top growth recommendations” and impact IV. Details button V. Subject selector VI. Dynamic part of dashboard with choice of “Competencies”, “Students” and “Progress”

The system generates personalized recommendations for students based on their performance data. Educators, whether they are subject teachers, learning support staff, or homeroom teachers, can immediately see suggested actions that students can take to improve their outcomes. Each recommendation is accompanied by an estimated impact score, reflecting its potential effect on student performance. Ultimately, the teacher retains the final decision-making authority to select the most appropriate interventions, which embodies the core idea of an AI-driven recommendation system. Several sketches that

informed this design iteration are presented in Appendix D.2. This approach emphasizes a clean and simple interface, which teachers indicated they preferred. They expressed a desire for a plug-and-play dashboard that presents clear insights at a glance, without overwhelming details (Figure 3.4).

In this prototype, the teacher selects a class and views the evolution of performance over time, filtered by the chosen subjects, or across all subjects if no filter is applied. Below the evolution graph is a dynamic panel with three views: “Competencies”, “Students”, and “Progress” (Figure 3.5). The Competencies view displays the distribution of mastery levels within the class, categorizing competencies as achieved, nearly achieved, or not achieved. The Students view highlights at-risk students for the selected subject, listing the competencies they have not yet mastered, as well as those on the verge of risk, along with the specific competency triggering that status. This enables teachers to form targeted small groups or to address broader trends in class discussions. The Progress view focuses again on competencies, showing which skills the class as a whole has yet to master, thereby guiding further instructional support and monitoring.

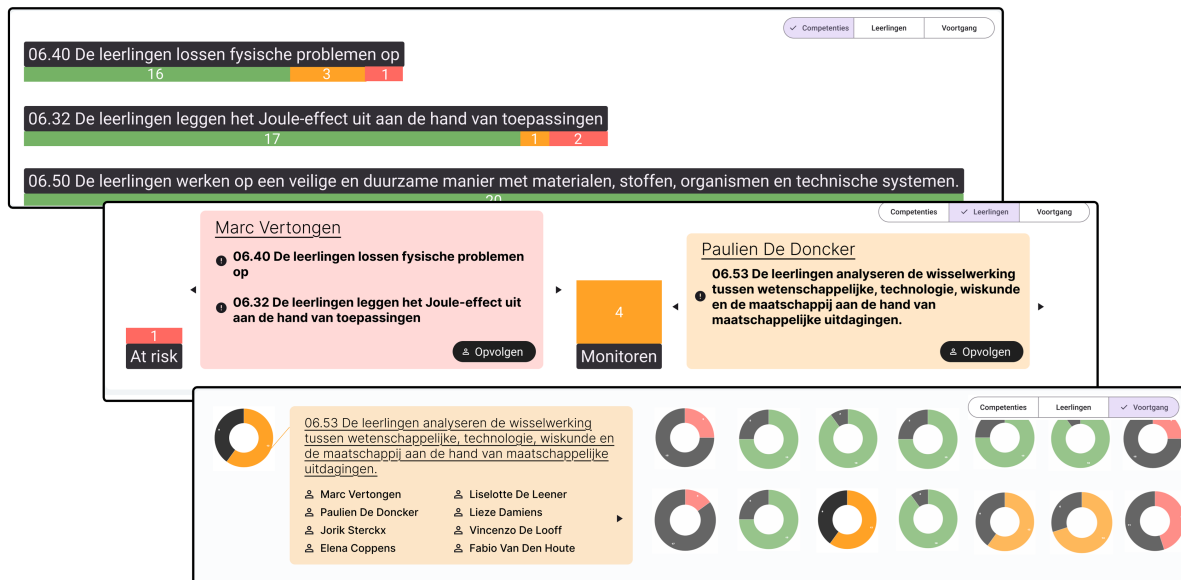


Figure 3.5: Detailed views of the lower section of prototype 2 showing performance evolution, competency mastery, and student progress.

The second screen presents an iteration focused on the individual student, consolidating all key elements into a single view (Figure 3.6). Here, the teacher selects a subject, chooses a student, and defines a time period (e.g., Semester 1). A student profile appears, displaying critical parameters such as current grade, engagement indicators, and competency overview. Adjacent to the profile is the familiar dynamic panel with the same three views: Competencies, Students, and Progress. For the selected student, the Progress view visualizes competency development clearly and concisely. Beneath this, the core of the

prototype is presented: the list of unmastered competencies paired with targeted suggestions to help the student achieve them. Teachers can interact with each recommendation by activating it, marking it as completed, or deleting it, thereby maintaining control over the support process.



Figure 3.6: Prototype 2: Global overview of student dashboard emphasizing suggestions + impact score for the unachieved competencies. The supervisor can activate suggestions, mark them done or remove them. I. Student selector and settings button II. Selected subject III. Selector for period IV. Dynamic subject with bar chart about e.g. progress of this student V. Profile of student with parameters VI. Competence with recommendations, impact score is shown as bar and action buttons are respectively “Do”, “Done”, “Delete”

3.5.1 Lessons learned

The prototyping and evaluation process showed that the first dashboard designs still needed improvement. Although the basic idea was strong, the early versions were not visually detailed enough and did not make the data easy to understand at a glance. Because of this, they were less effective as tools to support teacher decision-making.

Teachers were also somewhat skeptical of the recommendation feature, since implementing extra practice exercises represents additional workload. This showed that it is important to design features that are not only useful but also realistic to use in daily teaching practice.

Lastly, the step-by-step design process was very valuable. Each round of feedback helped make the design decisions clearer and improved the tool. This underlined how important it is to involve users during the development of educational technology.

3.6 Reorientation

This chapter has reviewed the main goals and design principles by following the development of the dashboard through several stages and discussions with stakeholders. This process led to a final concept that focuses on visualizing the competency framework, without including any AI features. After Prototype 1 (Section 3.3), the co-design session (Section 3.4.1), Prototype 2 (Section 3.5), and several iterations and discussions during project meetings, it became clear that the overall concept should focus on visualizing the competency framework without AI applications. Moreover, earlier prototypes did not produce significant gains and tended to overlook competency-based learning. Although they did track competency attainment, the emphasis shifted towards in-dashboard recommendations, predictive analytics, and impact scores for improvement measures generated by the student monitoring system. Currently, there is no support for AI features due to the absence of sufficient data. Although the underlying technology is sufficiently mature to derive useful insights, its effectiveness remains constrained by the quality and availability of data, which have not yet been collected. Earlier prototypes emphasized AI integration and its potential value for users, but the current decision is to center the concept on the competency framework used in Flemish secondary schools. Details of the final dashboard design (Prototype 3) are presented in Chapter 4.

3.7 Co-Design and feedback integration

3.7.1 Meeting with key partners (27/02/2025)

A strategic meeting was held with key partners, including representatives from Eummena—the implementing partner of the competency framework used in the collaborating schools—as well as the management teams of GITO Overijse and CVO Antwerpen. Researchers from KU Leuven, including me, were also present.

This meeting was essential for aligning the technical and pedagogical vision behind the dashboard prototype with the existing educational frameworks at both institutions. We discussed the integration of the competency framework into Moodle and its implications for curriculum structure, assessment, and student tracking. Since both schools are clients of Eummena, this provided an opportunity to ensure that the proposed solution would be compatible with existing systems and workflows.

For GITO Overijse, the proposed implementation involves structuring the curriculum into modular “lesson packages”. These modules will allow for the flexible composition of a student’s learning pathway. Each package will consist of multiple subjects, each designed to ensure the achievement of specific competencies. Competencies can span multiple subjects and will be stored in the Moodle database. This structure enables students who change study direction to retain previously acquired competencies that are still relevant in their new trajectory. The competency system will be aligned with the educational structure, operating on a two-year cycle per grade.

The dashboard's design was further informed by this structure. Specifically, it will visualize a hierarchical overview of competencies:

- At the highest level, subjects are listed.
- Each subject is composed of multiple competencies.
- Teachers determine the weight of each competency for passing the subject.
- Competencies are earned through various assessment methods, such as assignments, quizzes, and exams.
- Teachers have the flexibility to assign competencies based on student performance in these assessments.
- Assessments can cover multiple competencies, and a single competency may appear across different subjects.

This structure ensures that competencies are transparently tracked and that students can progress efficiently within their educational path while maintaining flexibility in their learning trajectory. Further refinements will be made based on feedback from teachers and educational stakeholders.

3.7.2 Feedback session at GITO Overijse (28/02/2025)

To evaluate the practical use of the dashboard in a real school context, a qualitative feedback session was organized at GITO Overijse. This session followed a structured think-aloud protocol, a well-established method in usability engineering [39]. Think-aloud techniques are widely applied within the field of Human-Computer Interaction (HCI) to investigate how users interact with digital systems, including Learning Analytics Dashboards (LADs).

Methodological protocol

The session involved eight educational staff members, selected to represent a broad range of roles and teaching backgrounds. Each participant interacted with the dashboard individually while verbalising their thoughts and reactions. The session was moderated by the researcher, who provided clarifications when needed and ensured that each feature of the system was reviewed. This approach provided qualitative insights into user experiences and classroom-related challenges, following usability methods described by Jakob Nielsen in *Usability Engineering* [39].

Participant Overview

Table 3.4 provides a summary of the participants' professional roles and subject expertise. While exact years of experience were not recorded, a distinction is made between more senior and younger staff.

Teacher (Subject Area)	Experience
Religious Education	Experienced
Mechanics (practice)	Mixed
English, Mathematics, Dutch	Experienced
Mechanics (practice)	Mixed
Physical Education	Medium
Informatics	Early career

Table 3.4: Profile of participating teachers in the feedback session

General impressions

Teachers generally found the system visually engaging and relevant to their class council discussions. However, some perceived the first screen (discussed in more detail in Chapter 4, Figure 4.1) as overwhelming. The following Table 3.5 summarizes their initial reactions.

Feedback Point	Teachers	Notes / Implementation
Clear visual representation using colors	6	Maintain and optimize usability
First impression: overwhelming, but clarity improves with use	4	Improve visual hierarchy of the main screen
Initial screen feels crowded but becomes intuitive over time	4	Rework layout for a more structured introduction

Table 3.5: General impressions of the dashboard

Positive aspects

Several elements of the dashboard were identified as beneficial for class councils, as listed in Table 3.6. Teachers particularly valued the ability to analyze student progress efficiently, visualize trends, and access key data at a glance.

Challenges and areas for improvement

Some aspects of the dashboard require further refinement to maximize its effectiveness in class councils. Teachers suggested improvements in data representation and navigation, along with potential new features to support individual student analysis (Table 3.7).

Feedback Point	Teachers	Notes / Implementation
Overall data view allows deeper analysis by subject, competency, and activity	5	Strengthen this feature with additional filters
Student overview is well-aligned with class council needs	4	Keep this functionality unchanged
All necessary information visible at a glance	4	Conduct UX testing to confirm efficiency
Student progress is clearly displayed	3	Consider adding more detailed trend analysis
Displaying actions instead of hours is well understood	3	No change required
Non-evaluated tests (e.g., absences) are useful to include	3	Explore the best way to represent this data
Ability to add notes is appreciated	3	Investigate integration with existing systems
Displaying comments directly in the system would be useful	3	Evaluate if this should be a core feature
Significant improvement over current black-and-white reports	3	Confirms the added value of a visual approach

Table 3.6: Positive aspects of the dashboard

Feedback Point	Teachers	Notes / Implementation
Teachers prefer minimal manual input and click-based LAD	4	Minimizing manual input as a key design goal
Evolution chart comparing students within a group is unclear	3	Additional context or explanation required
First screen feels overwhelming at first use	3	See previous suggestions on layout improvements
Displaying total hours might still be useful	2	Explore optional inclusion without cluttering the interface
Some teachers prefer individual analysis over group comparisons	1	Consider a toggle option for group vs. individual views
Yearly subject overview would be valuable	1	Can be considered as a later feature

Table 3.7: Challenges and areas for improvement

Chapter 4

Final design

This chapter describes the third and most mature version of the dashboard prototype. It provides a detailed overview of the key design elements and views, and presents the results of the final user validation phase. The goal is to assess whether this version can be considered the final design based on feedback from end users. If so, this prototype is validated as the final design and will serve as the foundation for the implementation phase, which is described in Chapter 5.

4.1 Prototype 3: final design description and validation

This section presents the third and most refined version of the dashboard prototype. It describes the three main views that make up the user interface: the global overview, the subject-level view, and the competency-level view. Each view is explained in detail and illustrated with screenshots.

4.1.1 Global view explanation

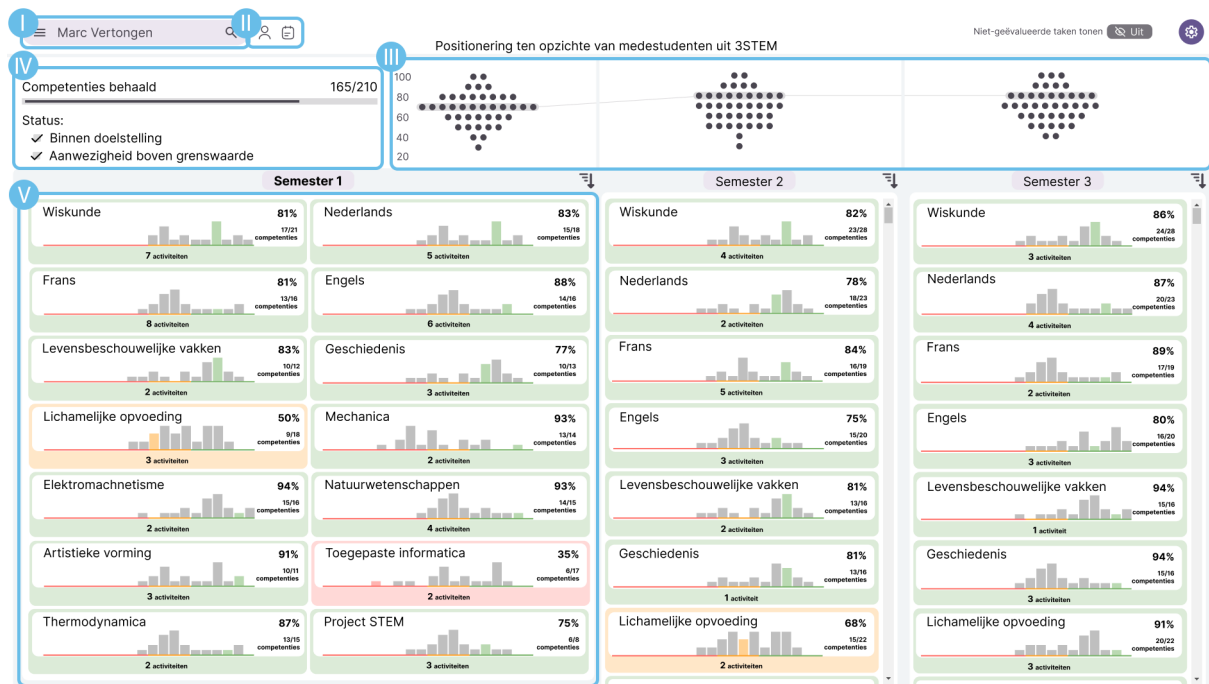


Figure 4.1: Prototype 3: Main dashboard screen, providing a global overview of student performance across semesters and subjects. I. Student selector II. Profile button and notes button III. Evolution visual of class over the semesters with student positioning IV. Student profile with parameters V. Overview of semester 1 courses with their class distribution and student score (competence-based)

The global view (Figure 4.1) is the main dashboard screen that first presents an overview of a student's performance across subjects and semesters, following the *overview first* design principle [52]. At the top left, there is a student filter (I) where a user can select a specific student. Next to it, there are two icons: one for the student profile and one for notes with extra information (II). In the top right corner, there is a settings menu for user preferences.

Below that, there is a competency section (IV). This shows the total number of achieved competencies, and whether the student's performance and attendance meet the expected conditions.

There is also an evaluation chart that compares results across semesters (III). It shows both the performance of the whole class and the specific group that the selected student belongs to.

At the bottom part of the dashboard, each semester is listed with the courses taken during that time (V). Each course is displayed in a card format. In each course card, a class distribution chart is shown. The selected student's group is highlighted with a specific color. The percentage shown in the chart is based on the number of competencies achieved compared to the total number of competencies in that course.

4.1.2 Subject-level view explanation

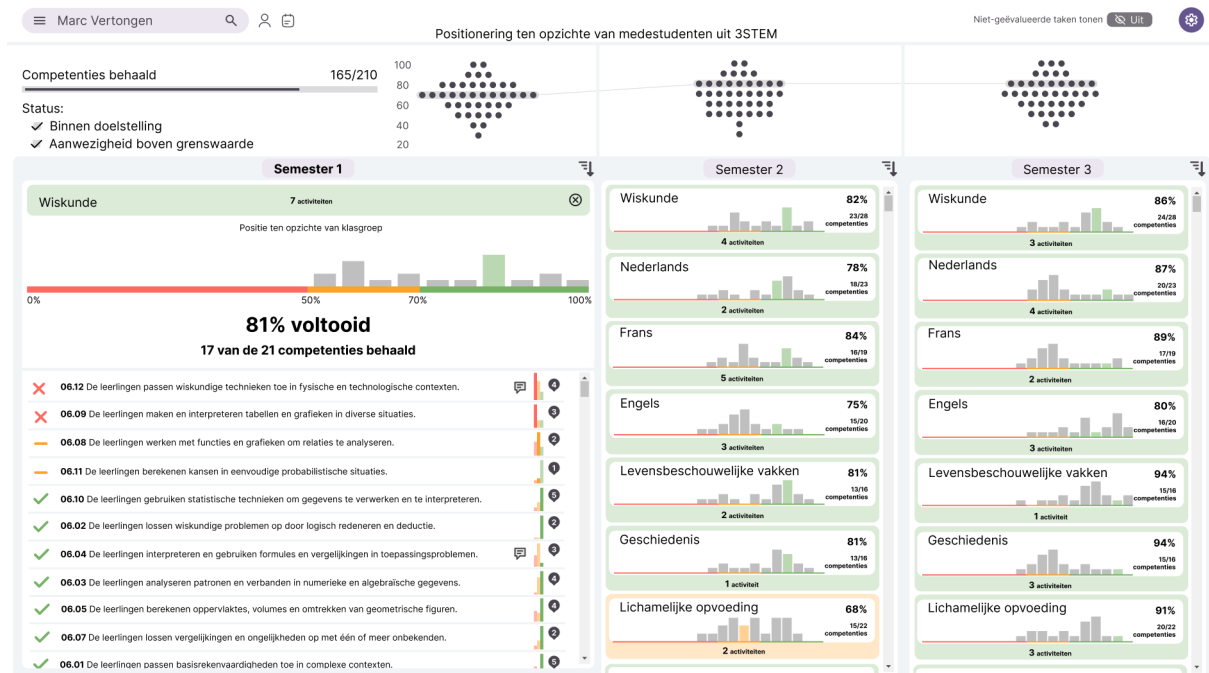


Figure 4.2: Prototype 3: Subject-level view showing a competency breakdown for the selected course, categorized by status and supported by class distribution data.

The subject-level view (Figure 4.2 and Figure 4.3) appears when the user clicks on a specific subject, such as Mathematics. This screen gives a more detailed look at the selected course and shows all related competencies.

The competencies are clearly grouped into three categories:

- Not achieved
- Almost achieved
- Achieved

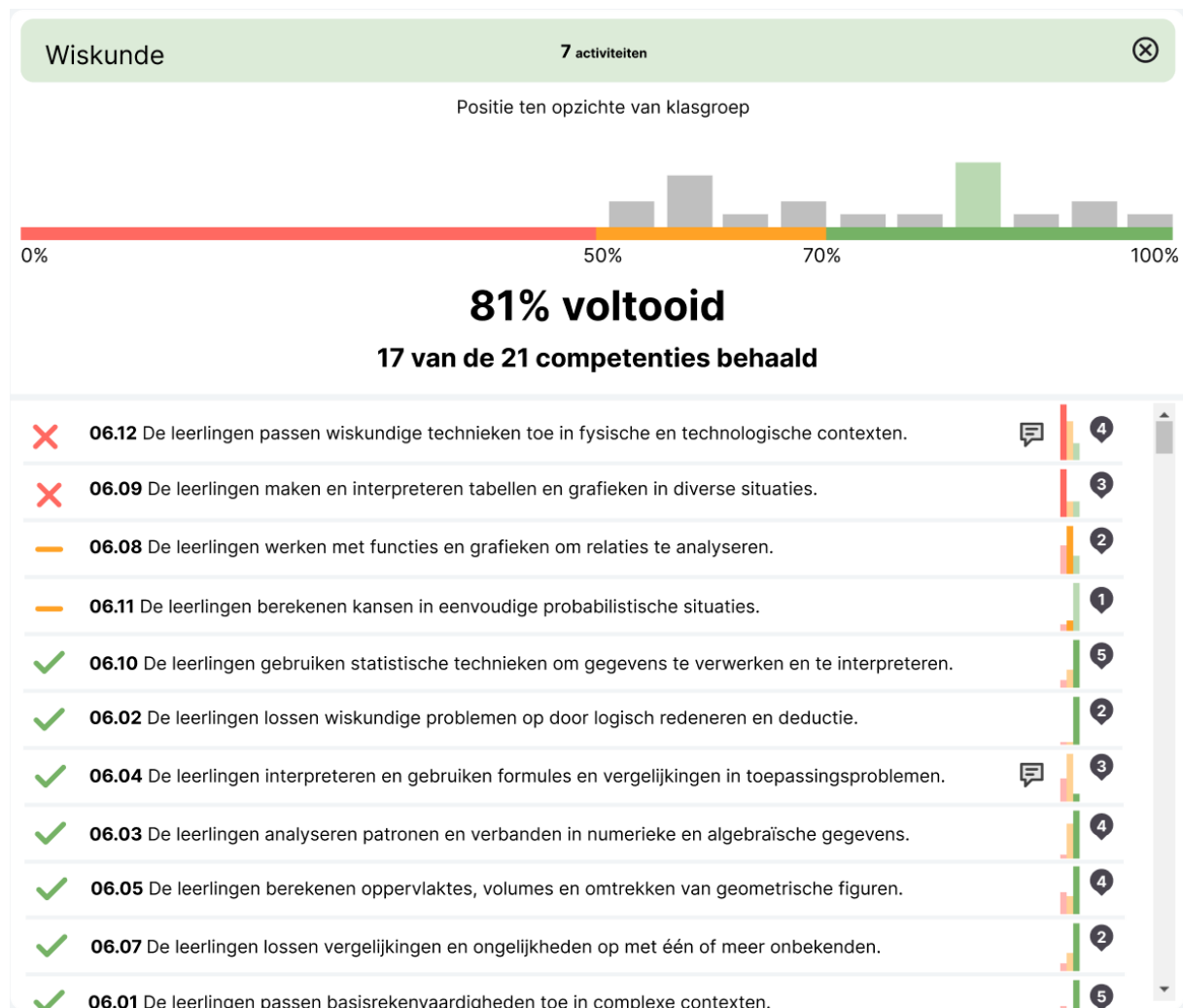


Figure 4.3: Subject-level detail view showing individual competencies with completion status, class distribution, and linked learning activities.

This organization makes it easy for teachers to see where the student still needs support, and how they can best help the student improve.

In addition, the view includes the option to:

- Read notes related to the student's progress or teacher observations.
- View the class distribution for each competency.
- See the number of learning activities that contribute to each competency.

This screen supports targeted feedback and enables more effective and personalized student support.

4.1.3 Competency-level view explanation

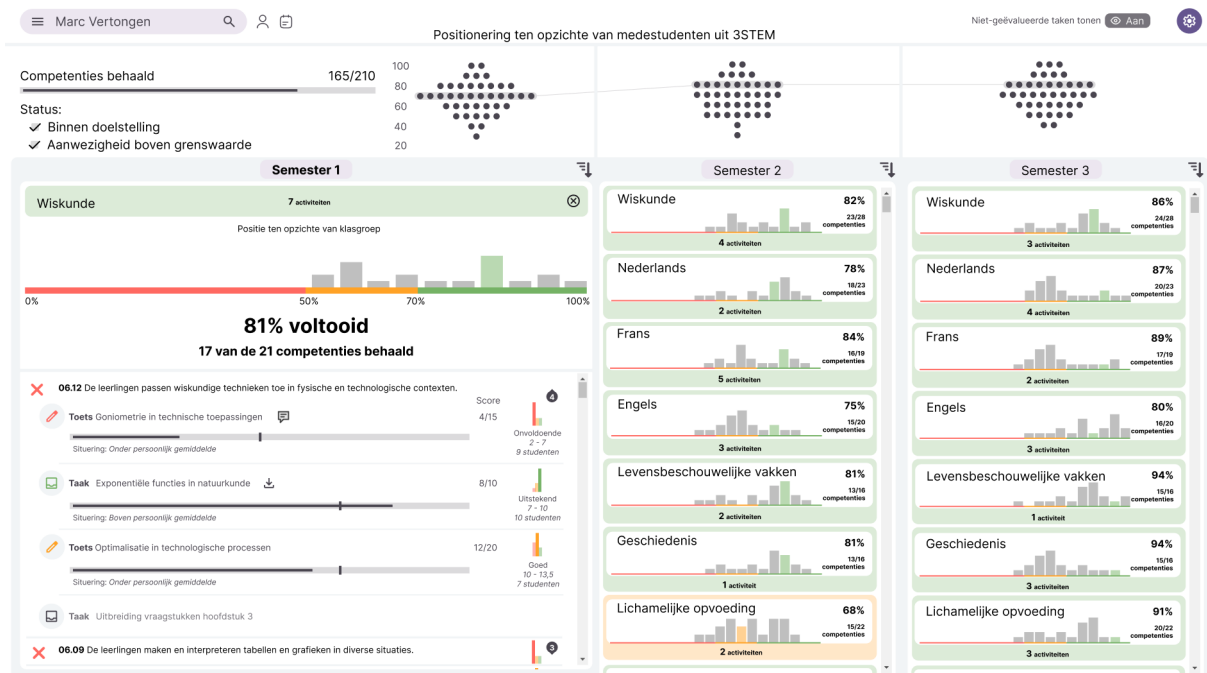


Figure 4.4: Prototype 3: Competency-level view listing all related evaluations, including performance details and class comparisons for each activity.

The competency-level view (Figure 4.4 and Figure 4.5) is the third level of detail in the system. It appears when the user clicks on a specific competency within a subject, such as Mathematics.

In this view, the user can see all activities linked to the selected competency. For example, there might be four activities that contribute to a certain math competency.

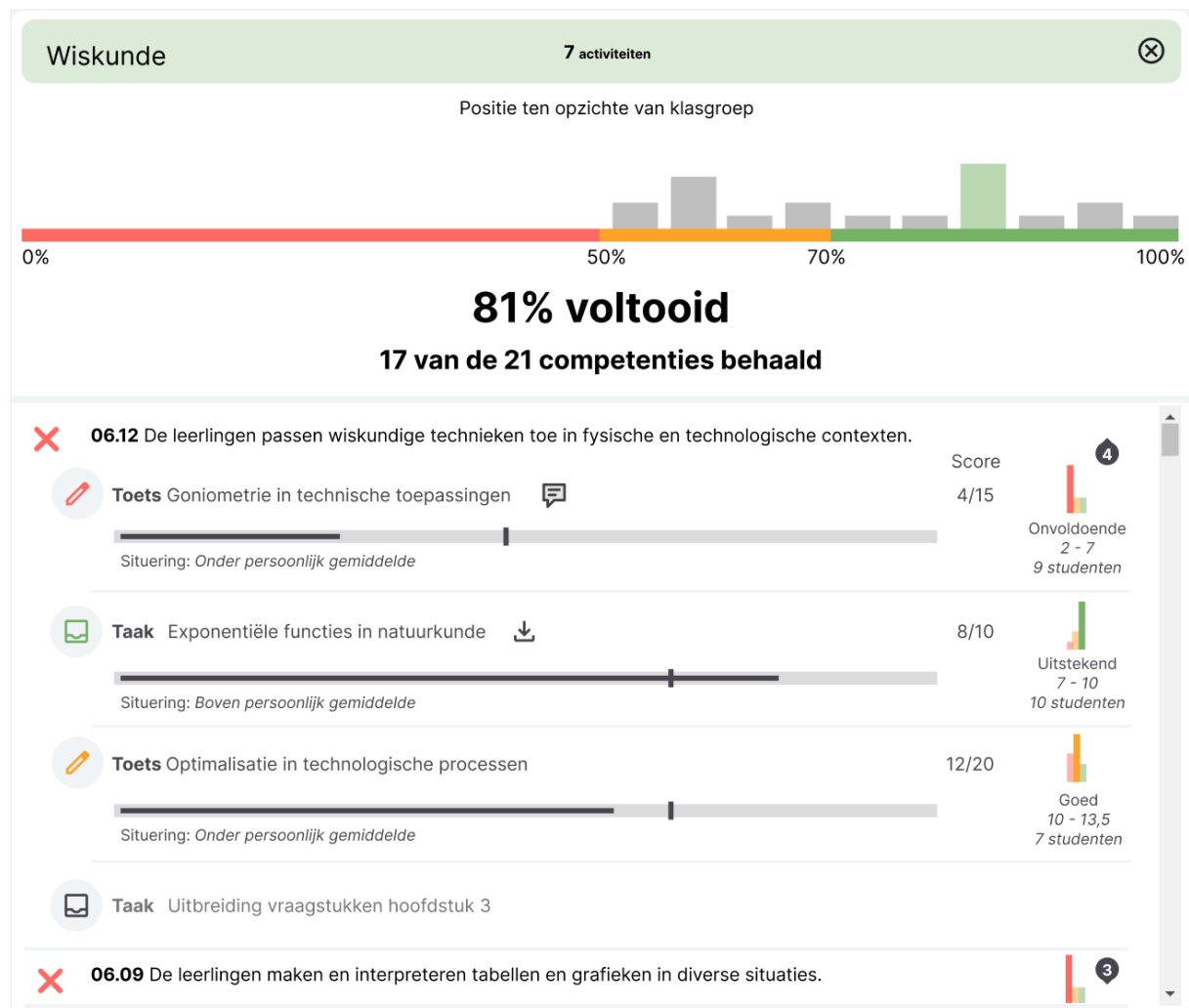


Figure 4.5: Competency-level detail view showing individual activities, including score, activity type, and visual comparison with class performance.

Each activity is shown with:

- The type of activity, such as a test, assignment, or exam
- The score obtained by the student
- A class distribution chart for comparison with peers

This allows teachers to assess whether the student is performing according to their expected ability level or not. Activities that have not been completed or not yet evaluated are displayed in grey, indicating that no result is available yet.

This screen provides detailed insight into the student's development for each competency and supports data-driven evaluation.

4.2 End-user evaluation and design justification

4.2.1 Design decisions on data visualization and sorting logic

Throughout the design process, multiple iterations were made based on testing, user feedback, and self-reflection. Earlier versions and design sketches can be found in Appendix D.3.

One key design question concerned whether to include class distribution charts directly on each subject card. In the early versions, these charts were hidden to avoid overwhelming users with too much visual information. The assumption was that displaying complex charts too early might confuse or distract teachers.

However, feedback from the second workshop (Section 3.7.2) challenged this approach. Teachers indicated that the charts became valuable once they started exploring the dashboard. They appreciated the visual comparison between individual and group performance, which helped them interpret student progress. As a result, the charts were included in the subject view, while keeping the overall interface clean and focused.

Another design decision involved how to sort subjects in the dashboard. Different sorting methods were explored, such as ordering subjects by weekly teaching hours, by the number of linked activities, or by performance score.

Each approach had its benefits, but in the end, flexibility was prioritized. Teachers now have control over the sorting logic. While some preferred sorting by teaching hours, most already had a sense of each subject's weight. Instead, the final design highlights the number of activities per subject, which was considered more informative and actionable.

This context shows how design decisions were shaped by real classroom needs. A consistent goal was to balance clarity and detail, with user input playing a key role in deciding both which data to show and how to present it effectively.

To support understanding and communication, a short demonstration video was created. This video walks viewers through the dashboard's key features and explains how it can be used.¹

4.2.2 Key insights from user feedback

This section brings together the main findings from two key user evaluation moments: the co-design workshop (20/10/2024, Section 3.4.1) and the structured feedback session at GITO Overijse (28/02/2025, Section 3.7.2). These sessions provided valuable insights into how teachers interact with the dashboard, what features they consider most helpful, and which areas require refinement.

Across both sessions, participants consistently highlighted the importance of clarity, flexibility, and minimal interaction effort. Teachers responded positively to the visual presentation of data and expressed a strong preference for interfaces that support quick decision-making. At the same time, they identified several usability challenges, particularly during first-time use, and shared suggestions to better support individual student analysis.

Table 4.1 summarizes the most recurring insights across both sessions, and how these were addressed in the final design.

¹Video presentation available at: <https://youtu.be/FRValUEIaqI>

Insight	Design response
Visual overview of student progress is clear and helpful	Maintained and emphasized in all views
Initial screen feels overwhelming at first use	Simplified layout and clearer visual hierarchy
Need to filter data by subject	Added filters at dashboard level
Prefer minimal manual input	Click-based navigation and low-input design
Desire to view individual students in detail	Addition of student profile, notes, and in-depth competency views
Notes and commentary features are valued	Kept note-taking options, evaluated deeper integration
Dashboard seen as a clear improvement over current tools (e.g., Moodle exports)	Confirms added value of visual dashboards

Table 4.1: Summary of key user insights and corresponding design decisions

These insights reinforced the core design principle behind CLAIRE: Support quick, informed, and personalized decision-making through clear visuals, intuitive navigation, and minimal interaction burden.

In both sessions, teachers responded positively to the potential of the dashboard to reduce complexity and make progress visible at a glance. User feedback also confirmed that unfamiliar visualizations (e.g., class distributions, evolution charts) can become meaningful and usable with small additions like tool tips, better grouping, and clear legends.

4.2.3 Recognition and development of CLAIRE



Figure 4.6: CLAIRE logo, generated using DALL·E via Microsoft Copilot [44].

As the design gained maturity, it grew into a more complete and usable tool. It also started to attract attention beyond the immediate project context. To reflect this, the prototype was given a clear identity: it is now called **CLAIRE**, short for **Competency Learning Analytics for Insights and Reflection in Education**.

An early public mention of the CLAIRE prototype occurred during the Learning Bytes Festival [29], a professional event focused on educational innovation and technology. The dashboard was briefly presented as part of a broader discussion on data-driven education tools by the Eummena team [36]. This initial exposure highlighted external interest in the dashboard's potential to support data-informed decision-making in schools.

CLAIRE is intended not only as a POC, but also as a foundation for future dashboards, both within the pilot school and potentially in broader educational contexts. The logo (Figure 4.6) was created using the DALL·E image generation model by OpenAI, accessed via Microsoft Copilot [44].

Chapter 5

Implementation

This chapter presents the technical implementation of the CLAIRE dashboard. It describes how the tool was connected to the existing learning platform Moodle, and how the user interface was developed based on earlier design decisions. The work was carried out in collaboration with Eummena, who supported the setup and integration process.

The main goal was to create a working version of the dashboard that could be tested in a realistic environment. Instead of a static prototype, CLAIRE was made accessible directly from Moodle, allowing it to be used in a realistic educational setting. The visual interface was designed to help teachers better understand student progress data, while the technical structure behind it supports future use and further development.

A live demo of the current version is available at <https://claire-thesis.netlify.app/>, the source code can be found at <https://github.com/JonasVanHove/CLAIRE>.

5.1 Plan of approach and technical partner requirements

The final design can now be executed and implemented. However some agreements still need to be made. The POC of CLAIRE must run on a Moodle environment, as our partner school GITO Overijse uses Moodle in their daily practice. In consultation with Eummena, a Learning Tools Interoperability (LTI) solution was chosen. An LTI is a standard that enables seamless and secure integration of external tools into learning management systems. This approach works well with Moodle because it preserves the full interface of the external tool and uses Moodle's existing authentication and role management. Compared to a custom plugin, the main drawback of a plugin is the limited screen size. Developing a plugin often hides a large part of the dashboard within Moodle's frame. By using LTI, user credentials are passed through and access to CLAIRE is granted without embedding constraints.

The agreement with the technical partner, Eummena, states that I am responsible for the front end. Eummena will develop and support the backend API and the data infrastructure. They will also maintain the Moodle environment. As a fallback plan, I will use my own generated data to minimize disruption to development.

An abstracted English version was created to ensure clear communication with Eummena (Figure 5.1). For API development, this API will perform data calls to the partner's database and supply the dashboard with data. The dashboard remains responsible only

for visualization. Some assets of this documentation can be found in Appendix E.



Figure 5.1: Abstract English rendering of the global view of CLAIRE for the API documentation

5.2 Moodle explanation

Moodle is a free learning platform that helps teachers create custom online learning environments [35]. It supports a range of activities, from course delivery and assessment to forums and multimedia resources. Moodle is a widely used LMS that provides plugin APIs, allowing external tools to add features and integrate with its interface.

A Moodle plugin is a package that adds extra features (such as activities, blocks, or reports) and can be installed and activated by site administrators. After being added to a course or the system, the plugin's PHP code, templates, and assets are loaded within Moodle's existing page structure. Configuration options appear in the site administration menu. Permissions are controlled through Moodle's role-based access system. Because plugins run inside Moodle pages, they do not require end-users to install software on their devices. The plugins can be enabled or disabled centrally per course or across the entire site.

Moodle plugins must conform to the platform's standard layout and theme grid, which fixes the width and height of content regions. Dashboard elements are therefore restricted to the central content area and cannot occupy the full browser window, limiting space for charts and interactive widgets. The persistent header and navigation blocks further reduce vertical real estate, often forcing users to scroll to view detailed data. As a result, densely packed analytics dashboards can lose clarity and usability when embedded as plugins. To fully exploit screen space and display high-resolution visualizations, a standalone application or a specialized full-screen component is preferable to the traditional Moodle

plugin model.

5.3 Why CLAIRE uses LTI

The LTI standard was developed to enable seamless and secure integration of external learning applications into learning management systems [25]. It provides a common protocol for exchanging user identity, roles, and context between an LMS and a tool provider. By leveraging LTI, teachers can access CLAIRE directly from Moodle without needing separate credentials. This reduces user friction and administrative overhead, enhancing the overall user experience. Furthermore, LTI supports fine-grained access control, ensuring that only authorized roles can reach sensitive dashboards. Another advantage of LTI is that users are redirected to CLAIRE in a new browser tab, allowing the dashboard to be viewed in full screen mode rather than within a constrained Moodle frame. This aligns with institutional requirements for data security and privacy, as user roles are validated before any data is transmitted. Finally, because LTI is widely adopted and maintained by a broad community, it ensures long-term compatibility and reduces the risk of vendor lock-in.

5.3.1 LTI Implementation

Upon receiving an LTI launch request, the server invokes the `lti.onConnect` handler with a validated token object. The handler extracts the user identifier and optional email claim from the token, providing default values when necessary. Next, it retrieves the list of role URIs from `res.locals.context.roles` and normalizes them by splitting on the “#” character. Filtering against a predefined list of allowed roles produces a clean set of role names relevant to CLAIRE. To enforce access control, the implementation defines an `accessRoles` array containing instructor-type roles. A simple check using `Array.prototype.some` determines whether the user holds any of these roles.

Access control: only allow specific roles to access the dashboard.

```
const accessRoles = \[
  "Instructor",
  "Teacher",
  "Administrator",
  "Mentor",
  "TeachingAssistant",
];
```

Students and parents are not permitted to access CLAIRE. If they are redirected there, they receive an error message stating that they lack the necessary role. So if the check fails, the server returns an HTTP 403 response with a descriptive error message. Authorized users are then redirected to the front-end dashboard URL, with their user ID, email, and roles serialized as query parameters. This method allows the React application to customize the interface and enforce its own UI-level safeguards. Additional LTI claims, such as the user’s full name or locale, can be forwarded in the same way by extracting them from the token and URL-encoding them into the redirect URL. However, this capability lies outside the scope of the POC. The LTI integration is based on the open-source `ltijs`

library by Cymcosta [60], which was extended with custom access control logic tailored to CLAIRE’s needs.

5.3.2 LTI access flow

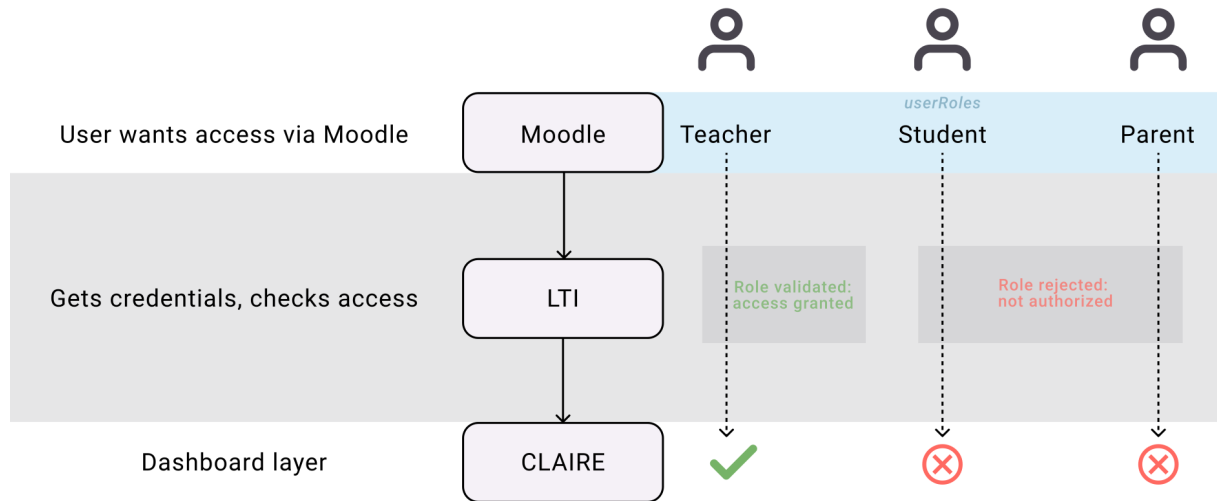


Figure 5.2: LTI-based role validation flow for accessing CLAIRE via Moodle. Only users with authorized roles (e.g., Teacher) are granted access to the dashboard. Students and parents are rejected during the credential check.

To better understand the technical architecture, Figure 5.2 provides a simplified view of how CLAIRE is accessed through Moodle using the LTI standard. This overview illustrates the separation of concerns: Moodle initiates the request, LTI handles identity and role verification, and CLAIRE handles the dashboard interface.

5.3.3 Ngrok for local development and LTI integration

During development, CLAIRE is not yet hosted on a public domain. To enable Moodle to communicate with the local development server, the tunneling tool ngrok is used [38]. Ngrok exposes the locally running front end and backend of CLAIRE to the internet via a secure, temporary HTTPS URL. This URL can then be registered in the Moodle administrator panel as the launch URL for a specific course (Figure 5.3).

External tool configuration

Expand all

Tool settings

Tool name	CLAIRE
Tool URL	I https://6d58-2a02-a03f-87db-6300-1cf5-8550-4225-c44.ngrok-free.app/
Tool description	
LTI version	LTI 1.3
Client ID	uAnggslsmXoxeqK
Public key type	Keyset URL
Public keyset	II https://6d58-2a02-a03f-87db-6300-1cf5-8550-4225-c44.ngrok-free.app/keys
Initiate login URL	III https://6d58-2a02-a03f-87db-6300-1cf5-8550-4225-c44.ngrok-free.app/login
Redirection URI(s)	I https://6d58-2a02-a03f-87db-6300-1cf5-8550-4225-c44.ngrok-free.app/
Custom parameters	

Figure 5.3: Configuration of the external tool CLAIRE using ngrok during development. The screenshot shows: I. URL pointing to the application, II. URL for the public keyset, III. login initiation URL.

In this configuration, Moodle uses the ngrok-generated public address to send LTI launch requests to the local CLAIRE server. This allows for full testing of the authentication and role validation flow during development without requiring deployment to a production environment.

The ngrok URL is updated with each new tunnel session. Therefore, the Moodle configuration must be updated whenever the local server is restarted and a new ngrok session begins. Although this is temporary, this setup allows realistic end-to-end tests of the LTI workflow, including access control and interface display.

5.4 Front-end and design process

Visual concepts were created in Figma [21] and translated into a working interface using web technologies. The POC was implemented using Next.js, a React framework that supports server-side rendering and scalable web applications. React is based on a component model, which makes it possible to separate parts of the interface into small, reusable blocks. This helps to keep the interface consistent and easier to manage. Next.js extends React with built-in routing, faster performance, and better support for backend connections. These features are important for a LAD that needs to connect with platforms like Moodle to access student data. To build the user interface, components from the shaden/ui library were used. This library is built on top of Tailwind CSS and offers accessible, customizable, and reusable UI elements. All these tools together enabled the rapid development of a clean, responsive, and modular interface.

Visual design was not only a technical consideration, but also directly informed by

teacher feedback. During the evaluation workshop at GITO Overijse (Section 3.7.2), six teachers explicitly mentioned the use of colors as a helpful element in understanding student progress (Table 3.5). This validated the use of a custom color palette (Figure 5.4) that emphasizes key signals: for example, green (#75B265) indicates achievement, red (#FF6961) highlights underperformance, and neutral tones improve structure and readability.

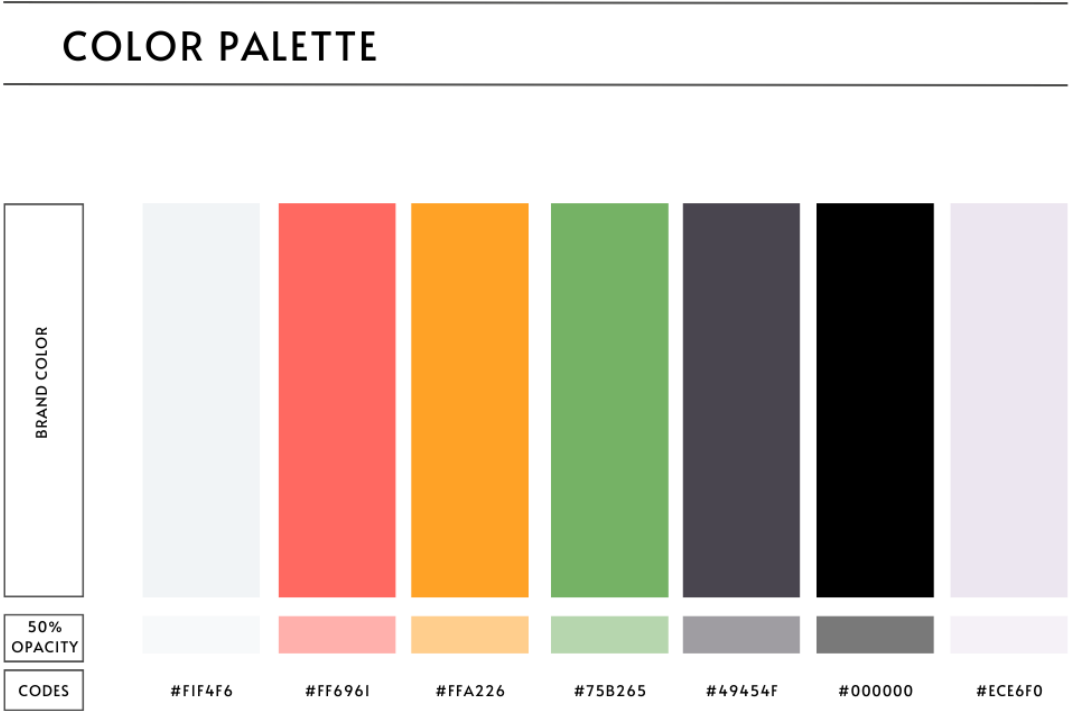


Figure 5.4: CLAIRE color palette with corresponding hexadecimal codes and opacity versions.

5.5 CLAIRE in practice

This section presents how the CLAIRE dashboard looks and functions in practice, using screenshots from the POC. Each screen corresponds to a specific view in the dashboard and highlights the key components that support teachers in their decision-making.

5.5.1 Global view: student progress overview



Figure 5.5: Overview of student progress, with five key interface components: I. student filter, II. quick overview of the selected student’s profile, including the number of competencies earned per semester, III. visual representation of the student’s performance evolution relative to the class group, IV. sorting filter for customizing the data display, and V. subject-level performance distributions per semester, showing both individual results and class benchmarks.

The global view provides a full overview of a student’s performance across all semesters. It is the first screen displayed after login and applies the principle of *overview first* [52], offering users a broad summary before they explore more detailed information. Teachers can select a student using the student filter at the top (Figure 5.5 and 5.6). They can also see a small profile summary for the selected student (Figure 5.5). This includes information on how many competencies the student achieved over time. In the center, a visual compares the student’s performance evolution to the class average. On the right, users can sort and filter how the data is displayed. At the bottom, the results per subject are shown, including how the student compares to peers.

5.5.2 Student selector and profile panel

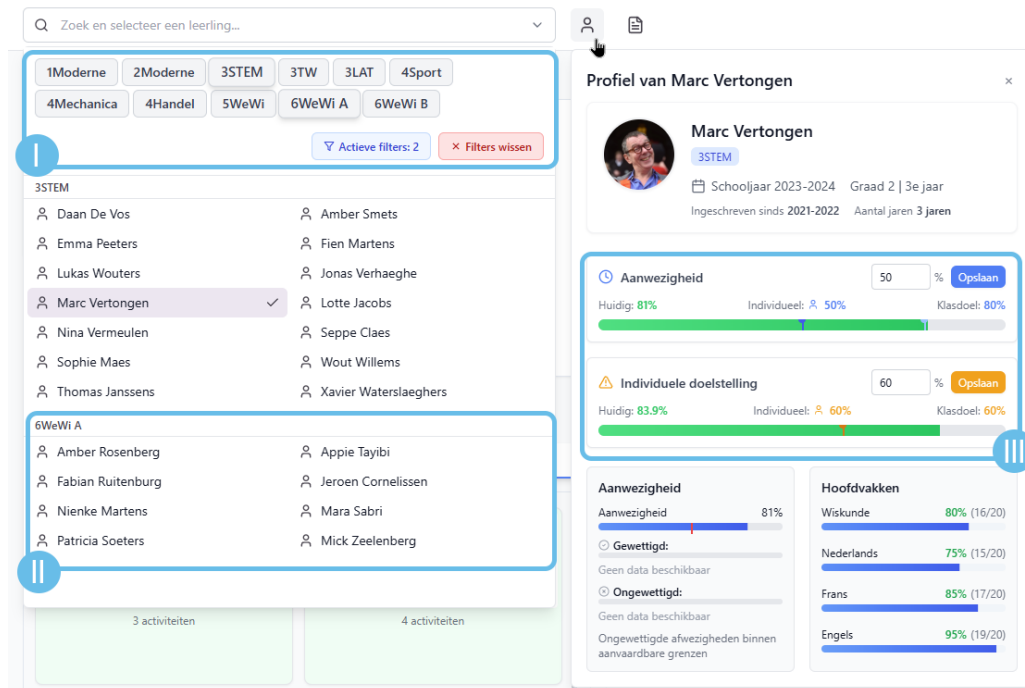


Figure 5.6: Student selection interface with three key interface components: I. filter panel to select which classes to display, including an indicator of active filters and a button to clear them, II. listing of students belonging to the selected class, and III. student profile panel showing configurable settings for individual attendance and personal learning goals.

The student selector helps teachers quickly find the relevant student by filtering on class (Figure 5.6). When no class is selected, students are grouped and displayed per class. Once a class is selected, only the students from that class are shown. On the right-hand side, a panel shows the selected student's attendance targets and individual learning goals. The user can open this panel by clicking the user icon at the top, next to the student selector. This allows quick access to key student information.

5.5.3 Student status panel

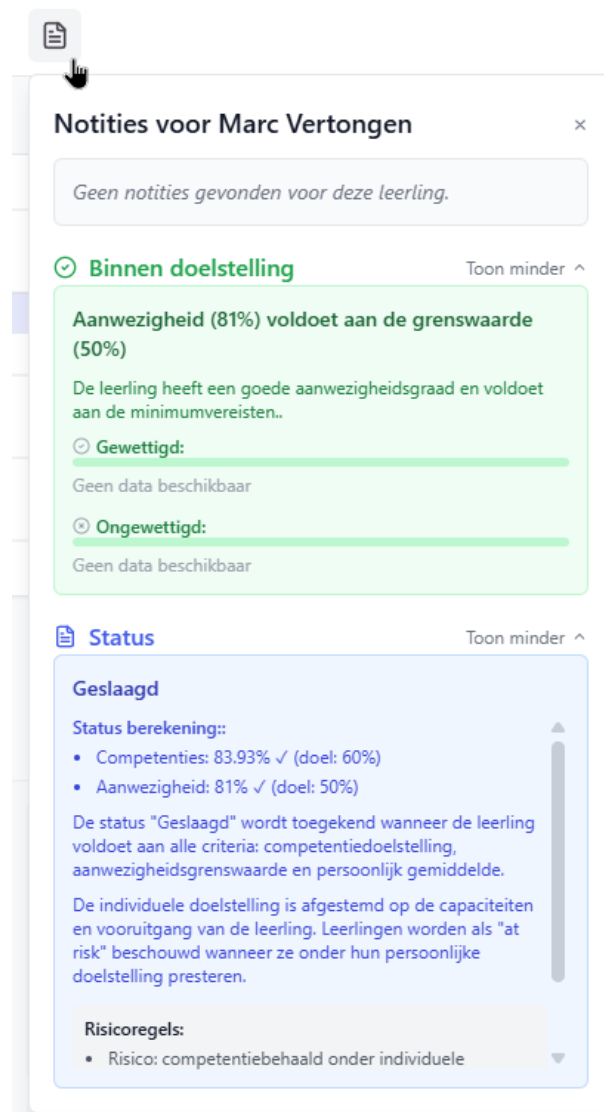


Figure 5.7: Student status panel displaying teacher notes, the configured attendance target, and the overall performance status based on attendance and competency completion.

The status panel offers a compact summary of important student information (Figure 5.7). It can be opened by clicking the notes icon. It shows the teacher's notes about the student, the set attendance goals, and whether those goals have been met. It also indicates if the student is at risk based on missed goals or incomplete competencies. This supports for example quick assessments during discussions with colleagues.

5.5.4 Settings menu

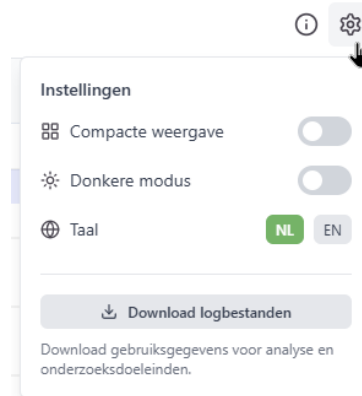


Figure 5.8: Settings menu with options for language, display mode, and log data download.

The settings menu allows users to customize their dashboard experience (Figure 5.8). Teachers can change the language, switch between light and dark mode, switch to a compact dashboard view, or download log data for further analysis.

5.5.5 Subject-level view

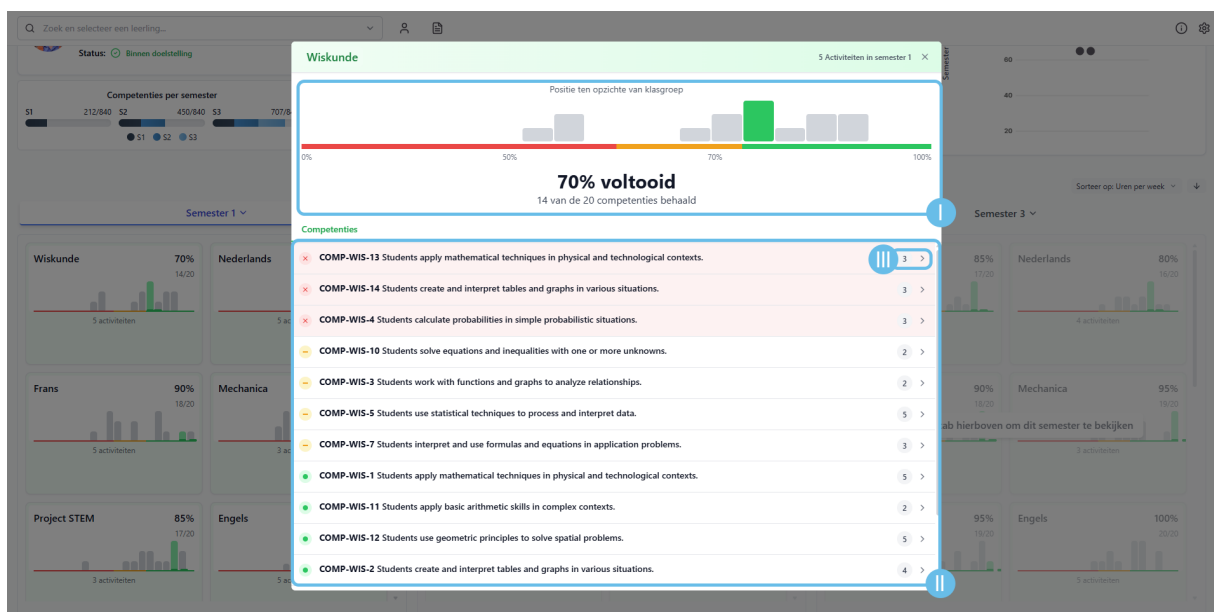


Figure 5.9: Detailed breakdown of mathematics competencies with three key interface components: I. class distribution graph for this subject, indicating the selected student's position, II. list of all competencies linked to the subject, and III. expandable indicator showing the number of recorded learning activities per competency.

When a subject is selected, CLAIRE displays a detailed view of the subject (Figure 5.9). This screen focuses on the student's performance in one specific subject, such as mathe-

matics.

The class distribution graph shows how the student compares to their classmates. All related competencies are listed, with clear labels and status. The expandable indicator shows how many learning activities contribute to each competency. This helps teachers to see which skills quickly need attention.

5.5.6 Competency-level view

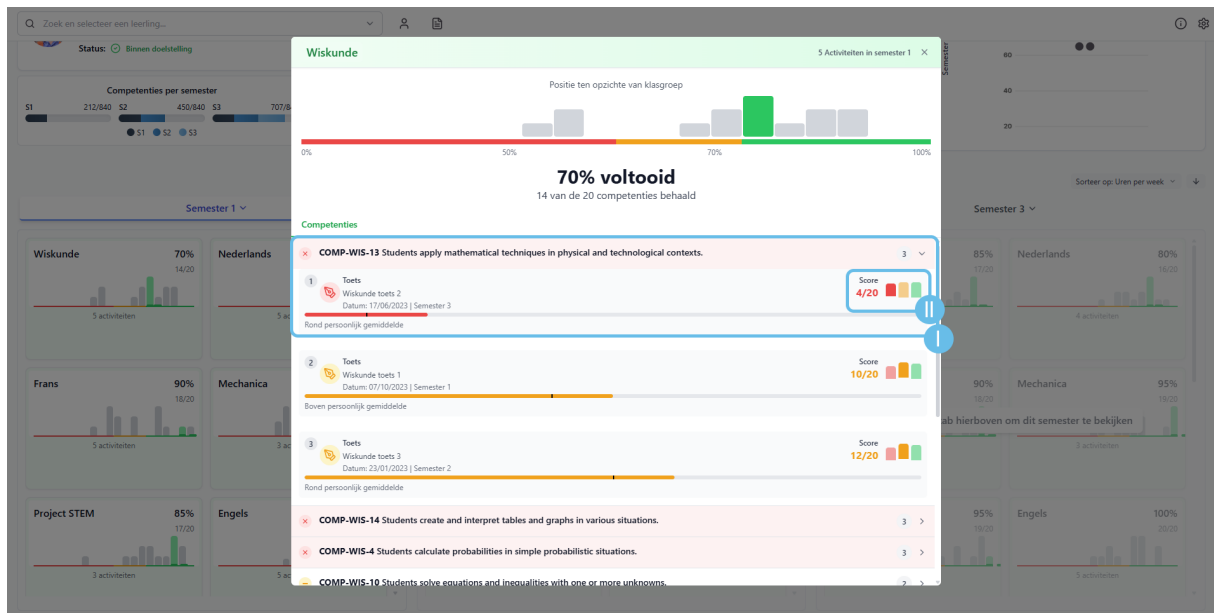


Figure 5.10: Detailed view of a specific math competency with two key components: I. learning activity that contributes to the competency score, and II. student's individual result along with the corresponding class distribution.

At the deepest level, the dashboard shows all learning activities linked to a single competency (Figure 5.10). Each activity is listed with the type (for example, test or assignment) and the student's result.

Next to it, the class distribution chart helps place the student's score in context. This view allows teachers to trace how a competency score is built up, and to detect gaps in understanding or participation.

5.6 CLAIRE front-end status and readiness

The front end of the CLAIRE dashboard has been developed through several design and testing cycles. It is now in a stable state and ready for practical use. From a user interaction and visualization perspective, the dashboard is fully functional.

All core features that were defined during the design workshops and refined through feedback sessions have now been implemented. These include layered student views that provide insights at the subject, competency, and activity levels, as well as class-level graphs that allow for comparisons between students. Each competency is accompanied by a status label—achieved, nearly achieved, or not achieved—offering a quick overview of student progress. Additionally, filters and navigation tools have been integrated to align with teachers’ daily workflows. And finally, internal notes and annotations have been included to support discussion and reflection.

During development, special care was taken to reduce visual clutter and to make the interface easy to navigate. The feedback session (Section 3.7.2) demonstrates that, after a brief walkthrough, teachers quickly found the dashboard intuitive and no longer overwhelming. What initially seemed complex became clear once they engaged with the interface. The current Moodle reports are black-and-white and contain almost no visual elements. Teachers mentioned that these reports offer little support for understanding student progress. In contrast, the dashboard’s visual design made it much easier for them to grasp patterns and insights in the data.

The current dashboard has reached a completed POC stage within the scope of this project. It provides a realistic view of how CLAIRE could be used in practice. Although the data behind the dashboard was generated for development purposes, the project structure already anticipates future use with real student data. The integration layer, based on LTI, was designed with this in mind.

A live demo of the current version is available at <https://claire-thesis.netlify.app/>, and the source code can be found at <https://github.com/JonasVanHove/CLAIRE>. The project is open source and aims to support further development in educational technology.

Chapter 6

Discussion

This chapter reflects on the implementation of the dashboard prototype. It discusses what worked well, what challenges were encountered, how the solution aligns with teacher needs and literature, and what can be improved in the future.

6.1 Results on the implementation

6.1.1 What worked well

Several aspects of the CLAIRE dashboard were positively received by teachers and aligned well with the initial user needs identified during interviews.

First, the clear and visual representation of student progress was frequently mentioned as a strength. Teachers appreciated how the dashboard made complex data more accessible and allowed them to quickly gain an overview of the class situation. This matches literature findings that emphasize the importance of simplicity and clarity in LADs, as shown in Table 6.1 [14, 49, 5, 30].

Source	Project	Key insight	Design feature
[14]	Teacher-facing LAD	Teachers preferred clear, actionable visualizations over complex analytics.	Participatory design focused on usability and insight
[49]	Dashboard design process	Involving teachers improves usability and workflow alignment.	Leads to simpler, more relevant tools
[5]	Course Signals	Traffic light indicators support timely student interventions.	Red-yellow-green risk color coding
[30]	Student Explorer	Enables advisors to interpret data quickly, even for large cohorts.	Uses tables and bar charts for quick insights

Table 6.1: Key design principles from literature on LADs

The importance of clear, actionable visualizations aligns with findings from Sousa et

al., who emphasized the need for simplicity and interpretability in dashboards for high school teachers [54].

Teachers found the use of thresholds and visual indicators (e.g., goal achievement bars) helpful to quickly identify students who might need extra attention. Although these indicators were not fully data-driven due to the lack of available student data, their conceptual implementation was well understood and valued.

The iterative design process—especially the incorporation of feedback through workshops—was effective. It led to a more refined dashboard that responded better to teachers’ practical needs. This reflects best practices in design-based research and participatory design approaches in educational technology.

6.1.2 Challenges

Several challenges emerged during the development of the CLAIRE dashboard, many of which were related to the limitations of working with a prototype and the lack of available data.

The most fundamental challenge was **translating the structure and evaluation logic of a CBE system into a usable and understandable dashboard interface**. CBE involves complex assessment frameworks, individual learning goals, and flexible progression, which are difficult to represent in a static visualization. Designing a system that could reflect this complexity while still being clear, practical, and easy to use for teachers turned out to be a continuous balancing effort.

A key issue was **the absence of real student data**, particularly attendance records. Because of this, certain planned features such as visual indicators for absenteeism risk could not be implemented or tested effectively. The same problem applied to the identification of at-risk students: without historical data or predefined rules, it was difficult to define thresholds or risk models in a meaningful way. To avoid delays in development, this limitation was addressed by generating artificial student data that mimicked realistic patterns. This approach allowed for continued design and testing of core features without relying on sensitive or unavailable school data.

The **diversity of teacher preferences** made it difficult to design a one-size-fits-all solution. Some teachers preferred detailed overviews, while others wanted only a few key indicators. This revealed the need for personalization features in future versions. It also became clear that practical subject teachers often reason differently compared to teachers of general academic subjects. Their evaluation approach tends to be more experience-based and less reliant on numeric or structured data. This contrast further complicates the design process, as the dashboard must serve users with fundamentally different expectations, workflows, and comfort levels with data-driven tools.

6.1.3 Reflection on technical choices

During this project, several technical choices were made to build the CLAIRE dashboard. These choices were based on practical needs, available tools, and the goal of long-term usability.

The front end was built using Next.js, a React framework that supports modern web development. This made it easier to create multiple views and manage the layout efficiently. The visual design used the shadcn/ui component library, based on Tailwind CSS.

This helped to create a consistent and clear interface with reusable parts.

To connect the dashboard to Moodle, the LTI standard was used instead of a classic plugin solution. This decision was important because Moodle plugins have layout limitations. They restrict the available screen space and can reduce the readability of charts. LTI allowed the dashboard to open in a full browser tab, while still using Moodle's login and role system. This made the user experience better and kept the integration secure.

For local testing, ngrok was used to simulate a public URL for the dashboard. This made it possible to test the full LTI flow without deploying the tool online. However, the ngrok link changes every time, which sometimes made testing less efficient.

One lesson learned was the difficulty of testing without real data. Because only test data was available, it was not possible to fully check how the dashboard reacts in all situations. In future versions, having access to real anonymous student data would improve testing and reliability.

Another insight was that visual simplicity is essential. Some early versions were too complex and confused first-time users. Based on teacher feedback, the interface was simplified to support faster understanding.

Beyond technical implementation, the process of iterative prototyping proved to be an essential thinking tool. Each version of the dashboard surfaced implicit assumptions, helped refine pedagogical objectives, and clarified the trade-offs between usability, flexibility, and data complexity. This reflective practice enabled more targeted design choices and deeper alignment with classroom realities.

What I would do differently in a future version:

- Start with a small but realistic dataset to test edge cases earlier.
- Add better handling for missing or incomplete data.
- Shift focus immediately to visualization concepts instead of integrating AI applications too early.

6.2 Discussion and implications

The CLAIRE dashboard was designed to support teachers by helping them interpret student performance data in a clear and structured way. Throughout the development process, user needs were gathered through interviews, a co-design workshop, and a structured feedback session. These sessions provided valuable insights into teachers' expectations, their decision-making routines, and the limitations of their current tools.

The final version of CLAIRE matches several key user expectations:

- A clear visual overview of each student's progress, which teachers found helpful for quick orientation.
- Layered structure (overview, subject, competency) supports step-by-step analysis, aligned with how teachers reflect on students during class councils.
- Ability to compare individual results with class distributions helps contextualize student performance.

- Notes and attendance information are shown alongside results, allowing a more complete view of the student.

In both workshops, teachers confirmed that the prototype responds better to their needs than current tools such as static spreadsheets or Moodle exports. They appreciated the ability to quickly switch between students and to drill down into specific subjects or competencies when needed.

However, there are still some unmet needs and areas for improvement:

- The dashboard currently focuses mainly on performance and competencies. Some teachers also wanted **behavioral indicators** or summaries of recent teacher comments [55].
- While filters and sorting options are available, a **more advanced search function** (e.g., flag students at risk) was suggested during feedback sessions [61, 30].
- First-time users found the interface slightly overwhelming without guidance. A **short on-boarding or tool tip** system could reduce this barrier [49, 9].

Additionally, while teachers expressed interest in receiving support to identify at-risk students, there was also skepticism toward automated decision-making. This highlights a key insight: dashboards should support, not replace, teacher judgment. Future versions may include optional recommendations, but these must remain explainable, adaptable, and always subject to teacher oversight [56].

This project contributes to the growing field of data-driven decision support in education. By developing CLAIRE as a working POC, the project shows how visual dashboards can support teachers in a practical and meaningful way.

Unlike many research projects that remain theoretical, CLAIRE offers a working solution that was developed in close collaboration with teachers and shaped by real classroom needs. It provides a visual layer on top of Moodle data, making student progress easier to understand, interpret, and discuss.

One important contribution is the open-source nature of the project. All code is publicly available on GitHub.¹ This allows other developers, schools, and researchers to reuse, adapt, or improve the tool. It can serve as a template for future dashboards or be integrated into other educational platforms.

The project also shows the added value of using an LTI-based integration instead of a traditional Moodle plugin. This approach gives more flexibility for design, allows full-screen dashboards, and still respects Moodle’s authentication and access controls. As a result, it creates a better user experience without sacrificing security or compatibility. It also avoids vendor lock-in and supports long-term maintainability.

These findings also resonate with key themes in the academic literature on LADs, teacher decision-making, and educational visualization. The importance of clear and layered visualization is widely supported in the literature. The dashboard follows the principle of “overview first, zoom and filter, then details on demand” [52], which is also a common guideline in dashboard design research.

Previous studies have shown that teachers prefer learning analytics tools that are easy to interpret [58] and that minimize cognitive overload during use [15]. This was reflected in

¹<https://github.com/JonasVanHove/CLAIRE>

the feedback received during the co-design sessions. Teachers preferred visual summaries over raw data tables and wanted minimal manual input. A recurring theme in recent reviews is the gap between the theoretical promise of dashboards and their actual impact on learning outcomes. This project supports the view that dashboards must be tightly embedded in teacher workflows to have practical value [27, 24]. This confirms that the focus on usability and simplicity in CLAIRE is aligned with user needs found in prior work.

The literature also stresses the importance of context when presenting learning analytics [16]. CLAIRE integrates both quantitative data (e.g. scores and distributions) and qualitative context (for example attendance goals, teacher notes). This combination supports richer interpretations, which was also appreciated by the teachers involved in this project.

One area where CLAIRE adds a new perspective is the integration of such a tool into the actual LMS environment using LTI. While most studies describe standalone dashboards, this project demonstrates how an LAD can be embedded directly into Moodle without compromising interface quality. This shows a practical pathway for adoption, especially in schools where changing core systems is not realistic.

There were no major contradictions with the literature, but one nuance emerged: some teachers needed time to get used to visual elements such as distribution charts. Although these are often recommended in research, their usefulness depends on clear explanations and intuitive design. This highlights the importance of gradual onboarding and familiarization, which remains an underexplored aspect in many academic studies.

6.3 Answering the research questions

To synthesize the findings and reflect on the original objectives of this thesis, this section explicitly answers the research questions that guided the study.

6.3.1 Sub-question 1

What are the informational and functional needs of secondary school teachers during class councils when interpreting competency-based student data?

Interviews, co-design workshops, and feedback sessions revealed several recurring needs:

- Quick overviews of student progress, with the ability to zoom into specific subjects or competencies when necessary.
- Contextual information such as notes, attendance, and personal circumstances shown alongside performance indicators.
- Early warning signals to identify students at risk, though teachers expressed some hesitation towards automated recommendations.
- Minimal manual input, as class councils are time-constrained and often cognitively demanding.
- Tools that support teacher reflection and decision-making without replacing professional judgment, especially in complex cases.

6.3.2 Sub-question 2

How can key student data be visualized to enhance clarity, accessibility, and actionable insights for teachers?

The iterative design of CLAIRE showed that effective visualizations share several features:

- Threshold indicators and goal markers that help teachers quickly identify students who may need support.
- Comparative views that place individual performance in context, such as class distributions or peer benchmarks.
- Simple, low-interaction elements like lists or summary tiles that reduce cognitive load during meetings.
- Avoidance of visual clutter. Teacher feedback led to simplifications between prototypes, reinforcing that too much detail hinders usability and trust.

6.3.3 Central research question

What design features should a dashboard have to effectively support secondary school teachers in interpreting competency-based student data?

The CLAIRE prototype demonstrates that an effective dashboard should include the following design principles:

- **Clear and layered visualizations.** Teachers benefit from hierarchical views that move from student overviews to subject areas and specific competencies.
- **Integrated context.** A combination of performance data with notes, attendance, and teacher annotations supports holistic decision-making.
- **Customizability and simplicity.** The interface should be straightforward but flexible enough to accommodate different teaching styles and preferences.
- **Seamless LMS integration.** LTI integration allowed CLAIRE to extend Moodle while maintaining authentication and offering a more usable full-screen experience.

Together, these design features make student data more actionable and relevant, helping teachers make informed and timely decisions during class councils.

6.4 Limitations

Although the CLAIRE dashboard reached a functional POC stage, several limitations remain that affect the generalization and completeness of the findings.

First, the dashboard was developed and evaluated using generated test data. No real-time or historical student data from the school's learning environment was available. As a result, some aspects of the dashboard—such as edge cases, incomplete records, or unusual student profiles—could not be fully explored. This limits the ability to assess how the tool behaves in realistic data situations. This highlights a broader challenge in learning analytics: meaningful, predictive feedback often relies on access to rich, fine-grained behavioral data [57]. Nevertheless, the available data still enabled the execution of the study, the presentation of results, and the collection of valuable teacher feedback.

Second, the evaluation was limited in scope. Although teacher feedback was collected through interviews and workshops, the dashboard was not used in an actual class council or over a longer period. This means that long-term usability, impact on decision-making, and integration into real school workflows could not be fully measured. In addition, the number of participants was relatively small and limited to a single school context, yet the findings provide meaningful insights for the design and evaluation of similar educational tools.

Third, while the LTI-based integration assumes that schools have the technical capacity and permissions to install external tools, the current implementation lowers this barrier. As a result, CLAIRE is likely to be used in the upcoming academic year, enabling further research and real-world applications. In some educational contexts, this might not be feasible without central IT support. The current prototype does not yet include role-based editing features, and students or parents cannot interact with the dashboard. However, partnerships with organizations such as Eummena offer opportunities to extend the tool's functionality in this direction. As noted by Rhoney et al., CBE must support both educators and learners in developing self-regulated learning skills [50].

The findings are grounded in the specific educational context of Flanders, and more specifically in a school where competence-based learning and Moodle are central. This context was not only a shaping factor but also a deliberate focus of the design. As such, the design is intentionally tailored to this environment and may require adaptation for use in other regions, curricula, or technical ecosystems.

These limitations do not reduce the value of the POC, but they highlight areas for future work. Real data integration, long-term evaluation, and broader testing across schools would be needed to further validate and generalize the results.

Lastly, ethical and regulatory uncertainty limits the immediate application of AI in the CLAIRE dashboard. Since the tool deals with data from minors, any future integration of intelligent recommendation systems must be accompanied by rigorous attention to privacy, transparency, and consent. Although legal frameworks for AI use in secondary education in Flanders are relatively clear, moral and ethical uncertainties remain. It is therefore essential to proceed with caution, engaging schools, policymakers, and guardians in a collaborative and transparent approach.

6.5 Future work

6.5.1 Technical improvements

Several technical extensions could further increase the value and interactivity of the CLAIRE dashboard in the future (Table 6.2).

Feature	Description
LLM	A local private AI assistant that helps teachers interpret dashboard data by answering questions, suggesting patterns, or highlighting students needing support, without sending data to external servers. A case study by Dorca and Bleda [13] illustrates how locally hosted LLMs can be used in educational settings to protect data privacy.
Student-facing version	A simplified dashboard for students, showing personalised feedback, goals, and progress in a motivating way. Encourages student ownership and reflection.
Interactive features	New options such as contacting a teacher, downloading reports, or receiving smart alerts when performance drops below thresholds. These features support communication and follow-up.

Table 6.2: Possible technical extensions to the CLAIRE dashboard

These features would turn the dashboard from a passive tool into an active assistant for both teachers and students.

6.5.2 Broader use cases

Although CLAIRE was designed for use in secondary education, the core concept could be adapted to other educational contexts. In adult education, dashboards could help instructors monitor learner progress across modular programs or flexible schedules. In art academies, learning outcomes are often qualitative and portfolio-based. A modified version of CLAIRE could visualize evaluation criteria, milestones, or feedback history per student. Technical schools might benefit from a dashboard that connects theoretical and practical performance, especially when students alternate between workplace learning and classroom instruction. These examples show that visual dashboards are useful beyond traditional subjects, as long as the data structure and educational goals are taken into account.

6.5.3 AI and ethical considerations

The future integration of AI into educational dashboards brings both opportunities and challenges. AI tools could support teachers by predicting learning risks, identifying patterns, or recommending interventions. However, these possibilities come with serious ethical concerns. Responsible AI integration in education must prioritize human oversight, fairness, and student rights, especially in high-stakes environments involving minors. This introduces additional ethical and practical complexity. In Belgium, while legal frameworks such as the GDPR clearly regulate the use of student data [6], the ethical boundaries of AI-driven decision-making in education are still evolving. Applying predictive models or recommender systems in real school contexts therefore requires caution. Before large-scale AI functionality can be responsibly deployed, clear guidelines on data governance, informed consent, and accountability must be established. Designers and developers must ensure transparency, avoid bias, and respect the rights of students and teachers. Responsible innovation in educational AI means putting people first, especially in contexts where data sensitivity is high and trust is essential.

6.5.4 Prototyping as a design method

The development of CLAIRE highlighted the value of prototyping not just as a technical step, but as a method of inquiry. Each iteration served to test assumptions, reveal hidden user needs, and navigate the trade-offs between pedagogical theory and real-world usability. Even simple early prototypes were instrumental in starting conversations with teachers and refining the dashboard's role within existing workflows. This underscores the importance of prototyping as a tool for participatory and reflective design, especially in complex educational contexts.

Chapter 7

Conclusion

7.1 Summary of key findings

This thesis explored how a learning analytics dashboard can support secondary school teachers in interpreting student data during in a CBE context. Three dashboard prototypes were developed and refined through participatory design with teachers. The main findings are as follows. Teachers appreciate structured overviews of student competencies, but the dashboard must remain simple and flexible. Visualizations should balance class-wide patterns and individual student performance. Teachers find actionable suggestions helpful, but they need to be clearly explained and easy to interpret. There is interest in AI-driven support, but teachers want to remain in control and avoid black-box systems. The final prototype, CLAIRE, shows that a carefully designed dashboard can provide relevant support for decision-making in the Flemish CBE system.

7.2 Reflection on the thesis contribution

This thesis contributes to both academic and practical understanding of dashboard design for secondary education. It addresses a gap in the learning analytics literature by focusing on class council support in schools using competency-based assessment. Methodologically, it applied a user-centered and iterative design process, combining co-design workshops, feedback sessions, and low-fidelity prototyping. The resulting dashboard is technically feasible within Moodle and compatible with existing educational workflows. Although the study lacked large-scale student data, it demonstrates that meaningful design can emerge from qualitative insight and teacher collaboration. This approach highlights the value of working closely with educators, especially in contexts where data access is limited.

7.3 Final thoughts

Despite some challenges, such as limited real data and skepticism about automation, this project achieved its main goal. It delivered a working proof of concept that supports teachers in their day-to-day decisions during class councils. Rather than focusing on advanced algorithms, the thesis prioritized clarity, teacher trust, and practical usability. Future development may include predictive models or intelligent suggestions, but only if teachers remain part of the design process. This thesis argues that good visualizations, combined with thoughtful design, can already provide powerful support for teacher decision-making.

Appendices

Supplementary materials for the study, including dashboards, prototypes, ethics documents, and API details.

Appendix A

LAD examples

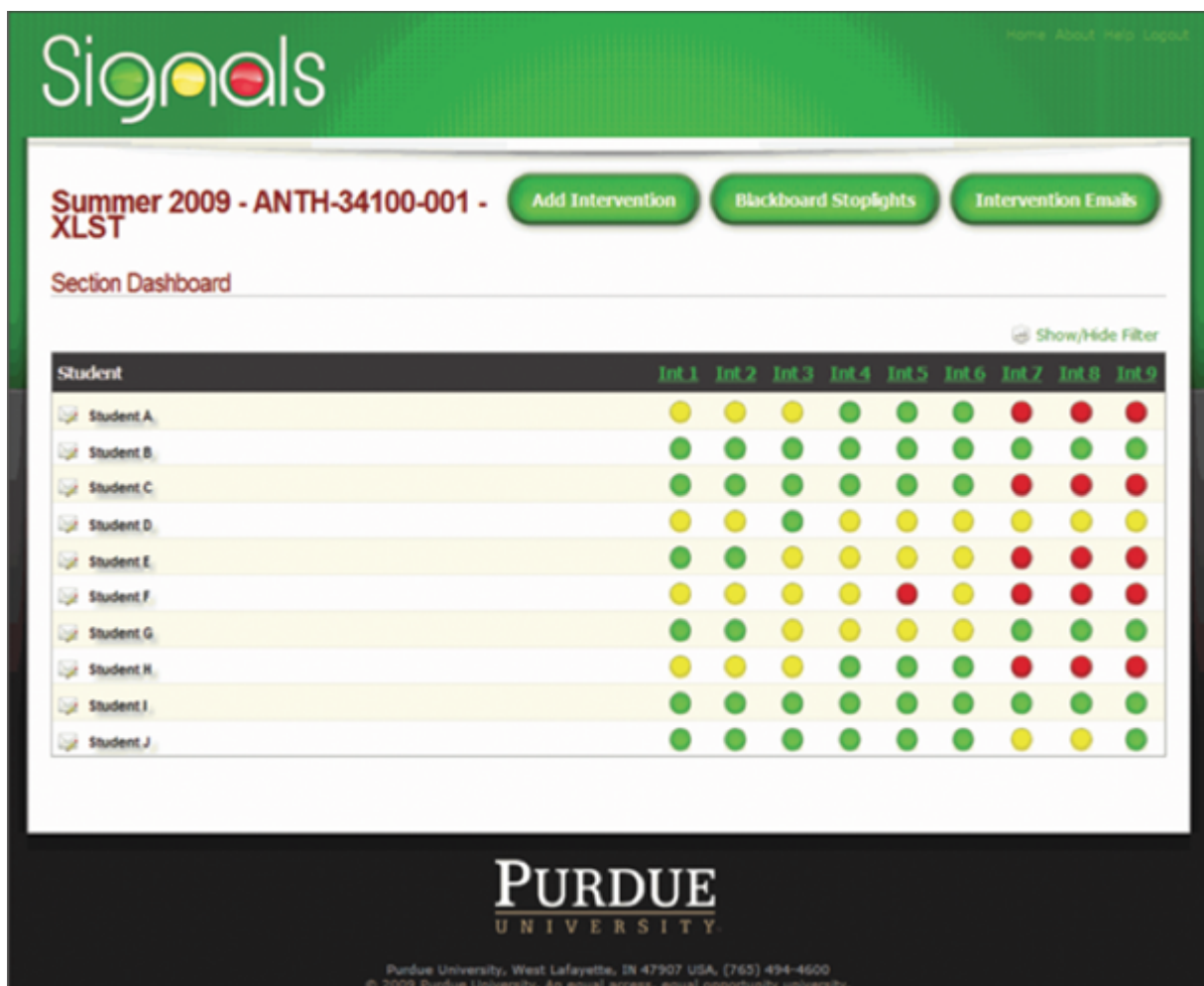


Figure A.1: Course Signals dashboard [5] in a learning management system, using red-amber-green traffic lights to indicate each student's risk level of falling behind.

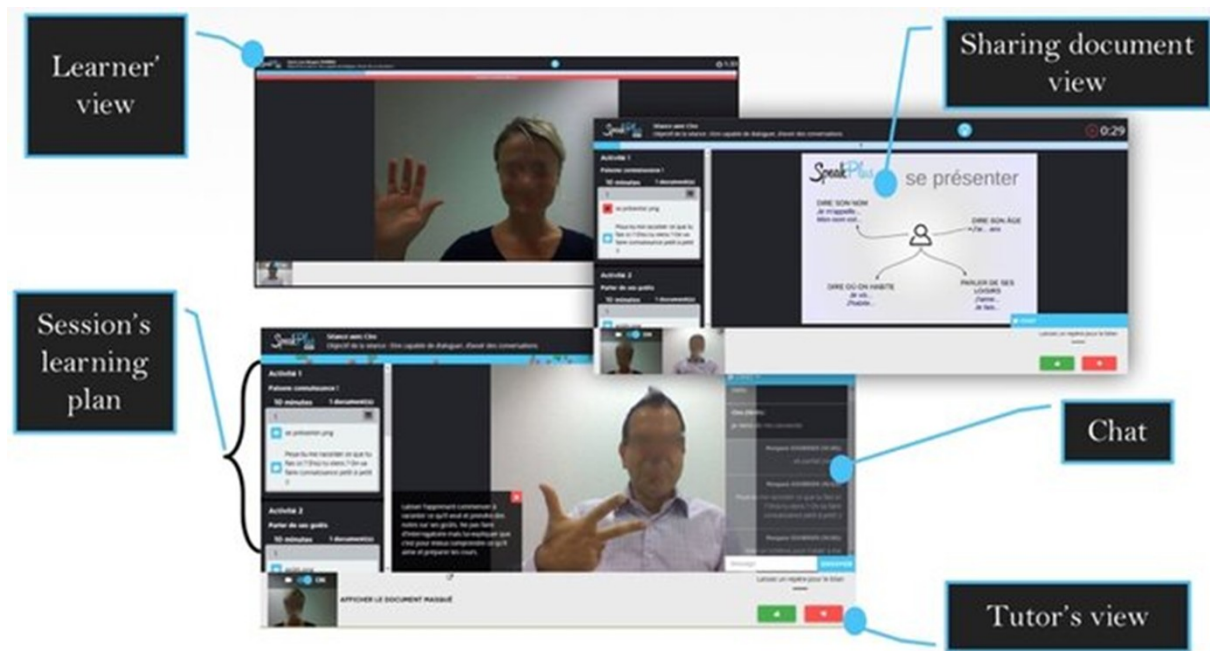


Figure A.2: EMODA system interface [19] showing real-time emotion analytics derived from synchronized audio and video streams.

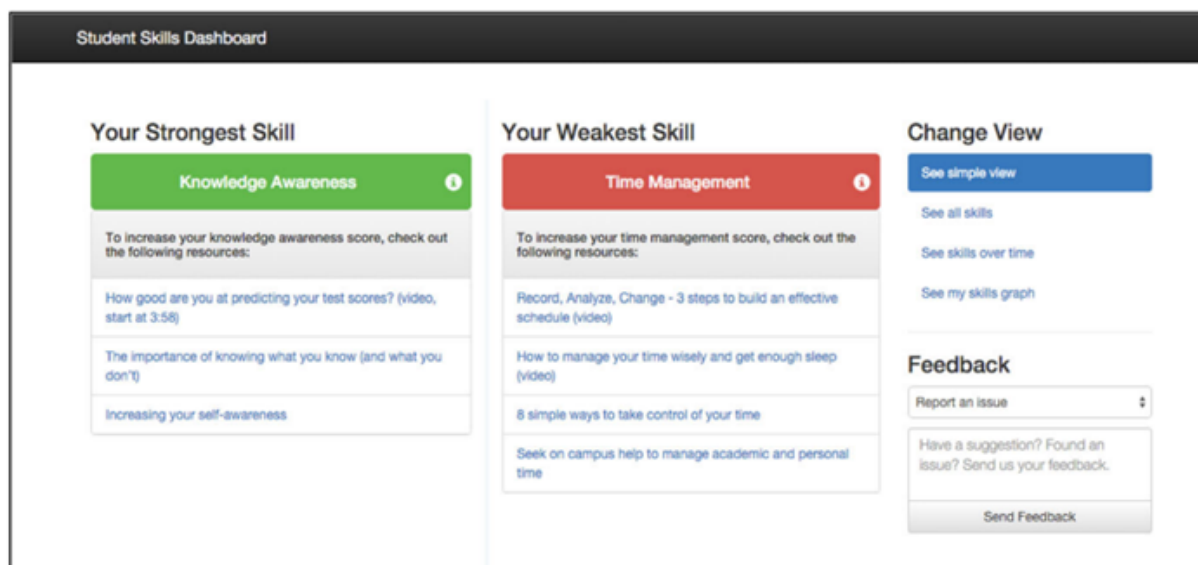


Figure A.3: Student Skills Dashboard [7] showing the learner's strongest skill ("Knowledge Awareness") in a green panel and weakest skill ("Time Management") in a red panel, each accompanied by targeted resource recommendations; the sidebar provides options to change views and submit feedback.

LearnSmart

HI LISA!

DASHBOARD
SUBJECTS +
CLASSROOMS +
PROFILE
ACCOUNT
LOG OUT

Question 2

Attempted by 24 students so far.
33% answered correctly on their first attempt.

A horizontal conveyor belt at an airport requires a constant force of 44 N to move at 2.0 ms^{-1} when there is no luggage on it.

The belt is then loaded with luggage at an average rate of 12 kg s^{-1} . What is the new total force required by the conveyor belt in order to maintain its velocity as the luggage is being loaded onto it?

A 24N B 44N C 64N D 68N

CONCEPTS? HINT? Report this Question

What's your answer?

☐ A
☐ B
☐ C
☐ D

Are you sure about this? [?]

☐ Not really confident
☐ Quite confident
☐ I am 100% sure my answer is correct

Learning Criteria [?]

Newton's Second Law of Motion
Progress bar: 0% to 100%

Using $F = ma$ and Free Body Diagrams
Progress bar: 0% to 100%

QUIT SKIP SUBMIT ANSWER

Figure A.4: LearnSmart App dashboard [31] displaying simple bar charts and tables to track learner progress and mastery of topics on a mobile device.

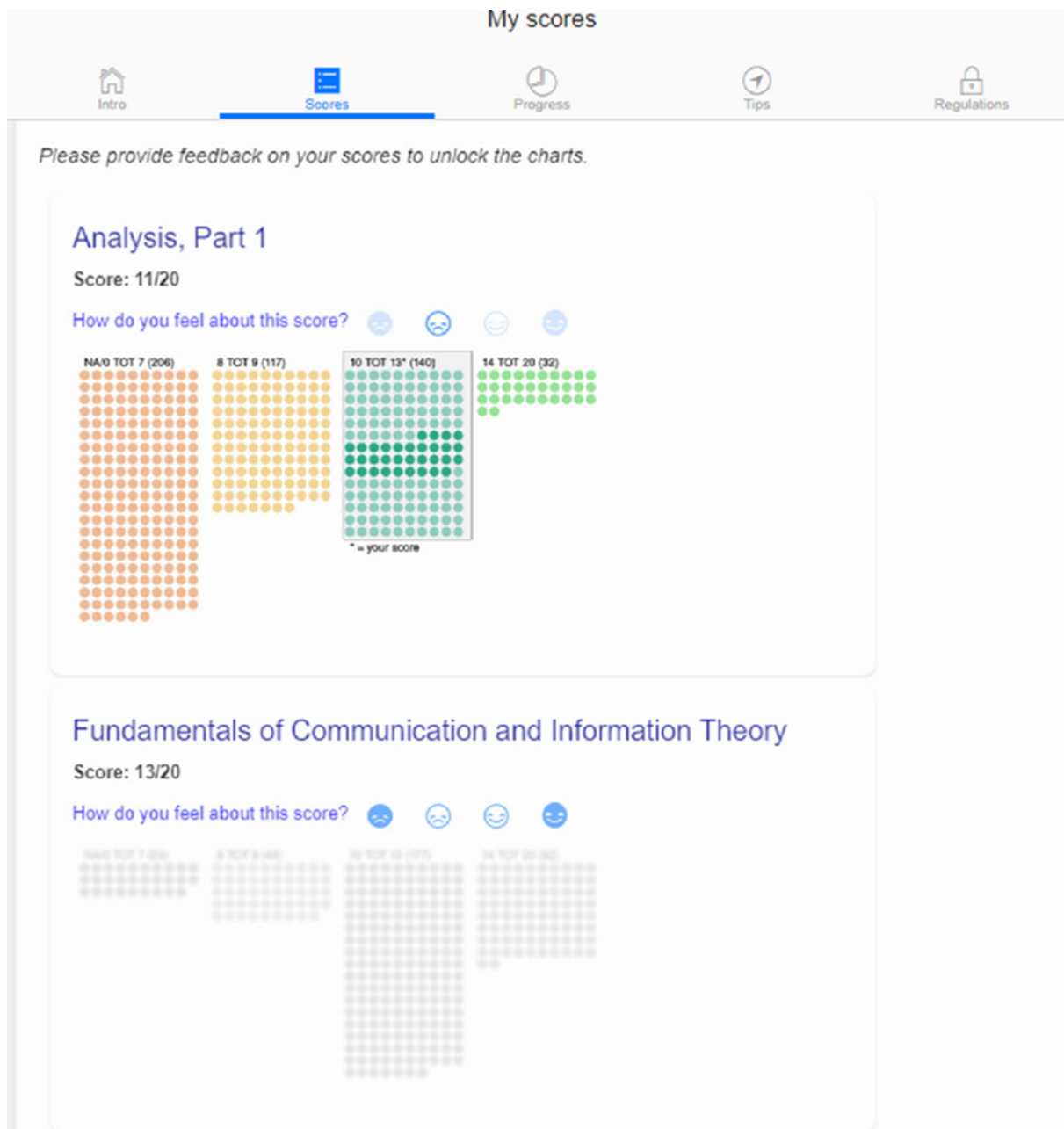


Figure A.5: REX dashboard [8] displaying exam performance with bar charts and emotive icons to prompt early intervention conversations.

Appendix B

Ethics application

Before the fieldwork of this study could be carried out, an ethics application was submitted to the KU Leuven Social and Societal Ethics Committee (SMEC). The committee reviewed and approved the proposed research activities. This appendix includes the following documents:

- The submitted PRET application form;
- The questionnaire used to gather teacher feedback;
- The informational brochure shared with participants;
- The signed confirmation of consent.

2.ALGEMEEN

ONDERZOEKERS

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u0040828

Oefent de promotor een gezondheidszorgberoep uit in de zin van de wet van 10 mei 2015? nee

Andere KU Leuven onderzoekers:

FINANCIER

Wordt het onderzoek gefinancierd (bijvoorbeeld in het kader van een onderzoeksproject/ contract/ mandaat)? nee

Dienst die instaat voor afgesloten of nog af te sluiten contracten:

VOORNAAMSTE / LEIDENDE ETHISCHE COMMISSIE

De voornaamste / leidende ethische commissie: SMEC

3.ONDERZOEK

BESCHRIJVING EN DOELSTELLINGEN

scite_

- 6 en volledige titel van het onderzoeksproject / protocol:
- 0 ing learning data into meaningful learning analytics dashboards (Leergegevens omzetten in zinvolle
- 0 analysedashboards)
- 0 jving van het onderzoeksproject / protocol:

Leraren spelen een cruciale rol in het begeleiden van studenten naar succes. In grote klassen of online leeromgevingen is het echter moeilijk om individuele studenten nauwgezet op te volgen. Dit onderzoek ontwikkelt een dashboard dat leraren ondersteunt bij het analyseren van de voortgang van studenten en hen helpt beslissen wanneer en hoe ze studenten gepersonaliseerd kunnen ondersteunen tijdens klassenraden

De interesse in LA in het onderwijs groeit, maar er zijn nog veel vragen over hoe dergelijke technologieën leraren praktisch kunnen ondersteunen. Dit onderzoek richt zich specifiek op de behoeften van leraren en onderzoekt hoe een data driven dashboard hen kan helpen efficiënter en effectiever te werken. Het draagt bij aan het wetenschappelijk debat door praktische oplossingen te ontwikkelen en te testen.

Doelstellingen van het onderzoek(sproject):

Het onderzoek richt zich op de ontwikkeling en evaluatie van een dashboard dat leerkrachten ondersteunt tijdens klassenraden. Dit dashboard biedt beter inzicht in de voortgang van studenten en helpt leerkrachten om gepersonaliseerde ondersteuning te bieden. Het hoofddoel is om de werkdruk van leerkrachten te verminderen en hun besluitvorming te verbeteren.

Door het dashboard te laten evalueren door leerkrachten, wordt niet alleen het gebruiksgemak getest, maar ook de impact ervan op hun dagelijkse werkprocessen. De resultaten van dit onderzoek leveren waardevolle inzichten en praktische aanbevelingen op voor de integratie van LAD's in het onderwijs.

ETHISCHE RECHTVAARDIGING ONDERZOEK

Omschrijving ethische rechtvaardiging onderzoek:

Dit onderzoek heeft maatschappelijke waarde doordat het informatievisualisatie inzet om leerkrachten te ondersteunen bij het beter volgen van de voortgang van studenten tijdens klassenraden. Wetenschappelijk draagt het bij aan het veld van analytics in het onderwijs en de toepassing ervan voor datagestuurde beslissingen. De selectie van deelnemers (leerkrachten) is eerlijk en vrijwillig, waarbij geïnformeerde toestemming wordt verkregen. De risico's voor de deelnemers zijn minimaal, en de opbrengst, zoals verbeterde onderwijspraktijken, wegen zwaarder. De privacy van de deelnemers wordt gewaarborgd en hun deelname kan op elk moment worden stopgezet zonder negatieve gevolgen.

ONDERZOEKSTECHNIEKEN, INSTRUMENTEN & APPARATUUR

Vragenlijst: ja

Niet-gevalideerde vragenlijst: ja



Vragenlijst Learning Analytics.pdf
393,63 kB

Interview: ja

Niet-gevalideerd interview: ja

Geen bijlage beschikbaar: Het interview is het overlopen van de vragenlijst (zie vorige) voor verdere toelichting van de deelnemer.

Video/audio-opnames: ja

Het interview met de deelnemers wordt opgenomen en wordt enkel gebruikt als verwerking. Deze opnames worden nadien verwijderd.

ONDERZOEKSMETHODOLOGIEËN

Methodologieën en praktische procedures:

De methodologie omvat kwalitatief onderzoek met semigestructureerde interviews van 5-8 leerkrachten om hun behoeften en ervaringen met het voorgestelde LAD te verzamelen. De gegevens worden geanalyseerd door middel van thematische analyse om inzichten te verkrijgen voor de ontwikkeling van een Moodle-plugin. De praktische procedures omvatten het selecteren van deelnemers, het uitvoeren van de interviews, het anonimiseren van gegevens en het analyseren van de resultaten om het ontwerp van de plugin te verbeteren.

Aspecten van het onderzoek die een eventuele verstrenging van de maatregelen rond COVID-19 zouden bemoeilijken:

De vragenlijst kan online ingevuld worden en de interviews kunnen ook online plaatsvinden.

VERWACHTE BEGIN- EN EINDDATUM

De verwachte begindatum van het experiment / de studie (dient in de toekomst te liggen) en de verwachte einddatum voor de deelnemers:

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atum: Het onderzoek start van zodra ethische goedkeuring wordt gegeven door SMEC.

um: 30/09/2025

4. VERZAMELEN EN DELEN VAN PERSOONSgegevens IN DE STUDIE

PRIMAIRE/SECUNDAIRE GEGEVENSVERWERKING

Verzamelt u nieuwe gegevens (primaire verwerking) en/of gebruikt u enkel eerder verzamelde gegevens (secundaire verwerking)?

Primaire verwerking: ja

Secundaire verwerking: ja

Er wordt gebruik gemaakt van eerder door uzelf verzamelde gegevens: nee

Er wordt gebruik gemaakt van eerder door iemand anders binnen de KU Leuven verzamelde gegevens in het kader van een ander onderzoeksproject aan KU Leuven: nee

Er wordt gebruik gemaakt van gegevens verkregen van een derde: ja

Derde partij: Jonas Van Hove (gegenereerde data), GITO Overijse (Leerkrachten hebben al toegang tot de data, het dashboard biedt een alternatieve en verbeterde weergave. Onderzoeker werkt op gegenereerde data tijdens ontwikkeling)

Leg uit hoe de deelnemers bij toestemming voor deelname aan het initiële onderzoek hebben toegestemd in het gebruik van deze gegevens voor verder onderzoek:

N.v.t.

EXTERNE PARTNERS

Andere niet KU Leuven onderzoekers:

Het betreft een niet-commerciële studie.

Is er naast KU Leuven nog een andere universiteit, onderzoeksinstelling of andere partner betrokken bij het onderzoek? nee

Overeenkomst:

N.v.t.

ROLLEN VAN DE BETROKKEN PARTIJEN

Wie bepaalt de doelstellingen van het onderzoek?

Dit wordt binnen KU Leuven bepaald.

Is er een andere partij betrokken die als verwerker in opdracht van KU Leuven (al dan niet samen met anderen) persoonsgegevens verwerkt (zoals bv. data verzamelen; analyses uitvoeren)? nee

DOORGIFTEN EN DELEN VAN PERSOONSgegevens

Zullen de verzamelde persoonsgegevens worden doorgegeven aan/gedeeld met personen/instanties buiten KU Leuven?

nee

PLAATS DATAVERWERKING

Waar zal de dataverzameling worden uitgevoerd?

België: ja

5. DEELNEMERS EN CATEGORIEËN VAN GEGEVENS

CATEGORIEËN VAN BETROKKENEN

Persoonsgegevens die u onderzoekt / verwerkt:

De persoonsgegevens van de deelnemende leerkrachten (vragenlijst + interview).

Zijn er kwetsbare personen betrokken? nee

Selectiecriteria:

Deelnemers dienen leerkrachten te zijn in het secundair onderwijs, met ten minste ervaring in het lesgeven, het werken met leerlingen en het deelnemen aan vergaderingen.

CATEGORIEËN PERSOONSgegevens

Categorieën van gegevens verzamelt u of gebruik u?

Alleen persoonsgegevens: ja

Identificatiegegevens (bv. namen, (e-mail)adressen)

Persoonlijke kenmerken (bv. leeftijd, geslacht)

Audio- en beeldopnames

Beroep en professionele bezigheden

Identificatiegegevens: e-mailadres

Opnames: audio-opnames

Beroep: anciënniteit

Persoonlijke kenmerken: leeftijd

Beroep: functie

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GROOTSCHALIGHEID/ KLEINSCHALIGHEID VAN DE VERWERKINGEN

Wat is het verwachte aantal personen wiens persoonsgegevens worden verzameld?

10-15 personen

Hoe verhoudt deze steekproef zich tot de relevante populatie?

De keuze om 10-15 leraren te betrekken bij dit onderzoek wordt ondersteund door recent onderzoek, waarin semi-gestructureerde interviews met 12 leraren werden uitgevoerd om feedback te verzamelen over AI-ondersteunde systemen voor het genereren van meerkeuzevraag-distractors (Szymanski et al., 2024). Dit aantal deelnemers bleek effectief voor het verkrijgen van diepgaande inzichten en het identificeren van duidelijke voorkeuren en behoeften van leraren met betrekking tot de interactie met AI-systemen. De bevindingen suggereren dat een dergelijke groepsgrootte voldoende is om representatieve feedback te verkrijgen zonder dat de gegevens te complex of moeilijk te analyseren worden.

Bronvermelding: Szymanski, M., Ooge, J., De Croon, R., Vanden Abeele, V., & Verbert, K. (2024). Feedback, Control, or Explanations? Supporting Teachers With Steerable Distractor-Generating AI. In Proceedings of the 14th Learning Analytics and Knowledge Conference (pp. 690–700). ACM. <https://doi-org.kuleuven.e-bronnen.be/10.1145/3636555.3636933>

Hoeveel gegevens verwerk je van één betrokkene en hoe divers zijn deze gegevens?

Ik verzamel gewone persoonsgegevens, identificatiegegevens (email), persoonlijke kenmerken (leeftijd), audio-opname van het interview na de vragenlijst, beroep (functie, anciënniteit) zoals hierboven vermeld.

Wat is de geografische reikwijdte van de persoonsgegevens die je verwerkt?

De data blijft binnen KU Leuven.

WERVING, BELONING EN VOORDELEN

Wie werft de deelnemers, hoe, waar en door wie gaan de deelnemers benaderd worden voor inclusie en het verkrijgen van de geïnformeerde toestemming:

De deelnemers voor dit onderzoek zullen worden geworven door de contactpersoon (zoals een schooldirecteur of coördinator, voor GITO Overijse is dit Jan Velghe) van de betrokken scholen die ik contacteer. Deze contactpersoon zal de uitnodiging per e-mail naar de leerkrachten zal sturen. In de e-mail wordt een informerende bijlage toegevoegd waarin het opzet van het onderzoek, de doelstellingen, en de voorwaarden voor deelname duidelijk worden uitgelegd. Leerkrachten die geïnteresseerd zijn in deelname kunnen zich vrijwillig aanmelden door mij een e-mail te sturen waarin ze aangeven akkoord te gaan met de voorwaarden van het onderzoek. De geïnformeerde toestemming wordt verkregen zodra de leerkrachten hun deelname bevestigen via deze e-mail.

Werving gebeurt met een poster of flyer, voeg toe als bijlage:



Informatiebrochure onderzoek masterproef Jonas Van Hove.pdf
56,19 kB

Zullen deelnemers een beloning of een compensatie krijgen voor hun deelname? nee

Geen beloning of compensatie voor deelname.

Zijn er andere voordelen verbonden aan deelname aan deze studie / project? ja

De leerkrachten kunnen hun bevindingen en ervaring delen via dit onderzoek, wat een waardevolle bijdrage kan betekenen voor het onderwijs van de toekomst. Via dit onderzoek hebben leerkrachten een extra klankbord en een kans om mee te helpen aan nieuwe oplossingen.

RISICO'S, ONGEMAKKEN EN COUNSELING

Bij mogelijk risico's en desgevallend of deelnemers een gevoel van ongemak (fysiek of psychisch), schaamte, angst, etc. kunnen ervaren in de loop van de studie:

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Enige steun of counseling aangeboden na de deelname?

6. TECHNISCHE EN ORGANISATORISCHE MAATREGELEN BIJ VERWERKING EN BEHEER VAN GEGEVENS

BEWARING VAN DE GEGEVENS

Waar worden de digitale gegevens bewaard?

Anders, namelijk ...

MS Teams (KU Leuven)

Waar worden papieren gegevens bewaard?

Er zijn geen papieren gegevens (bv. ook de geïnformeerde toestemming wordt digitaal afgenomen).

Wie heeft toegang tot de (persoons)gegevens tijdens de studie?

De betrokken KU Leuvenonderzoekers (zie pagina 2)

Wie heeft toegang tot de (persoons)gegevens na de studie?

De betrokken KU Leuvenonderzoekers, behalve eventuele betrokken studenten. (**)

Hoe lang zullen de (persoons)gegevens bewaard worden na het onderzoek?

De (persoons)gegevens worden verwijderd na 10 jaar (KU Leuven RDM-richtlijn).

ANONIMISERING / PSEUDONIMISERING GEGEVENS

Is er een ogenblik in uw onderzoek waarop u persoonsgegevens gaat anonimiseren of pseudonimiseren?

Niet geanonimiseerde of niet gepseudonimiseerde gegevens: nee

U gaat zelf persoonsgegevens pseudonimiseren.: ja

De gegevens uit het onderzoek, zoals het aantal jaren in het onderwijs (gecategoriseerd), leeftijd (leeftijdsgroepen) en e-mailadres (voor eventuele opvolging), worden gepseudonimiseerd. Dit betekent dat direct identificerende informatie wordt vervangen door codes. Alleen de onderzoeker heeft toegang tot de sleutel die de koppeling tussen de codes en de oorspronkelijke persoonsgegevens bevat. Deze sleutel wordt veilig bewaard in een versleuteld bestand en is alleen toegankelijk voor de onderzoeker. Na afronding van het onderzoek worden persoonlijke gegevens en audio-opnames verwijderd, en de gepseudonimiseerde data wordt uitsluitend gebruikt zoals beschreven in het informed consentformulier.

OVERIGE TECHNISCHE EN ORGANISATORISCHE MAATREGELEN

Neemt u nog andere maatregelen ter bescherming van de privacy van de betrokkenen?

Nee

7. INFORMATIEVERSTREKKING AAN DE BETROKKENEN/DEELNEMERS

ONDERZOEK DAT MISLEIDING INHOUDT

Zullen de deelnemers misleid worden? nee

INFORMATIEVERSTREKKING AAN DE BETROKKENEN/ DEELNEMERS

Zal de nodig informatie aan de betrokkenen worden verstrekt of werd dit reeds gedaan?

In geval van primaire verwerking: ja



Informatiebrochure onderzoek masterproef Jonas Van Hove.pdf
56,19 kB



Informatiebrief AVG.pdf
33,11 kB

In geval van secundaire verwerking: nee

N.v.t.

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6 PROCEDURE VOOR GEÏNFORMEERDE TOESTEMMING VOOR DEELNAME AAN HET ONDERZOEK.

0 Beschrijf uw procedure voor de ethische geïnformeerde toestemming in detail:

0 Afgaand aan de studie ontvangen deelnemers een informatiebrochure waarin het doel en de opzet van het onderzoek
0 elijk worden uitgelegd. De brochure beschrijft hoe het Learning Analytics Dashboard wordt getest, welke taken worden
0 ngevoerd, en hoe de gegevens worden verwerkt. Er wordt benadrukt dat deelname volledig vrijwillig is en dat alle
verzamelde gegevens anoniem en vertrouwelijk worden behandeld. Audio-opnames van mondelinge toelichtingen worden
uitsluitend gebruikt voor analyse en vernietigd zodra de verwerking is afgerond. De geïnformeerde toestemming wordt
verkregen via een eenvoudige procedure: deelnemers sturen een e-mail naar jonas.vanhove@student.kuleuven.be met de
melding "Ik ga akkoord". Hiermee bevestigen zij dat ze de verstrekte informatie hebben gelezen, begrepen en akkoord gaan
met de voorwaarden van het onderzoek. Bij vragen kunnen deelnemers altijd contact opnemen met de onderzoeker voor
verdere verduidelijking.



Geïnformeerde toestemming.pdf
109,66 kB

NABESPREKING ("DEBRIEFING")

Welke informatie krijgen deelnemers tijdens de debriefing en hoe wordt deze informatie voorzien?

Na het onderzoek wordt de deelnemer bedankt voor zijn/haar/hun medewerking. Ze krijgen daarbij ook mijn contactgegevens, voor mochten er nog vragen of onduidelijkheden zijn na het onderzoek.

INFORMATIEVERSTREKKING OVER DE RESULTATEN VAN DE STUDIE

Welke informatie wordt aan deelnemers gegeven over de resultaten van het onderzoek? Ontvangen deelnemers hun individuele resultaten of alleen de algemene studieresultaten? Hoe wordt deze informatie aan deelnemers verstrekt?

Indien de deelnemer dit wenst wordt er een kopie verzonden van de masterproef na afloop.

8. RECHTEN VAN BETROKKENEN EN RECHTMATIGHEID VERWERKING

AFWIJKING OP RECHTEN VAN BETROKKENEN

Wordt uw onderzoek ernstig belemmerd indien de betrokken personen hun recht van inzage, rectificatie, beperking van de verwerking en recht van bezwaar willen uitoefenen?

nee

RECHTMATIGHEID VAN DE VERWERKING

Geselecteerde rechtsbasis:

Universitair onderzoek wordt doorgaans gevoerd in het algemeen belang: ja

9. RISICO-ANALYSE DOOR ONDERZOEKER

Houdt het onderzoek een hoog privacy-risico in voor de betrokkenen?

Indien de gegevens openbaar gemaakt zouden worden, zou dit een grote impact hebben op de betrokkenen? nee

Werkt u met bijzondere categorieën van persoonsgegevens? nee

Verwerkt u persoonsgegevens van kwetsbare groepen? nee

Verwerkt u gegevens op grote schaal? Hou voor het beantwoorden rekening met de absolute hoeveelheid persoonsgegevens, maar ook met de grootte van de steekproef t.a.v. de relevante populatie (zie vraag 4)? nee

Worden de gegevens doorgegeven aan een land buiten de EU dat niet op de 'witte lijst' staat? nee

Gaat u verschillende (bijzondere categorieën van) persoonsgegevens aan elkaar koppelen? nee

Hebben de verwerkingen juridische gevolgen of een gelijkaardig effect voor de betrokkene zoals uitsluiting of discriminatie van de betrokkene? nee

Hebben de verwerkingen het gevolg dat de betrokkene wordt belet om zijn rechten uit te oefenen, of gebruik te maken van een dienst of contract? nee

Gaat u op systematische wijze toezicht houden op personen in openbare ruimten? nee

Dienen de verwerkingen om profielen van personen op te stellen en voorspellingen te maken? nee

Maakt u innovatief gebruik van technologische toepassingen (bijvoorbeeld het gecombineerd gebruiken maken van vingerafdruk en gezichtsherkenning voor toegangscontrole)? nee

Werkt u met niet-gepseudonimiseerde persoonsgegevens? nee

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Vragenlijst Learning Analytics

* Vereist

* Dit formulier registreert uw naam, vul uw naam in.

⋮

1. Wat is uw rol in het onderwijs? *(Meerdere antwoorden mogelijk)* *

- ☐ Vakleerkracht
- ☐ Klastitularis
- ☐ Zorgleerkracht
- ☐ Directie
- ☐ Andere

2. Hoe vaak neemt u deel aan klassenraden? *

- ☐ Nooit
- ☐ 1 keer per jaar
- ☐ 2-3 keer per jaar
- ☐ 4-5 keer per jaar
- ☐ 6 keer of meer

3. Wat is uw leeftijd? *

- ☐ 20-30 jaar
- ☐ 31-40 jaar
- ☐ 41-50 jaar
- ☐ 51-60 jaar
- ☐ 60+ jaar

4. Hoe lang werkt u al in het onderwijs? *

- ☐ Minder dan 5 jaar
- ☐ 5-10 jaar
- ☐ 11-20 jaar
- ☐ Meer dan 20 jaar

5. Hoe vertrouwd bent u met het gebruik van data om de vooruitgang van leerlingen te evalueren? *

- ☐ Helemaal niet vertrouwd
- ☐ Enigzins vertrouwd
- ☐ Vertrouwd
- ☐ Zeer vertrouwd

6. Welke systemen gebruikt uw school momenteel om leerlingendata te beheren of te visualiseren? (Meerdere antwoorden mogelijk) *

- ☐ Geen specifiek systeem
- ☐ Moodle
- ☐ Smartschool
- ☐ Excel of Google Sheets
- ☐ Eigen ontwikkelde systemen
- ☐ Andere

7. Context

In plaats van alleen te kijken naar cijfers, richt competentiegericht onderwijs zich op de vaardigheden en kennis die een leerling daadwerkelijk beheerst. Dit kan helpen om leerlingen beter voor te bereiden op de toekomst. Systemen zoals dashboards kunnen helpen om deze vaardigheden en voortgang gemakkelijker te volgen en inzichtelijk te maken. We zijn benieuwd naar uw mening over hoe zo'n systeem u kan ondersteunen in het volgen van de voortgang van leerlingen.

Hoe ervaart u het huidige systeem in de context van competentiegericht onderwijs? (Wat is nuttig? Wat mist het systeem?) *

8. Hoe belangrijk vindt u het dat een systeem inzicht biedt in de ontwikkeling van vaardigheden en competenties naast cijfers? *

- ☐ Helemaal niet belangrijk
- ☐ Enigzins belangrijk
- ☐ Belangrijk
- ☐ Zeer belangrijk

9. Hoe staat u tegenover het gebruik van competentiegericht onderwijs als methode om de ontwikkeling van leerlingen te ondersteunen? *

- ☐ Helemaal tegen
- ☐ Enigzins tegen
- ☐ Neutraal
- ☐ Enigzins voor
- ☐ Helemaal voor

10. Welke informatie gebruikt u tijdens klassenraden om beslissingen te onderbouwen? (Meerdere antwoorden mogelijk) *

- ☐ Cijfers van taken en toetsen
- ☐ Aanwezigheid
- ☐ Sociale/emotionele informatie
- ☐ Feedback van ouders
- ☐ Observaties van leerkrachten
- ☐ Andere

11. Hoe nuttig vindt u visuele hulpmiddelen (zoals grafieken) om leerlingendata te interpreteren? *

- ☐ Helemaal niet nuttig
- ☐ Enigzins nuttig
- ☐ Nuttig
- ☐ Zeer nuttig

12. Wat zijn volgens u de grootste uitdagingen bij het interpreteren van leerlingendata tijdens klassenraden? *

13. Wat zou een dashboard volgens u efficiënter maken tijdens klassenraden? (Meerdere antwoorden mogelijk) *

- ☐ Overzichtelijke visualisaties
- ☐ Gepersonaliseerde aanbevelingen
- ☐ Snel inzicht in trends en patronen
- ☐ Mogelijkheid om data eenvoudig te filteren
- ☐ Andere

14. Hoe overzichtelijk vindt u de informatie op het voorgestelde dashboard? *

- ☐ Helemaal niet overzichtelijk
- ☐ Enigzins overzichtelijk
- ☐ Overzichtelijk
- ☐ Zeer overzichtelijk

15. Welke onderdelen van het dashboard vindt u het meest nuttig? *

16. Welke verbeteringen zou u aanraden? *

17. Heeft u suggesties voor functionaliteiten die nog ontbreken op het dashboard? *

18. Heeft u nog aanvullende opmerkingen of suggesties over het gebruik van dashboards tijdens klassenraden?

Deze inhoud is niet door Microsoft gemaakt noch goedgekeurd. De gegevens die u verzendt, zal worden gestuurd naar de eigenaar van het formulier.



Microsoft Forms

Hartelijk dank voor uw interesse in deelname aan het onderzoek van Jonas Van Hove. Hieronder vindt u de belangrijkste informatie over het onderzoek en wat er van u wordt verwacht als deelnemer.

Doel van het onderzoek

Dit onderzoek heeft als doel te onderzoeken hoe **Learning Analytics Dashboards (LAD)** leerkrachten kunnen ondersteunen bij het interpreteren van leerlingendata, specifiek in de context van **competentiegericht onderwijs**. Het idee is om een prototype te ontwikkelen dat leerkrachten helpt bij het visualiseren van leerlinginformatie, zodat ze beter geïnformeerde beslissingen kunnen nemen tijdens klassenraden en hen kan ondersteunen in het geven van gepersonaliseerde feedback.

Verloop van het onderzoek

Het onderzoek bestaat uit de volgende onderdelen:

1. **Inleiding en uitvoering van taken** op het prototype van het Learning Analytics Dashboard.
2. **Vragenlijst** van 10-15 minuten om de ervaringen van leerkrachten met dit systeem te verzamelen.
3. **Mondelinge toelichting** van de ingevulde vragenlijst, waarin u de mogelijkheid heeft om verdere verduidelijkingen te geven.

Gegevensverwerking

- **Veiligheid en vertrouwelijkheid:** Alle gegevens worden veilig en discreet behandeld door de hoofdonderzoeker, Jonas Van Hove. De audio-opname van de mondelinge toelichting wordt uitsluitend gebruikt voor onderzoeksdoeleinden en zal worden vernietigd nadat alle data schriftelijk verwerkt zijn.
- **Persoonlijke gegevens:** Behalve uw e-mailadres en het aantal jaren tewerkstelling in het onderwijs, worden er geen andere persoonlijke gegevens van u bewaard.
- **Gebruik van resultaten:** De resultaten van dit onderzoek worden uitsluitend gebruikt voor wetenschappelijke doeleinden en zullen anoniem worden gepubliceerd.

Deelname en geïnformeerde toestemming

De deelname aan dit onderzoek is **vrijwillig**. Door deel te nemen, bevestigt u dat u de bovenstaande informatie heeft gelezen en begrijpt, en dat u akkoord gaat met de voorwaarden.

Hoe kan ik deelnemen?

Om deel te nemen aan het onderzoek, kunt u een e-mail sturen met de melding "Ik ga akkoord". Hiermee bevestigt u uw deelname.

Bij vragen of onduidelijkheden kunt u gerust contact met mij opnemen.

Jonas Van Hove
Student master Toegepaste Informatica
jonas.vanhove@student.kuleuven.be



To whom it may concern

PRET approval number: G-2024-8842

Title: **Turning learning data into meaningful learning analytics dashboards (Leergegevens omzetten in zinvolle leeranalyse dashboards)**

Principal investigator: Katrien Verbert, Submitter: Jonas Van Hove

Leuven: 2025-02-25

GDPR compliance and ethical approval

The above-mentioned project application was submitted to KU Leuven's Privacy and Ethics platform (PRET). The project application was scrutinised in view of principles and obligations laid down in the General Data Protection Regulation of the European Parliament and of the Council of 27 April 2016. Based on the information presented and given the researcher's explicit declaration that the project will be carried out accordingly, KU Leuven issued a favourable advice and confirmed that the project may be implemented as such.

All relevant information concerning the processing of personal data in the framework of this project has been registered in KU Leuven's records of processing activities.

The project application was also reviewed by the Social and Societal Ethics Committee (SMEC) of KU Leuven. The Committee confirmed that the project application meets the expected ethical standards regarding the voluntary involvement of human participants in scientific research. SMEC's decision regarding this protocol is favourable.

Yours sincerely

Two handwritten signatures in blue ink. The signature on the left is "Toon Boon" and the signature on the right is "Dieter Baeyens".

Digitally confirmed by Toon Boon (data protection officer) and Dieter Baeyens (chair SMEC)

Appendix C

Workshop assets

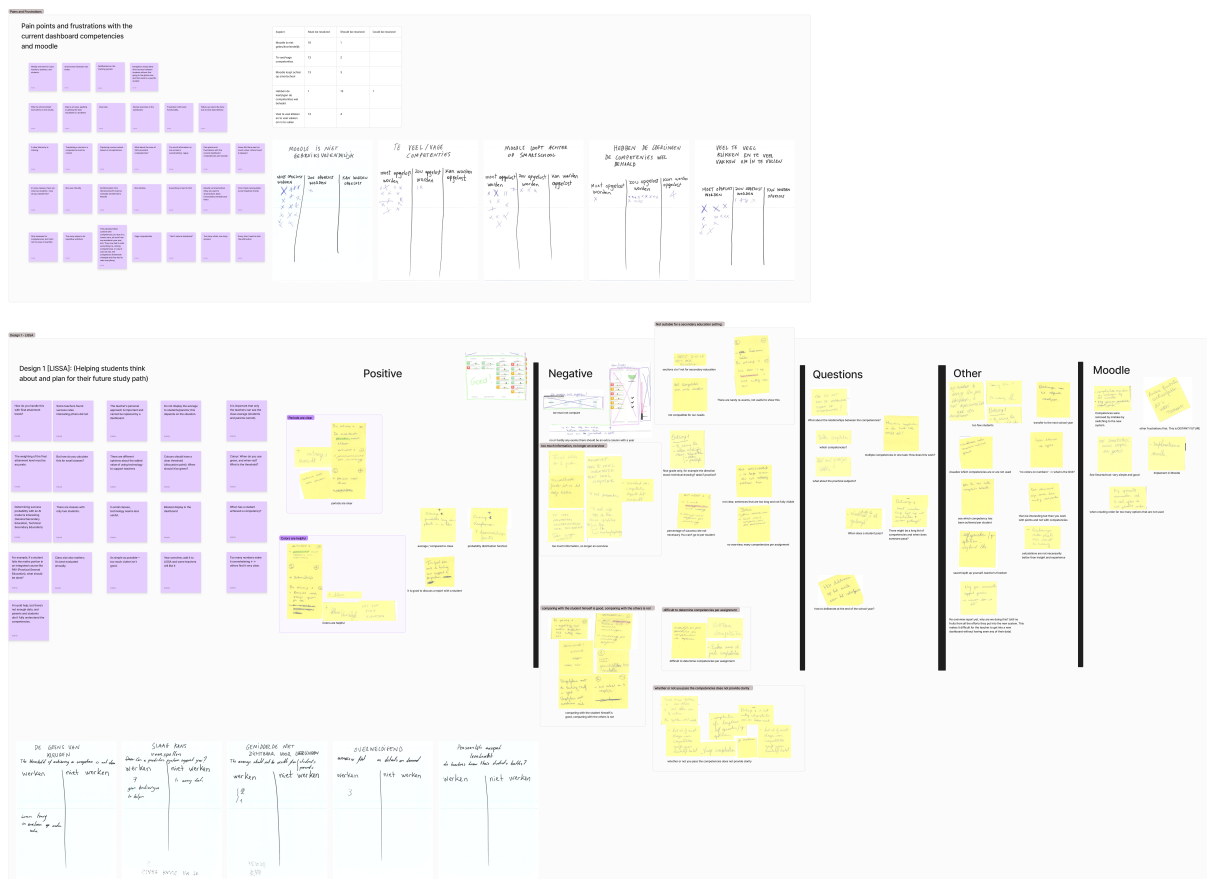


Figure C.1: Zoomed-out overview of our LeerTrac Analysis workshop whiteboard where researchers grouped ideas to provide a global overview.

Appendix D

Additional prototypes and sketches

D.1 Prototype 1 iterations

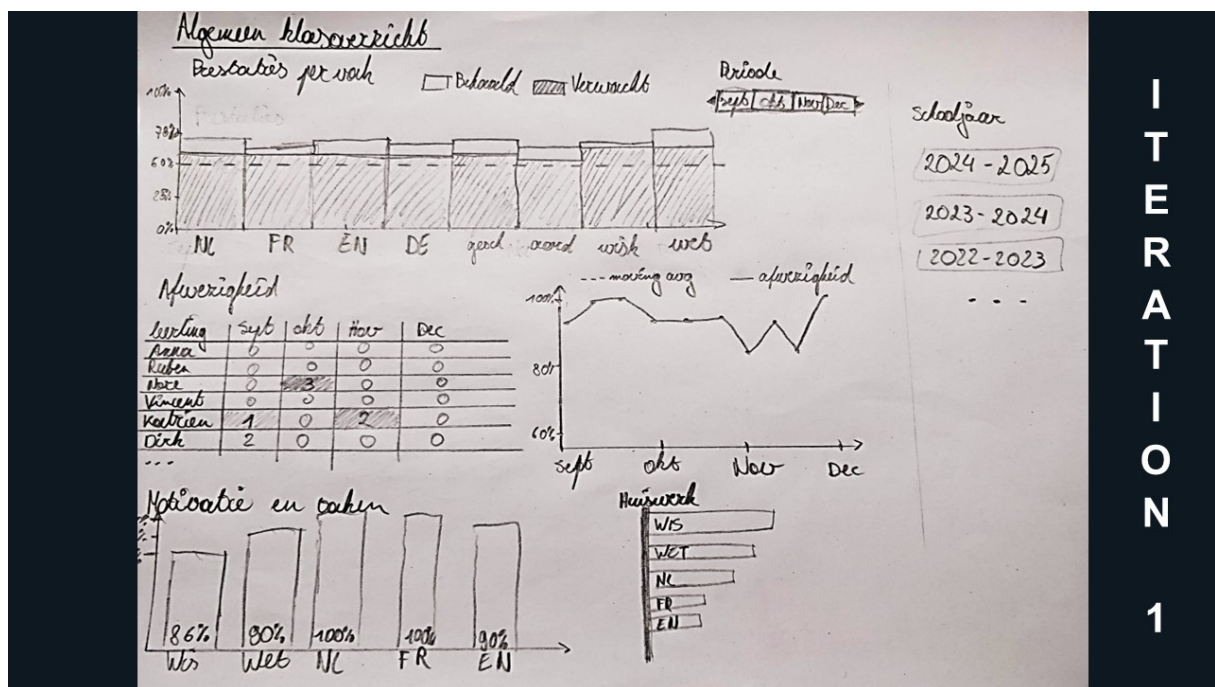


Figure D.1: Prototype 1 sketch class overview

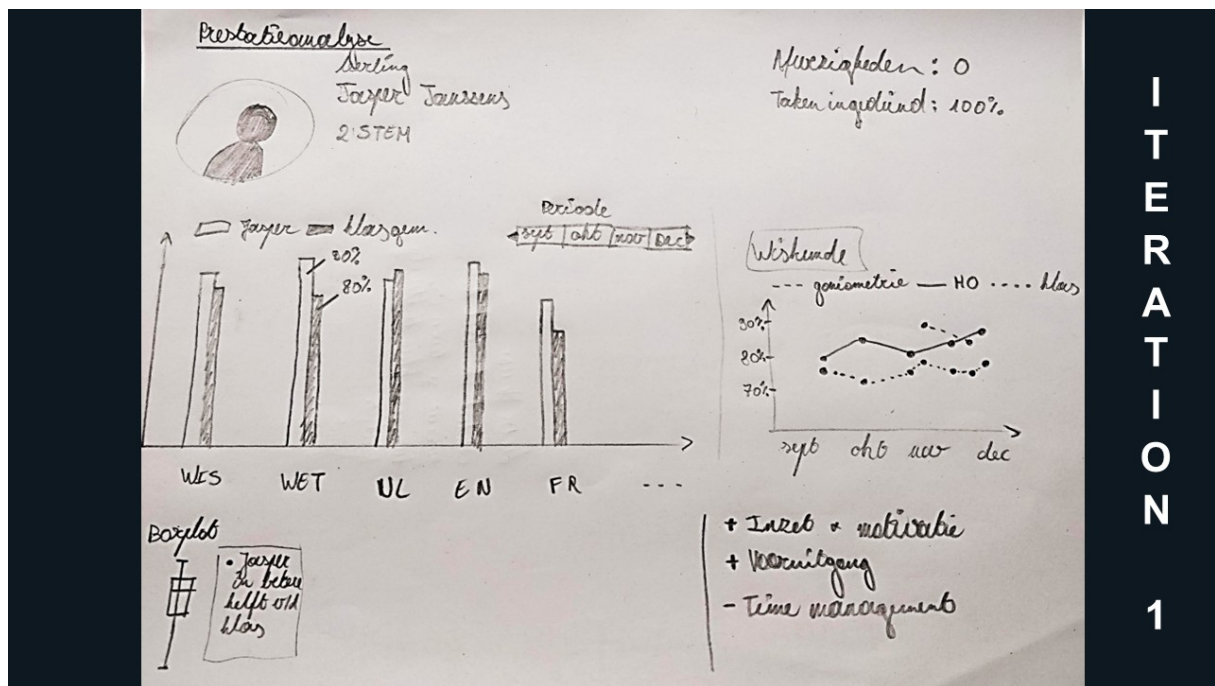


Figure D.2: Prototype 1 sketch performance analysis

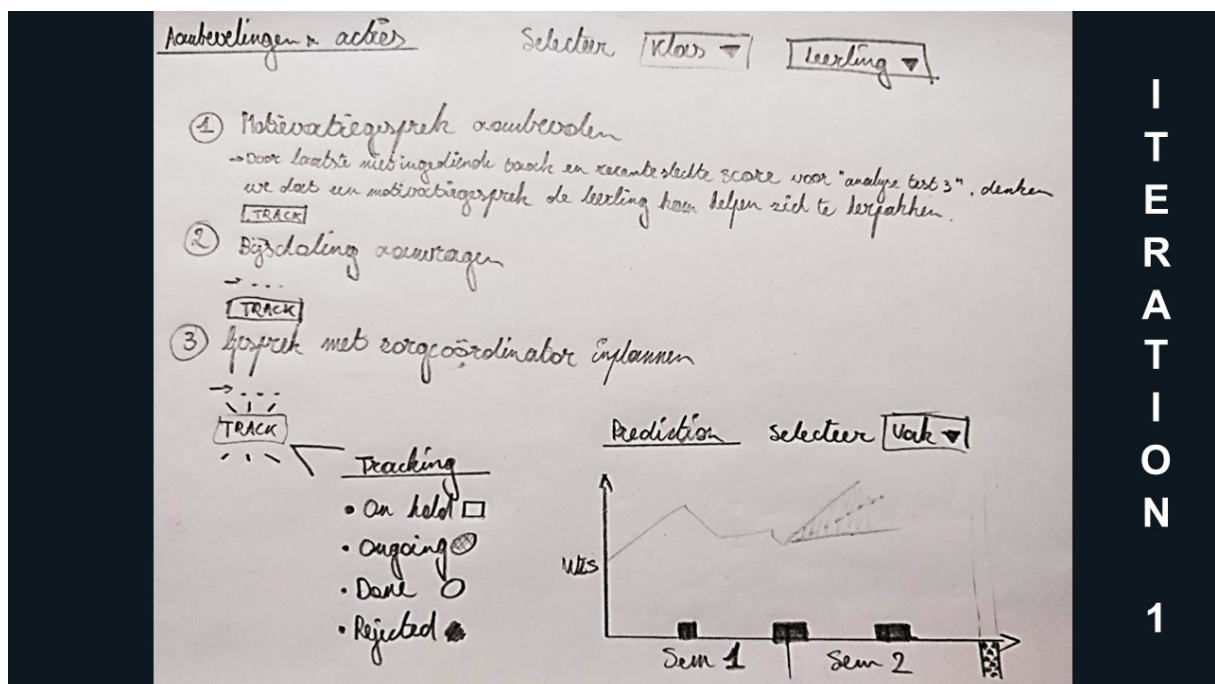


Figure D.3: Prototype 1 sketch recommendations and actions

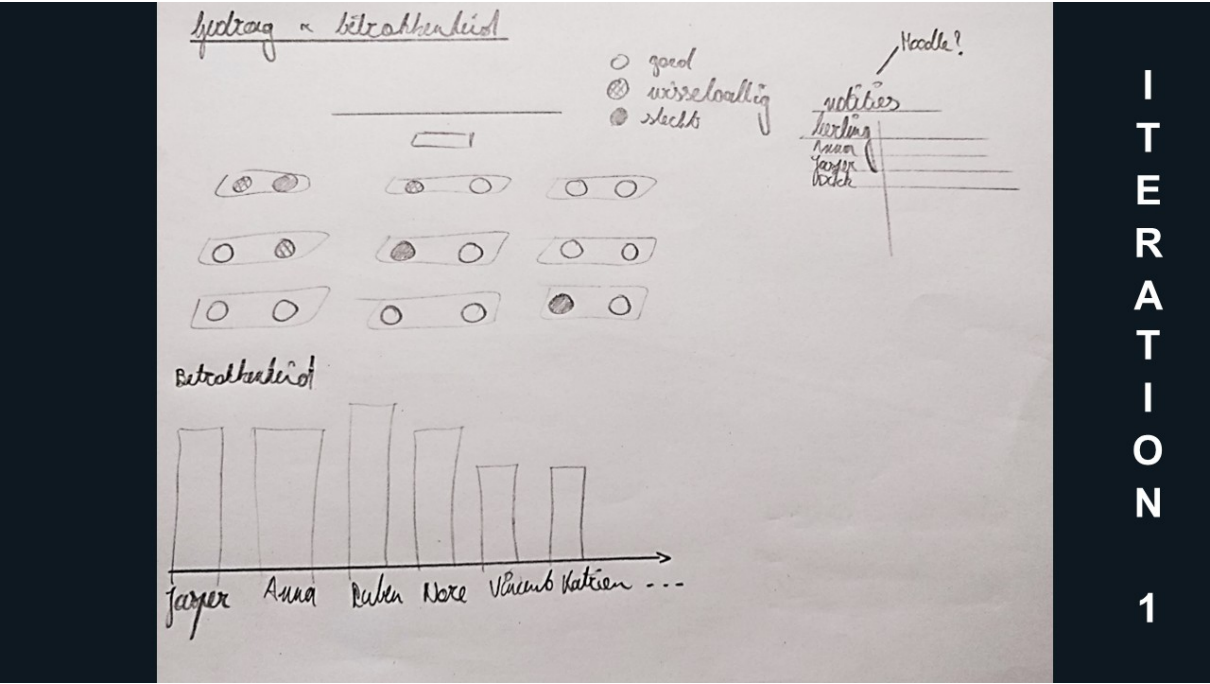


Figure D.4: Prototype 1 sketch recommendations and actions

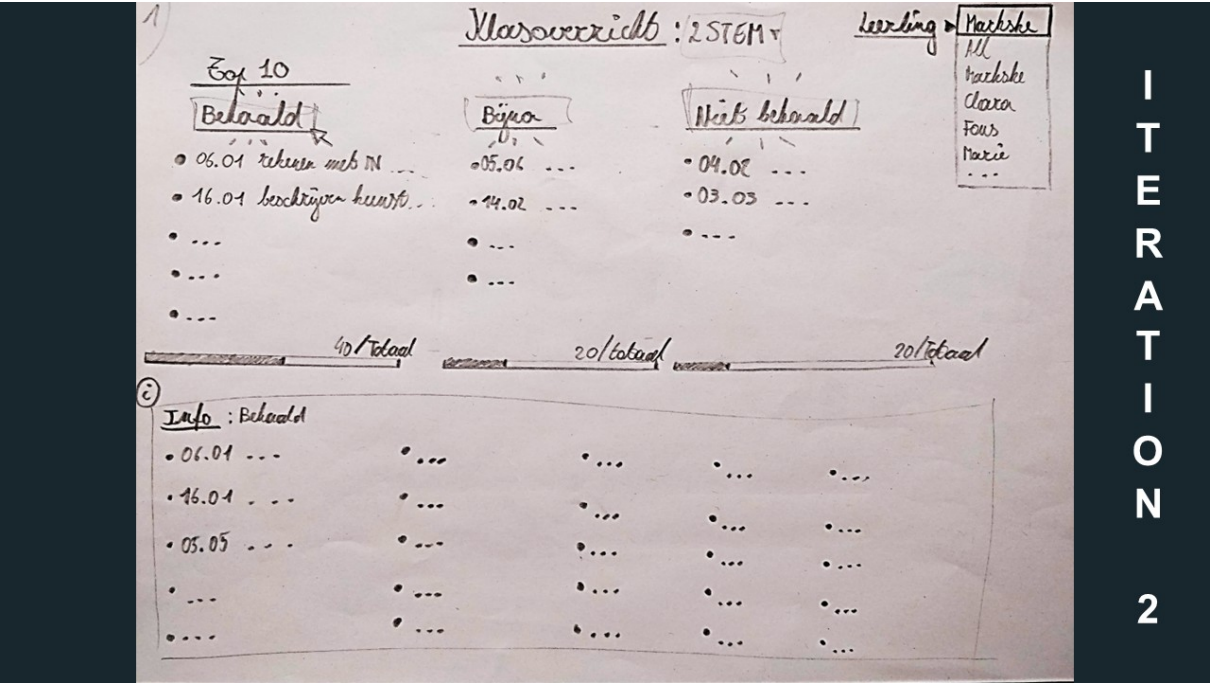


Figure D.5: Prototype 1 sketch class overview rankings

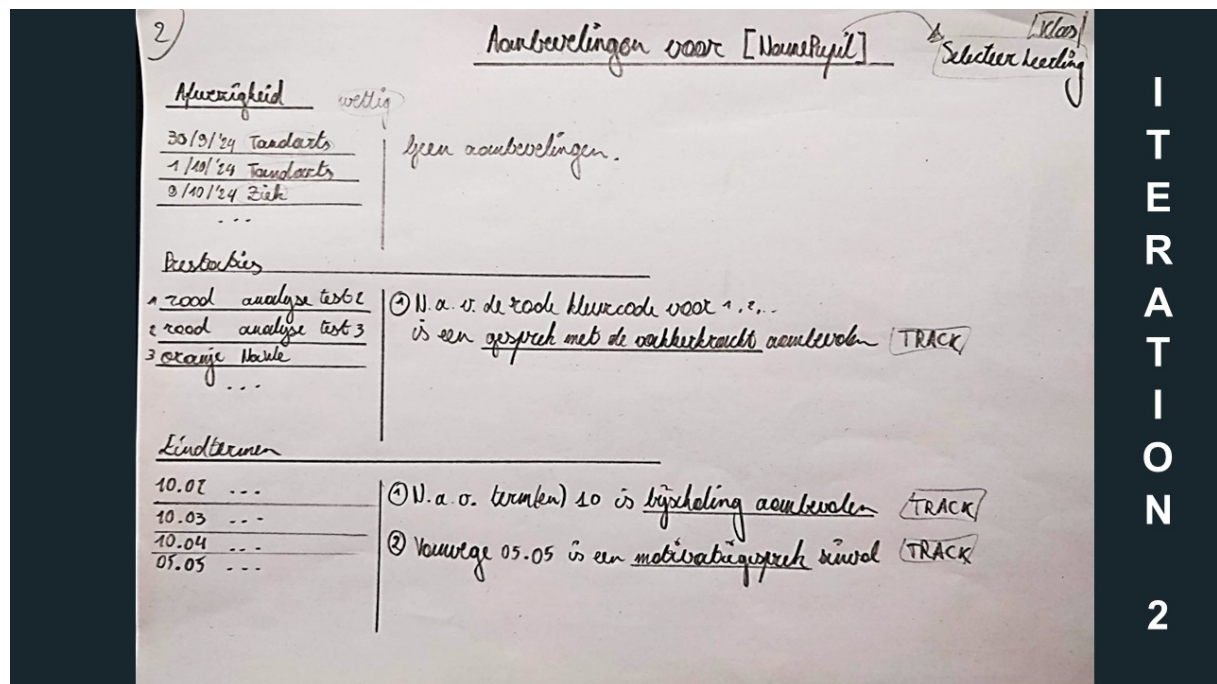


Figure D.6: Prototype 1 sketch class overview rankings

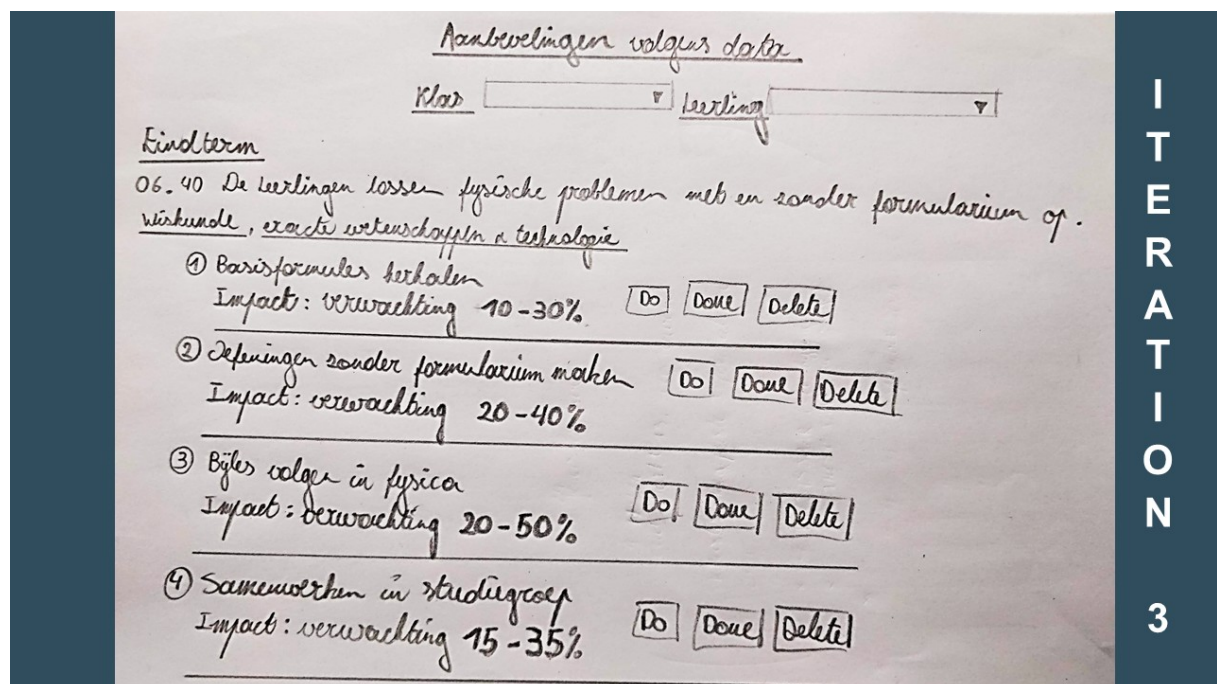


Figure D.7: Prototype 1 sketch recommendations according to competence

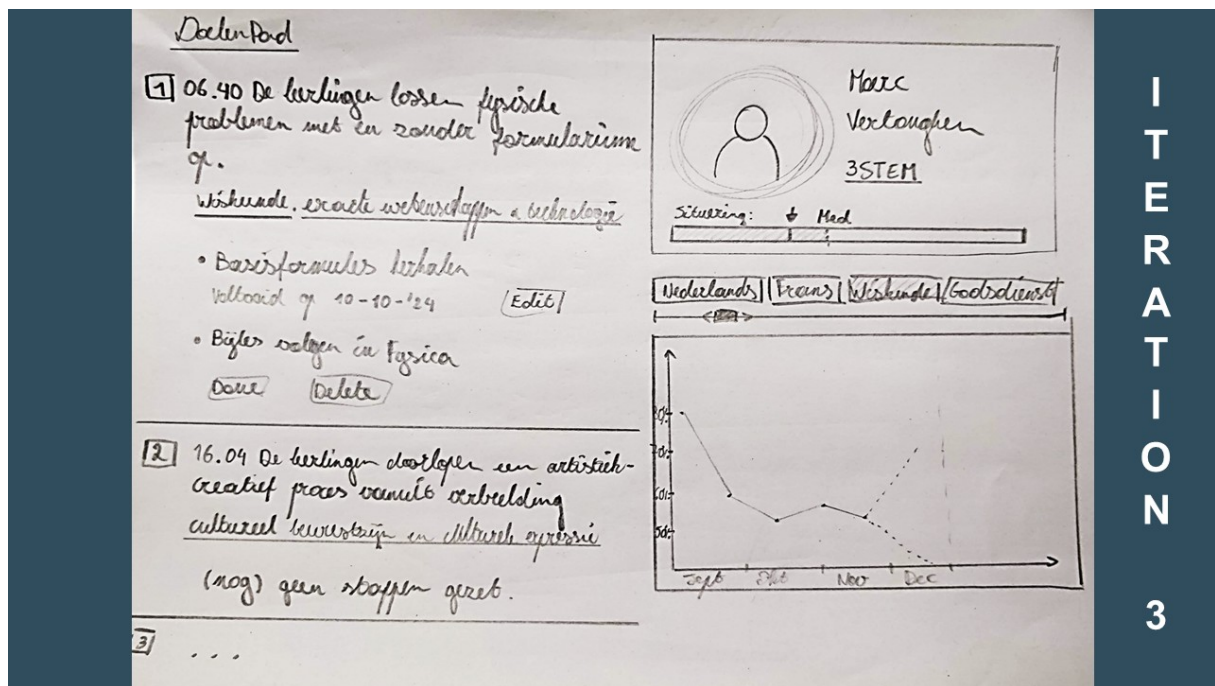


Figure D.8: Prototype 1 sketch goal path

D.2 Prototype 2 iterations

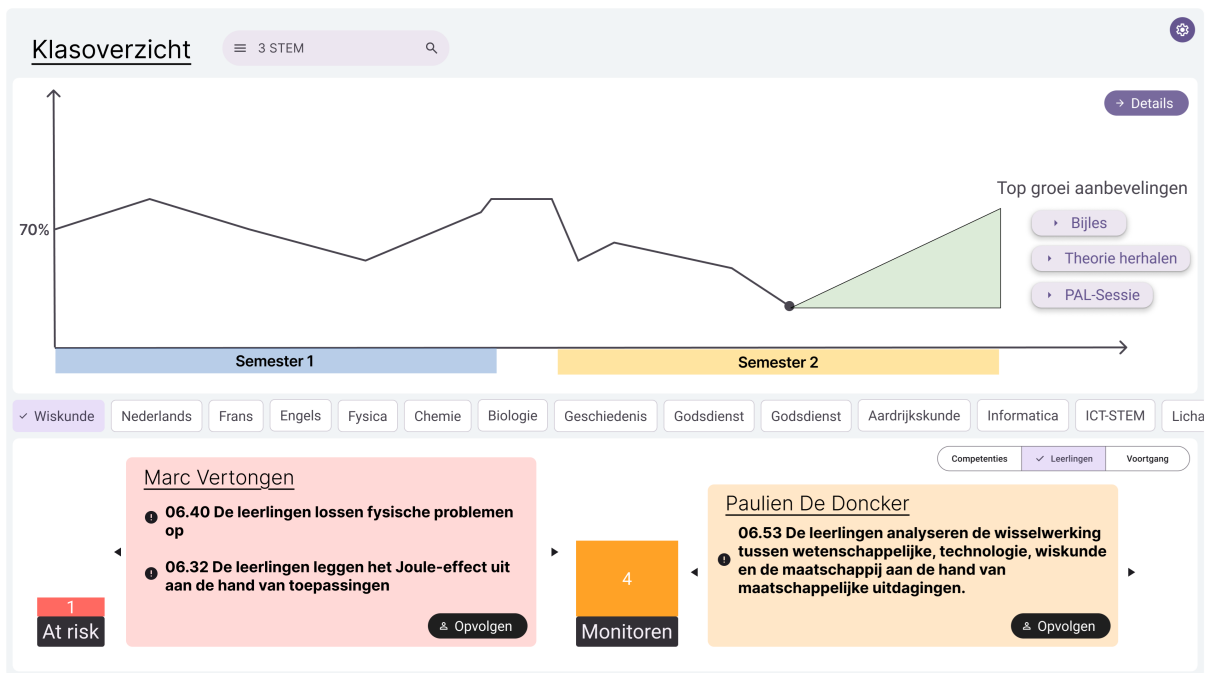


Figure D.9: Prototype 2

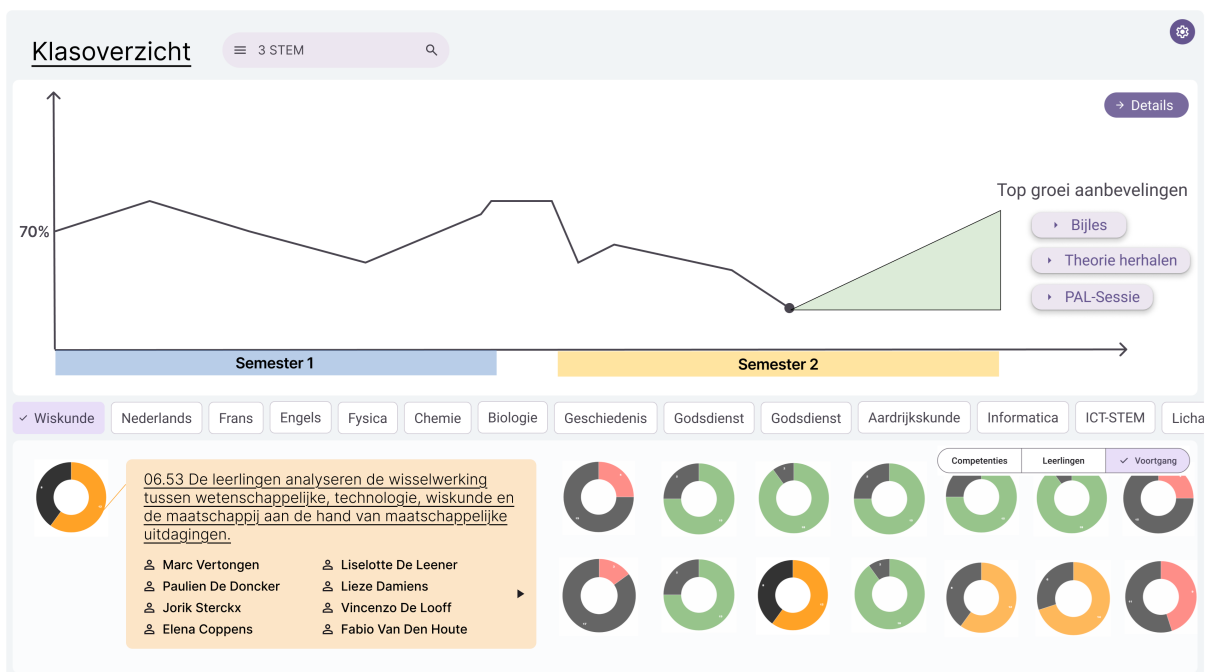


Figure D.10: Prototype 2

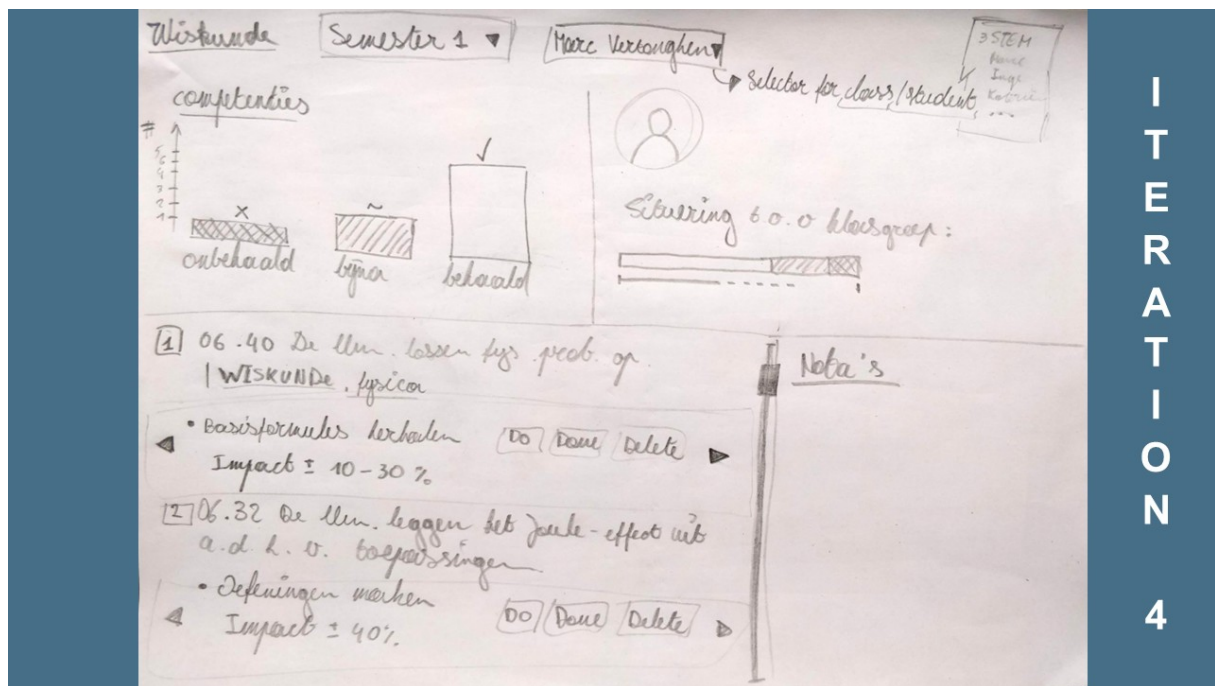


Figure D.11: Prototype 2 sketch

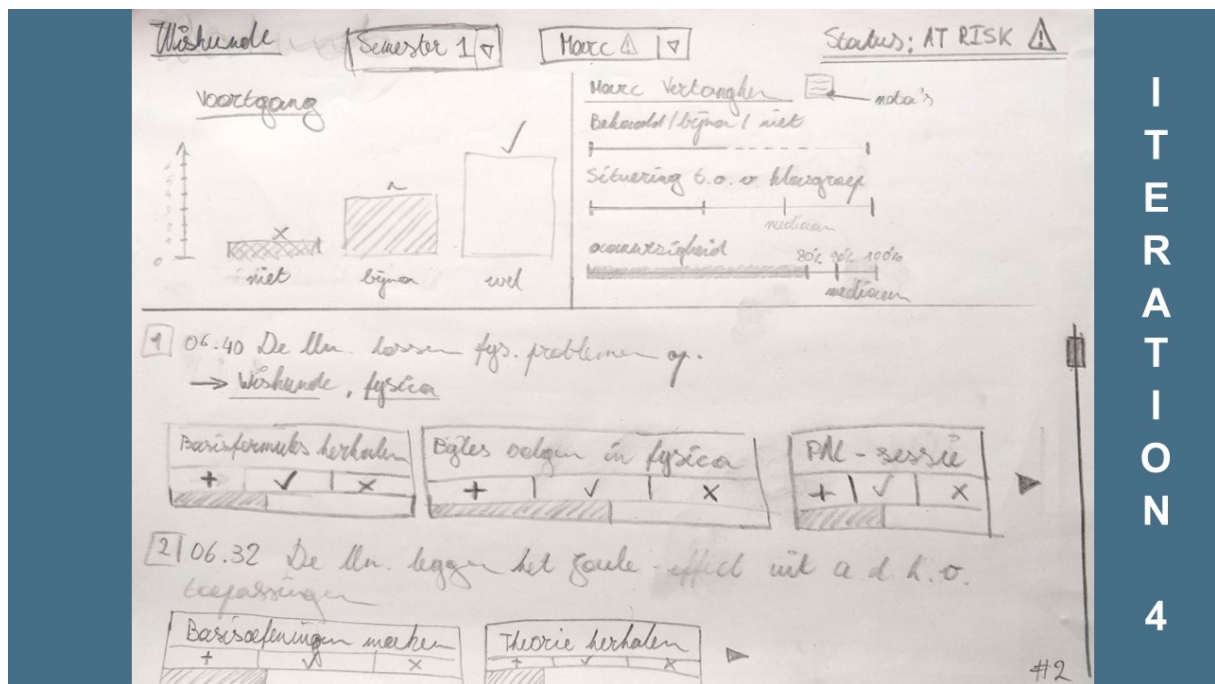


Figure D.12: Prototype 2 sketch

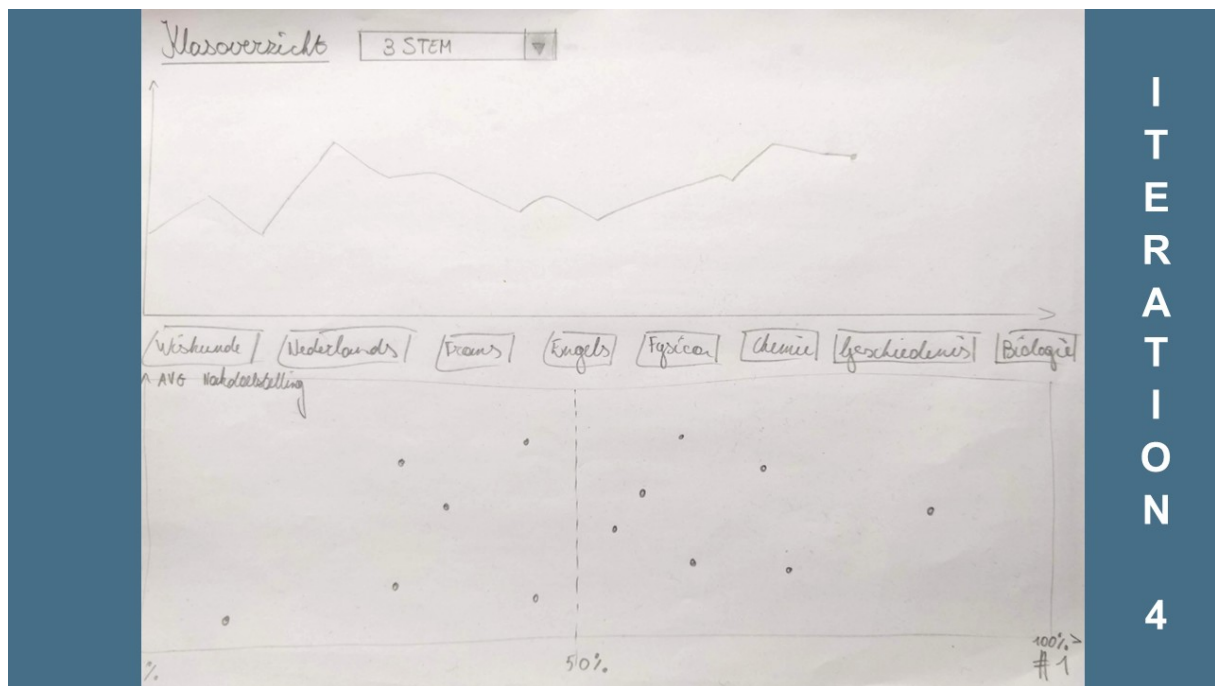


Figure D.13: Prototype 2 sketch

D.3 Prototype 3 iterations

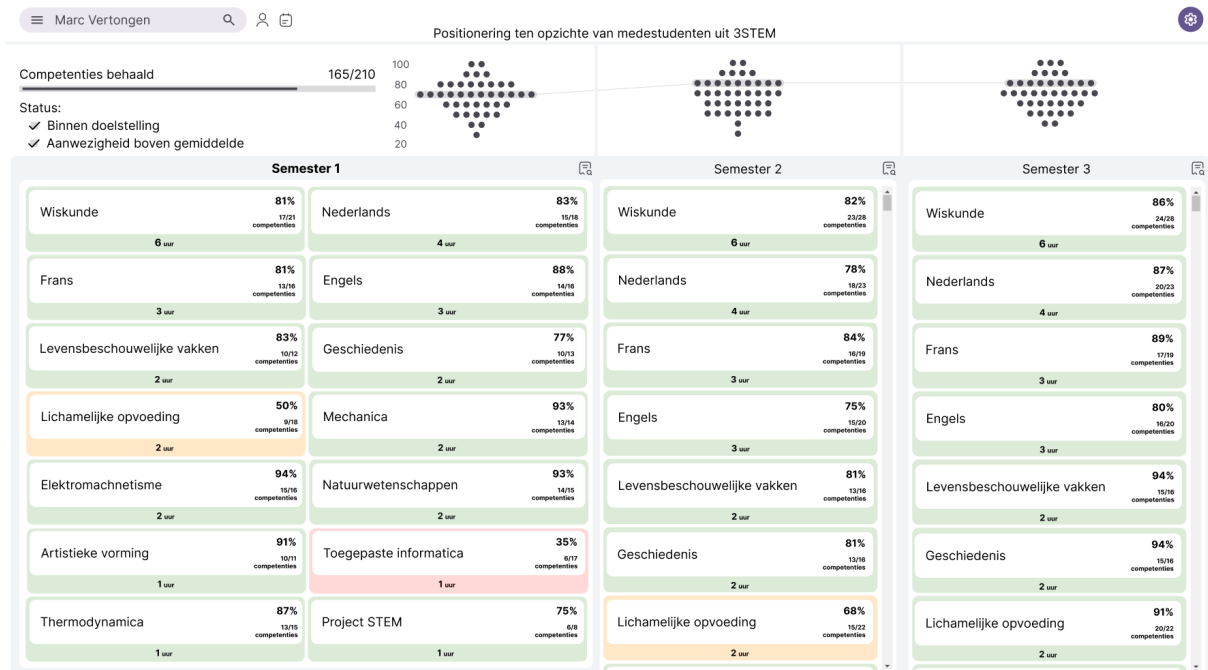


Figure D.14: Prototype 3 main overview simplified

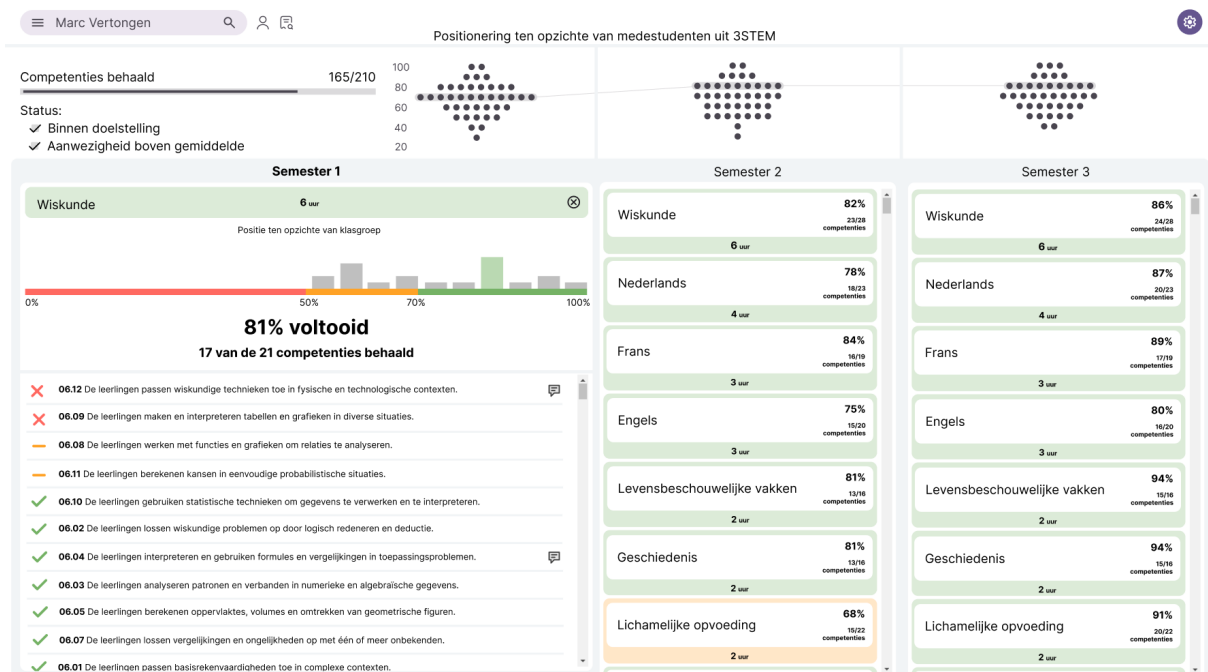


Figure D.15: Prototype 3 achieved course

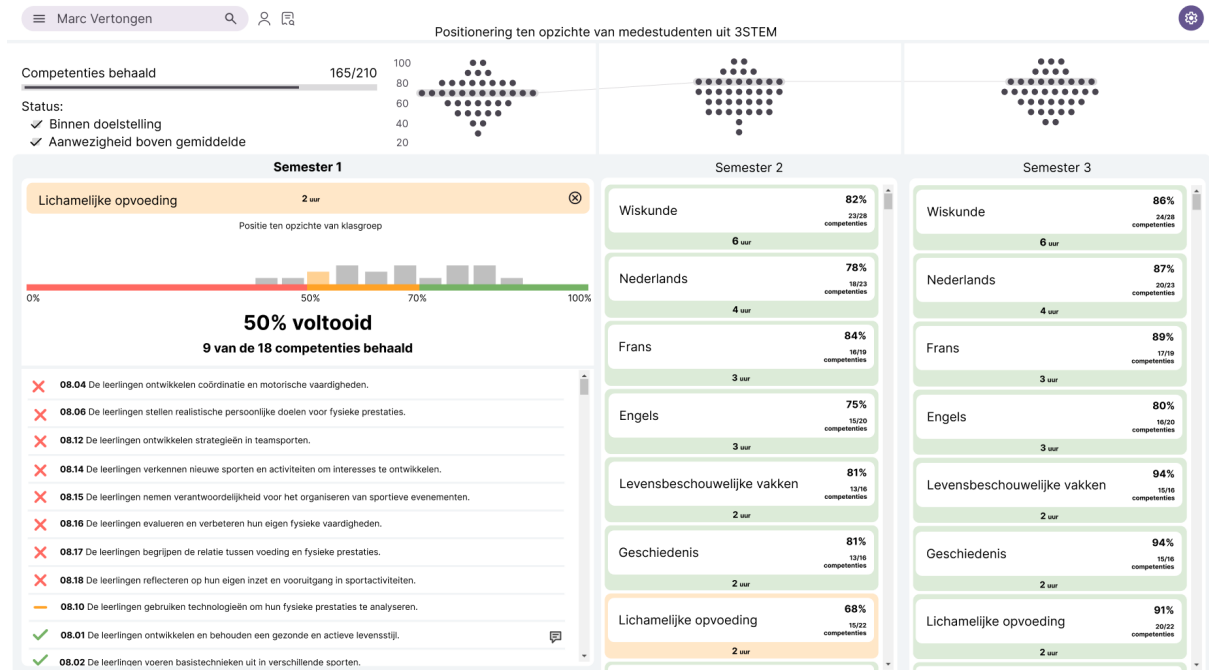


Figure D.16: Prototype 3 almost achieved course

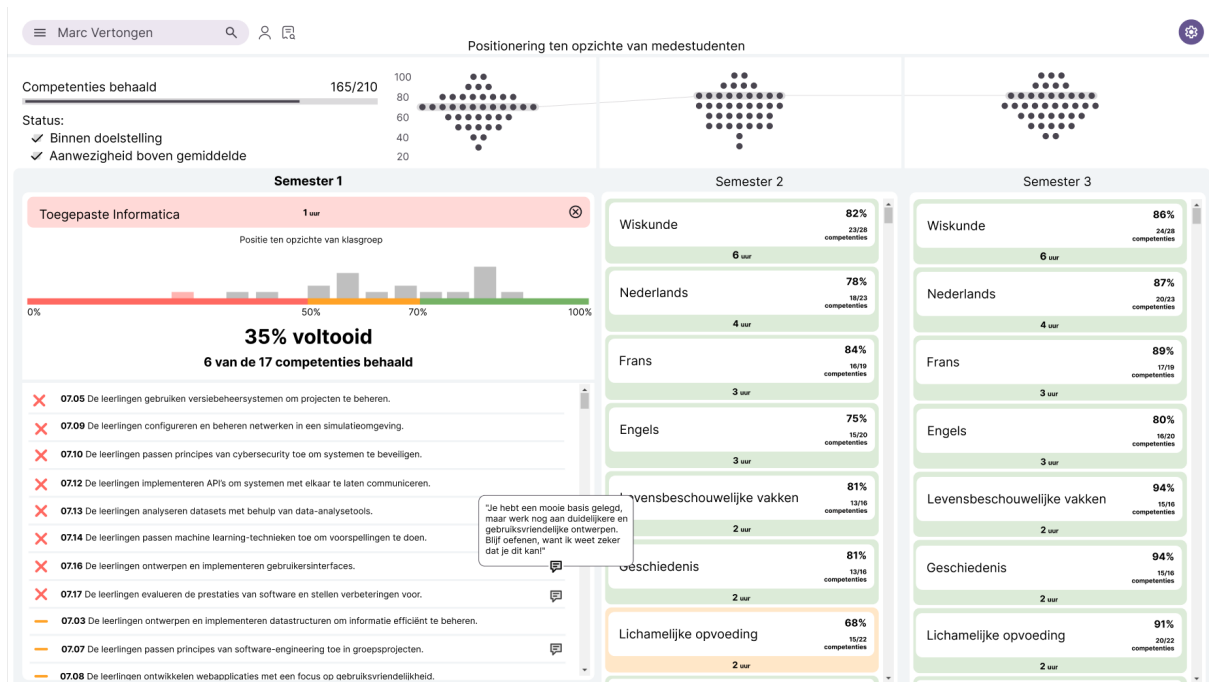


Figure D.17: Prototype 3 not achieved course



Figure D.18: Prototype 3 main overview added complexity

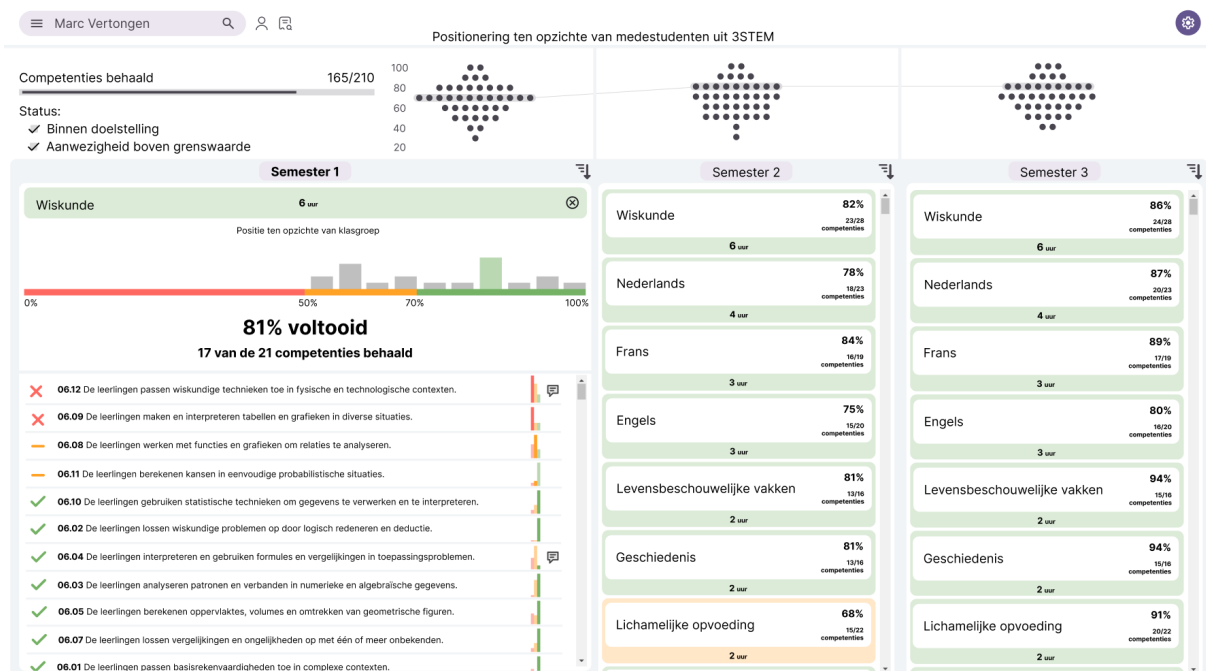


Figure D.19: Prototype 3 course overview simple (without unfold)



Figure D.20: Prototype 3 main overview

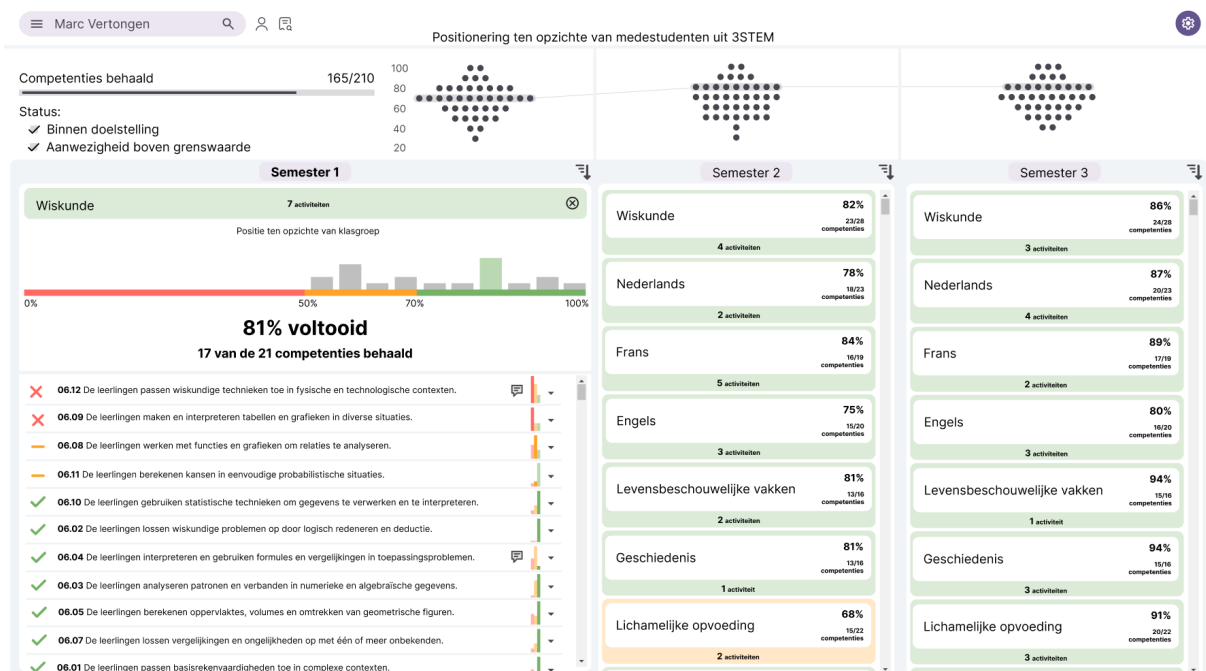


Figure D.21: Prototype 3 course overview (with unfold)

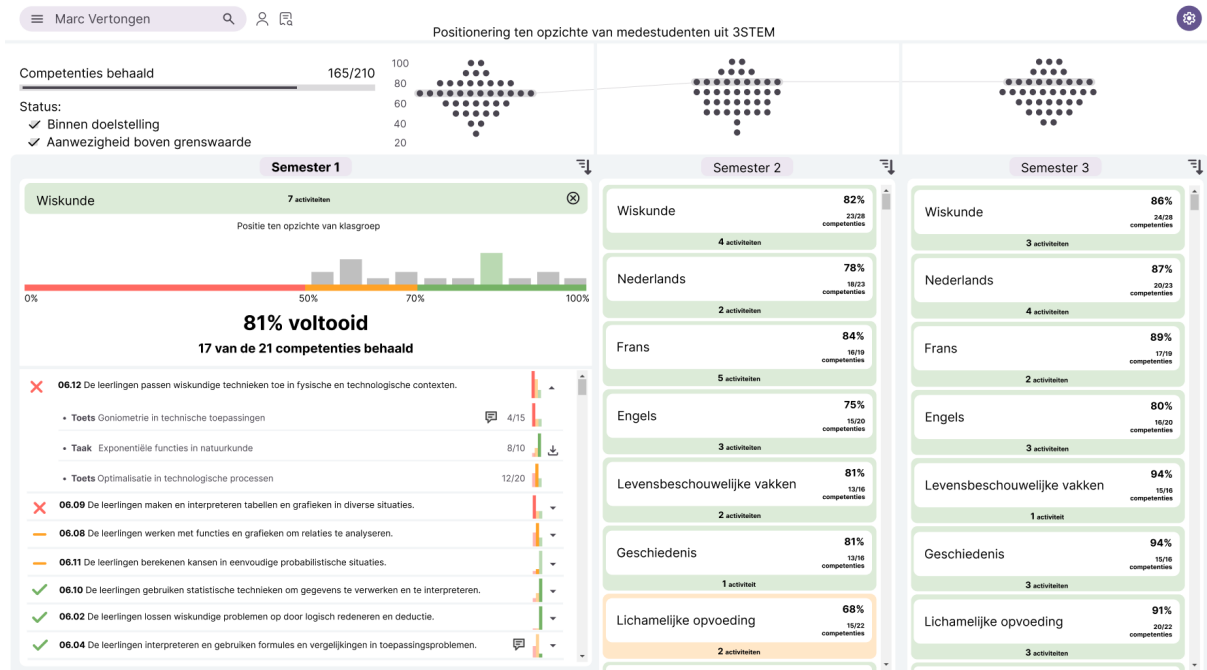


Figure D.22: Prototype 3 details competence

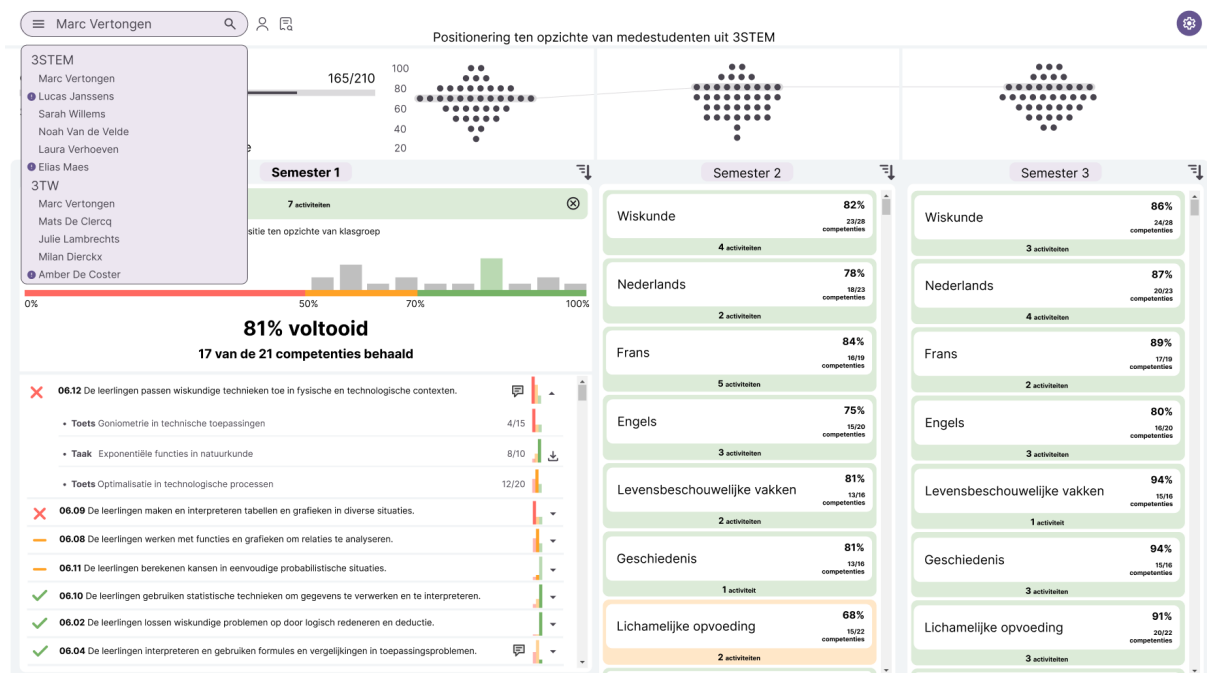


Figure D.23: Prototype 3 student filter

Appendix E

API documentation

This appendix presents all materials related to the API documentation for the CLAIRE dashboard. Included here are the abstracted English prototypes of each view, as well as design documentation:

- Figure E.1: Abstract English rendering of the Global View.
- Figure E.2: Abstract English rendering of the Subject-Level View.
- Figure E.3: Abstract English rendering of the Competency-Level View.
- Figure E.4: Abstract English overview combining all three views.
- CLAIRE dashboard API documentation.



Figure E.1: Abstract English rendering of the Global View for the API documentation.

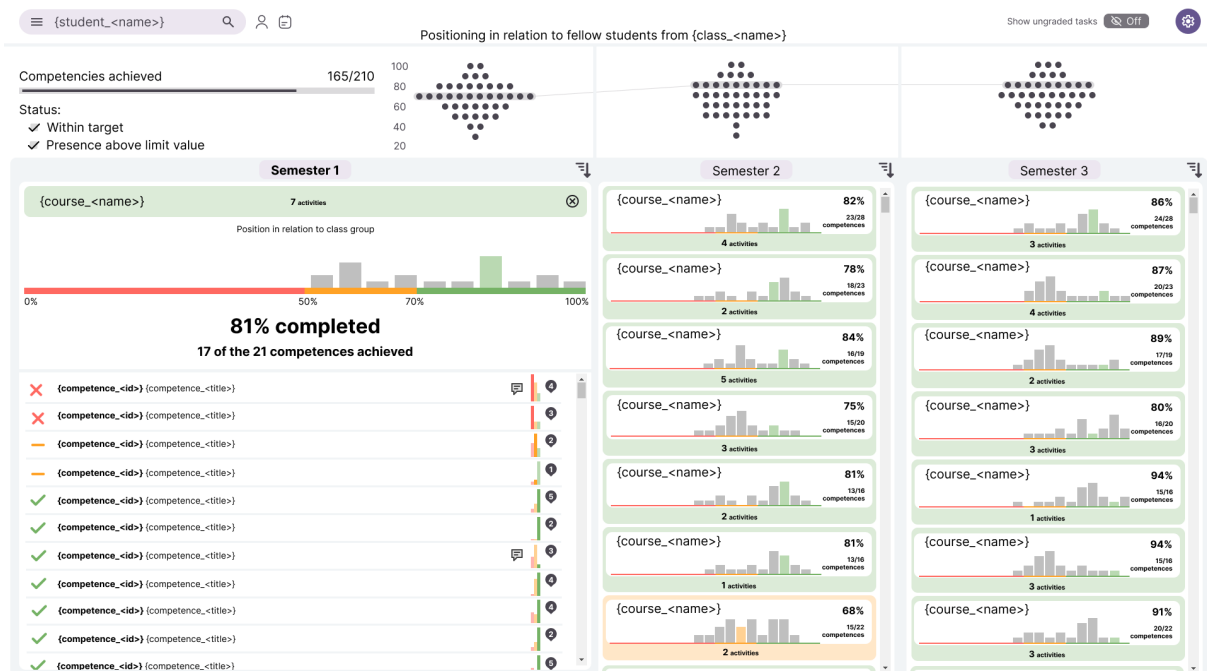


Figure E.2: Abstract English rendering of the Subject-Level View for the API documentation.

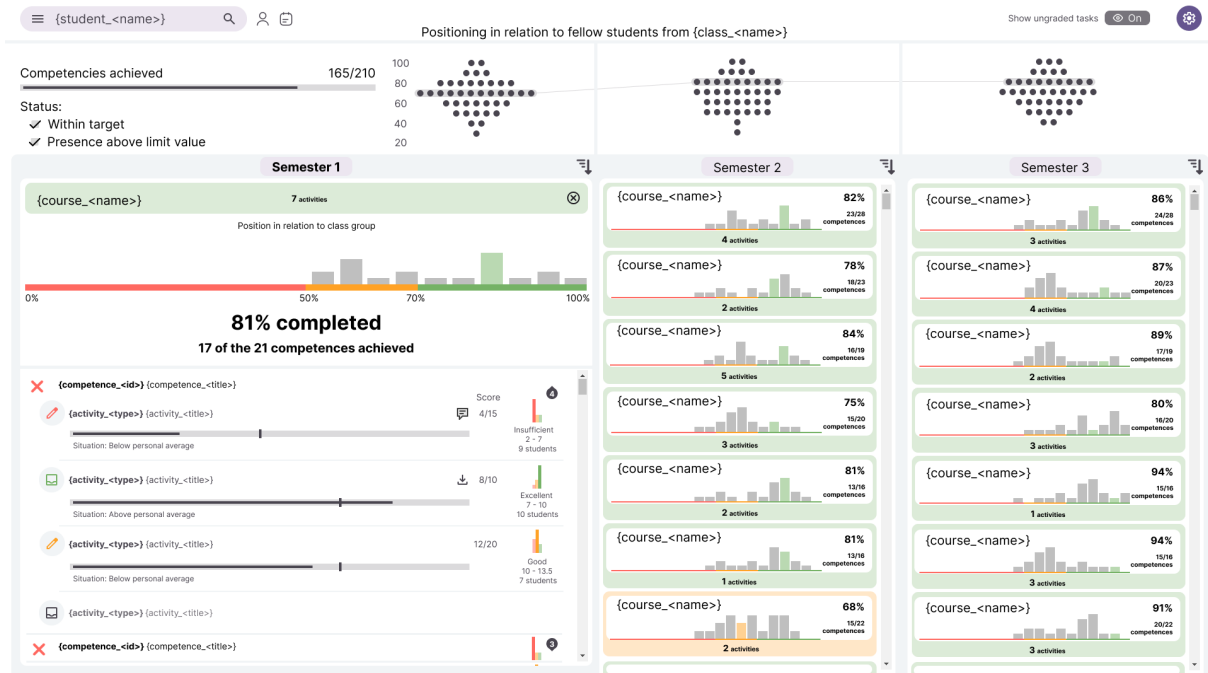


Figure E.3: Abstract English rendering of the Competency-Level View for the API documentation.



Figure E.4: Abstract English overview of Global, Subject-Level, and Competency-Level Views for the API documentation.

CLAIRE Design Documentation

Competency Learning Analytics for Insights and Reflection in Education

2025 – Jonas Van Hove (KU Leuven)

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Global Overview

CLAIRE is a Learning Analytics Dashboard (LAD) designed to support secondary school teachers during class councils. The tool transforms raw learning data into clear and actionable insights, helping teachers interpret student performance with a focus on competency-based learning.

CLAIRE was developed as a proof of concept (PoC) in collaboration with KU Leuven, GITO Overijse, and Eummena, as part of the master thesis project “Turning Learning Data into Meaningful Learning Analytics Dashboards” by Jonas Van Hove (2025).

The goal is to create a dashboard that is both intuitive and insightful, allowing teachers to identify trends, weaknesses, and strengths at a glance — facilitating timely and personalized interventions.

CLAIRE Dashboard Overview



Key Features

- Student Selection & Notes – Filter students and access individual profiles and notes
- Competency Overview – Track overall status and achievement across semesters
- Subject Breakdown – Explore competency coverage, evaluation quantity, and class performance
- Competency Details – Dive into which specific competencies need more attention
- Activity Insights – Visualize student performance on evaluations vs. class metrics

Summary of the Dashboard Prototype

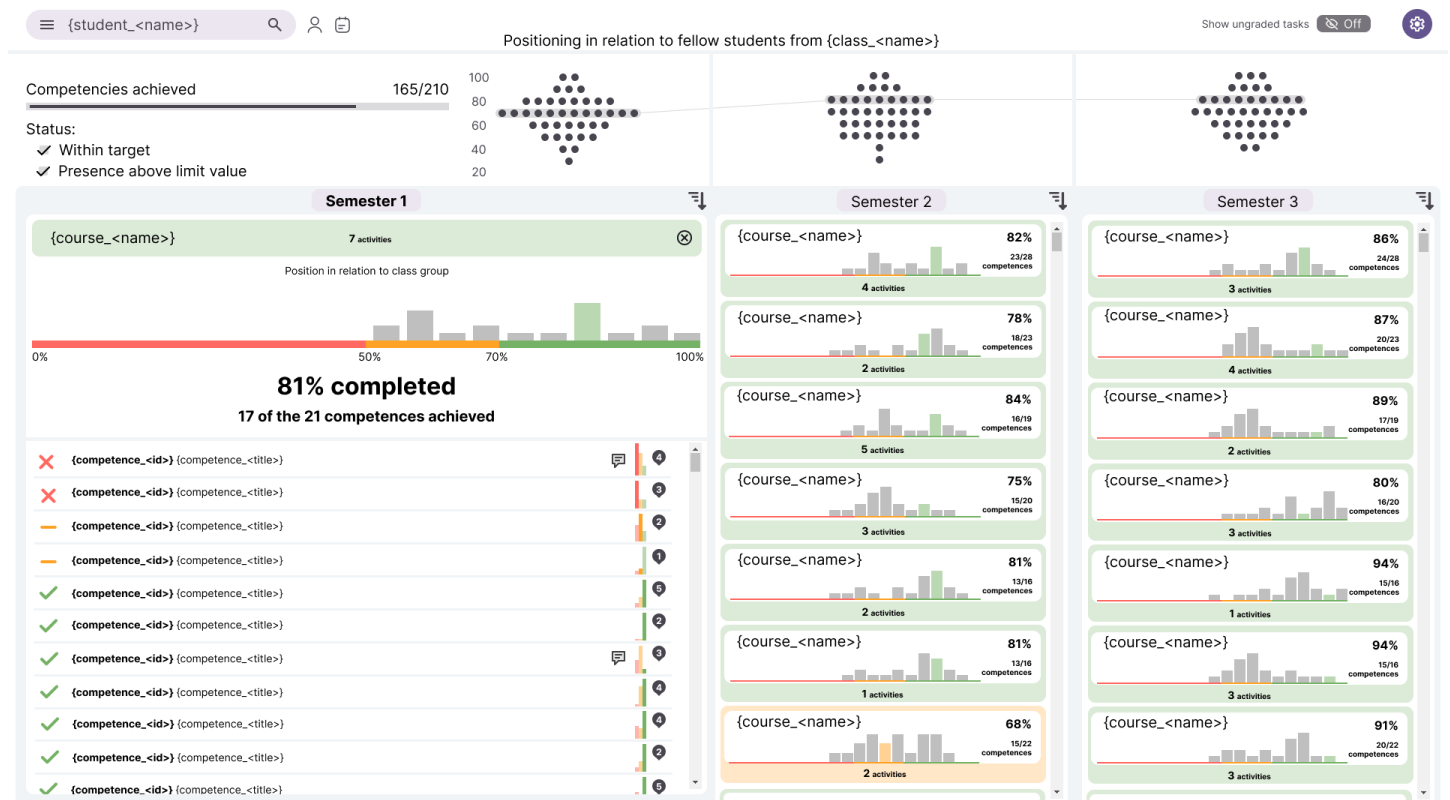
1. Student Overview Panel



This section allows the teacher to:

- Filter and select a student
- Open the student's profile
- Read and add teacher notes
- Toggle visibility of unevaluated tests/assignments
- Access general student information (e.g., number of achieved competencies, attendance, overall status such as "on track")

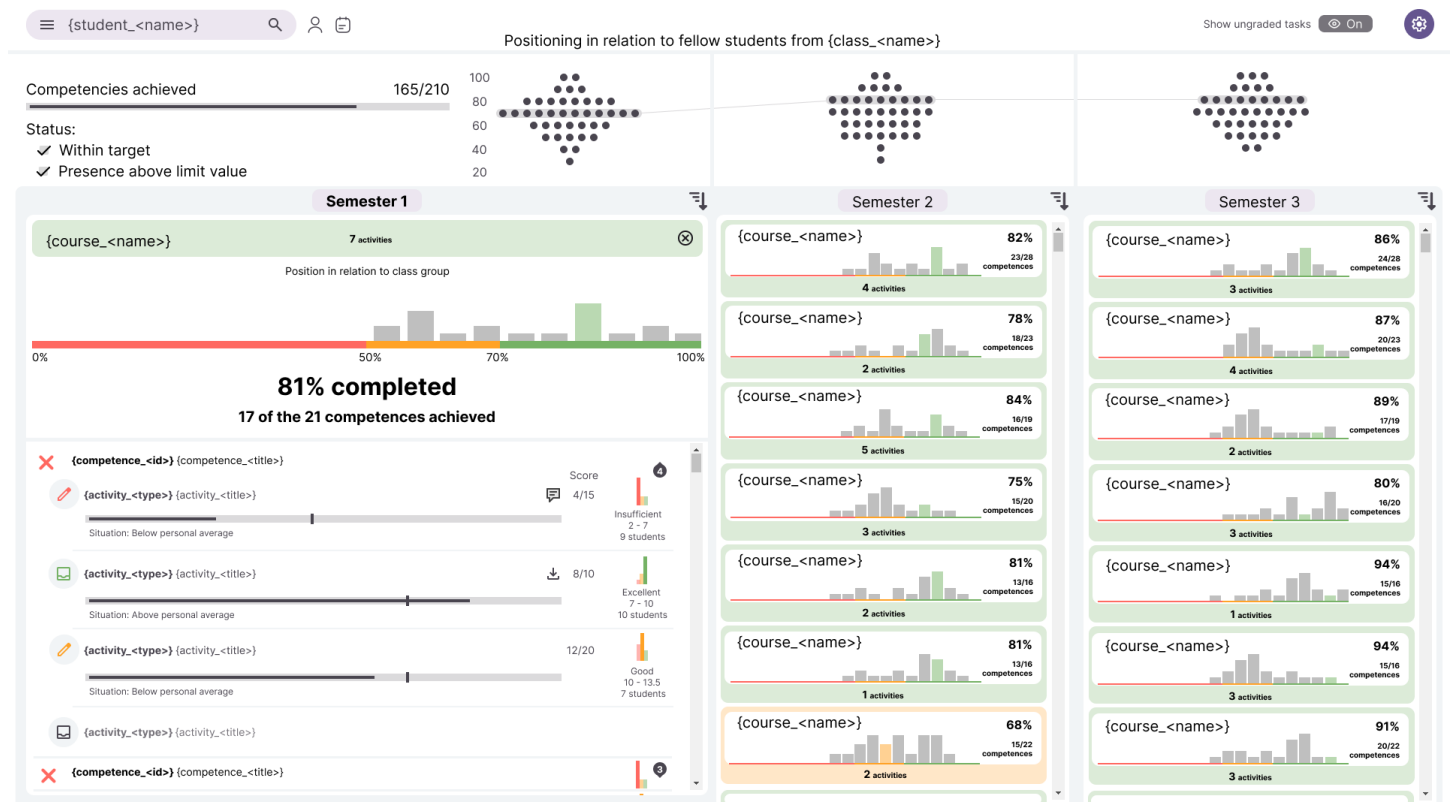
2. Semester Comparison & Subject Overview



This section provides:

- A three-semester comparison of the student's standing relative to classmates
- Visualizations per subject with:
 - Achieved competencies
 - Number of evaluations
 - Graphical class distribution
- A subject is clickable, leading to a detailed competency breakdown

3. Competency Details & Evaluation Breakdown



This deeper view shows:

- Which competencies are completed, nearly achieved, or need attention
- A breakdown of all tests/assignments contributing to the competency
- Per evaluation:
 - Student's progress visualization
 - Raw score
 - Class average comparison
 - Toggle to show/hide unevaluated items

API Mapping by Dashboard Area

Get Class Name



🔍 Zoek een leerling...

Competenties behaald

706/840



Marc Vertongen

Klas: 3STEM

Status: ⌚ ✓ Binnen doelstelling

Student Filter Logic



UI element: Student selector in top-left corner

Action: When selecting a student, CLAIRE fetches:

- Available classes (GET /api/classes)
- Students in those classes (GET /api/classes/{class_id}/students)
- Mapping between student and class
- Metadata for student previews (e.g., name, ID, status)

Zoek een leerling...

1Moderne 2Moderne 3STEM 3TW 3LAT 4Sport

4Mechanica 4Handel 5WeWi 6WeWi At Risk

Afwezigheidsrisico

1Moderne

Liam Janssens Mila Claes

Olivia Peeters Finn Dubois

Noah Maes Nora Vermeulen

Emma Jacobs Levi De Vos

Lucas Willems Ella Wouters

2Moderne

Adam Verstraeten Wout Mertens

Fien Vandenberghe Fleur Vandecasteele

Roos Hendrickx Seppe Verschueren

Stan Goossens Noor Vandermeulen

Lotte Verhoeven Tuur De Ridder

3STEM

Marc Vertongen Lotte Jacobs

Emma Peeters Seppe Claes

Thomas Janssens Fien Martens

Sophie Maes Wout Willems

On Student Selection

UI element: Clicking a student name

Action: The dashboard loads:

- Student-specific data (GET /api/students/{student_id})
 - Achieved competencies
 - Attendance
 - Semester comparison
- Class-level data for context (GET /api/classes/{class_id}/analytics)
 - Class averages, medians
 - Class distribution
 - Relative positioning per competency and subject

Subject Element (Course Overview)



Each course card in the subject overview section presents a compact but informative visualization of a student's progress within a specific subject (`{course_name}`).



Displayed Elements

- **Course Name** – The subject's title (e.g., "Mathematics", shown abstract as `{course_name}`).
- **Competency Score** – Displayed as a fraction, e.g., 17/21 competencies achieved.
- **Class Distribution** – A set of grey bars represents the distribution of students across performance groups.
- **Student Highlight** – The student's own group is visually highlighted (green = strong, orange = average, red = weak).
- **Border Color** – The border of the course card reflects the student's performance category.
- **Activity Count** – The number of registered activities (tests, assignments) contributing to the score is shown at the bottom of the card.

API Involved

- GET /api/students/{student_id}/courses
→ Retrieves all subjects linked to the student.
- GET /api/students/{student_id}/courses/{course_id}/competencies
→ Returns the number of achieved vs. total competencies for the course.
- GET /api/classes/{class_id}/courses/{course_id}/distribution
→ Provides performance distribution of the class for this subject and the student's assigned group.
- GET /api/students/{student_id}/courses/{course_id}/evaluations
→ Returns the list and count of activities that contribute to the course score.

Bibliography

- [1] Samsu Abdullah, Mohd Hazwan Mohd Puad, Masrah Murad, and Erzam Marlisah. Implementation of learning analytics in primary and secondary school: A systematic literature review. *International Journal of Academic Research in Progressive Education and Development*, 11, 06 2022.
- [2] Kashif Ahmad, Waleed Iqbal, Ammar El-Hassan, Junaid Qadir, Driss Benhaddou, Moussa Ayyash, and Ala Al-Fuqaha. Data-driven artificial intelligence in education: A comprehensive review. *IEEE Transactions on Learning Technologies*, 17:12–31, 2024.
- [3] AHOVOKS – Agentschap Hoger Onderwijs, Volwassenenonderwijs, Kwalificaties en Studiebeurzen. Kwalificatieniveaus. De Vlaamse Kwalificatiestructuur website, 2025. accessed 19 May 2025.
- [4] Chiara Antonietti, Maria-Luisa Schmitz, Tessa Consoli, Alberto Cattaneo, Philipp Gonon, and Dominik Petko. “development and validation of the icap technology scale to measure how teachers integrate technology into learning activities”. *Computers and Education*, 192:104648, 10 2022.
- [5] Kim Arnold and Matthew Pistilli. Course signals at purdue: Using learning analytics to increase student success. *ACM International Conference Proceeding Series*, 04 2012.
- [6] Belgische Gegevensbeschermingsautoriteit. Artificial Intelligence Systems and the GDPR – A Data Protection Perspective, december 2024. Informatiebrochure van de Belgische Gegevensbeschermingsautoriteit.
- [7] Robert Bodily, Tarah Ikahihifo, Benjamin Mackley, and Charles Graham. The design, development, and implementation of student-facing learning analytics dashboards. *Journal of Computing in Higher Education*, 30, 12 2018.
- [8] Tom Broos, Katrien Verbert, Greet Langie, Carolien Soom, and Tinne De Laet. Small data as a conversation starter for learning analytics: Exam results dashboard for first-year students in higher education. *Journal of Research in Innovative Teaching & Learning*, 10:94–106, 07 2017.
- [9] Patricia Carney, Stefanie Sebok-Syer, Martin Pusic, Colleen Gillespie, Marjorie Westervelt, and Mary Goldhamer. Using learning analytics in clinical competency committees: Increasing the impact of competency-based medical education. *Medical Education Online*, 28, 02 2023.

- [10] Sven Charleer, Andrew Vande Moere, Joris Klerkx, Katrien Verbert, and Tinne De Laet. Learning analytics dashboards to support adviser-student dialogue, 2018-07-01.
- [11] Sébastien Combéfis and Guillaume de Moffarts. Reinventing evaluations with competency based assessments: a practical experiment with future computer science engineers. In *2020 IEEE Frontiers in Education Conference (FIE)*, pages 1–5, 2020.
- [12] European Commission, Mike Coles, Jens Bjornavold, and Isabelle Le Mouillour. Using learning outcomes. Technical Report ISBN 978-92-79-19759-5, European Centre for the Development of Vocational Training (Cedefop), Luxembourg, June 2011. Available from: <https://data.europa.eu/doi/10.2766/17497>.
- [13] Aleix Dorca Josa and Marc Bleda Bejar. Local llms: Safeguarding data privacy in the age of generative ai. a case study at the university of andorra. In *Proceedings of ICERI2024*, 11 2024.
- [14] Raphael A. Dourado, Rodrigo Lins Rodrigues, Nivan Ferreira, Rafael Ferreira Mello, Alex Sandro Gomes, and Katrien Verbert. A teacher-facing learning analytics dashboard for process-oriented feedback in online learning. In *LAK21: 11th International Learning Analytics and Knowledge Conference*, LAK21, page 482–489, New York, NY, USA, 2021. Association for Computing Machinery.
- [15] Erik Duval. Attention please! learning analytics for visualization and recommendation. In *Proceedings of the 1st International Conference on Learning Analytics and Knowledge*, pages 9–17. ACM, 2011.
- [16] Anna Dyckhoff, Dennis Zielke, Mareike Bültmann, Mohamed Chatti, and Ulrik Schroeder. Design and implementation of a learning analytics toolkit for teachers. *Educational Technology and Society*, 15, 01 2012.
- [17] McGraw Hill Education. Smartbook® , 2025. Accessed: 2025-05-18.
- [18] Eurydice Network, EACEA – European Commission. Belgium – flemish community: Overview. Eurypedia website, 2024. Last update: 16 December 2024; accessed 19 May 2025.
- [19] Mohamed Ez-zaouia and Elise Lavoué. Emoda: a tutor oriented multimodal and contextual emotional dashboard. In *Proceedings of the Seventh International Learning Analytics & Knowledge Conference*, LAK '17, page 429–438, New York, NY, USA, 2017. Association for Computing Machinery.
- [20] Rebecca Ferguson, Andrew Brasher, Doug Clow, Adam Cooper, Garron Hillaire, Jenna Mittelmeier, Bart Rienties, Thomas Ullmann, and Riina Vuorikari. Research evidence on the use of learning analytics - implications for education policy. *Publications Office of the European Union*, 12 2016.
- [21] Figma, Inc. Figma: Collaborative interface design tool, 2025.
- [22] Swapna Gottipati and Venky Shankararaman. Mycompetencies: Competency tracking mobile application for is students. In *2016 IEEE Global Engineering Education Conference (EDUCON)*, pages 254–260. IEEE, April 2016.

- [23] Andrew Hill. Are pie charts evil? an assessment of the value of pie and donut charts compared to bar charts. *Information Visualization*, 24, 06 2024.
- [24] Kenneth Holstein, Bruce M. McLaren, and Vincent Aleven. Intelligent tutors as teachers' aides: exploring teacher needs for real-time analytics in blended classrooms. In *Proceedings of the Seventh International Learning Analytics & Knowledge Conference*, LAK '17, page 257–266, New York, NY, USA, 2017. Association for Computing Machinery.
- [25] IMS Global Learning Consortium. Learning tools interoperability® (lti®). <https://www.imsglobal.org/activity/learning-tools-interoperability>, 2020. Accessed: 2025-05-27.
- [26] IntelliBoard. Intelliboard plugin for moodle, 2025. Accessed: 2025-01-06.
- [27] Rogers Kaliisa, Kamila Misiejuk, Sonsoles López-Pernas, Mohammad Khalil, and Mohammed Saqr. Have learning analytics dashboards lived up to the hype? a systematic review of impact on students' achievement, motivation, participation and attitude. In *Proceedings of the 14th Learning Analytics and Knowledge Conference*, LAK '24, page 295–304, New York, NY, USA, 2024. Association for Computing Machinery.
- [28] Oscar Klassdata and Angel KlassData. Smartklass™ learning analytics plugin for moodle, 2025. Accessed: 2025-05-18.
- [29] Learning Bytes Festival. Learning bytes festival 2025. <https://www.learningbytesfestival.be>, 2025. Accessed June 3, 2025.
- [30] Steven Lonn and Stephanie D. Teasley. Student explorer: A tool for supporting academic advising at scale. In *Proceedings of the First ACM Conference on Learning @ Scale Conference*, L@S '14, pages 175–176, New York, NY, USA, 2014. Association for Computing Machinery.
- [31] Intuitif Technologies Pte. Ltd. Learnsmart app, 2025. Accessed: 2025-05-18.
- [32] Riccardo Mazza and Christian Milani. Gismo: a graphical interactive student monitoring tool for course management systems. *Placeholder Journal Name*, 01 2004.
- [33] Sean Mckenna, David Mazur, James Agutter, and Michael Meyer. Design activity framework for visualization design. *Visualization and Computer Graphics, IEEE Transactions on*, 20:2191–2200, 12 2014.
- [34] Martijn Millecamp, Francisco Gutiérrez, Sven Charleer, Katrien Verbert, and Tinne De Laet. A qualitative evaluation of a learning dashboard to support advisor-student dialogues. In *Proceedings of the 8th International Conference on Learning Analytics and Knowledge*, LAK '18, page 56–60, New York, NY, USA, 2018. Association for Computing Machinery.
- [35] Moodle. Moodle, 2024. Accessed: 2025-01-05.

- [36] Jad Najjar. Learning bytes festival - claire dash-board mention. https://www.linkedin.com/posts/jnajjar_learningbytesfestival-innovation-smarteducation-activity-7311882411145854976-4pf- 2025. LinkedIn post. Accessed June 3, 2025.
- [37] Yessika Adelwin Natalia, Christel Faes, Thomas Neyens, and Geert Molenberghs. The covid-19 wave in belgium during the fall of 2020 and its association with higher education. *PLOS ONE*, 17(2):1–18, 02 2022.
- [38] Ngrok, Inc. ngrok: Secure introspectable tunnels to localhost. <https://ngrok.com>, 2024. Accessed: 2025-05-27.
- [39] Jakob Nielsen. *Usability Engineering*. Morgan Kaufmann, 1994.
- [40] VRT NWS. Digitaal platform smartschool wil leerproblemen opsporen met ai, 2024. Online; accessed 2025-01-03.
- [41] VRT NWS. Smartschool herbekijkt ai-tool na kritiek, 2024. Online; accessed 2025-01-03.
- [42] Jeroen Ooge, Leen Dereu, and Katrien Verbert. Steering recommendations and visualising its impact: Effects on adolescents’ trust in e-learning platforms. In *Proceedings of the 28th International Conference on Intelligent User Interfaces*, IUI ’23, page 156–170, New York, NY, USA, 2023. Association for Computing Machinery.
- [43] OpenAI. Chatgpt. <https://chat.openai.com>, 2024. Accessed May 2025.
- [44] OpenAI. DALL·E. <https://openai.com/dall-e>, 2024. Image generated via Microsoft Copilot using DALL·E.
- [45] Susan Patrick, Maria Worthen, Dale Frost, and Natalie Truong. Current to future state: Issues and action steps for state policy to support personalized, competency-based learning, 2018. ERIC Number: ED589866.
- [46] Ivan Peraić and Ani Grubišić. Development and evaluation of a learning analytics dashboard for moodle learning management system. In Panayiotis Zaphiris and Andri Ioannou, editors, *Learning and Collaboration Technologies. Novel Technological Environments*, volume 13333 of *Lecture Notes in Computer Science*, pages 390–408, Cham, November 2022. Springer International Publishing.
- [47] Mar Pérez-Sanagustín, Isabel Hilliger, Jorge Maldonado-Mahauad, and Ronald Pérez-Álvarez. Building institutional capacity for learning analytics: Top-down & bottom-up initiatives. *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje*, 17(3):281–289, 2022.
- [48] Sameer Qazi, Muhammad Kadri, Muhammad Naveed, Bilal Khawaja, Sohaib Khan, Muhammad Alam, and Mazliham Su’ud. Ai-driven learning management systems: Modern developments, challenges and future trends during the age of chatgpt. *Computers, Materials & Continua*, 80:1–10, 08 2024.

- [49] Teodoro F. Revano and Manuel B. Garcia. Designing human-centered learning analytics dashboard for higher education using a participatory design approach. In *2021 IEEE 13th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM)*, pages 1–5, 2021.
- [50] Denise H. Rhoney, Aleda M.H. Chen, Mariann D. Churchwell, Kimberly K. Daugherty, Jennie B. Jarrett, Erika L. Kleppinger, James J. Nawarskas, Stephanie L. Sibicky, Cindy D. Stowe, and Susan M. Meyer. The need for competency-based education. *American Journal of Pharmaceutical Education*, 88(6):100706, 2024.
- [51] Elizabeth Sanders and Pieter Jan Stappers. Co-creation and the new landscapes of design. *CoDesign*, 4:5–18, 03 2008.
- [52] Ben Shneiderman. The eyes have it: A task by data type taxonomy for information visualizations. *IEEE Symposium on Visual Languages, Proceedings*, 03 2000.
- [53] Smartschool. Smartschool, 2024. Accessed: 2025-01-05.
- [54] Erverson Sousa, Bruno Alexandre, Rafael Ferreira, Taciana Pontual Falcão, Boban Vesin, and Dragan Gasevic. Applications of learning analytics in high schools: A systematic literature review. *Frontiers in Artificial Intelligence*, 4:737891, 09 2021.
- [55] StudentPulse. Studentpulse, 2025. Accessed: 2025-05-18.
- [56] Maxwell Szymanski, Jeroen Ooge, Robin De Croon, Vero Vanden Abeele, and Katrien Verbert. Feedback, control, or explanations? supporting teachers with steerable distractor-generating ai. In *Proceedings of the 14th Learning Analytics and Knowledge Conference, LAK '24*, page 690–700, New York, NY, USA, 2024. Association for Computing Machinery.
- [57] Dirk Tempelaar and Bart Rienties. Learning analytics en de noodzaak van rijke data. *Tijdschrift voor Hoger Onderwijs*, 41(1), Apr. 2023.
- [58] Katrien Verbert, Sten Govaerts, erik duval, Jose Santos, Frans Van Assche, Gonzalo Parra, and Joris Klerkx. Learning dashboards: An overview and future research opportunities. *Personal and Ubiquitous Computing*, 18, 11 2013.
- [59] Floris Versmissen, Wouter Buelens, Ruben Vanderlinde, Jo Tondeur, Bram De Wever, Tijs Rotsaert, Tim Surma, and Martin Valcke. *Blended learning in het Vlaams secundair onderwijs: Van noodzaak naar structurele implementatie*. Placeholder Publisher Name, 08 2022.
- [60] Carlos Vicente. ltijs: A node.js library to create lti 1.3 tool providers. <https://github.com/Cvmcosta/ltijs>, 2020. Accessed: 2025-05-27.
- [61] Ong Xin and Dalbir Singh. Development of learning analytics dashboard based on moodle learning management system. *International Journal of Advanced Computer Science and Applications*, 12(7):697–703, July 2021.

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