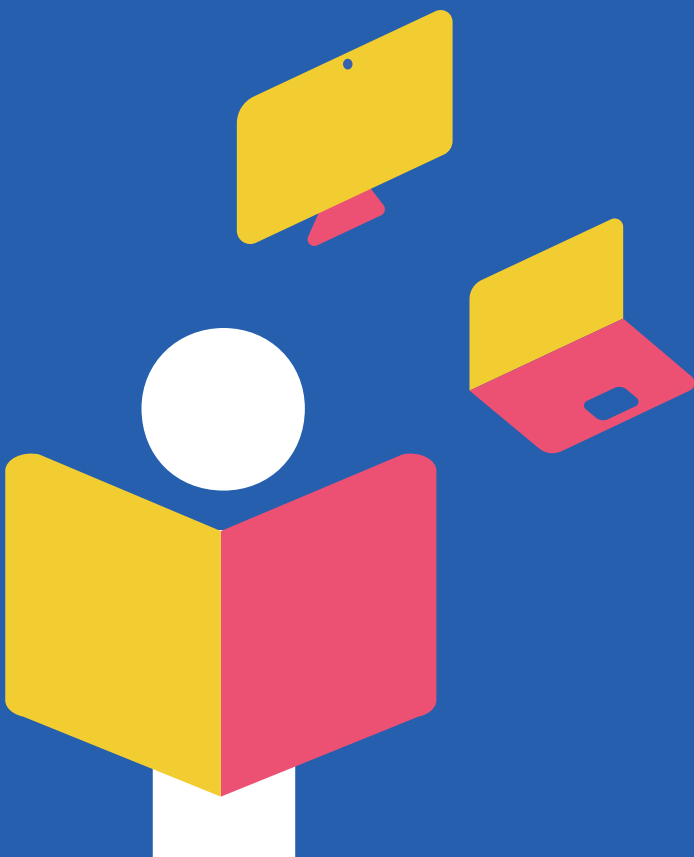i•Learn

Introduction to the i-Learn project

Reference

i-Learn team. (2022). *i-Learn paper 1: Introduction to the i-Learn project.* i-Learn. URL

Contents

Introduction and background

The i-Learn project was made possible by the Flemish government, KULeuven and imec.

The i-Learn papers originated from the project of the same name on personalised digital learning, commissioned by the Flemish government. The project started in September 2019 and will run until June 2023. With the i-Learn project, the Flemish government intends to focus on responsible and sustainable use of technology and wants to help teachers implement personalisation in Flemish primary and secondary schools.

The project makes it possible to tailor personalised learning to each student using existing digital tools that are made easily accessible. The content of these tools has not been adapted, but didactically framed to support daily classroom practice, in which students and teachers are central. This increases the autonomy of teachers and reduces their planning burden, and also gives students insight and participation in their learning process. The aim is to professionalise teachers and broaden the Flemish EdTech sector.

The expertise and evidence-based practices that we have acquired during the design, development and evaluation of the i-Learn project are now written down and shared in the i-Learn papers.

PURPOSE OF THIS PAPER

This first i-Learn paper explains MyWay and the Academy. The basic concepts are explained and insight is given into the use of the platform. More information is provided about creating 'learning tracks' using (adaptive) digital tools as a solution to the need for differentiation. The paper answers the following research questions:

- What is the i-Learn project?
- How do i-Learn MyWay and the i-Learn Academy work?
- What is digital personalised learning and how does it happen in i-Learn MyWay?
- What are the features of the platform?

WHO THIS IS FOR

This document has been compiled with the aim of sharing knowledge and insight with people who use personalised learning in practice and people who are interested in the operation of i-Learn. Examples include: teachers, IT coordinators, school boards, EdTech players, developers, web designers and other interested parties. Each i-Learn paper provides insight into the acquired expertise, know-how and/ or evidence-based practices that were collected during the development and implementation of the i-Learn project.

1. About i-Learn

In the educational landscape of recent years, two trends — which eventually led to the research project i-Learn — have stood out. Firstly, it has become increasingly clear that the future, including the future of education, will be digital. Schools are encouraged to formulate an IT vision as a matter of necessity. It is important to support and train people in the education sector to deal with these developments. Secondly, schools are experiencing greater diversity. It is therefore becoming increasingly urgent to create customised learning pathways. While this task is certainly not easy, technology can help. Advances in Education Technology (EdTech) offers new opportunities to support teachers and students in the learning process and enables greater differentiation. These two dynamics have led to the emergence of i-Learn, which is a research project commissioned by the Flemish government with the financial support of Flanders Innovation and Entrepreneurship (VLAIO). The aim of this project is to facilitate and strengthen customised digital learning. The target group consists of mainstream and special education schools at both primary and secondary levels.

The i-Learn platform: 'MyWay' and the supporting 'Academy' module were developed on the basis of **design-based research**[1]. The creation process progressed through a series of different phases: analysis, design, evaluation, reanalysis, and re-evaluation. The 'design side' was combined with scientific research, and there was cooperation with stakeholders in the field. For example, in addition to the technological development aspect of the 'product', needs assessments, effectiveness studies, scientific research and literature studies were carried out. Didactic experts contributed to the content and provided high-quality educational material.

The i-Learn project started in 2019, when a market exploration and needs assessment were carried out (https://www.i-learn.vlaanderen/en/news/inquiry/do-flemish-schools-need-i-learn/). Based on the information collected at the time, a prototype was launched in the 2020-2021 school year. The 12 pilot schools which tested this prototype were observed and surveyed, and the feedback collected led to the current portal with the solutions MyWay and Academy. MyWay is the actual portal where customised learning takes place. Both teachers and students use this portal, and it is there that students follow personalised learning paths, carefully selected or developed by teachers. The Academy platform provides support for teachers and helps them to upgrade their skills. In the Academy, teachers will find a wide range of online modules, manuals and other material to support them. They can search and browse through the online learning material themselves, which can be about using the portal, but can also go beyond that, thus covering a wide range of didactic topics including differentiation, effective digital instruction, blended learning and gamification.

In addition to the general pedagogical content, there are also sessions that focus on personalised digital learning within a certain domain (e.g. languages or STEM) or for a specific target group (e.g. learners of Dutch as a second language, gifted students). Teachers who want face-to-face guidance from a specialist coach can register for an interschool training programme. They can even go a step further by signing up for a unique, tailor-made coaching programme that allows them to map the school's own context during the selected sessions. There are also upskilling opportunities for other stakeholders such as school boards, for example to develop a supported IT vision for their school.

Since the launch of these products in September 2021, i-Learn has been rolled out and made available to other schools. The research project runs until mid-2023, when the government will decide in what form or capacity the project will exist going forward. The schools currently using i-Learn are regularly surveyed and research and studies are still being conducted to evaluate and improve MyWay and its support offerings.

WHO CAN USE I-LEARN?

Any primary or secondary school can participate. It does not matter whether the school has already implemented an IT vision or is just at the beginning of the process, or whether the school wants to launch the platform school-wide or just use it in one classroom. The way in which schools use i-Learn is also very flexible: classroom-based, in flex hours, in special needs education, in project work or in group work. All of these options are possible! i-Learn does not only focus on single classes, but also makes it possible to work across school class boundaries.
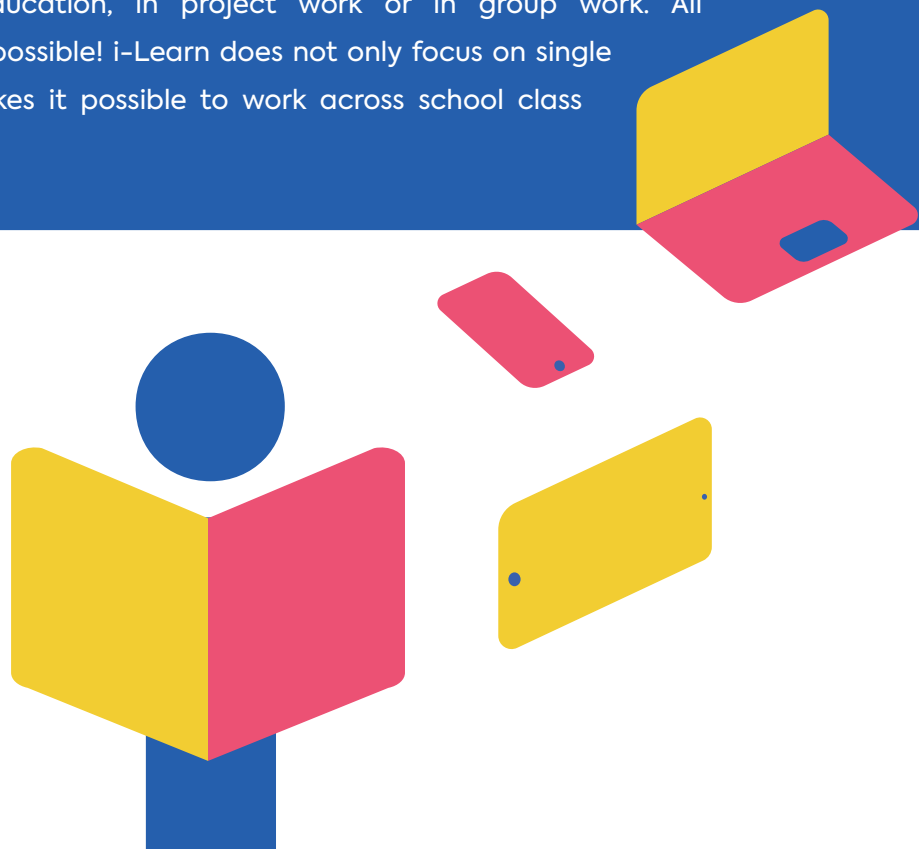
2. Outlining i-Learn MyWay and the Academy

In this paper, explanations, examples and screenshots are used to show how MyWay and the Academy work and what teachers can expect. It is not possible to describe every feature down to the smallest technical details, but if this introduction fuels curiosity, please check the Academy or the website https://www.i-learn.be/ for further info.

Below are two screenshots. Figure 1 shows the i-Learn MyWay login screen, where both students and teachers can log in to the platform. If a user logs in as a teacher, they will see the screen in Figure 2. This is the teachers' homepage, where they can find all the didactic material for digital personalised learning.

In order to explain the features of the platform clearly, some basic concepts for the use of i-Learn MyWay will be discussed first, and then the Academy will be discussed.

FIGURE 1: MyWay login screen

FIGURE 2: MyWay homepage for teachers
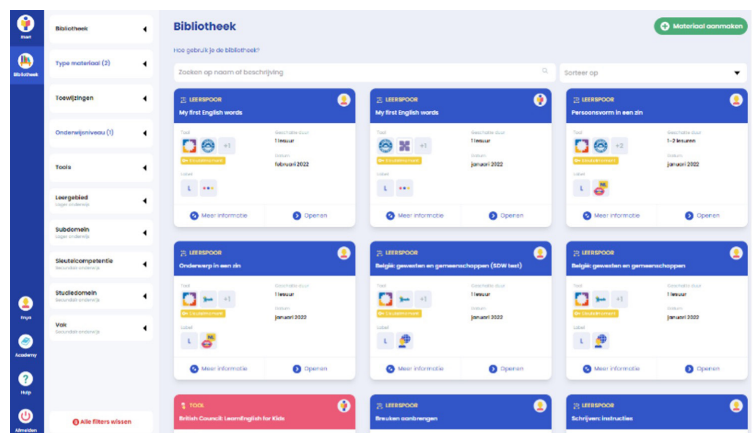
2.1 I-LEARN MYWAY BASIC CONCEPTS

The tools

MyWay is a platform with around 50 carefully selected, digital educational tools. Thanks to a **Single Sign-on**, users can easily access all these tools with just one login. Where teachers previously had to create separate accounts for all tools and apply for (and/ or pay for) licenses, they can manage and use all these tools at once on the i-Learn platform. i-Learn has opted for a range of widely deployable tools that had to meet certain didactic and technical requirements. The tools are intended for mainstream and special education at both primary and secondary levels. The needs assessment and market exploration that took place at the beginning of the project also indicated a need for specialisation around different themes. Particular attention was therefore paid to the following themes: NT2, reading comprehension, gifted students and computational thinking. In MyWay, there are also several digital tools related to these themes.

All these tools can be used by teachers to offer learning materials to their students. This can be done in two ways: through 'free learning' or by making or using learning tracks. Free learning is an option on the home screen of students logging into MyWay (see Figure 3). The 'free learning' button takes students to an overview of the tools, divided into different folders depending on the topic. They can explore the tools themselves or follow instructions from their teacher.

FIGURE 3: Free learning zone
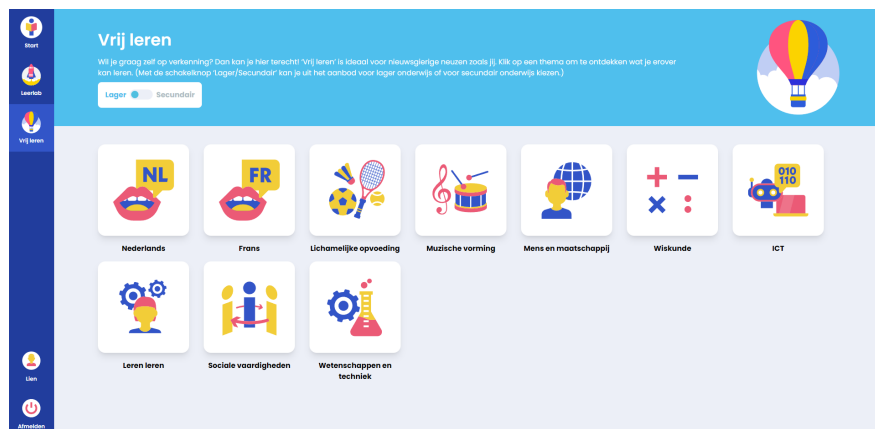
An instruction might go as follows: "Dear class, we are going to do some extra maths practice. In free learning, go to the maths folder and open the Junior Einstein tool. Choose the add and subtract with bridge exercise."
A Dutch teacher can let their students browse independently in the free learning folder 'Dutch', for example. Students with enough knowledge, IT skills and ability to self-manage can search for exercises or instructions they like in the tools themselves.

Teachers can find all the tools in the library. They will immediately get to this when they register with MyWay. For a tool overview and a list for which all these tools can be used (year, course, lesson content, etc.), teachers can visit the Academy or the website (https://www.i-learn.be/alle-educatieve-tools-op-een-rijtje).

Teachers who want their students to start working in a more guided and didactically based way can use learning tracks. A learning track is a sequence of learning activities. These activities can come from different i-Learn tools or can refer to the teacher's own material, for example. A student follows a learning track and goes from exercise to exercise through the various tools, without having to log in each time.

Figure 4 shows the different 'cards' that can be found in the library: learning tracks, learning activities and tools. These concepts and the way they work will be explained in further detail below.

FIGURE 4: The visual representation (or 'card') in the i-Learn library of a learning track, a learning activity and a tool.
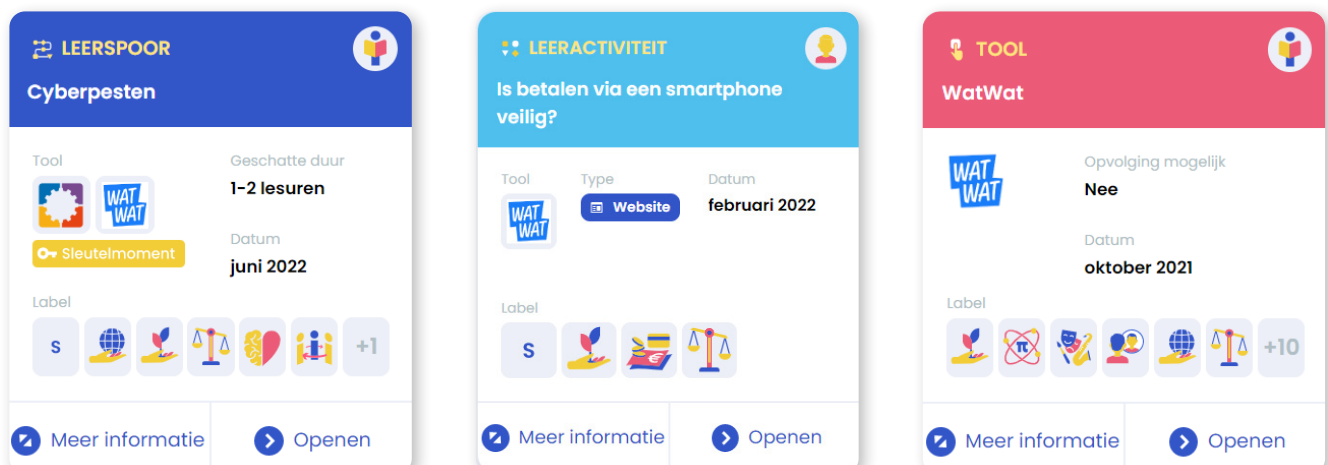
The learning tracks

After logging in to MyWay, teachers can use, adjust and create personalised digital learning paths or 'learning tracks' themselves. Building a learning track requires time and energy, as the teacher must plan the structure and content and has to build it in the portal. Creating a learning track is similar to designing a series of lessons. Once this is done, the teacher can continue to use and adjust the learning tracks.

At the start of a learning track, a teacher assigns learning objectives to the students. This is important for the students' development of self-regulatory skills and insight into their own learning process. At the end of each learning track, a student must assess themselves with respect to these learning objectives: how well did they do? This assessment is also seen by teachers in the teacher dashboard (see 'Monitoring with the teacher dashboard').

A learning track is a path that students take to achieve a learning goal. To learn, they receive instructions, exercises, tests and repetition. In the library (see Figure 2 above) there are sample learning tracks, created by the i-Learn didactic team. Teachers can use these **inspiration learning tracks** as they are or adapt them for their own class. In addition, teachers can make their own learning tracks, as

they can best assess what differentiation is necessary for their students.

A learning track consists of learning activities and key moments (see Figure 5).

FIGURE 5: Visual representation of a learning track in MyWay with learning activities (dark blue) and a key moment (light blue) about the present tense.
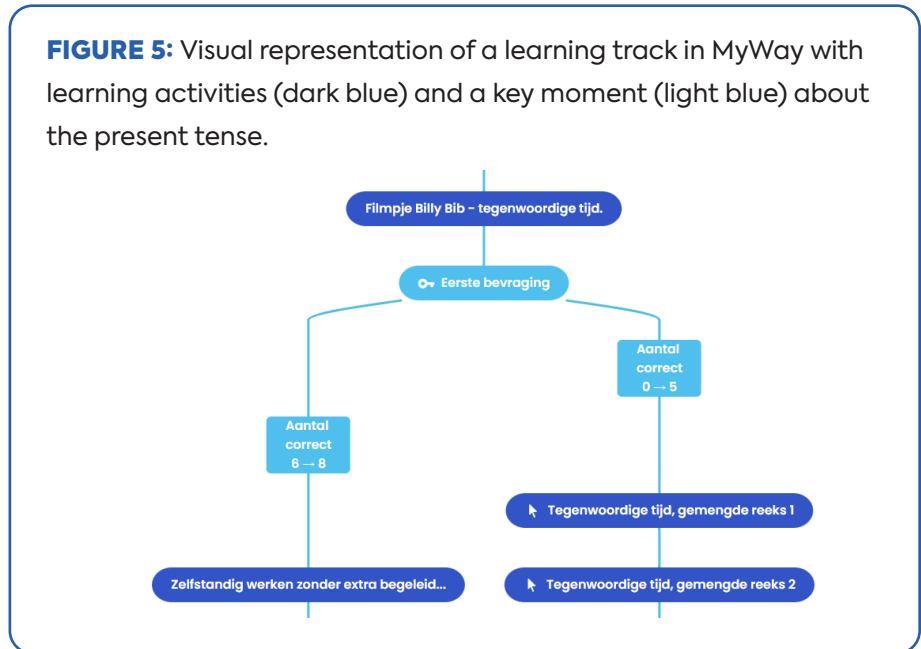
In this learning track about the present tense, the key moment, 'first quiz', follows the learning activity 'Billy Bib film – present tense'. A student with high scores (6 or more correct) in the quiz will end up on the left branch. This student will carry out the learning activity 'working independently without additional supervision'. A student with lower scores (less than 6) will end up on the right branch and go through at least two more learning activities with exercises about the present tense. The diagram in Figure 5 is not visible to students. The students follow the learning track step by step and do not know which branch they end up on. The teacher will be able to see which branch the student takes (see 'Monitoring with the teacher dashboard').

Thanks to the integrated text to speech software, instructions and other text can be read aloud or translated in the MyWay portal. Students with reading difficulties and non-native speakers can thus receive the necessary support.

The learning activities

Learning tracks consist of learning activities. First of all, these come **from i-Learn tools**. In the library there are already a lot of learning activities that come from the i-Learn tools (light blue cards in figure 4): an exercise, a video, an image, etc. which teachers can use in a learning track. But not every exercise from every tool already has a light blue card. Teachers can therefore create their own learning activities with existing exercises from the tools and thus make light blue cards in the library. They can also determine the content of learning activities themselves by using one of the authoring tools in i-Learn. With AssessmentQ, BookWidgets and La Digitale (free tool), teachers can create interactive exercises, quizzes, tests, videos and so on to include in the learning track.

Secondly, teachers can also add **external, digital content** as a learning activity, such as their own website or a form in their own cloud. Since this is external content, a login may be required. The i-Learn Single Sign-on only works for the tools that are present within the platform.

Finally, in addition to using the tools and external material, teachers can also use **offline learning material** (blended learning). For example, they can give students an instruction in MyWay, after which the students perform this exercise offline in the classroom, for example, a scientific experiment. When the students have completed it, they can return to their laptop, tablet or other device to continue the learning track. A teacher could also give an instruction in the learning track that refers to an exercise in a textbook.

When a student navigates through the learning track and comes to a learning activity that was linked from a tool, they can start this activity by clicking on the green 'activiteit starten' ('start activity') button (see Figure 6 at the bottom left). The exercise, video, etc. will open in a new tab in the web browser. When the student has finished the learning activity, they close the tab and return to i-Learn. The 'Ik ben klaar' ('I'm finished') button has now turned green. If the student clicks on it, they will see the next activity.

FIGURE 6: A learning activity in the Noorderlicht learning track from a student's account.

In order to train this technical action, there is a short practice learning track in the library where the opening and closing of tabs is shown and practised. Once the students understand how to follow a learning track and they begin working, the teacher has more time to focus on individual students and targeted scaffolding in the classroom.

Key moments

The key moments are the places in the learning track where there is a split in the track. These key moments can be cognitive, motivational or metacognitive. **Cognitive** means that it is a test of knowledge. Differentiation is made on the basis of content level and, for example, mastery of the subject matter. Depending on the number of right or wrong answers, students will be directed to one or the other branch. For example, a French teacher may use a cognitive key moment to test students on the conjugation of the verb être (see Figure 7).

FIGURE 7: A cognitive key moment about the conjugation of être.
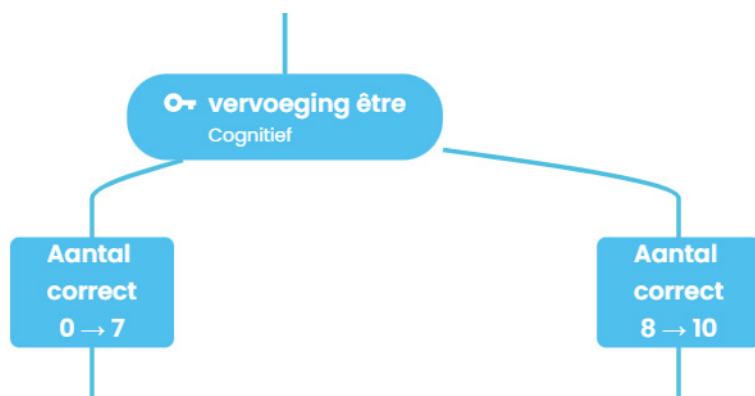
This is the screen for the student. The student selects the correct form of the verb.

FIGURE 8: The cognitive key moment for the conjugation of être as the student sees it and can fill it in.

However, research shows that motivation is also extremely important for students' learning process. A **motivational** key moment ensures differentiation in terms of interest. Interest is an important driver for the learning process and certainly for intrinsic motivation. This gives students freedom of choice regarding the content or form of an exercise.

Example 1: A student is given a choice between several topics for an exercise in reading comprehension: a text about racing cars, or about human rights, or about a popular TV series. If the text is more in line with a student's interest, their concentration and motivation will be higher.

Example 2: To learn the theory about a certain topic, such as earthquakes, a student can choose between different formats: a text, a video or an interactive exercise. Learning preferences can also be requested.

FIGURE 9: In this key moment, the student chooses a video or a text entitled 'How does personalised advertising work?'
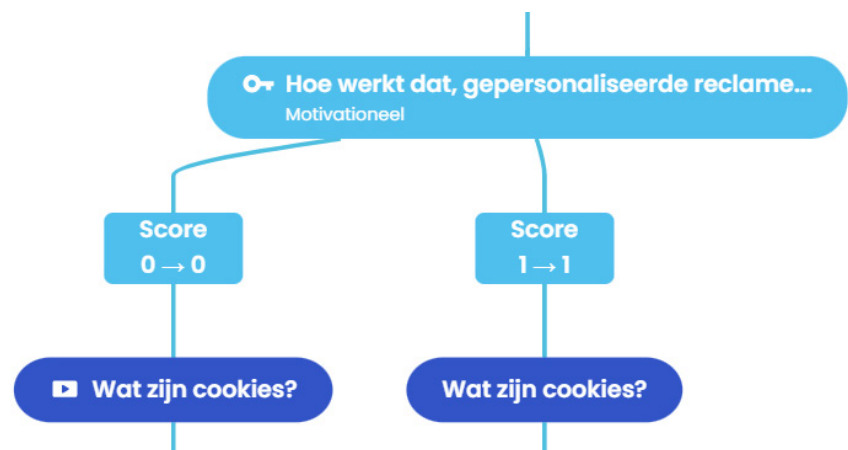
With a **metacognitive** key moment, students reflect on their understanding of their own learning process (self-regulated learning). This is a very important skill in the context of lifelong learning. In a rapidly changing society, people are expected to be flexible in the face of change. In order to do this, it is important to have insight into your own learning process. The metacognitive key moment asks about a student's own sense of understanding and their own preference concerning the continuation of the process. For example, a student may be asked: 'We just learned some theoretical concepts and tried some exercises. Do you think you're ready to try some harder exercises? Or would you prefer to continue practising at this level?' The students are therefore challenged to think about the learning process themselves, to question it and to make choices in it.

Example: The learning track in Figure 10 starts with a metacognitive key moment so that the student can assess for themselves how much they already know about the topic 'fiction or non-fiction'. At this key moment, the following is asked: 'Do you know the difference between fiction and non-fiction?' The student can choose between four answers: 'Yes, I know the difference and can immediately do an exercise on it', 'I'm not completely sure', 'Yes, I know the difference, but I would like to hear the explanation again' and 'No, I do not know the difference. I'd like to have the explanation first.' If the student chooses the first option, they will proceed to a further step in the learning track. If they choose one of the other three options, they will first be shown a video: 'fiction of non-fiction (theory)'.

FIGURE 10: The beginning of the learning track scheme for the learning track 'Technical reading (M5) fiction or non-fiction?'
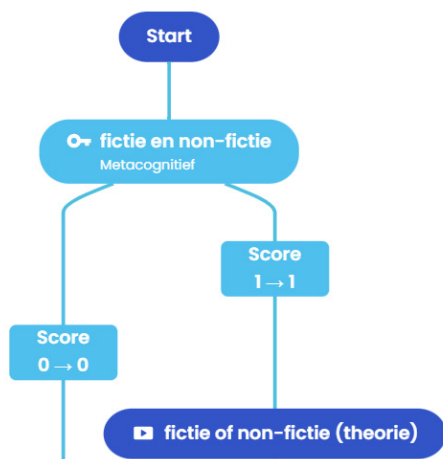
FIGURE 11: The details of the metacognitive key moment on fiction and non-fiction, as visible to teachers.

So these are the three ways in which teachers can differentiate within a learning track.

COGNITIVE

- Knowledge test
- Differentiation based on content level, mastery of the subject matter

MOTIVATIONAL

- Interest is an important driver of the learning process, intrinsic motivation
- Freedom of choice, e.g. in the content or form of the exercise.

METACOGNITIVE

- Self-regulated learning is a key skill for the 21st century: understanding one's own learning process
- Ask about the student's own sense of understanding and their own choice for continuation (the right to make mistakes!)
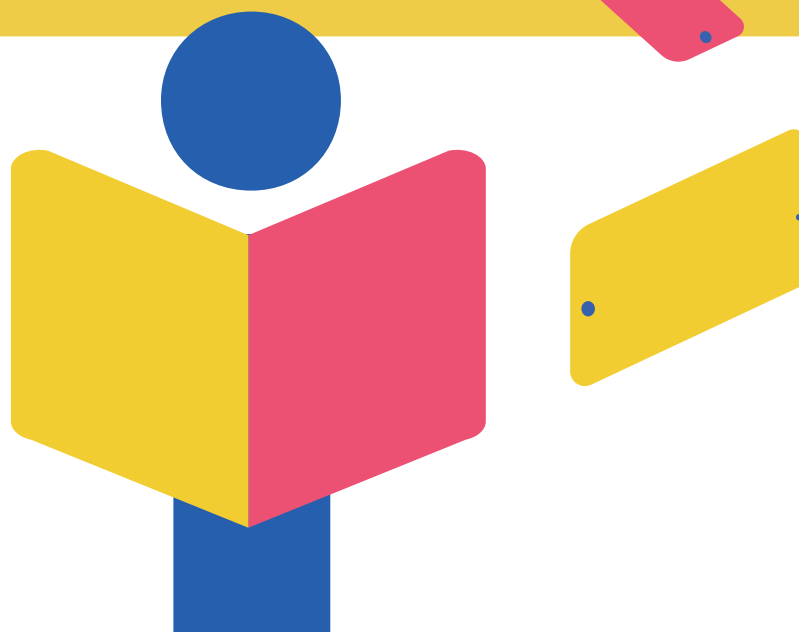
The libraries

A teacher has three libraries in MyWay: a personal library, a school library and a public library. Learning tracks that they create themselves are automatically stored in the personal library. The teacher can use these learning tracks in the personal library with students (see 'assigning'). Additionally, the teacher can search for learning tracks in the public library. When a teacher clicks on a learning track and then clicks on 'use', this learning track also goes into their personal library.

FIGURE 13: Detail of a learning track from the public library. At the bottom right is the green 'gebruiken' ('use') button.

In between the public and private libraries, there is the school library. Each i-Learn school has its own school library. If a teacher makes a learning track and would like to share it with colleagues, but not with the whole i-Learn community yet, they can share the track with the school library. The learning tracks shared with the public library are accessible to all teachers that use i-Learn.

The learning track cards have an icon at the top right that indicates who made the learning track. As can be seen in Figure 14, the left learning track was created by the user themselves (or they found this learning track in the school or public library and clicked on 'use'). This is indicated by a little man in the top right corner. The middle learning track was created by the didactic team of i-Learn, which is shown by the little i-Learn man in the top right corner. The right learning track was made by another teacher, which can be seen by the little blue man in the top right corner.

**FIGURE 14:** Three learning cards from different creators.

The filters

To navigate the library there are different filters. For example, the material can be filtered by library (personal, school or public). In addition, you can filter by the type of material: the learning track and tool are checked by default, but you can also search by learning activity. There is also a filter for assigned or unassigned learning tracks and one for searching for material that contains a particular tool.

When a user filters by 'education level', additional filters appear for, among other things, 'year or grade', 'key competencies', 'building blocks' and 'subjects'. These filters are designed to help teachers find materials efficiently and quickly.

FIGURE 15: The home screen for a logged in teacher with the filters on the left of the screen.
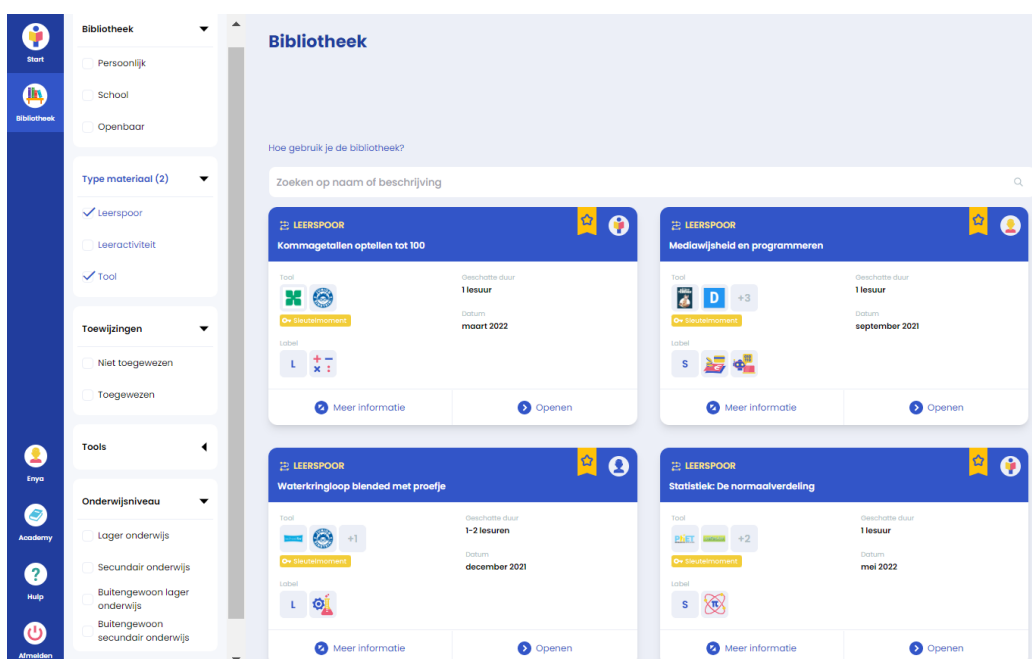
Use, change or create a learning track yourself

Once a teacher has found an interesting learning track using the filters, they can look closer to see if it is suitable. By clicking on 'More information', a more extensive learning track card opens. A teacher can quickly go through the results with the arrows, as can be seen in Figure 16.

FIGURE 16: Use the 'vorige' ('previous') and 'volgende' ('next') arrows to go through the learning tracks.

After clicking on 'Open', a complete description per learning track will appear. Among other things, the first tab, 'Content', lists which tools are used, what the estimated duration is to go through the learning track as a student, what the date of creation is, the appropriate grade, the key competencies and study domains that fit it, the learning outcomes that apply and the subjects for which it is useful. This collection of data is collectively called the metadata. The designer of the learning track fills in this metadata.

The second tab is a diagram of the learning track. This shows all the steps that users of the learning track will or can go through. It shows a start, end and intermediate learning activities, key moments and the branches. Every learning activity and every key moment can be clicked and viewed there. If the teacher decides that this learning track is useful, they can use the track by clicking on the green button. The learning track then goes to their personal library where they can work on it further. A teacher can delete, adjust, or withdraw learning tracks in the personal library, view an example of how it looks to students, and assign the learning tracks to the students.

FIGURE 17: The screen with metadata and information about the 'water cycle blended with experiment' learning track.
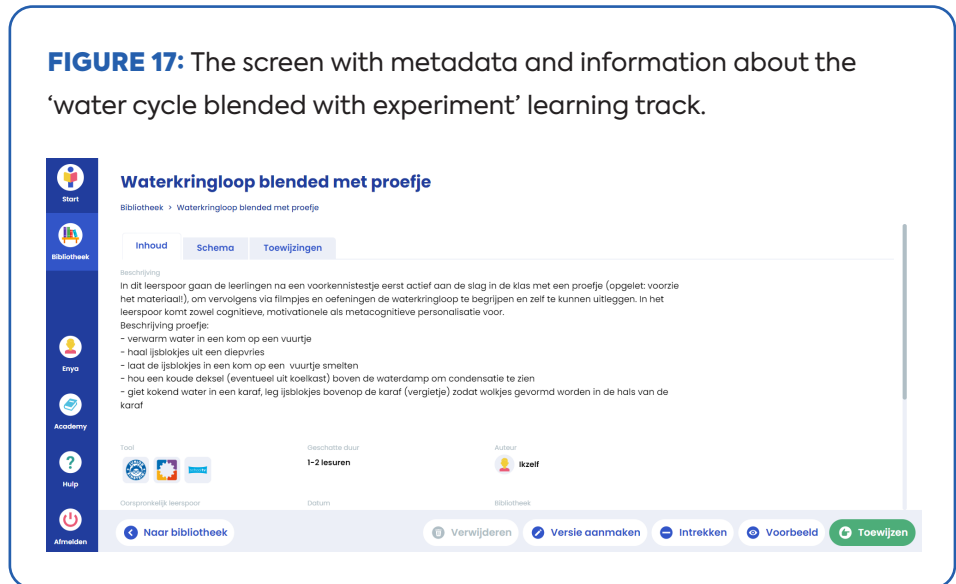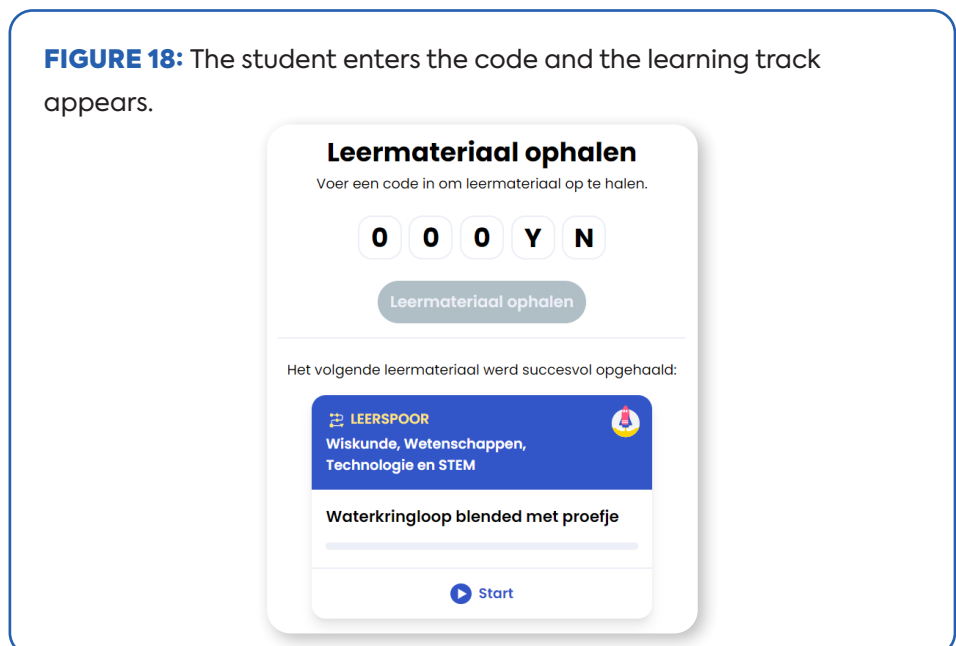
Assign a learning track

When the teacher has chosen, adapted and/or made a learning track, they can 'assign' the learning track to students. For this, the teacher gives the learning track its own name and chooses which theme the track belongs to. When the teacher clicks on 'assign', a code appears.

When a student logs in to MyWay, they will automatically be taken to a home screen that says 'retrieve learning material'. The student enters the code of the learning track here, after which the learning track appears, and they can start it. The retrieved and started learning tracks, as well as the completed learning tracks, can be found by a student in the 'learning lab'.

FIGURE 18: The student enters the code and the learning track appears.

Monitoring with the teacher dashboard

When a learning track is assigned to students, the teacher can monitor their progress by opening the track in the personal library. In addition to the 'content' and 'scheme' tabs, 'assignments' are now also visible. By clicking on this, the teacher will again see the code that was generated and some additional information, such as how many students have retrieved the learning track, how many have started it and how many have completed it.

FIGURE 19: The assignment with the corresponding code for the learning track as seen by the teachers.

Mediawijsheid en programmeren

Bibliotheek > Mediawijsheid en programmeren

Schooljaar 2021 – 2022

Computationeel denken - persmoment
Wiskunde, Wetenschappen, Technologie en STEM
13/09/2021

006J2

Huidige versie

Status opgehaald	Status gestart	Status afgerond
0	0	2

With each assignment of the learning track, the teacher can click on the large blue button with an arrow. This leads them to the teacher dashboard as shown in Figure 20:

FIGURE 20: The dashboard for teachers.

Mediawijsheid en programmeren

Bibliotheek > Mediawijsheid en programmeren > Computationeel denken - persmoment

Computationeel denken - persmoment
006J2   Huidige versie

| Voornaam	Achternaam	Klas	Status	Sleutelmoment (cognitief)	Zelfinschatting	
Lien	Leerling	testklas	✅	🔴	60%	Bekijk vooruitgang ❯
Nikias	Leerling	1A	✅	🔴	53%	Bekijk vooruitgang ❯
						2 resultaten

As can be seen in Figure 20, 'Computational thinking – press moment' has been assigned to two students. The green bullet under 'status' shows that the students have started the learning track. If the green bullet has a tick, the students have completed it. Whether a student has completed the learning track can also be seen when looking at the self-assessment score. At the end of the learning track, the students are asked to assess themselves in relation to the learning objectives stated at the beginning. If a percentage can be seen here, this means that the student has reached the end of the learning track. There is one key cognitive moment in the learning track. How the students scored on it can be seen from a red or a green bullet. Only the answers to the key moments (not the learning activities in the tools) are visible in the i-Learn dashboard.

Here, for example, it is interesting for a teacher to look at the student's score on the cognitive key moment in combination with their self-assessment. For instance, if the student had a low score on the knowledge test (red bullet), but self-assessed that they had mastered the subject matter, then a conversation or more feedback is probably needed. This also applies to a student who achieved a high score on the cognitive part, but self-assessed that they had not mastered the subject matter at all.

By clicking on 'look at progress', it is possible to see how each individual student went through the track and what answers they gave to the key moments (see Figure 21). It can be interesting for a teacher to go over the diagram of the student's journey with the student in question to see how they did it. This is offline, one-on-one feedback.

FIGURE 21: The path that the student called Lien followed in the learning track
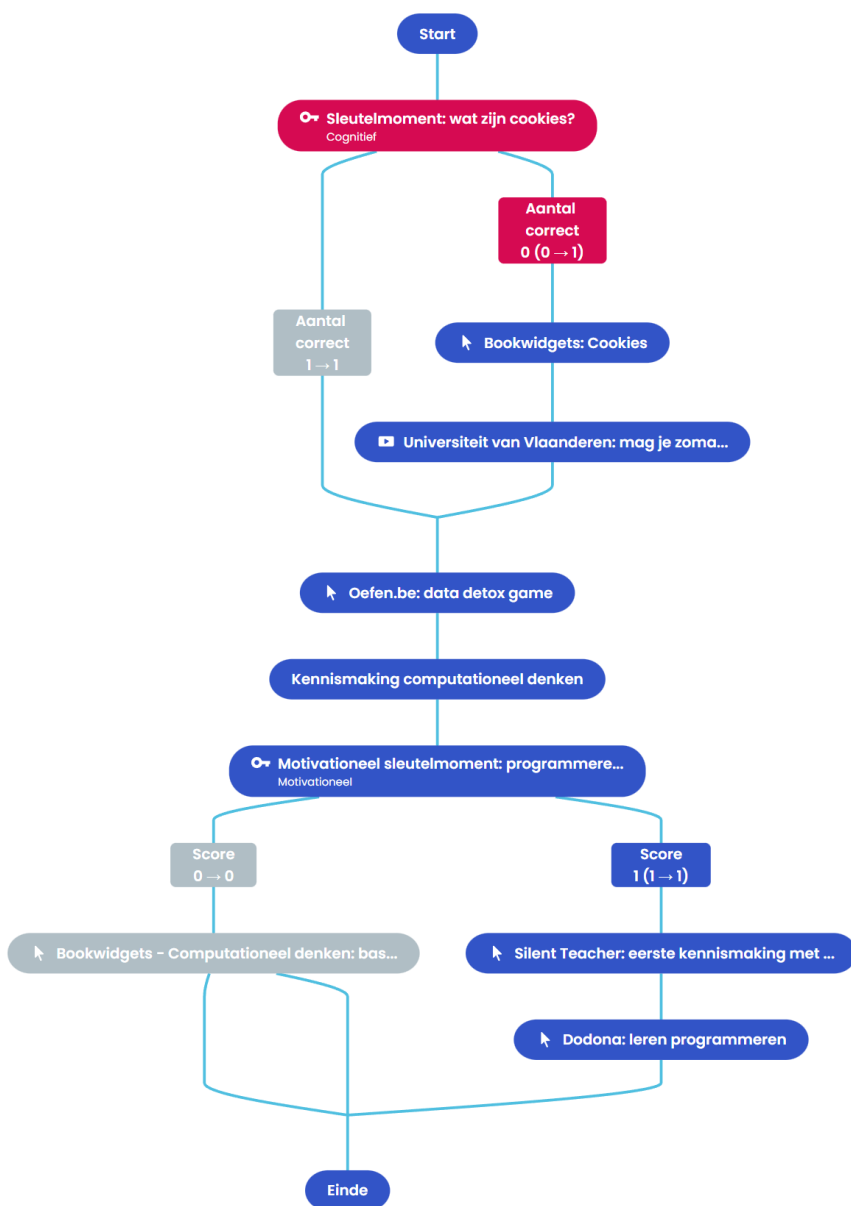
For example: Lien scored low on the first knowledge test in the key cognitive moment about cookies, so her bullet turned red. She was given an additional explanation about cookies. In the second key moment (motivational), Lien was allowed to choose between a learning activity about the theory and basic concepts of programming or a learning activity to get started with programming in practice. She went for the second option and started working with Silent Teacher and Dodona.

Register for i-Learn

If a school wants to become an i-Learn school, they can do so at www.i-Learn.be. The school will then receive all the information it needs to get started. An administrator and a core team are appointed. When setting up access, the school can choose from several sign-in options. They can sign in with Smartschool, Microsoft 365 Teams or Google, and teachers can also use an option provided by the Flemish government (Itsme). The school can start independently or under supervision.

FIGURE 22: Single Sign-on methods for i-Learn.

2.2   SUPPORT FOR SCHOOLS AND TEACHERS THROUGH THE ACADEMY

As mentioned above, in addition to the MyWay portal, there is also the Academy, a platform with all the support resources for i-Learn users. Digital personalised learning on an online platform is not something that can be imposed on a team of teachers without offering help. It is therefore very important to work together with the team and to upgrade everyone's skills in good time.

FIGURE 23: The homepage of the Academy.
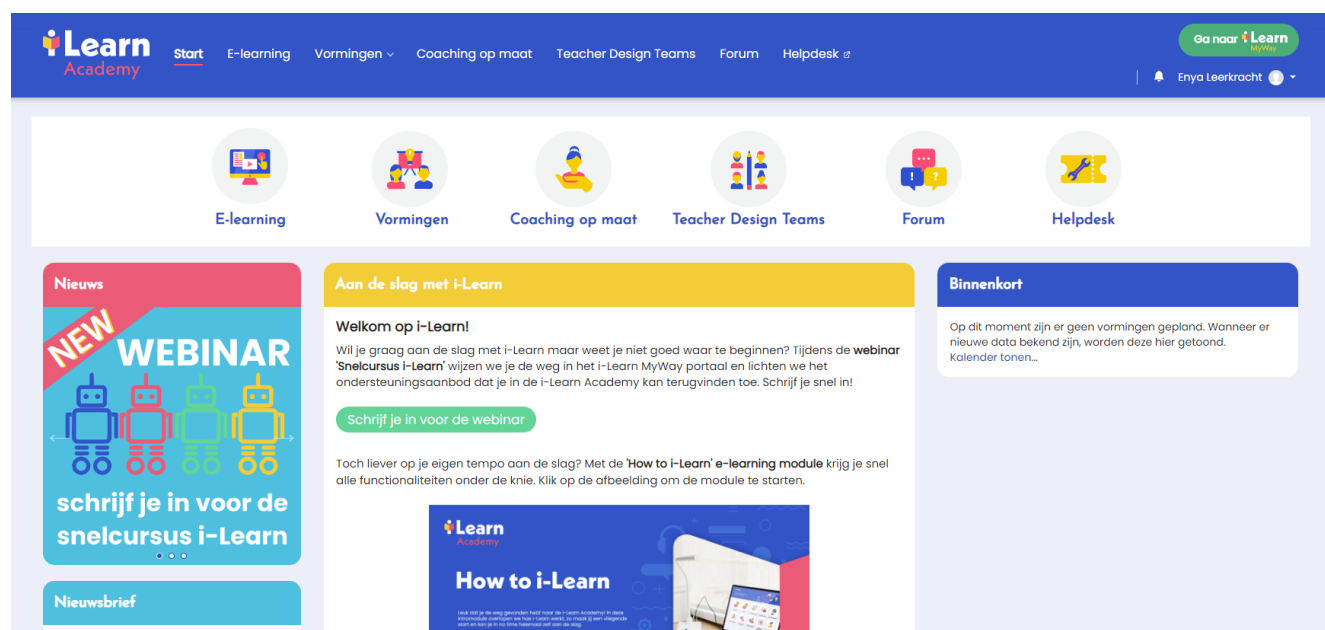
Firstly, the support package consists of online material such as e-modules, information pages and knowledge clips. This information is about digital personalised learning and how this can be applied in MyWay. Secondly, training sessions can be followed: portal-specific or portal-transcending (such as training on effective digital instruction), online or offline, and both basic (half day – theoretical) or more extensive (full day – theoretical and practical). These sessions are scheduled, and teachers can sign up for them. Thirdly, a school can request tailored coaching. The coach will work with the team to see what the best support process would be. The pieces of the puzzle are fitted together based on the needs, possibilities, locations and free times of the participants. Finally, there are Teacher Design Teams (TDT). Together with other teachers, they create online learning tracks. This can be done across schools and the TDT is supervised by a coach who is specialised in i-Learn and possibly in the topic on which the learning track is based. When a Teacher Design Team has finished, a learning track has been created that is shared in the public library. The participants have also learned new skills, gaining hands-on experience in instructional design.

MyWay and the Academy are connected. More information can be requested anywhere in the portal. On most screens in MyWay, there is a link that brings the user to an info page, or e.g. a tool sheet (for example: 'How do you use the library?'). These links (usually) lead directly to a page on the Academy. Because the two are so closely integrated, the Academy offers just-in-time knowledge and support.

In the Academy, teachers or others can also subscribe to the newsletter to stay informed about new features or learning tracks, attend training, etc.

3. Conclusion

This i-Learn paper gave an introduction to the project and to the two products: i-Learn MyWay and i-Learn Academy. The i-Learn project is intended to help support and spread digital personalised learning in Flanders. A portal was developed where differentiation was made possible by means of a range of (adaptive) educational tools as well as easy access through a Single Sign-on. In MyWay, teachers and students can view and execute learning activities from the linked tools. Teachers can use existing learning tracks or create their own where they combine learning activities and key moments in a learning track that splits according to the answers in key moments. These forms of differentiation give both teachers and students control over the learning process. The system in MyWay facilitates this by means of filters and pre-made learning material. Teachers can also let students work independently in i-Learn MyWay's free learning zone. When students use learning tracks, the teachers can monitor them from the teacher dashboard, which allows teachers to provide tailored feedback. The i-Learn project was developed on the basis of design-based research. Future i-Learn papers will describe various aspects that were explored, developed and experienced during this process.

This i-Learn paper is part of the i-Learn project (https://www.i-learn.vlaanderen/en/), a project commissioned by the Flemish government.

4. Which i-Learning papers are coming soon?

i-Learn paper 2: About personalised digital learning

**i-Learn paper 3:** Learning Analytics

References

Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational technology research and development, 53*(4), 5-23.

End notes

1   Wang and Hannafin (2005) define design-based research as a systematic but flexible methodology aimed at improving educational practices through iterative analysis, design, development and implementation, based on collaboration between researchers and practitioners in real-world settings, and leading to context-sensitive design principles and theories. (p. 6) They describe five characteristics: (1) pragmatic (i.e. design-oriented and intervention-oriented); (2) based on theory and research; (3) iterative, interactive and flexible; (4) contextual; and (5) integrative.
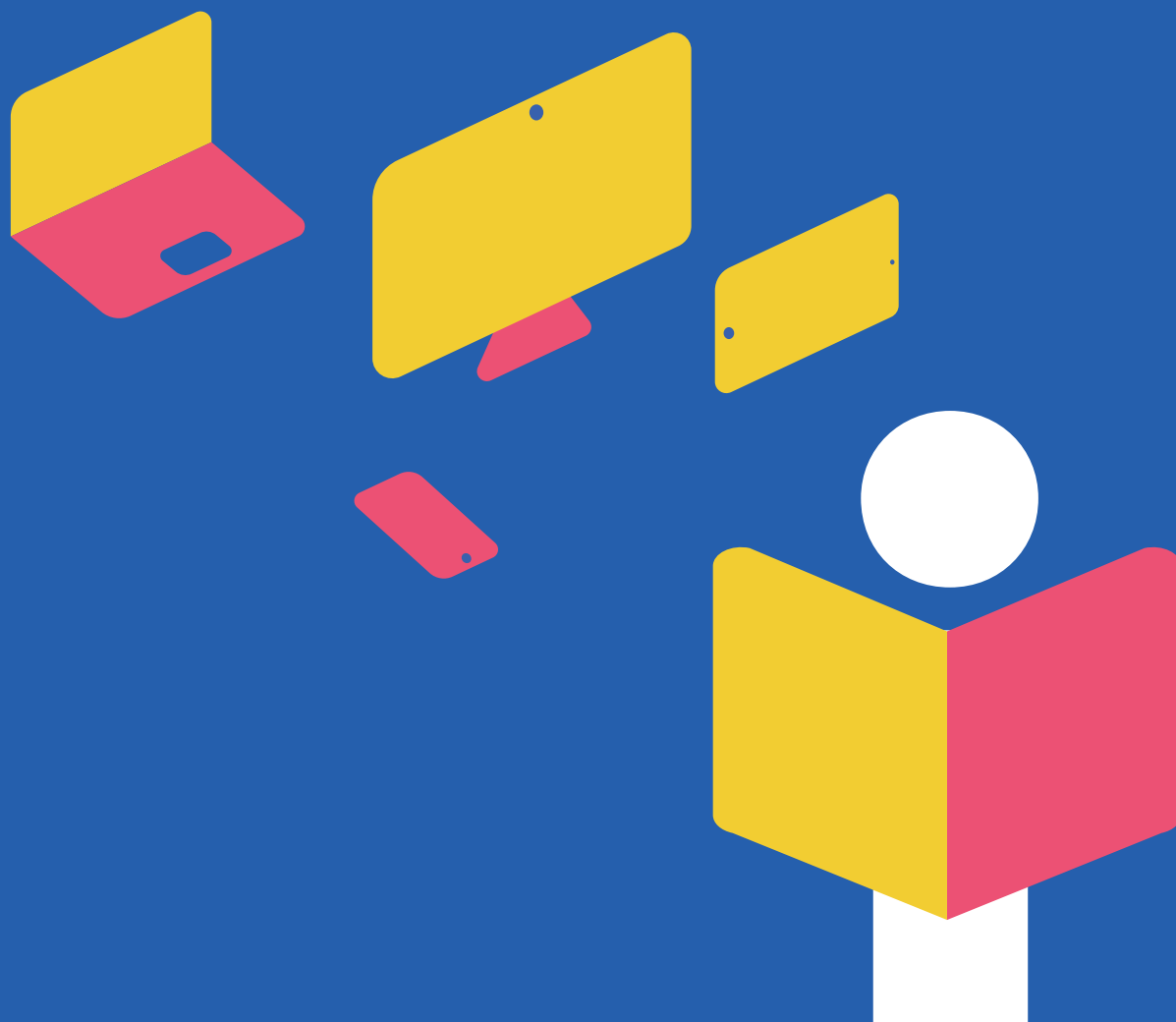
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