



# How to study – supporting students in their design of digital Personal Learning Environments

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## Abstract

Personal Learning Environments are a promising phenomenon that holds various benefits for students at universities. There is however a need for adequate support and guidance to successfully design a Personal Learning Environment. Existing models and design principles are usually not actively addressing students therefore making it difficult for university students to effectively create and maintain a PLE. In this project, a Design-based Case Study was conducted to gain insights into students decision-making process when designing a Personal Learning Environment and develop a student-centred design model. Created for students, this design model will focus on equipping students with PLE designing skills for an improved (lifelong) learning experience.

## Introduction

The 2009 Horizon report identified the emergence of technology in traditional learning environments as one of the key trends affecting teaching and learning in all educational institutions (Johnson et al., 2009). Traditional learning environments are not physical spaces anymore, but community-driven and interdisciplinary spaces that are supported by technologies. During the global Covid-19 pandemic, technology became a key part of education and of student life at universities. Customised online learning environments have emerged to support different learning activities such as discussions or team projects (Harasim, 2017). Furthermore, in the university learning environment the focus shifted from “learning outcome to learning process and treating students as co-contributors [instead of pupils]” (Leow & Neo, 2015, p. 187). Thus, the concept of Personal Learning Environments emerged which describes “the tools, communities, and services that constitute the individual educational platforms that learners use to direct their own learning and pursue educational goals” (Castaño Muñoz & Villar-Onrubia, 2023, p. 2).

Personalised learning environments hold promising benefits for students and their skill development. By personalising their learning environment, students are encouraged to “manage their own learning as [...] independent and inquisitive learner[s]” (Tsui & Sabetzadeh, 2014, p. 52). PLEs are self-directed by the learner which requires self-regulated learning knowledge and skills. Furthermore, learning in PLEs is considered a continuous process and does not end when, for instance, a degree is received. The connection of formal and informal learning within a PLE supports learners in their development of lifelong learning skills (Dabbagh & Castaneda, 2020). Lifelong learners who are flexible, motivated and in control of their learning are demanded to meet changing education and employment conditions (Mikroyannidis et al., 2013).



Due to the complexity of learning, a PLE "requires an aggregate of technology, learning resources, cognitive processes, experiences and strategies from each student" (Dabbagh & Castaneda, 2020, as cited in Cenka et al., 2022a, p. 2). If students do not possess or are not able to apply those prerequisites, they will experience challenges in the design and use of their PLE (Valtonen et al., 2012). So; how can students be supported in their development of a Personal Learning Environment?

Each learner will design their very own Personal Learning Environment incorporating their specific needs and preferences. But there is still a "need to support individuals (and groups) to gain awareness and control over a range of learning activities and their environments" (Fiedler & Väljataga, 2011, p. 8). This support can take various forms and abstraction levels depending on which stage should be supported. Yet, to provide effective assistance, it is necessary to explore the critical elements in the development of a PLE. Therefore, the first research question is:

**RQ1:** What are the critical elements of a Personal Learning Environment and its development for students<sup>1</sup>? And why?

For many students going to university means they must organise and manage themselves for the first time in their life. Studying at a university includes many different knowledge-building, learning and documenting activities. These vary from taking notes during lectures to managing tasks during group projects (Cenka et al., 2022a). In addition to that there is a plethora of websites, e-learning platforms, and institutions students have to be aware of and navigate confidently in order to access learning resources and stay informed.

A student needs to manage their time and workload, organise learning resources, apply planning skills, employ effective study strategies, and interact with the social network (Cameron & Rideout, 2020). While at the same time maintaining motivation to continue studying. Due to a lack of time and overburdening, many students are discouraged to spend sufficient effort on developing a Personal Learning Environment. Additionally, they need support and guidance to first develop the required skills for maintaining a PLE.

Learning is a key aspect of a student's life at a university. Nowadays, it is quite common that "students use digital tools in almost all aspects of learning" (Cenka et al., 2022a, p. 1). Learning and a learner's identity are closely linked which makes learning quite an individual process on the one hand, but the interaction with other learners makes learning a social process (Dabbagh & Castaneda, 2020; Løfvall & Nygaard, 2013). Introducing students to learning and the concept of Personal Learning Environments can support the understanding of the learning process in general.

Approaching the concept of PLEs from a student-centred perspective helps to gain an understanding of a student's decision-making process when developing a PLE. Observing students and their use of Personal Learning Environments can provide insight into their design process. A digital application that can serve as a digital PLE is used as an example to explore students' PLEs and formulate a student-centred design model. So, the second research question is:

**RQ2:** What decisions does a student take when designing a Personal Learning Environment?

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<sup>1</sup> Student in this paper means a person who is learning at a university. It does not include students who are, for example, in medical training or enrolled in vocational schools.



If appropriate resources and opportunities to refine self-directed learning skills are provided to students, it would “enhance students’ adjustment to the university learning environment and help lay the groundwork for their success at university” (Cameron & Rideout, 2020, p. 679). The introduction of a student-centred design model should encourage and guide students in their development of a PLE.

As a start, a literature search was carried out to provide an overview of the current state of research on Personal Learning Environments and identify critical elements of PLE design. After examining the existing models, a design-based case study was conducted to monitor the design process of students. Finally, a design model was developed with help of existing conceptual models and insights from the case study.

## Theoretical Background

The general term learning environment is often used differently depending on the context which calls for clarification on how it is understood in this article. Virtual Learning Environments (VLE) are digital environments hosted by the institution and mainly intended to deliver online course content as well as provide facilities for students to communicate (Chatti et al., 2010; Milligan et al., 2006). Moreover, it allows educational institutions to manage their students and communicate with them.

A Learning Management System (LMS) is a VLE that specifically focuses on managing the learning process to make it both more effective and efficient (Cenka et al., 2022a). Blackboard, Moodle, or ILIAS are examples of learning management systems (Chatti et al., 2010). An LMS organises course content and learning resources in a standardised and digital way (Chatti et al., 2010). Usually, it is also connected to a university’s administration system.

## Personal Learning Environment

Before describing a Personal Learning Environment, a theoretical foundation will be introduced. Several theories of learning exist that “help us understand how people learn” (Harasim, 2017, p. 4). Employing a theory determines what we see and consider important plus how we will design as well as implement our practice (Harasim, 2017). The concept of Personal Learning Environments is based on the constructivist and the collaborative learning theory. Learning environments or online learning platforms are “constructivist in that they facilitate user-generated content” (Harasim, 2017, p. 78). The collaborative learning theory thus focuses “on approaches & techniques that use the internet to facilitate collaborative learning & knowledge building”(Harasim, 2017, p. 108). By combining collaborativism and constructivism, Personal Learning Environments allow learners to create environments that fulfil their personal needs while still facilitating collaboration with other learners.

Personal Learning Environments can be perceived as either a pedagogic approach to e-learning or as a (technological) object (Dabbagh & Castaneda, 2020; Fiedler & Våljataga, 2011). However, attempts to define a PLE should always include both the concept of a PLE and the required technology to realise it. Existing definitions for a Personal Learning Environment vary from online learning systems, a set of tools for students, collection of integrated applications to a combination of Web 2.0 tools and services (Cenka et al., 2022a). However, all definitions place the learner in the centre of a learning environment, hence only “a learning environment that can be fully managed by individual learners [...] is a personal learning environment” (Cenka et al., 2022a, p. 1). Thus, in this article a PLE is understood as “a facility for an individual to access, aggregate, manipulate, and share digital artefacts of their ongoing learning experience” (Mikroyannidis et al., 2015, p. 3).



## Benefits of Personal Learning Environments

Personal Learning Environments hold various benefits for learners as well as society in general. Being aware of one's own PLE improves the understanding of learning processes as well as digital practices and competences (Castaño Muñoz & Villar-Onrubia, 2023). Therefore, "enabling students and citizens to intentionally curate their PLE may empower them to engage more effectively in technology-mediated learning and lead to enhanced autonomy as self-regulated learners" (Castaño Muñoz & Villar-Onrubia, 2023, p. 17). Due to their self-directed nature, PLEs can "increase feelings of ownership and control [...] [which leads] to more meaningful learning experiences" (Valtonen et al., 2012, p. 733).

A PLE encourages students to direct their learning and develop lifelong learning skills (Dabbagh & Castaneda, 2020; Dabbagh & Kitsantas, 2012). Developing your own PLE makes the "learning experience more personal, connected, social, and open" (Dabbagh & Castaneda, 2020, p. 3044). So by becoming "the protagonist of the learning experience" each learner can personalise the PLE according to their individual interests and learning styles (Kompen et al., 2019, p. 205). The personalisation of the learning environment makes the learning process more relevant for a student and also increases motivation to keep up with the learning efforts (Sasson & Yehuda, 2022). Moreover, the learning experience becomes more social as it "[generates] discussion, collaboration, inter-group communication and community engagement" (Dabbagh & Castaneda, 2020, p. 3044).

In conclusion, PLEs can advance the development of metacognitive and self-regulative skills, which are fundamental skills for the knowledge society and information age (Valtonen et al., 2012). Nevertheless, students need "adequate pedagogical support from teachers to make use of [their] PLEs for learning" (Valtonen et al., 2012, p. 738).

## Elements of a Personal Learning Environment

Personal Learning Environments require but also enable several learning approaches, such as self-regulated Learning and lifelong learning. Additionally, there are design approaches to consider when creating a PLE. Finally, an overview of existing guidelines for developing a PLE is presented.

### Learning Approaches

The personalised learning process, the concept of ownership and the possibility to provide feedback make a PLE suitable as a supporting tool for self-regulated learning (Cenka et al., 2022a). Self-regulated learning is an ability or skill and at the same time a method applied by learners for organising and managing themselves to achieve learning goals (Cenka et al., 2022a). It is a constructive process "whereby learners set goals and make plans for their effective learning, then attempt to monitor, regulate, and control their cognition, behaviour, and motivation, guided and constrained by these goals and the contextual features in the environment" (Sasson & Yehuda, 2022, p. 2).

By acquiring and applying knowledge management and SRL skills, students can "become successful designers, curators, and evaluators of their learning experience" (Dabbagh & Fake, 2017, p. 34). Consequently, the existing SRL knowledge and skills of a learner play a significant role in the design of a PLE (Cenka et al., 2022b).

PLEs can be considered tools for lifelong learning because they acknowledge the continuing character of learning and the self-direction of the learning process (Attwell, 2007; Valtonen et al., 2012). Lifelong learning refers to all the learning activities carried out throughout one's life aiming to develop or enhance knowledge, skills and competences within different contexts (Dabbagh & Castaneda, 2020). Learning should not be "limited to formal learning environments, since people learn throughout their lives in



various informal contexts” (Conde et al., 2014, p. 42). Thus, to achieve lifelong learning, learners have to “actively control their learning activities while addressing the requirements imposed on them in their respective life contexts” (Mikroyannidis et al., 2015, p. 1). PLEs support personal as well as social learning experiences, therefore empowering learners to develop lifelong learning skills (Dabbagh & Castaneda, 2020).

## Design approaches

Designing an effective PLE requires prerequisites in the form of cognitive processes, learning strategies, experience and of course technology (Cenka et al., 2022a). Each student’s individual abilities affect the development process of a PLE especially the skills for self-directed learning. For that reason, it is necessary to teach students how to become self-regulated learners and acquire knowledge management skills which are fundamental for creating, managing and maintaining a PLE (Dabbagh & Fake, 2017).

The structure of a PLE usually follows a bottom-up approach “starting with personal goals, information management, and individual knowledge construction, and progressing to socially mediated knowledge and networked learning” (Dabbagh & Kitsantas, 2012, p. 5).

Normally, the tools which are provided through a PLE should enable the learner to “learn with other people, control their learning resources, manage the activities they participate in and integrate their learning” (Milligan et al., 2016, as cited in Bartolomé & Cebrian-de-la-Serna, 2017, p. 23). Valtonen et al. (2012, p. 733) list “tools for managing a personal profile, tools for editing and publishing materials & tools for retrieving external resources and materials from different websites” as the essential components of a PLE.

Vázquez and Nistal (2013) describe a perfect PLE should provide *knowledge acquisition and discovery, knowledge management, knowledge exchange, communication, social media and content consumption tools, and learning management* (Vázquez & Nistal, 2013, p. 38). Other researchers focus more on categorising tools and digital applications needed for a successful PLE. Wisudawati and Isa (2022, p. 188) for example, state “specialized instruments (for example MSN talk, Skype, or Viber), devices for production (for example web journals, Twitter, Wikispaces), asset sharing (for example Flickr, Slideshare, Delicious), person-to-person communication (for example Facebook), advanced media (for example Daringness) and archive cocreation (for example Google docs)” as possible digital tools that can be incorporated into a Personal Learning Environment.

## Guidelines for PLE creation

Although students are supposed to be the centre of a PLE, few researchers focus on formulating guidelines or models that could equip students with the necessary skills to design as well as maintain a PLE. Milligan et al. (2006) identified design patterns essential for an effective learning environment and required services for those patterns. Their *PLE Reference Model* is an aggregation of both the patterns as well as the services and includes a *Personal Learning Toolkit* which consists of specific tools that were identified from the design patterns. Van Harmelen (2008, p. 35) considers a PLE as the “computer-based parts of a learning ecosystem” and therefore, focused on testing four prototypes. Each prototype was assessed based on the activities it supported. Similarly, Tsui and Sabetzadeh (2014) also engaged in prototype testing. They, however, were rather concerned with testing a prototype system based on learning stereotypes and then formulating criteria for what to include in a *personal learning environment & network (PLE&N)*. In addition to the inclusion criteria, they identified various factors that influence the learner in using the developed personal learning environment & network. These factors include Do-It-Yourself aspects, alignment with the learners’ goal, mobile access, value-add as well as rewards or incentives for the use (Tsui & Sabetzadeh, 2014, p. 56).

Another digital tool was developed by Gillet and Li (2015). Based on previous research projects on technology-enhanced learning, they identified four features that are essential for a PLE platform.

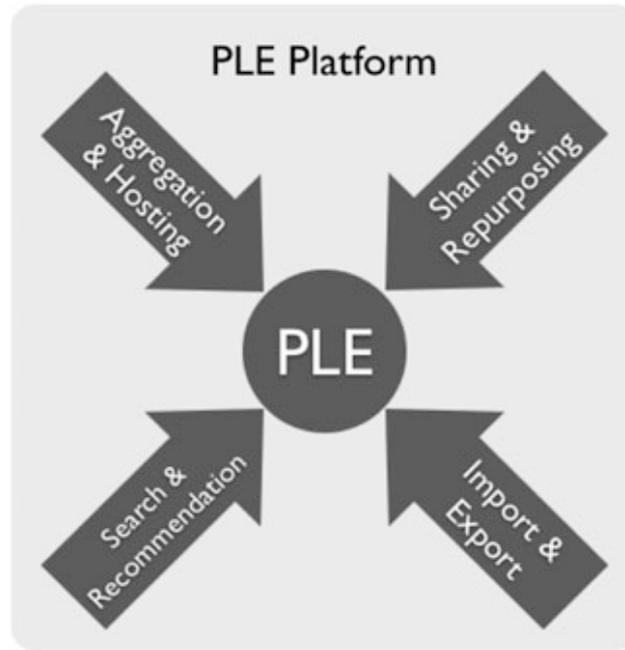


Figure 1. Required features for PLE platforms (Gillet & Li, 2015, p. 120)

The researchers then designed and implemented a PLE platform, called Graasp (grasping resources, apps, activity spaces, and people) and tested it with undergraduate students, PhD students and teachers. Students, however, had to use the platform for their learning activities which takes away the control from the student and neglects the core idea of PLEs. Nevertheless, the developed PLE platform together with the test provides implications for future technology and the role of PLEs in academic institutions. Within the ROLE<sup>2</sup> project, a widget-based approach to PLE design was introduced to provide widgets specifically for learning purposes while still promoting individual design (Mikroyannidis et al., 2015). Widgets can be accessed from a widget store and inserted into a personal Widget Space. In addition, the ROLE project offered free online courses on building a PLE and developing self-regulated learning skills which can be considered a first step towards a more student-centred perspective in PLE research.

There are attempts to conceptualise PLEs by developing frameworks. Chatti et al. (2010) designed a framework for mashup personal learning environments and tested it with students from different disciplines. The Personal Learning Environment Framework (PLEF) is based on characteristics of a PLE therefore addressing "the following attributes: Personalized, Social, Open, Ubiquitous, Filter [and] Easy to use" (Chatti et al., 2010, pp. 72-73). Through the evaluation, it was possible to detect some difficulties with the framework regarding usability, technical stability and available functionalities. Again, the framework has proven useful for developing PLEs but lacks the student-centred approach as students were not involved in formulating requirements.

Using functionalities, existing reference models, and frameworks, Cenka et al. (2022a) identified essential components of a PLE and proposed a conceptual model. However, the proposed model has implications for teachers, developers, researchers and policymakers rather than for students.

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<sup>2</sup> ROLE stands for Responsive Open Learning Environments and was a European collaborative project from 2009 to 2013 focusing on supporting learners in construction their Personal Learning Environments.



Figure 2. Conceptual model (Cenka et al., 2022a, p. 12)

Kompen et al. (2019) developed a set of guidelines to help learners in developing and using a Web 2.0-based PLE based on an eight-year research project with students in higher education. The guidelines include the role of support networks and collaboration as well as the role of rewards and encouragement. But then again, the formulation of the guidelines is not actively addressing the learner but rather the teacher or instructor.

Although existing models, design patterns and guidelines have enhanced the understanding of PLE they have some drawbacks. A lot of the prototype testing and implications are based on specific software which students need to comprehend before using it. Finding your way around a new programme takes time and resources of which students normally have little in a university learning context. Many of the students participated with the prospect of receiving credits. Furthermore, the formulation of the results usually addresses researchers, practitioners and developers rather than students. The students are not actively involved in the research and are more seen as passive research subjects which explains why for example design guidelines are not formulated for students.

This project aims to develop a model specifically for students by placing the students at the centre of the design process. Moreover, the insights will be expressed in a way that students can comprehend and



apply them. The challenges and time constraints that exist within the university context will be incorporated as well. In general, the new design model is supposed to facilitate students' decision-making when designing their PLE.

## Methodology

A design-based case study (DbCS) was chosen to observe a student's design process of a Personal Learning Environment to develop a student-centred model for PLE design. By applying this blended approach of design-based research and case-study research, it is possible to refine instructional innovations to meet learning outcomes (Deaton & Malloy, 2017).

Design-based research (DBR) focuses on addressing real-world problems, combining existing theory and practical experience to develop plausible solutions as well as iteratively reflecting and refining these solutions (Amiel & Reeves, 2008).

Whereas design-based research is more process-oriented, the case study approach is focused on observing a phenomenon in its natural setting. More specifically the case study approach is "a research approach that is used to generate an in-depth, multi-faceted understanding of a complex issue in its real-life context" (Crowe et al., 2011, p. 1). Additionally, through case studies researchers can "investigate a given phenomenon to a much greater depth, bringing out the interdependencies of parts and emerging patterns" (Law & Wild, 2015, p. 70).

The design-based case study approach combines the strengths of both DBR and case-study research to "provide a framework for engaging in iterative cycles of data collection and analysis" (Deaton & Malloy, 2017, p. 72). The evaluation of a PLE is preferably conducted in iterative cycles of planning, evaluation and reflection (Law & Wild, 2015). Therefore, combining the case study approach with the design-based research framework can support the iterative evaluation by adding a design cycle. The figure below visualises the process for this design project and demonstrates the integration of the case study approach for data collection in the testing step.

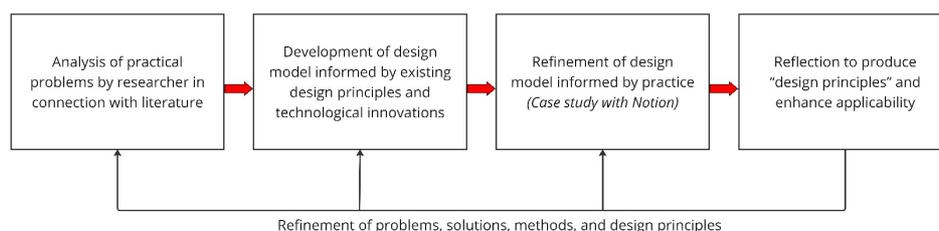


Figure 3. Process model for the DbCS (Own representation based on Amiel & Reeves, 2008, p. 34)

The first step of a case study is the definition of the case including the goals of the study. Defining the case includes "the nature and time period covered by the case study (i.e., its scope, beginning and end), the relevant social group, organisation, or geographical area of interest to the investigator, the types of evidence to be collected, and the priorities for data collection and analysis" (Crowe et al., 2011, p. 5).

The case study for this project consists of a work sheet with two tasks and was sent out to participants between March 27<sup>th</sup> and April 17<sup>th</sup> 2023. Recruiting was mainly done on social media, for instance in Facebook groups for students and on Instagram since the relevant social group for this case are university students. This random selection resulted in a very divergent group of participants.



Participants were university students in Denmark or Germany and therefore the tasks could be completed in either German or English. The types of evidence to be collected include a visualisation of each participant's PLE and a screen recording of how a specific platform (the case) is used for studying. The research objective for this case study is about investigating the decisions students make when designing their Personal Learning Environment with one specific digital platform.

The case selection was based on the sampling strategies in the three-cluster framework developed by Shakir (2002).

Purposeful sampling clusters	Purposeful sampling strategies	is contrasted to	Purposeful sampling strategies	Purposeful sampling clusters
Significant cases	Extreme case	↔	Typical case	Ordinary cases
	Intensity case			
	Critical case			
	Politically important case			
Different cases	Maximum variation	↔	Homogeneous	Similar cases
	Random purposeful			
	Stratified purposeful case			
Fieldwork determined cases	Snowball	↔	Convenience	Ad hoc cases selection
	Opportunistic			
Priori theory determined cases	Criterion			
	Theoretical			
	Confirming and disconfirming			

Figure 4. A three-cluster framework encompassing the different strategies for case study selection (Shakir, 2002, p. 194)

Case selection needs to be driven by appropriateness and adequacy. Appropriateness describes the suitability of a case for the research purpose and the investigated phenomenon, whereas adequacy is related to the right quantity of cases (Shakir, 2002). Appropriate case selection means determining how to sample cases which is where the three-cluster framework steps in.

Before focusing on strategies for case study selection, it is essential to remember the research goal of the case study which not only aims to understand the decision-making process behind a student's PLE and its design, but also to fathom how students organise their learning in general with the help of digital tools. Only one digital tool should be selected to ensure comparability. In this case study, Notion was selected as that one digital application. However, there are some criteria the tool needs to fulfil. It needs to be available for free, accessible on all devices, multi-lingual and should offer functionalities to support learning. Notion is free for students, can be used on several devices and in five different languages such as English and German. The first criteria are therefore successfully met. Regarding the learning functionalities, Notion provides functionalities to store files, manage tasks, take notes and organise one's personal responsibilities (David Ch, 2023).

A combination strategy of convenience and criterion cases was employed in this project. Criterion means a case was picked because it meets predetermined criteria, whereas convenience cases are usually selected because they do not require a huge time or financial effort and are usually information-rich cases (Shakir, 2002). Nevertheless, the convenience strategy "does not satisfy the appropriateness condition [mentioned earlier]" (Shakir, 2002, p. 194). Therefore, a combination strategy including a strategy in each of the contrasting parts in the cluster was decided to be the most suitable (Shakir, 2002).

When designing a case study, two main questions need to be answered: Which method can be used to answer my research question? And what data do I need for it? (Marx, 2019). A work sheet was designed with instructions for the participants. It is structured into an introduction section, a section for the first task description, a theoretical introduction of PLEs, a section for the second task description and a final



section to show gratitude for participating. Different visual designs were used to distinguish the individual sections from each other.

# MY LEARNING ENVIRONMENT

Hej! Welcome to this little experiment where we are going to find out more about your learning environment and Notion.

## 1 SKETCHING

Please draw your learning environment based on Web 2.0 tools or any other tools that you use and take a screenshot of your result.

You can do it digitally with Miro or analogue with the materials I provide. Use the toolbox for inspiration, in case you feel stuck.

In my thesis project, I would like to find out how students can be supported in their development of Personal Learning Environments.

Have you heard of the concept of PLEs before? 🤔

If not, do not worry you are not alone! Many students unknowingly develop their PLE and my goal is to make students more aware of PLEs and support them in their PLE development. Typically, a PLE is described as a student-designed learning environment that involves finding, selecting and using tools and resources to pursue educational goals.

## 2 OBSERVING

Please show and tell how you use notion in your learning process.

You can decide whether you would like to do a screen recording of you using your PLE and explaining what you are doing or if you would like to do it in person with me observing you using your PLE.

Send your screenshot and recording to [mleis21@student.sdu.dk](mailto:mleis21@student.sdu.dk)

 Thank you for participating!

Figure 5. Work sheet case study



First, participants were asked to visualise their PLE, while in the second task they had to show how they use Notion for learning activities. The participants received a link to a digital whiteboard with a toolbox for inspiration for visualising their personal learning environment. Icons were chosen instead of keywords to avoid restricting participants in their visualisation of their Personal Learning Environment. Activities represented by the icons are managing appointments, creating to-do lists, taking notes, communicating with classmates, attending lectures, writing texts, managing learning resources and collaborating online. Concerning the observation task, participants could choose individually which tool to use to complete the task.



Figure 6. Provided toolbox on the digital whiteboard

Data collection was done by sending out the worksheet to the participants and each participant could decide between working on the tasks independently or together with the researcher. However, the researcher was available at all times to provide support in case something was unclear or a participant had difficulties finishing a task.

In the end, eight students participated in the case study. Data analysis and interpretation were made in relation to the proposed design model. The visualisations of the participants were evaluated and compared with the identified learning activities from the design model. By comparing and reviewing the learning activities the design model can be tailored to the students' needs. Furthermore, with the help of the participants' video recordings, it was possible to observe how students organise themselves and their learning. These insights in combination with the learning activities enabled the refinement of the design model to increase relevance and integrity.

## Results

Before presenting the results, it is essential to emphasise that the project aims to understand how a PLE can be designed with the identified critical elements and how those elements are reflected in students' PLE design. Therefore, this section starts with illustrating the critical elements of a Personal Learning Environment followed by a presentation of the design decisions made by the case study participants. Based on these insights a PLE design model for university students was developed which will be introduced thereafter.

First, existing conceptual or reference models were evaluated and centred around students to investigate which elements are critical for a successful student-centred PLE design. More specifically, elements of



models were written on digital sticky notes on Miro<sup>3</sup> and evaluated for their relevance to a student's PLE design choices. The remaining elements were then structured into themes and ultimately seven categories were identified. Each category consists of keywords which represent the model elements. The categories are called *Searching*, *Knowledge Management*, *Creating*, *Exchanging*, *Communicating*, *Studying* and *Personal Management*. Some category labels have been adopted from existing concept models; others were newly formulated. In addition, an *Activity* dimension was added to integrate student activities and assign them to different categories. Finally, tools and technologies mentioned in the literature were noted and sorted into the identified categories.

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<sup>3</sup> Digital collaboration platform which provides an online whiteboard for users to brainstorm, design interfaces and sketch ideas.

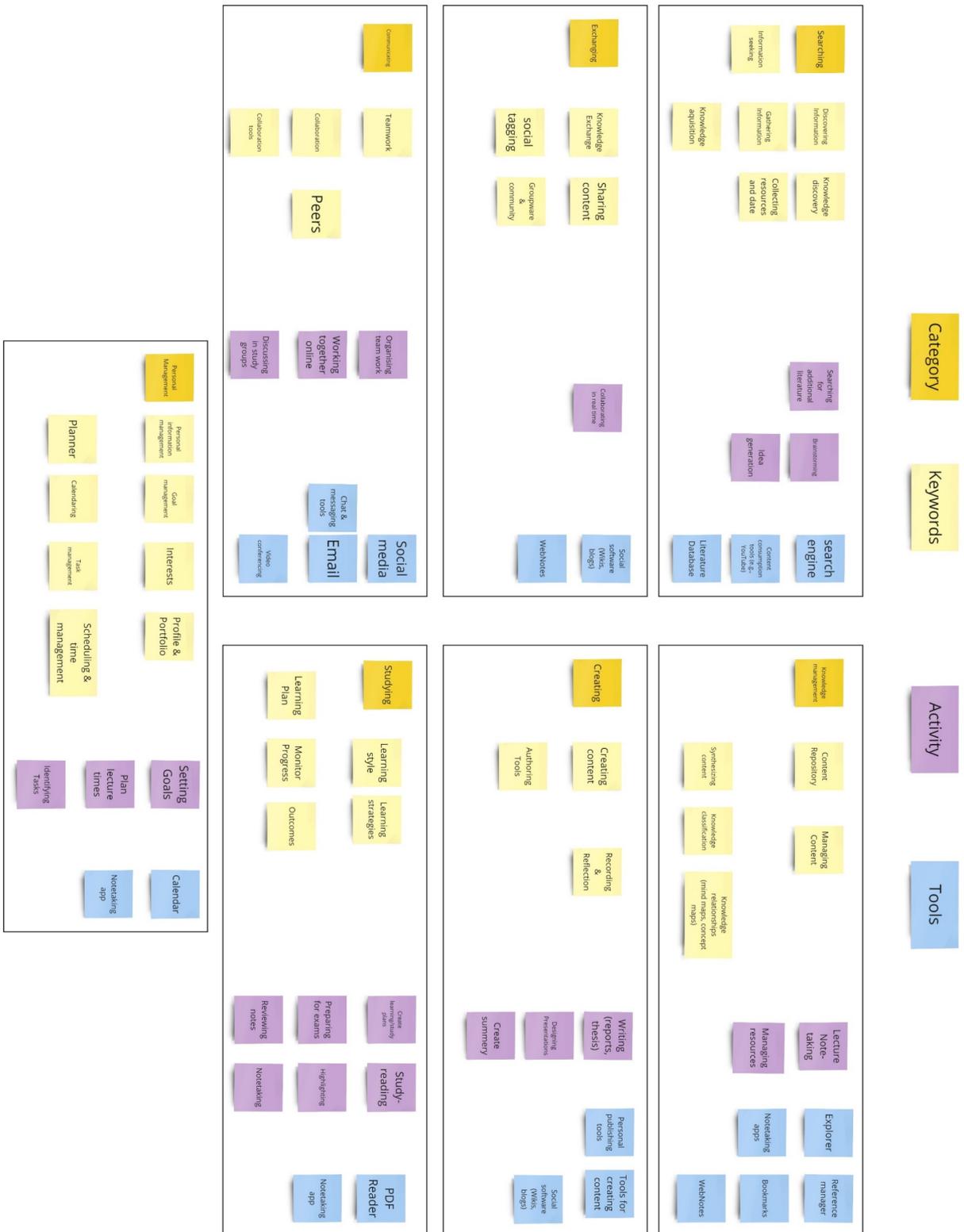


Figure 7. Identified categories with keywords, activities and tools



## Participants

The participants are postgraduate students in Germany and Denmark and were allowed to fill in the worksheet in English or German. P2, P4, P5 and P6 asked to complete the tasks on the worksheet with the researcher present, the other four participants decided to complete the worksheet by themselves. Below is an overview of the participants, their current location, their current degree and their educational background.

Table 1. Overview of current country of residence, level of education and thematic background of the 8 case study participants

Participant	Location	Education	Background
P1	Denmark	MSc. 4 <sup>th</sup> semester	Graphic design, product design
P2	Germany	Completed MSc	Media Management, Business
P3	Germany	Completed MSc	Computer Science, Economics
P4	Germany	MSc 2 <sup>nd</sup> semester	Economics, Management
P5	Denmark	MSc. 4 <sup>th</sup> semester	Industrial Design, UX Design
P6	Denmark	MSc. 4 <sup>th</sup> semester	Design, Industrial Design
P7	Germany	MSc 2 <sup>nd</sup> semester	Natural Sciences, Engineering
P8	Germany	MSc 2 <sup>nd</sup> semester	Business administration

Most participants centred their personal learning environment around the university and sometimes work. Only P3 put herself in the centre of the learning environment. Most of the visualisations look like mind maps or types of mind maps, only P6 decided to use a combination of drawings and icons. P1, P4 and P8 connected all their elements in the visualisation whereas P2 did not connect the different parts with each other. P5 is the only participant who included work in his visualisation and his drawing shows that work and university are strictly separated. Additionally, P4 and P5 included the systems provided by the university in their drawing but separated them visually from their personal activities.

When looking at the colours and shapes, most participants used different colours or shapes to distinguish certain activities from each other. Five participants chose specific tools, for example, Zoom or Blackboard to represent activities.

Regarding the toolbox and the provided icons seven participants used the toolbox to an extent and some added descriptions for the chosen icons. The categorisation of the PLE elements was done differently across the participants. P4, P6 and P7 ordered the PLE elements by device such as iPad, laptop, phone, and analogue notebook whereas P2 and P5 ordered the elements based on the used digital application. P3 ordered her tools into online tools and personal tools. Furthermore, she added the category “Personal Motivation” which no other participant included in their drawings.

Participants were not familiar with the concept of Personal Learning Environments and several asked what they should and should not include in the drawing. Participants were unsure whether the learning environment was the physical environment or the digital architecture they use on their laptop. This uncertainty has led to discrepancies between the drawings and the observations.





When looking at the observations, it becomes clear that the majority uses Notion for their task management. Most participants spend a lot of time creating a to-do list with categories that include time effort, due date and course. This shows that many participants do not actively learn with Notion but rather use it for self-organisation. Tasks related to studying are usually realised with other tools, for example, Microsoft Word or Adobe Acrobat PDF reader.

Another frequently performed activity is note-taking. Many participants appreciate the functionality Notion provides to take quick notes irrespective of form or type of note

## Design decisions

Many of the study-related activities were confirmed by the participants. There are however some activities that were missing or were discarded but participants named other activities instead. Based on these findings the list of activities as well as the categories were adjusted. The proposed design model now consists of eight categories *Searching, Knowledge Management, Creating, Exchanging, Communicating, Studying, Organising* and *Personal Management*

Many participants think in tasks and Notion provides an easy way of individually managing those tasks. Therefore, the most appreciated functionality of Notion by the participants lies in the creation of customised lists. Having the option to customise the to-do list to meet anyone's demands, is one of the greatest reasons for participants to use Notion. Consequently, the choice of using Notion was affected by the ability to customise the task list.

In connection with task management, many participants explain that Notion allows them to switch between different life contexts, such as university, work and personal and keep an overview of the responsibilities in all of them. This is achieved by a combined to-do list that integrates all the tasks from the different contexts. One participant explained, she *"created a so-called Inbox where all the tasks arrive and are structured based on urgency and life context"* (P7). In general, the participants concluded that this feature improved their time management and personal planning skills. They did not feel overwhelmed any more instead they could focus on completing the tasks and did not need to worry about forgetting something. The all-in-one aspect influenced the participant's continued use of Notion as part of their Personal Learning Environment.

Another factor that convinced participants to choose Notion in their PLE, was Notion's ability to grow with you therefore enabling lifelong learning. Especially the two participants who already completed their degrees can now continue to use Notion although their Personal Learning Environment changed. This growing process which is illustrated in the proposed design model as the Reflection arrow thereby affects students in their selection of PLE tools.

Personal motivation and getting in the right mindset were communicated by participants as crucial for learning. A PLE should encourage students in designing a motivational and inspiring environment. Notion fulfils this need by providing many possibilities for designing a page, for instance, background image, colour scheme and font styles. One participant remembers that her motivation increased when she designed her dashboards. Additionally, she is not scared anymore to look at her to-do list because it is nicely arranged so she enjoys opening it now. Another participant highlighted the fact that she feels *"more organised and confident now because there is a system behind it and everything is one place, so no need to go through several PDFs to find something"* (P4). The design opportunities offered by Notion helped the participants to maintain and increase motivation. Additionally, it supported participants in focusing on learning and studying.

The findings regarding to-do lists and task management activities can also be seen as self-regulated learning strategies. Participants create study plans and monitoring mechanisms to self-regulate their



learning process and achieve their learning goals. Furthermore, the progress bars and timelines usually utilised for complex writing assignments can be considered an implementation of a self-regulated learning strategy. Learners were aware of their lack of motivation or goal-orientation and developed solutions in the form of customised to-do lists or progress bars. Notion allowed learners to creatively apply their self-regulated learning strategies for certain learning activities.

The participants' decision-making process was influenced by three additional factors. First, the field of study and the associated needs that affected the suitability of Notion in a PLE. One participant, for instance, studies a very scientific and technical subject and therefore needs a place to keep all her exercise sheets and corresponding notes.

Another factor is newly discovered digital tools. Two participants explained that thanks to their master's they got introduced to Miro and adopted this tool for some activities, such as project documentation or brainstorming. Although one participant already organised her bachelor's thesis with Notion, she decided to organise her master's thesis with Miro because it was more suited to her topic-specific needs. There will always be new digital tools and services that students discover, but the key is to integrate those in the PLE which requires reflection by the student.

Finally, the third factor addresses technological aspects. Notion as a digital application is evolving and expanding. New technological innovations, such as the Notion AI, for example, affect students in their decision to use Notion in a PLE since AI can be either perceived as helpful or not relevant. Two participants mentioned using AI to ask questions or generate written texts, whereas the rest did not mention AI at all. Compatibility with external technological innovations is also important. One participant explicated that she mainly uses her iPad with an Apple Pencil at university, but Notion does not support the Pencil which prevents her from adjusting notes directly in Notion instead she needs to use her laptop. Additionally, three participants would appreciate if Notion provides an integration with a calendaring application such as Google Calendar for example. All those technological issues but also innovations are part of a student's decision-making process.

## The proposed design model

The structure of the proposed model follows the usual workflow of a design process which consists of four steps: Research, ideation, prototype and iterate (Zerbe, 2023). Starting with research is crucial to figure out the needs, requirements, and functionalities of the respective user (Zerbe, 2023). Next is the ideation or design phase which consists of developing concepts or design ideas based on the research insights (Zerbe, 2023). Prototyping is about developing an appropriate prototype which then can be tested by users. Finally, in the iteration phase findings from the user testing will be incorporated to refine the design.

It is important however, to differentiate between a usual design project where a designer creates something for someone else and this design process where the student designs something for themselves. The *Introduction* section can be considered the research phase and should help students in starting with the design process. Among other things, there needs to be a general understanding of the concept of PLE, otherwise, it will be challenging for a student to take ownership of the different learning activities (Fiedler & Våljetaga, 2011). Additionally, students should reflect on their learning as well as their learning style (Cameron & Rideout, 2020). This can be done individually by observing one's behaviour during the semester as well as during examination periods or together with a counsellor or pedagogue. Having conversations about learning can be beneficial not only for designing a PLE but also as a preparation for lifelong learning. Another critical aspect are the student's current personal circumstances. This includes usually the university as an educational institution, but can also encompass a student's work environment or voluntary engagement. All these factors influence the tools a student already uses and therefore must be considered in the PLE design. Students from different fields of



education have different digital experiences or literacy which affects their expectations and abilities when it comes to designing a PLE (Valtonen et al., 2012). Expectations are also closely related to personal as well as learning goals determined by a student. Because a PLE encourages a high level of personalisation it should be designed in a way that supports a student in achieving their goals. In the actual model, those requirements are formulated as questions to ensure that they are directly addressing the student and therefore actively involve them in the design process.

The next step is the needs analysis displayed in the centre of the design model. The aim is to guide the student in the design process by providing some orientation and not dictate a certain path. To emphasise the student-centred focus of this design model, the question *What do you need your PLE for?* is placed in the centre surrounded by the identified learning activities. The circular arrangement was also chosen because it does not define a specific order or a beginning. Instead, the student can individually determine where to start.

After finishing the needs analysis, the student proceeds to building the PLE which corresponds to the prototyping phase mentioned before. The resulting PLE should be regularly tested and modified just like a prototype. Students should identify feedback and monitoring mechanisms that allow them to review their personal as well as educational goals and the efficiency of their PLE. In the proposed design model, the *Reflection* arrow illustrates the iterative testing procedure to regularly reflect on the designed PLE. The dynamic nature of a student's PLE was confirmed by the participants as many regularly evaluated the digital tools or adjusted the PLE for a new learning context.

The *Example* and *Tipps* section should be extended in collaboration with students to ensure relevance and integrity. Moreover, there are many prototypes currently developed which could be added here as well.



Figure 9. The proposed PLE design model



## Discussion

The proposed design model bridges the gap between the theory of Personal Learning Environments and students' design of Personal Learning Environments. There are, however, limitations regarding the chosen methodology and the number of participants. Having more participants would allow for a stronger student-centred approach when developing the design model. Furthermore, due to time constraints it was not possible to circle back to the participants to validate the findings which could have enriched the final outcome and make the proposed design model more applicable.

Additionally, the role of the teacher or instructor in a student's Personal Learning Environment should not be neglected and its effect on students' PLE design should be investigated further before being implemented in the design model.

The notion of self-regulated learning and its implication for the design of PLEs need to be investigated in more detail. Students are expected to be self-directed and autonomous learners, but prior to being that they need to develop the necessary skills. Depending on how well the skills are developed, the better they can respond to multi-tasking and attention-related challenges in their learning environment. It is essential to determine how and where students can be supported in acquiring those skills.

Finally, the proposed model can be applied by students as it is but usability could be increased by making it interactive. The interaction dimension was not part of this project but is crucial when it comes to implementing the design model. When realising the model in the form of, for instance, an interactive website that guides students through the development process of their Personal Learning Environment, user experience principles need to be considered. Moreover, instead of asynchronously interacting with the students, an idea would be to test the model actively with students in different scenarios to refine the model even more. In addition to getting insights into their learning strategies and behaviour patterns, it would raise awareness of the PLE concept among students.

## Conclusion

This project aimed to examine Personal Learning Environments from a student-centred perspective to identify critical elements for the development process and visualise the design process with its components. A case study was conducted to gain insights into a student's PLE design process to formulate an appropriate design model that supports students in developing their PLE by acknowledging the university context. Although, the proposed model has its limitations regarding methodology and completeness, it marks a first step towards a more student-centred perspective for the development of PLEs. Moreover, it guides students in their process of designing Personal Learning Environments to successfully engage in lifelong learning activities. The next step should be implementing and adjusting the design model in collaboration with more students. Additionally, undergraduate students should be involved as their challenges might differ from the ones post-graduates face.



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