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Student personas and their learner journeys in co-creative curriculum innovation

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Abstract

This multiple-case, participatory action research studied design thinking methods for co-creative curriculum innovation in higher education. The results intend to assist in designing curricula that meet future students' learning needs and offer them a pedagogically bespoke and integrated learning process. Five co-creative degree program innovation processes in design and engineering education were observed at different European universities. The co-creators in each case consisted of educators (teachers and management), current students, industry and non-profit organizations, and academic developers and consultants. Each case aimed to actively include the future students' perspective by having the co-creators create personas and user journey mapping scenarios throughout the design process. These human centered co-design methods originate in generic design thinking methodology but were fine-tuned from a learning experience design perspective. They zoomed in on the learning that happens in and because of the program curriculum design. Backed by learning theories, studying the five program curriculum innovation cases showed how future learning experiences can be considered by articulating learner student persona details on background, personality, learning behavior, motivations and needs, and plans after the program. Diverse learner journey mapping with these personas led to a wide array of flexible design ideas, ranging from program progression ideas and course specifics to didactic choices in the future classroom. The obtained empathic insights led the curriculum (re)designs beyond discipline-oriented perspectives to student-centered pedagogic innovation.

Keywords Curriculum design, Higher education, Co-design, Learning experience design, Personas, User journey mapping

1 Introduction

Design thinking [1] has significantly influenced various fields and practices—including educational design—over the past decades, emphasizing a focus on the user experience [2–5]. Different stakeholders in a co-design process approach the design challenge at hand from their perspectives, leading to a multi-faceted fulfilling of user needs and desires in the results. This leads to a higher chance of success of the design.

Such varied perspectives are also needed in higher education curriculum design and thus asks for collaborative approaches [6]. With co-creative methods, educators can



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apply a student-centered approach of program curriculum innovation [7, 8]. But when they work on new or redesigned programs, they do not have access yet to the potential or desirable *future students*. Co-creation with current students is a good first step. This can help co-creators consider the variations in students' prior knowledge and experiences, learning habits, preferences, and backgrounds, which all impact their educational journey [9–11]. But design thinking has more to offer.

Drawing on learning theories, design thinking, and user-centered methods, the overall focus of this paper is to showcase how to design curricula that meet future students' learning needs and offer them a pedagogically bespoke and integrated learning process.

1.1 Human-centered co-design in curriculum innovation

Higher education curriculum innovation on degree program level seeks to—incrementally or radically—redesign existing programs or design new programs, sometimes disruptively replacing old ones. Norman [12] questions how one can design something without knowing the user. By emphasizing the needs and abilities of the people for whom a design is intended, the understanding, acceptance, and experiencing of the product can be significantly improved. Human-Centered Design (HCD) is a design approach aiming to develop products, services, or systems that are intuitive and effective [13], by involving the human perspective in all steps of the problem-framing process [3, 12]. It is employed as an iterative process that involves cycles of ideation, prototyping, feedback, and refinement. This allows for continuous improvement based on ongoing input and evaluation [13]. Higher education research emphasizes the importance of student-centered teaching and learning to tailor the educational practices and curricula to meet the diverse needs and preferences of all students [14]. The two approaches share similarities. In iterations, user-centered designers apply design methods to improve their product based on user feedback [15], while student-centered educators develop education using student feedback to adjust teaching strategies and improve learning premises and outcomes [16].

HCD draws other humans involved and affected by the design into the process as well, referring to them as the stakeholders [3]. By involving a diverse group of stakeholders, the co-design process reflects a wide range of perspectives, making it both comprehensive and inclusive [17]. Such a co-design process facilitates mutual learning among all stakeholders in curriculum development and innovation [6, 18]. Higher education institutions (HEIs) tend to rely mostly on student evaluations for incremental, course-based improvements [19]. Involving a more diverse group of stakeholders into curriculum innovation allows the design to align with all relevant values [18, 20]. Notably, teaching staff is identified as a critical stakeholder for the successful adoption of curriculum innovation, as their willingness to embrace change is essential [21]. In addition, the role and advocacy of leadership is crucial in gaining acceptance for significant curriculum innovations [22]. In fact, curriculum development necessitates a comprehensive perspective that considers the needs of students, teachers, institutions, employers, and governments [23]. For this reason, co-design can be seen as an essential approach to curriculum innovation.

In HCD, use and users are always interconnected [24]. In the context of education, the concept of 'use' can refer to student's engagement with the curriculum (i.e., teacher interaction, assignments, learning material, examination, environment and other learning

resources). Use in an educational context is always for a learning purpose, not just for the sake of the program or courses themselves. Beyond mere engagement with educational resources, a program seeks to offer purposeful high-quality learning that contributes to successful students. Learning Experience Design [25, 26] is a practical translation of HCD to instructional design. It aims to assist user/learner performance by engaging behaviorally—what are students doing, cognitively—how are they being challenged, and emotionally—how does it make them feel [26]. To this empathic approach of students' learning needs in designing curriculum structure, organization, contents and pedagogy, the HCD methods of personas and user journey mapping are particularly helpful [25]. Both personas and journey maps are best generated within the co-design process itself, to gather the diverse stakeholder perspectives and foster a shared and comprehensive understanding of the user experience at hand.

1.2 Personas

Personas are used in HCD to create semi-fictional characters based on user research and past experiences, representing different user archetypes [27] as an instrument to empathize with 'the user' and identify different needs [27–29]. It can help educators to better understand the different needs, goals, and behaviors of the diverse student body, facilitating the creation of better adapted and relevant curriculum for all. It can also help to imagine the future student body that a newly designed program is aimed for and that isn't necessarily the same as the current students who fill in evaluations or can join the co-creative innovation process as stakeholder. Nielsen [27] suggests that a persona creation should involve basic information, such as name, age, gender, and an image to give a face to the persona. It should also describe relevant experiences and skills that affect how the persona interacts with the design. In addition, a short scenario should illustrate the persona's typical experiences and interactions. All can be fictional but based on available user research insights. Canziba [29] distinguishes four types of personas. Personas can be goal-based, focusing on what the personas want to do with the design, or role-based, describing their behavior around a design. Engaging personas add emotions to the goal- and role-based personas, which helps to see them as 'real people'. Last, fictional personas are less based on user research but can guide the development of a design in the early stages of development when assumptions are needed about the envisioned future users. In all four types, the art lies in balancing detailed, empathetic descriptions and concise, actionable insights. Overly detailed personas can become contradictory, less credible or hard to remember, while too vague or roughly stereotyped personas may fail to come to life and provide useful insights.

1.3 User journey mapping

After customarily four to six different archetypical users have been described in personas, their interaction with the design can be mapped to 'test' the design proposal for appropriateness and utility [29, 30]. User Journey Mapping (UJM) is a scenario-based design method, a visualization technique to uncover opportunities for enhancing user experiences. UJM visualizes the path a user takes to achieve a goal by using the design—by identifying key milestones and in-between touchpoints of interaction of the user with the curriculum—and placing these on a timeline [31]. These touchpoints can be positive or negative experiences. Of course, a fictitious persona could go on a fictitious journey

without a single problem, but that would not give any grip on how to advance the design. It is beneficial to identify the different possible bottlenecks, challenges and triggers of all personas [32] to understand the experience more holistically and identify areas for improvement [29], for instance in course planning, learning activities, learning formats, and assessment.

All sorts of different UJMs can help educators to increase their empathy for students throughout the phases of curriculum innovation. Student journey mapping can be used in education to think of students' journey before, during and after their studies. It explores and assesses what happens within the study in overarching lines of such as program degrees, student social life, available facilities, but does not enter the 'black box' of what happens within the courses. With Learner Journey Mapping (LJM) that box is opened, focusing on the learning and the pedagogic processes supporting it [25]. There, both content and context are considered [26]: the why, what, how, where, when, with whom and for whom of the learning experience. Empathy mapping [25, 33] is a specific type of user journey in which the emotions of the user during the interaction with the design are imagined by uncovering the layers of what users will Think, Say, Do, and Feel about the design. Like in the other UJMs, both positive and negative touchpoints can come up. As its name implies, empathy mapping can intensify empathy for diverse students' learning experiences and get insight into their social, pedagogical, and well-being-related needs from the program. It can reveal how what students think and feel can be quite opposite of what they do and say, and aims to open up a deeper, more personal level.

1.4 The study

One of the main aspects for a pedagogically sound curriculum innovation is the learning that should be happening during the 'journey' of studying. Learning theories support understanding how we humans can acquire knowledge, skills, and new behaviors. This, in turn, can help educators to adapt and optimize learning environments for a better student learning experience [11, 34]. We have seen in the introduction that HCD methods can be helpful in designing and innovating curricula with the student centrally in mind. The question this study wants to address is if such design methods are sufficiently equipped for designing effective and satisfying learning experiences for students. Is it enough to replace the word user for student and product/service for program? Or should learning theories and educational values be included to make them serve purpose? Seeking to add such knowledge to co-creative curriculum innovation theory, we study the application of the HCD methods of personas and LJM in five different curriculum innovation cases. Each case aimed to include future students' perspectives and needs in their program's curriculum (re)design to offer effective and meaningful learning experiences. The study answers the question:

How can the human-centered design methods of personas and user journey mapping be adapted to contribute to curriculum innovation on program level in higher education?

In this study, we explore how five co-creative teams of educators—researcher-teachers, managers, administrative staff, educational developers, and involved external stakeholders—implemented the methods of student personas and journey mapping for

pedagogically sound, student-centered curriculum innovation in five different design and engineering disciplines. The study compares and evaluates their approaches and combines them with learning theories to attune the methods to the higher education context, forming templates for such *learner student personas* and *learner journey mapping* to support *future student-centered* higher education curriculum innovation. This is done by participatory action research and abductive thinking and sensemaking.

2 Method

2.1 Participants

By participatory action research, data was collected on the generation and use of student personas and LJM in five co-creative program curriculum innovation cases, see Table 1. The personas and user journey mapping methods were used in different stages of the innovation design process, from first idea to sketches (Cases 1, 3, 4, and 5), concept version (Cases 1, 2, and 5), prototype (Cases 1, 2, and 5) and even implementation (Case 1). The cases represent both artistic design and engineering design education.

In all cases, different stakeholders, including educators (lecturers, senior lecturers, professors, administrators, and management) and external parties that had importance for the program, were involved, see the last column of Table 1. We refer to the stakeholders as the participants or co-creators. Current students contributed as co-creators, either in separate sessions in which they responded to personas made by the educators (Case 3 and 5) or by being integral part in the making of the personas in mixed groups (Case 1 and 4). In Case 2, one student was part of the proposal evaluation committee and gave feedback later in the process. The teaching educators had diverse affiliation to designing such as aesthetics, graphic design, technology, IT, computer sciences, business, sustainability, design research, and design methodology. As such they were familiar with design thinking and the use of HCD methods.

The first author was—besides participatory action researcher in all cases—head of program, senior lecturer, academic developer, as well as project leader in the first case. In the other cases, she combined the research role with curriculum innovation advisor,

Table 1 The five co-creative curriculum innovation cases of this study

Time	Institution	Program(s)	Curriculum Innovation	Participants
1 2015– 2019	The Hague University of Applied Sciences, the Netherlands	Industrial Design Engineering; Open Innovator BSc	Radical program re-design, from first ideas to implementation	21 educators 25 students 5 industry people 3 academic developers
2 2020– 2022	Applied Physics and Electronics, Umeå University, Sweden	Intelligent Systems Engineering MSc	New program curriculum, design proposal	8 educators 1 student 1 academic developer
3 2020– 2023	School of Design, Luleå University of Technology, Sweden	Industrial Design Engineering MSc, Industrial Design Engineering BSc, Graphic Design BFA	Redesign of three existing design programs, from vision and ideation till before implementation	15 educators 20 students 1 academic developer
4 2022	The Royal Academy of Music, Sweden	Artistic Interdisciplinary Masters MA	New multi-disciplinary master's program design, co-creation session 2 in the vision and ideation phase	6 educators from 2 universities 4 students/alumni 1 industry person 1 academic developer
5 2022– 2024	Umeå Institute of Design, Umeå University, Sweden	Industrial Design New BFA	Redesign of bachelor program, from vision and ideation to design	12 educators 5 students 1 academic developer

design education specialist, and workshop facilitator, which is summarized as academic developer in the participants list in Table 1. All participants in all the cases were aware of this double purpose and gave freely-willingly their informed consent to be part of the study and publication. The second author was one of the educators, as head of program and project leader in the third case, with a special research interest into innovation of design education and the use of artifacts such as personas and maps in it.

2.2 Procedures and simultaneous data collection

The participatory action researcher took part in the specific HCD activities in each case and kept logbooks of each curriculum innovation process. Copies and photos of the resulting personas in all their stages and the different journey maps were collected for afterwards studying.

To make the personas, the co-creators brainstormed in groups of two to four people during the designated workshops. Most were done in a physical room with all co-creators present. Case 2 took place during the pandemic, meaning the workshops were held online, using a digital brainstorm platform. Case 4 had a hybrid personas session, with the industry co-creator present online. The sessions of Case 5 were always hybrid, with two to four alternating people online.

In Cases 1 and 3, the persona co-creation started from scratch and co-creators were given the task to make personas in groups by using provided materials—offline resources such as magazines and online resources such as photo stocks—and sharing ideas and feedback within and among groups. No specific instructions were given on what the elements the personas should contain, as this was tacit knowledge within the groups. To facilitate the process in Cases 2, 4, and 5, a template with names and pictures of the personas and specific fill-in fields was offered, see Table 2.

The templates were sent around beforehand as ‘homework’. A beginning was made with the descriptions, and co-creators were asked to edit, change and fill in the details on characteristics, descriptions, challenges and needs of each persona. During the workshop, those intermediary results were then discussed in groups and edited and completed as the groups saw fit, ending with a joint decision that the personas were each unique and together indeed representative of the envisioned student body to design for.

Next, user journey maps were made of students’ educational journeys throughout the whole program design and in specific (types of) courses. Each case used different LJM formats, varying from empathy mapping to different timeline-based ones [33],

Table 2 Persona co-creation templates as they were used in case 2, 4 and 5

Persona template case 2	Persona template case 4	Persona template case 5
Name	Name, gender, photo	Name, gender, photo
Photo	Characteristics, where from, what background?	Description of the persona?
Short descriptor?	What hobbies?	Characteristics?
Characteristics	A good habit, a bad habit	Short story about their acceptance into the program?
What can they do before entering the program?	Talents, interests, what passion?	Passions and interests?
What can they do after graduation?	What mental strength, needs?	Influenced by?
Their needs?	Which specialization?	Wants to learn what?
What we offer?	What do they want to learn at AIM?	Needs from the program?
	What have they done as bachelor graduation project?	Has learned after the BFA?
	What support from the program are they looking for?	
	Has learned at the end of the master’s?	

depending on the vision and strategic goals each case had. But all focused on what and mostly how learning would happen in and over the courses of their program.

2.3 Data analysis

The qualitative data in the cases consist of the logged observations and notes from the participatory action researcher, and documents containing the student personas and LJM that the co-creators generated during the designated sessions within their curriculum innovation process.

The initial stage of analyses involved describing and typifying the created sets of student personas (goal-based, role-based, engaging, and/or fictional), examining their similarities and differences in both their creation process and the characteristics they embodied. This comparative analysis aimed to consider archetypical student characteristics present across the different design specializations. While similarities were anticipated due to the shared context of design curriculum innovation, local diversity both in current students and desired future students made uniform outcomes not a prerequisite. However, making the comparison was intended to get insights into the kinds of student characteristics that the co-creators in each case thought of when considering students' learning experiences.

Next, the LJM created with the student personas in mind underwent the same analysis by comparison and categorization. They were listed, ordered and labelled. This comparison aimed to develop a classification of LJM approaches useful in higher education program curriculum innovation processes.

Drawing upon the preceding data analyses, an abductive inference was made using Kolko's approach of abductive thinking and sensemaking [15]. All generated personas were organized in a matrix, and their descriptors were subjected to categorization through labelling the likeliest subcategories. Initial categories aligned with the headers that were used in the original persona templates but became supplemented with new categories and sub-categories that emerged during the labelling process. To enhance objectivity, the first data categorization was conducted by the first author, who was present at all sessions, and checked by a student who was completely unfamiliar with the sessions and stakeholders. These intermediate results were then discussed and refined in collaboration with the second author, an expert in HCD.

As a final step, a theoretical analysis was conducted by examining the categories through the lens of relevant learning theories that address learning motivation, behavior, and emotions, and learning challenges. This theoretical synthesis, involving the abductive selection of pertinent theories, aimed to broaden and complete the categories.

3 Results

3.1 Student personas

A variety of student personas were made in the five cases, with the co-creators in each case developing a set of four to six personas, representing the kind of students that they attract or would like to attract, see Fig. 1. The level of details per persona differed over the cases, but all sets had divided a wide variety of archetypical student characteristics over the different personas.

In Case 1, an initial personas set was made at the start of the four-year curriculum innovation process, see Fig. 2. These personas were fictional and role-based, focusing



Fig. 1 The archetypal student persona sets of the five cases of this study, color-coded per case

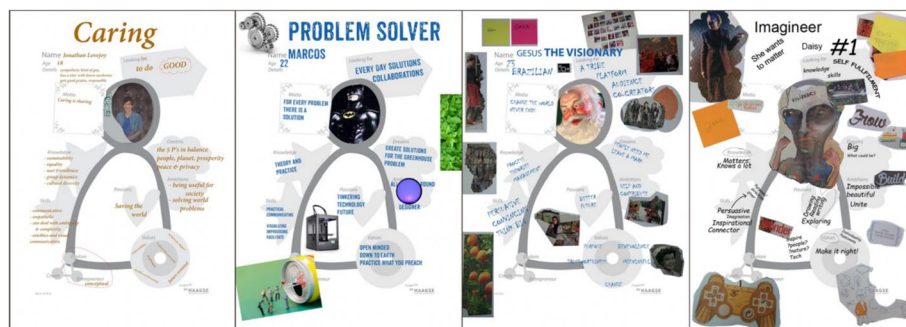


Fig. 2 The initial set of fictional personas in case 1: caring Jonathan, Problem Solver Marcos, Visionary Jesus, and Dreamer Emma

on behavior characteristics of students and what they would want to do and learn in the new program. The latter set, as represented in Fig. 1, were engaging personas, where emotions were added to the goals and behaviors with the program the personas would have. Those were made at implementation. In Case 3 the personas were fictional, intuitively made to describe their assumed reactions to the design in early stages. In Case 2, 4, and 5 engaging personas were made, where emotions played a big part, and attention focused to foreseen experiences that students could have in the new curriculum design.

All twenty-eight student persona descriptions were organized in a matrix. Eight categories were identified: Name and Descriptor, Photo and Anecdote, Background, Personality, Learning Behavior, Motivation for Learning, Learning Needs, and What Comes Next. Nearly all personas had details in each category, although Case 3 personas had very limited information on Background and Personality. The categories form the basis of the synthesized template for *learner student personas*. In the following, their sub-categories will be illustrated by details from the cases and where relevant supported by learning theory. Each category starts with *instructions* for future use of the template, derived from the five cases in combination with HCD literature.

3.1.1 Name and descriptor

Assign a realistic name to personalize the persona. Include names from other cultures in the full set to de-stereotype and diversify. Add a descriptor to highlight something unique about the student persona to remember them by and quickly refer to them. Make sure that descriptor is not stigmatizing or flattening the persona.

In Fig. 1, descriptors can be seen for each persona. For example, 'Mature Bengt' in Case 4 represents the older-than-average, well-behaved, motivated but a little stuck audio design student, whereas Case 2's YOLO Theodor stands for the young systems engineering design student who likes his social student life to the max, but in a carefree way is also very motivated for his studies. On the opposite, Future Expert Stefan already knows that he wants to do a PhD and is hyper-goal oriented in everything he does.

Using the descriptors without considering more detailed information brings the risk of 'flattening' the persona to a stereotype. In one case, a discussion occurred if the fine line between archetypes and stereotypes was crossed by calling Marisa 'ordentlig' in Swedish, which translates to tidy, neat. To the only male co-creators, this type of female student was very recognizable from their experiences, but to members of the advisory board it reeked of stereotyping girls. Marisa's descriptor was then changed to 'hard-working'.

3.1.2 Photo and anecdote

Include a representative photo to help visualize the persona. Ensure that you don't stereotype or exclude throughout the whole set. Not every student needs to look like a model. Add a brief anecdote that brings the persona to life. This story can illustrate what keeps them busy and clarify their descriptor.

Anecdotes are a quick way of bringing a persona to life. 'Influencer Rayan' in Case 5 represents the politically and ethically aware, social-media-savvy kind of product design student who came to Sweden from abroad, see Fig. 3. In the first column the anecdote can be read. Note that Rayen's photo does look like a model, but in this case that is a functional element fitting their description. Pictures of fictitious but real people are most powerful to humanize personas and make them memorable [30].

3.1.3 Background information

Add descriptive and relevant details about the students' life so far. Make use of available university statistics about the student population or even program-specific statistics in the case of an existing program redesign:

- a. Age: due to broadened accessibility, inclusion, and lifelong learning developments, the ages and stages of life in the student population can vary widely

Persona Rayen * ♀ ♂


<p>Rayen (21 years old)</p>  <p>Tunisian social media influencer, politically aware, mixes righteousness with pleasure, dares to dream big, comes with emotional ups and downs</p> <p><i>Rayen opens the mailbox and sees the acceptance letter...immediately feeling euphoric joy and fear at the same time...Next in creeps doubt, and insecurity... "Will I fit in?" "Do I know enough?" After that: "How cold will it be and will I soon look like the Brik (=Tunisian pastry) I made for the week and put in my freezer?" Rayen realizes it is serious now... leaving his family behind to embark on this new adventure.</i></p>	<p>Characteristics</p> <p>Rayen comes from Tunisia, a newly awake democracy. Rayen has a multi-cultural background, with a mother from France, and a father from Tunisia. Both parents are teachers, and intellectual discussions are dominant at home. Rayen is one of twins and they used to do synchronized diving on a high level. With a love for black humor, Rayen loves a good horror movie and adores Lady Gaga. Rayen has high endurance and has a plan for the future. Rayen has good social skills, is curious, and open to learn. Rayen has a poetic use of language. Rayen also has spells of withdrawal and isolation. That started when Rayen's twin died.</p> <p>Influenced by</p> <p>Instagram and Tiktok have made a huge impact on Rayen. Rayen is a big fan of Lady Gaga. Rayen has heard a lot about the Arab spring and how it all started in Tunisia in December 2010, when Tunisian street vendor Mohammed Bouazizi set himself on fire to protest the arbitrary seizing of his vegetable stand by police over failure to obtain a permit. This was the catalyst of the Jasmine revolution, resulting in the authoritarian president Zine El Abidine Ben Ali to abdicate his position and flee to Saudi Arabia. He had ruled the country with an iron fist for more than 20 years. The country's first democratic parliamentary elections were held in October 2011. Rayen was only 10 at the time but has always been inspired by and thankful for the big different the little man can make.</p>	<p>Passions and interest</p> <p>Between high school and the BFA Rayen took two years off and volunteered at a dog shelter. Rayen helped the shelter start an online account to find new homes in Europe for stray Tunisian dogs. Rayen knows a little about the potential impact of social media, with a foodie-Insta and Tik-tok account with over 5000 followers. Rayen worked in a pop-up food-truck for a while to save money for studying, a strangely inspiring surroundings! Rayen likes fusion cooking.</p>	<p>Wants to learn</p> <p>Rayen is interested in the role that social media can play in making the world more equal. How can design influence politics?</p> <p>Needs from the program</p> <p>Rayen would like support in networking and connecting outside of Tunisia to start making a real difference in the world.</p> <p>Has learned after BFA</p> <p>At the end of the BFA, Rayen will have a broadened view on all aspects of sustainability (environmental for example), has learned to channel critical thinking, and learned to collaborate.</p>
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Fig. 3 Filled-in template from case 5 of student persona 'Influencer' Rayen

- b. Gender: different gender identities can be addressed to achieve inclusive teaching- and learning activities.
- c. Socio-economic status (SES): to discuss and ensure access to necessary resources
- d. Geographic origins: including rural and urban, national and international settings to discuss differences from students' former environment, culture and (educational) traditions.
- e. Parent's background, job, and/or education: to discuss what kind of study references and values students might have.
- f. Social circle: details about family and/or friends of the student, possible support systems and indicators of motivations and obstacles.
- g. Former education: experiences and achievements to understand how to better meet students on their terms.
- h. Hobbies: not per se related to their studies, in the past or present.

What was called 'characteristics' in Fig. 3 has been eventually labelled Background Information in the Learner student persona template. Where Rayen comes from afar, 'Forest Man Rune' from Case 2 is a local. He grew up on his parents' farm and is religious, caring deeply for the forest where he spends his time of and eventually wants to end up doing meaningful work for as well. Although demographics such as age and economic status usually should not need to be included in personas [30], in this case they can directly affect learning behavior and thus do matter. Case 5's Young Optimist Janne moves abroad to study aged 18 while applauded and stimulated by his parents. Five years older Autodidact Mia (Case 4) on the other hand is going against the wishes of her affluent parents and always feels she must defend herself. Both are very talented high achievers but will have different learning behavior. Family oriented Kim (also from Case 5) has a lower SES and has always worked to earn her keep. She is afraid to be corrupted by making money and is more interested in social jobs. Product Company Piet on the other hand sees his studies as a vehicle to start make big bucks as an entrepreneur.

3.1.4 *Personality traits*

Personality can be described by the Big Five model [35] and its expansion HEXACO [36, 37]. A meta-study has shown that a high conscientiousness is strongly associated with academic performance, and albeit to a lesser extend so are openness and agreeableness [38]. Extroversion and neuroticism show higher associations with job performance than with academic performance. Honesty-Humility as a sixth dimension can be linked to ethics, social behavior and self-monitoring. Having these traits to a certain degree can say something about perseverance in studying, behavior in group settings, handling feedback, self-efficacy, values, etcetera.

- a. Conscientiousness: represents reliability, organization, and a tendency to be disciplined and goal oriented.
- b. Openness: reflects curiosity, creativity, and a willingness to embrace new experiences and ideas.
- c. Agreeableness: involves empathy, trustworthiness, and a tendency to prioritize others' needs and harmony in relations and interaction.
- d. Extroversion: indicates a preference for social interaction, being noticeable giving energy, or the opposite as introvert spending much energy on these interactions.
- e. Neuroticism: relates to emotional sensitivity and instability, self-consciousness, and vulnerability to stress.
- f. Humility: reflects sincerity, fairness, modesty, and a lack of greed.

To exemplify, Organizer Adeline in Case 3 is a high-achieving student who works hard and often goes beyond what is required. She struggles in group settings that do not acknowledge individual contributions and experiences self-doubt and stress despite her good performance in classes. Adeline prefers clear guidelines and assignments. In a cross-case comparison, she shows similarities with engaging personas Hard Working Marisa from Case 2 and Ambitious Kitty from Case 1. The co-creators in those cases also recognized such an archetypical student in their (current/desired) population. There could be a risk of stereotyping female students. But because the level of detail of the personas is so high, there are nuances. Kitty does not lack self-confidence and sees collaborations as possible fruitful networking opportunities. She has high expectations and is critical towards herself and others. In Marisa, we see self-confidence directly connected to achievement, but less of the stress that this gives Adeline. Marisa beliefs her educators and listens to them. She thrives on their compliments but does not dare to question them. Nor does she go beyond the requirements. Her learning journey therefore shows less intrinsically motivated deep dives, which brings us to the next category.

3.1.5 *Learning behavior*

As behavior, motivation and expectations are important elements of any kind of persona [30], we focus on the learning in these categories in the learner student persona template:

- a. Self-efficacy: A student's belief in their ability to succeed in specific situations or accomplish certain tasks is seen as a key factor in student motivation, learning, and achievement [39]. When students rightly believe they are capable (high self-efficacy), they are more likely to employ effective learning strategies, such as goal setting, self-monitoring, and seeking feedback [40]. They tend to approach challenging tasks with

a positive attitude, stay resilient in the face of setbacks, and engage more actively in learning processes.

- b. Mindset: whether students have a fixed mindset (“I can never”, “I always do”) or a growth mindset (“I can try”, “I can develop”) [41] influences their learning behavior and how they handle challenges in learning.
- c. Grit: says something about the level of perseverance and resilience to stay on a task [42].
- d. Performance: describes to what extent and how the student personas (do not) perform within a learning context. All of them have performed well enough to get into university, but what are their strengths or weaknesses? Are there any special circumstances or disabilities to consider? When including neurodiversity, it can be a choice to literally mention any diagnosis a persona might have or describe their diverse learning behavior. Not all will have or want (to share) a formal diagnosis.

From the description of Family Oriented Kim, we know that she wears a hearing aid and has a non-ableist approach to life and work. In some other personas we can read between the lines to find neurodiversity addressed in their learning behavior. Motorcycle Lover Charlie could be on the ADHD spectrum, Environmental Activist Niika on the autism spectrum. In Case 2, this could be true for YOLO Theodor resp. Expert Stefan and in Case 4 for Priorities Elsewhere Youssef resp. Mature Bengt. In all cases, Personality Traits and Learning Behavior are intertwined in a way that the co-creators empathize why their personas show certain behavior, increasing their considerations in the design.

3.1.6 Motivations for learning

To give leads to what kind of teaching and learning activities could motivate students, and may have led them to choose for this program, indicate motivational aspects such as:

- a. Talents and passions.
- b. Heroes and role models.
- c. Values driving their worldview and choices.
- d. Drivers shaping their intuition and preferences.
- e. Ambitions, varying in intensity, focus, and scope.
- f. Study interests, special topics offered within the program.
- g. Relevant pre-knowledge.

All personas have talents, heroes and ambitions that give them a personal direction within the master program that was being designed in Case 4, some well-known, others more personal. In Case 5, the values and drivers are more central in the descriptions, fitting to the ethical and sustainability focus of the program design. Case 2 described study interests and relevant pre-knowledge in all their personas.

3.1.7 Learning needs

The self-motivation theory elements competence, autonomy and relatedness [43] help to address emotional and psychological needs next to disciplinary and academic ones:

- a. Discipline-related: what specific personas need to learn within the discipline(s) of the program to become good graduates.

- b. Sense of mastery: the importance they place on achieving mastery, and how it will be acknowledged.
- c. Connectivity: their needs for social interaction and a sense of belonging.
- d. Autonomy: the need for independence or guidance.
- e. Safety: how they can feel safe in the learning environment.
- f. Flexibility: via adaptable learning environments and personalized paths
- g. Inclusivity needs: based on their background, personality, and learning behavior.
- h. Learning preferences: for concrete learning, reflective observation, conceptualization, and experimentation [9].

This category is connecting the persona to the program design from their individual point of view, representing a group of students with those same needs. From this category, it is just a small step towards LJM and adjustments to the program design. To illustrate, Sporty Ella from Case 2 is an elite sports woman, see Fig. 4. She will encounter planning challenges during her studies, when deadlines coincide with (inter)national ski competitions. She needs a certain level of flexibility from the program, but in return has grit and is sensitive to positive reinforcement, as she is used to from her ski coaches. This made the co-creators add self-assessment possibilities and focus on formative assessment to the curriculum design to sustain her openness to learning. Independent Design Consultant Kitty (Case 1), rebellious but talented Absent Louise (Case 3), former piano-wonderkid Autodidact Mia (Case 4), and insecure Family Oriented Kim who does not recognize the amazing social innovations she has done (Case 5) would, for their own reasons, thrive on training to value their own and positive reinforcement as well. So, although not every persona set has an elite sports student, other personas can lead the co-creators to the same kinds of curriculum design alterations.

3.1.8 What comes next

The last category looks towards the persona's end goals and result of studying at the program.

- a. What have they specifically learned? Personal learning goals and individual learning challenges can play a role here.

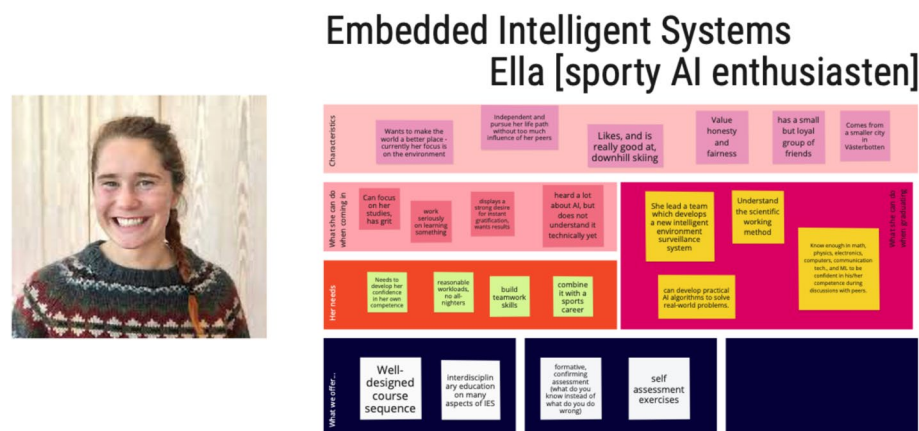


Fig. 4 Sporty Ella from case 2, with in the lower bar her learning needs and what the program can offer to support those

- b. The next step after graduation: will students continue studying, do a PhD, get a job or take a break? This links back to their motivation for learning.

Some personas know exactly what they want. Expert Stefan is going for a PhD whereas Extroverted Francesca already is and continues to make art, Piet will be an entrepreneur, Rune wants to go into forestry. But others have no idea yet and will need to search for their niche during their studies.

3.2 Learner journey mapping

In each case, the student personas were applied in student journey mapping. Each time, the main goal of the mapping was to discover how to adjust the program's new design in content and pedagogy to the envisioned student body. The maps helped in identifying both potentially positive and negative experiences throughout the program, allowing the co-creators to enhance and smoothen the draft of the curriculum design. They identified moments where the learning experience aligned well with their personas' needs, interests, and expectations, leading to high engagement and effective learning. For example, in several of the cases, semi-authentic practical assignments became part of the design, foreseen to lead to such resonating moments. But they also identified aspects in the design where the learning experience would possibly cause frustration or disengagement. Group work where individual contributions were not recognized was one such example, for instance for Organizer Adeline or Einzelgänger Linus in Case 3. Better guidelines for teamwork, more follow-up of individual contributions, and a framework for group vs individual work were design tweaks to prevent this.

The personas were recognized to need different learning activities and guidance from the program and different structures and rewards to be supported in their learning. For example, for Organizing Adeline, providing intensive support during project assignments and helping them identify their own interests and intentions beyond course goals, would offer significant emotional and psychological support. This would also help Mature Bengt from Case 4 and Family Oriented Kim from Case 5. Integrating real-world applications and authentic, external feedback mechanism in the curriculum would make learning more engaging for students like who are overly critical and self-critical, and who might think the educators might be overly lenient in their feedback, like Junior Innovator Kelly from Case 1, and again Family Oriented Kim.

Except for empathy mapping, which is an existing design method [33], the student journey maps had many different, custom-made shapes and foci. We have named them in the data analysis in hindsight for the purpose of this study.

3.2.1 Empathy mapping

In Case 2 and 4, the co-creators thought about what their student personas would Say, Feel, Do, and Think about the curriculum design, see Fig. 5. It gave the co-creators in Case 4 the insight how their future students could feel quite uncomfortable for different reasons while working together with each other and while interacting with their teachers. It also helped them to see what kind of content their personas would be looking for in the program, so they included what wasn't in the design already.

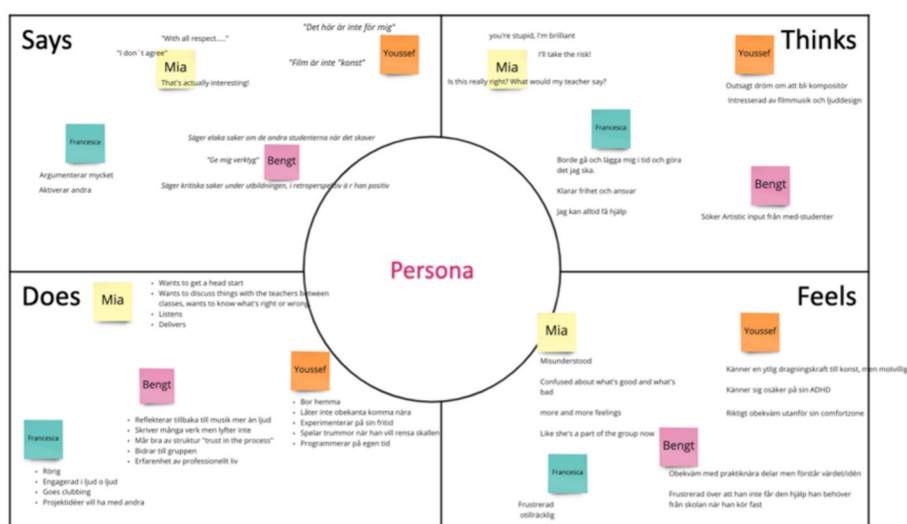


Fig. 5 Empathy mapping of all four personas in case 4

3.3 Learning activity experience mapping

Case 3 looked specifically at the student–teacher interaction, in their learning activity experience journey mapping. They discussed how and where to apply teaching versus independent practice, social learning opportunities, and formative and summative assessments. They included both the journey through a course, as well as progression throughout the program, and decided to scaffold more in the first encounters and gradually less.

The co-creators of Case 1 considered how they could improve the curriculum design based on their personas' experiences in the envisioned authentic learning activities with real clients, with self-directed oral assessments. Different approaches were needed to match the personas' needs and juxtapositions needed to be solved with the envisioned increase of in-course flexibility and personalization of the curriculum. For instance, not all personas would be comfortable to present orally at an assessment, so they allowed optional presentation recording beforehand. Some personas needed more support than others to choose what competencies they wanted to be assessed on, so supportive sessions were added as learning activity that introduced the student-owned assessment system with test runs and feedback sessions plus an online tool for students to keep track of which competencies they had proven already.

3.3.1 Course experience journey mapping

In Case 2, the co-creators imagined the journeys their personas would make through each course of their concept program design by course experience mapping. They considered which persona would thrive in which course due to their personal values, learning needs, personality traits, or motivations. They then looked to give pointers to the envisioned courses to improve the learning experience for all or if courses needed to switch places in order not to lose students along the way.

3.3.2 Program experience journey mapping

Zooming out one more step, Cases 1, 2 and 4 focused on the haves, feelings, and wants of their personas during their learner journey from the beginning till the end of the

program. This LJM is most like the common student journey map, as it takes the time before and right after the program into account: with what luggage of pre-knowledge and diversity do students come in? And what will they do after finishing, as a logical continuation of their studies and profile choices? However, the output of these program experience journey maps is geared towards refining the design of the intended, planned, and extracurricular learning inside the program, more than towards the unique selling point and strategic positioning. See Fig. 6 for an example of such a journey map from Case 5, where Influencer Rayen reminded the co-creators to offer projects on social aspects of sustainability, not just environmental ones, and to support them in the beginning when finding housing and the big cultural change would weigh heavy and distract from the learning.

3.3.3 Flexible learning paths mapping

The flexible learning paths mapping is a special version of the program experience journey mapping. Cases 1, 2, 3, and 5 envisioned different flexible learning paths for their personas, with the curriculum design offering choices based on different pre-knowledge, interests, motivations, etc. The co-creators negotiated which grounds for choice were desirable and constructive. Flexible elements varied from a course menu and student-owned assessment (Case 1), profile choices in the last two years/master's (Case 2), room for electives (Case 3), room for flexibility in theoretic and skill-focused string courses underlying projects (Case 5).

In Fig. 7, the choice menu of 30 EC courses throughout the three-year bachelor program of Case 1 was explored from the perspective of the personas, represented by the different threads that co-creators got to pin on big posters with the menu pre-printed on it. Based on these yarn paths of choice, path profiles were identified: the explorer, the entrepreneur, and the creator path. For instance, Caring Jonathan (from the first set of personas) ended up in a generic combined explorer-entrepreneur-creator path, whereas Visionary Gesus liked to choose courses with an explorer or combined explorer profile.

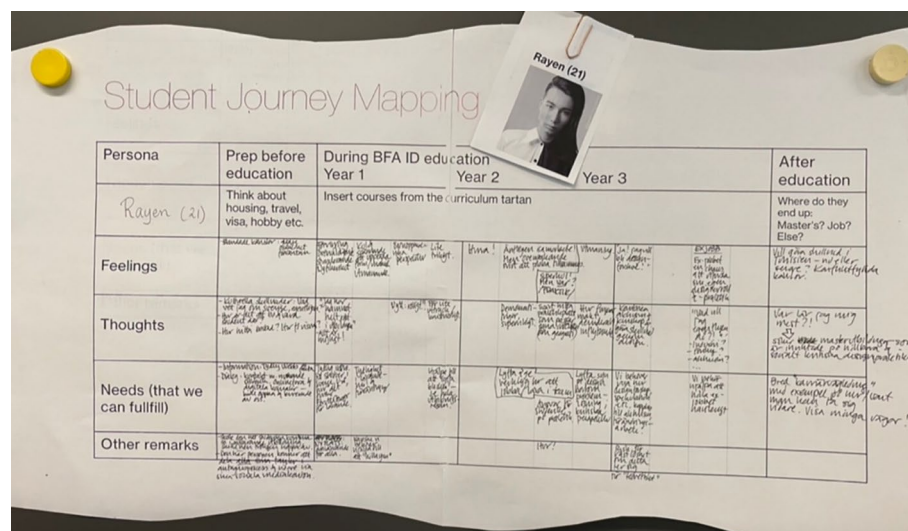


Fig. 6 Influencer Rayen's journey through the program, mentioning their thoughts, feelings, and needs such as their co-creators empathically imagined them (case 5)



Fig. 7 The flexible learning paths map of case 1

Mapping sessions with other stakeholders—current design students, middle management, other technical studies—were done as well, to hear their thoughts on what plausible or undesirable paths would be. For instance, they discussed personas choosing courses because friends did them too, there were pre-formed group project ideas, or wanting to build on already present strengths, such as aesthetic design. This helped the co-creators to decide if any choice could, would, and would be ok to be work or if choices had to be limited or guided in some way. Also, a mentoring strand was designed after this mapping to guide students in their choices.

3.4 One learner journey mapping approach for different maps

Deducing from the processes the five cases went through, how they made and used the different kinds of learner journey maps, a series of steps can be recognized for how to use this method in the context of higher education curriculum innovation:

1. *Define objectives:* This can vary according to the overall aims of the curriculum innovation.
2. Create or finetune the student personas: See above.
3. *Visualize the map:* use visualizing tools to map out the entire journey with room for stages, touchpoints, actions, emotions, enablers and obstacles. Whiteboards, paper or cardboard, sticky notes, yarn, pins, big print outs, or tools in the digital space... anything goes.
4. *Outline the learner journey stages:* indicate a fitting start, middle, and end point (in learning activity, course, whole program) on the timeline.
5. *Identify touchpoints in those stages:* indicate relevant moments of interaction that matter in light of the objectives.
6. *Capture learner actions and emotions:* document actions like attending classes, working in groups, submitting assignments, and giving and receiving feedback. Describe the behavior and note emotions.
7. *Identify enablers and obstacles:* think both in enablers and obstacles, key moments of resonance (good for learning) and of friction (not always good for learning). Possible obstacles that evoke confusion, frustration, or even drop-out, give insight into preventative design improvements. Enablers give insight into what design elements should come back in any upcoming iterations of the design. Often enablers for one persona can be obstacles for others, and that is where design flexibility, negotiation and compromise is needed.
8. *Review and iterate:* Present the journey maps per persona to each other. Gather feedback from students and other stakeholders. Sharpen and refine the learner journey map accordingly.

9. *Evaluate and formulate improvements to the curriculum design:* Alter the current design of the curriculum and preserve important elements, so that all personas (and thus the future student body) see their learning needs met and can develop favorably during their studies.

LJM is a tool to increase the successfulness of the eventual curriculum design and not a result in itself. Note that it doesn't help to map only positive or only negative stories. Just like with the student personas, there is a need to make them realistic and nuanced, and perhaps iterate, tweak, and try again several times. Curriculum design is, after all, a continuous process.

4 Discussion

The HCD acronym can inform the process stages; hear, create, deliver [1]. The cases showed that using student personas and learner journey maps helps co-creators to develop a program, its courses and even planned interactions in the learning activities from a scenario-based, student-centered, and pedagogic perspective. The methods offer a way to 'hear' future students' needs, by stepping into the personas' life, taking the time to wander around for a while, and stepping back out for competent action [44]. The co-creators in all cases were enthusiastic about how these future students 'came to life' and the journey mapping with them made it easy to imagine who to design the program for. They felt empathy and even some pride for them as they imagined their progression through the program and felt a responsibility to make the program design right. Even the 'non-designer' co-creators who had no prior experience with the method and who were even reluctant at first, became engaged to think about 'their' students in the co-creation process.

Using the methods was context-specific per case, based on preferences of the co-creators in their specific curriculum innovation process stages. As a result, each had a different approach and used different—or no—templates. Still, a stable frame of categories could be identified and build upon, enriching the *student* personas into *learner student* personas. Where the original *user* persona method of Nielsen [27] prescribed name, age, gender, an image, relevant experiences and skills, plus a short story illustrating the persona's typical experiences and interactions, the *learner student* persona template goes deeper by adding the multi-dimensional diversity of students and their background, deeper into the personality by detailing on the big six and student learning needs, and deeper on the expected experiences with learning behavior and motivations. As such, the details gave guidance to different educational design purposes, for instance for study success, inclusion of neurodiversity and socio-cultural diversity.

This higher level of detail could be argued to be necessary when the 'product/service' is a—from a developmental perspective seen quite pivotal—three to five-year period in the lives of 'the user'. Yet, for the desired empathic and pedagogic effect, it is not important for each persona that something on each subcategory is described. Which ones should be included, depends on the character of the curriculum innovation. Except for age and gender, the personas of Case 3 lacked background information. In that case, the co-creators were a group with experienced designers in the majority and could more easily empathies with the personas based on their short descriptions. Instead, they focused on learning needs. Those gave handles to think about how to give feedback to the students, which was the main goal of the journey mapping.

What does matter is that the personas within one set should stand out as unique archetypes with little overlap, to best cover the future population of students. In the comparisons made between the five cases, we could identify common themes and behaviors that all co-creation teams foresaw in their sets. Those match the present-day diversity challenges of university students.

In most cases, the co-creators steered away from stereotypes and added characteristics of the desired future students based on the vision and strategies for the program's curriculum innovation. For example, they included marginalized groups, so that the curriculum design could be adjusted to attract those groups. In Case 2, one of the goals was to increase the number of female students in the new program, hence unlike reality half of the personas were female. In Case 5, the set of personas was initially all non-binary, in attempt to eliminate gender-specific thinking. But when the current design students reviewed the personas, they pointed out that gender-specific role-models for female students in the workshop environment were missing (all workshop technicians were male in this institution), which would not pop up as a problem when gender was eliminated. The students advised to add gender again, but in a non-typical way. Charlie became the motorcycle-loving female, and Janne the hard-working young male.

Applying the learner student personas in LJM yielded insights on how the diverse backgrounds, motivations, preferences, and challenges of their personas impacted how the co-creators thought about a good program design. It helped to widen from an initial discipline-specific content-narrative towards an empathic, pedagogic, student-centered one. The LJM led in some of the cases to direct changes in the concept program design. In other cases, it resulted in notes for course designers later in the process. An interesting direction of further research would be extending the HCD skills of educators to support the use of personas in all these stages of the curriculum design, and the role academic developers could play in this. It would also be interesting to do further research in the use of personas in agile, continuous curriculum development processes, for instance in fast-developing disciplines [45]. Here the curriculum ends up in a perpetual state of prototyping and changes need to be made on the go. The personas and LJMs could be of help next to the commonly used student evaluations as a feedforward mechanism on how the next upcoming changes would affect the learning experience of the students.

5 Conclusions

In the participatory action research cases of five co-creative curriculum innovation processes on program level in higher—artistic and engineering—design education, we observed the adjustments in use of HCD methods Personas and User Journey Mapping. Making archetypical *learner* student personas gave the co-creators in the cases empathic insights into the unique characteristics of their foreseen and desired future student body. Applying them in *Learner* Journey Mapping (LJM) provided a comprehensive overview of the student learning experience, highlighting key moments of resonance and friction.

In order to get to this level of detail, after comparing the practice in the five cases with learning theories, the study suggests including the following categories of information in the student persona: name and descriptor, photo and anecdote, background, personality, learner behavior, motivations for learning, learning needs, and what comes next. Each of these categories has sub-categories in which the co-creators can attribute different details per persona. In Table 3 the learner-student persona template is summarized.

Table 3 Template for student personas for program-level curriculum innovation

Persona	Background	Personality	Learning behavior	Motivation for learning	Learning needs	What comes next
Name	Age	Conscientious-ness	Self-efficacy	Talents and passions	Disciplinary-related	What they have learned
Descriptor	Gender	Openness	Mindset	Heros and role models	Sense of mastery	What they will do next
Photo	SES	Agreeableness	Git	Values	Connectivity	
Anecdote	Geographic origin	Extroversion	Performance	Drivers	Autonomy	
	Parents' background	Neuroticism		Ambitions	Safety	
	Social circles	Humility		Interests	Flexibility	
	Former education			Pre-knowl-edge	Inclusivity	
	Hobbies				Learning preferences	

Table 4 Eight steps to learner journey mapping with learner student personas

Step	Learner journey mapping action
1	Define objectives
2	Create learner student personas
3	Visualize the learner journey timeline (learning activity, course, program)
4	Indicate key moments of interaction in each stage
5	Capture learner expectations, behavior and emotions
6	Identify enablers and obstacles in the design
7	Evaluate and formulate improvements to the curriculum design
8	Review and iterate

LJM can come in many shapes and sizes. Which depends on what the reasons for changing an existing or creating a new program are. LJM can for example focus on teaching professionalism, progression in multiple discipline-specific courses in an inter-disciplinary program, attracting female students, inclusion of neurodiversity, or accommodating lifelong learners. It supports imagining incremental to disruptive changes in which and how education is offered to students.

In the five cases, we could distinguish five types of LJMs: Program Experience Journey Mapping, Course Experience Journey Mapping, and Learning Activity Experience Mapping, as well as Empathy Mapping and Flexible Learning Paths Mapping. We abducted the approach with which student personas were taken on their learning journeys, see Table 4.

No matter which journey is mapped—on program, course or learner activity level—and in which design iteration this is done, it is important to empathically think from the different archetypical *learner* student personas' perspectives and motivations. By growing understanding for their emotions, behavior and needs, and coherently using their potential and foreseeable learning experiences, the details of the curriculum design can be sharpened in the design iterations. This will increase the chances of effective student learning in the program and a successful curriculum innovation in that regard.

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Authors' contributions

All authors contributed to the study design. Material preparation and data collection was done by S.B. The data analyses were performed by S.B. and Å.W.N. The main manuscript text was written by S.B. and Å.W.N., and adjusted based on feedback and suggestions from W.A., M.d.H. and E.S. All authors reviewed and approved the final manuscript.

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Data availability

The dataset generated and analysed during the current study is not publicly available in order to safeguard the anonymity of the participants in the curriculum innovation processes in which the data is embedded, but is available from the corresponding author on reasonable request.

Declarations

Ethical approval

This project has been approved by the ICLON Research Ethics Committee, Leiden University, the Netherlands, under number IREC_ICLON 2021-09.

Consent to participate

Freely-given, informed consent was obtained from all participants included in the study.

Consent to publish

Freely-given, informed consent was obtained from all participants to publish.

Competing interest

The authors declare no competing interests.

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References

1. IDEO. The human-centered design toolkit. IDEO. Retrieved June 18, 2024, from <https://www.ideo.com/journal/design-kit-the-human-centered-design-toolkit>
2. Buchanan R. Human dignity and human rights: thoughts on the principles of human-centered design. *Des Issues*. 2001;17(3):35–9. <https://doi.org/10.1162/074793601750357178>.
3. Brown T. Design thinking. *Harv Bus Rev*. 2008;86(6):84–141.
4. Kimbell L. Rethinking design thinking: Part 1. *Des Cult*. 2011;3(3):285–306.
5. Norman D. The design of everyday things. MIT Press; 2013.
6. Zeivots S, Hopwood N, Wardak D, Cram A. Co-design practice in higher education: practice theory insights into collaborative curriculum development. *High Educ Res Dev*. 2025;44(3):769–83. <https://doi.org/10.1080/07294360.2024.2410269>.
7. Bovill C, Woolmer C. How conceptualisations of curriculum in higher education influence student-staff co-creation in and of the curriculum. *High Educ*. 2018;78(3):407–22. <https://doi.org/10.1007/s10734-018-0349-8>.
8. Chemi T, Krogh L. Co-creation in higher education: students and educators preparing creatively and collaboratively to the challenge of the future. Sense Publishers; 2017.
9. Kolb D. Experiential learning: experience as the source of learning and development. FT Press; 2014.
10. Curry L. A critique of the research on learning styles. *Educ Leadership*. 1990;48(2):50–6.
11. Dewey J. Experience and education. *Educ Forum*. 1986;50(3):241–52.
12. Norman D. Human-centered design considered harmful. *Interactions*. 2005;12(4):14–9. <https://doi.org/10.1145/1070960.1070976>.
13. Sanders EN, Stappers P. Co-creation and the new landscapes of design. *Co-design*. 2008;4(1):5–18. <https://doi.org/10.1080/15710880701875068>.
14. Biggs J, Tang C, Kennedy G. Teaching for quality learning at university. McGraw-Hill Education; 2022.
15. Kolko J. Abductive thinking and sensemaking: the drivers of design synthesis. *Des Issues*. 2010;26(1):15–28. <https://doi.org/10.1162/desi.2010.26.1.15>.
16. Kemmis S, McTaggart R, Nixon R. The action research planner. Doing critical participatory action research. Springer; 2014.
17. Manzini E, Rizzo F. Small projects/large changes: participatory design as an open participated process. *CoDesign*. 2011;7(3):199–215. <https://doi.org/10.1080/15710882.2011.630472>.
18. Bamber A, Kligyte G, van der Bijl-Brouwer M, Pratt S. Learning together: a transdisciplinary approach to student-staff partnerships in higher education. *High Educ Res Dev*. 2020;39(3):395–410. <https://doi.org/10.1080/07294360.2019.1684454>.
19. Kolmos A, Hadgraft RG, Egelund Holgaard J. Response strategies for curriculum change in engineering. *Int J Technol Des Educ*. 2016;26(3):391–411. <https://doi.org/10.1007/s10798-015-9319-y>.
20. O'Donnell VL. Organisational change and development towards inclusive higher education. *J Appl Res Higher Educ*. 2016;8(1):101–18. <https://doi.org/10.1108/JARHE-04-2014-0051>.
21. Lindsay ED, Hadgraft RG, Boyle F, Ulseth R. Disrupting engineering education. Routledge; 2023.

22. Merton P, Froyd JE, Clark MC, Richardson J. A case study of relationships between organizational culture and curricular change in engineering education. *Innov High Educ.* 2009;34(4):219–33. <https://doi.org/10.1007/s10755-009-9114-3>.
23. Walkington J. A process for curriculum change in engineering education. *Eur J Eng Educ.* 2002;27(2):133–48. <https://doi.org/10.1080/03043790210129603>.
24. Hallnäs L, Redström J. *Interaction design. Foundations, experiments.* The Interactive Institute; 2006.
25. Floor N. *This is learning experience design: what it is, how it works, and why it matters.* New Riders Pub.; 2023.
26. North C. *Learning experience design essentials: designing for users and impact.* American Society for Training & Development; 2023.
27. Nielsen L. *Persona-user focused design.* Springer; 2013.
28. Cooper A. *The inmates are running the asylum: why high-tech products drive us crazy and how to restore the sanity.* Sams Publishing; 2004.
29. Canziba E. *Hands-on UX design for developers: design, prototype, and implement compelling user experiences from scratch.* Packt Publishing; 2018.
30. Saffer D. *Designing for interaction: creating innovative applications and devices.* New Riders Pub.; 2010.
31. Stickdorn M, Horness M, Lawrence A, Schneider J. *This is service design doing.* O'Reilly Media Inc.; 2018.
32. Endmann A, Keßner D. User journey mapping—a method in user experience design. *I-com.* 2016;15(1):105–10. <https://doi.org/10.1515/icom-2016-0010>
33. Martin B, Hanington B. *Universal methods of design.* Rockport Publishers; 2012.
34. Dewey J. *Democracy and education.* Columbia University Press; 2024.
35. Komarraju M, Karau S. The relationship between the big five personality traits and academic motivation. *Pers Individ Differ.* 2005;39(3):557–67. <https://doi.org/10.1016/j.paid.2005.02.013>.
36. Ashton MC, Lee K, de Vries RE. The HEXACO honesty-humility, agreeableness, and emotionality factors: a review of research and theory. *Personality Soc Psychol Rev.* 2014;18(2):139–52. <https://doi.org/10.1177/1088868314523838>.
37. Ashton MC, Lee K. Honesty-humility, the Big Five, and the five-factor model. *J Pers.* 2005;73:1321–53. <https://doi.org/10.1111/j.1467-6494.2005.00351.x>.
38. Zell E, Lesick TL. Big five personality traits and performance: a quantitative synthesis of 50+ meta-analyses. *J Personality.* 2022;90(4):559–73. <https://doi.org/10.1111/jopy.12683>.
39. Bandura A, Schunk DH. Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *J Pers Soc Psychol.* 1981;41(3):586–98. <https://doi.org/10.1037/0022-3514.41.3.586>.
40. Schunk DH, Zimmerman BJ. *Handbook of self-regulation of learning and performance.* Routledge; 2011.
41. Dweck C. *Mindsets: developing talent through a growth mindset.* Olympic Coach. 2009;21(1):4–7.
42. Almeida D. Understanding the concept of grit in higher education. In: Paulsen M, editor. *Higher education: handbook of theory and research.* Springer International Publishing; 2016. p. 559–609.
43. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am Psychol.* 2000;55(1):68–78. <https://doi.org/10.1037/110003-066X.55.1.68>.
44. Kouprie M, Sleeswijk Visser F. A framework for empathy in design: stepping into and out of the user's life. *J Eng Des.* 2009;20(5):437–48. <https://doi.org/10.1080/09544820902875033>.
45. Brink SC, de Hei M, Sjoer E, Carlsson CJ, Georgsson F, Keller E, et al. Curriculum agility principles for transformative innovation in engineering education. *Eur J Eng Educ.* 2024;50(3):455–71. <https://doi.org/10.1080/03043797.2024.2398165>.

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