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# Designing EdTech tools using a codesign model: a multi-stakeholder design case

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## ABSTRACT

This work presents a model to support the process of learning experience design (LXD) for educational technology. The model was developed and applied in the design of a self-reflection tool for 21st-century skills in maker education. Grounded in LXD, it integrates procedural and methodological perspectives from codesign and user experience (UX) design, by mapping three codesign dimensions - *Staging*, *Negotiation*, and *Reframing* - onto four UX phases - *Analyse*, *Design*, *Prototype*, and *Evaluate*. Enacted through an agile process involving 29 designers across four European countries, the model structured the collaborative activity across *phases*, *dimensions*, *roles* and *objects*. It offered the necessary clarity and practical scaffolding required in navigating complex, multistakeholder, multicultural and multidisciplinary initiatives. Key findings highlight process transparency, particularly between the *preparatory* and *reflective* dimensions that precede and follow the main design negotiations, designer role fluidity, inclusive participation, and the evolving role of design objects. The work offers a structured and transferrable approach to EdTech design at the intersection of LXD, UX, and codesign.

## KEYWORDS

EdTech (Educational Technology); UX; codesign; learning experience design (LXD); learning design (LD); maker education; design case

## 1. Introduction

This paper presents the design of a digital learning tool aimed at supporting learners' use and assessment of 21st-century skills in makerspaces, guided by a new integrated model. Over the past years, makerspaces have emerged as powerful environments for experiential, inquiry-based, and constructivist learning (Halverson and Sheridan 2014), fostering creativity, problem-solving, collaboration, and critical thinking - commonly identified as 21st-century skills (Binkley et al. 2012; Bowler and Champagne 2016; Kipp, Kapros, and O'Keeffe 2018). Despite the potential of makerspaces, educators lack appropriate means to systematically integrate and assess these skills in the curriculum, due to their complex and elusive nature, compared to that of tangible making outcomes (Kipp, Kapros, and O'Keeffe 2018). In response, *self-assessment* and *self-reflection* have gained traction as appropriate for maker-oriented assessment, supporting both formative feedback and scaffolded skills development (Cun, Abramovich, and Smith 2019; Lin et al. 2020; Ogata et al. 2024). Yet, learners

often struggle to articulate or reflect on their skills, being immersed in their hands-on activities or distracted by these busy environments Bieraugel and Neill (2017); Geisinger (2016); Peppler et al. (2017).

Educational technology (EdTech) has shown promise in addressing these, by promoting self-reflection and developing skills awareness while helping educators measure these complex competencies (Bolden et al. 2020; Geisinger 2016; Keune and Peppler 2017; Turakhia et al. 2022). However, the integration of reflection and assessment into the design of technological learning tools is challenging. Importantly, there is scarcity in systematic, research-driven, and empirically verified knowledge on the processes, roles and materials needed in the design of engaging learning experiences that can capture and sustain the learners' interest within formal and informal educational settings (Barbera, Garcia, and Fuertes-Alpiste 2017; Breien and Wasson 2022; Cober et al. 2015; Slattery, Saeri, and Bragge 2020).

To address this gap, this paper introduces a design case focused on the development of an EdTech tool to support learners' self-reflection in makerspaces. The tool was created through a scaffolded codesign process involving educators, designers, developers, and researchers from four European countries, building on earlier efforts in using digital tools to capture 21st-century skills development (Kipp, Kapros, and O'Keeffe 2018). At the heart of this work is a new model that combines principles from user experience (UX) design, learning experience design (LXD), and codesign methodology, to direct the *planning*, *coordination*, and *analysis* of such collaborative design efforts. The model addresses identified gaps in both research and practice which call for structured guidance on the design of multidisciplinary, evidence-driven, and human-centred educational technology that promises to 'deliver superior learning outcomes' (Feldstein 2016), moving beyond a *one-size-fits-all* approach.

Grounding this model in Learning Experience Design (LXD) principles was essential for meeting the objectives of our work, as LXD reflects the shift from traditional learning design towards more human-centred and socio-culturally sensitive approaches (Schmidt and Huang 2022a). LXD integrates *learning science* and *user experience* (UX) to enable effective knowledge construction and sustained learner engagement, requiring multidisciplinary designer expertise (Schmidt and Huang 2022; Vann and Tawfik 2020). This explains why it is often associated with *codesign* methodology, which, in EdTech development, involves teachers, researchers, technologists and end-users (Roschelle, Penuel, and Shechtman 2006). Such collaborations respond to the dynamic demands of EdTech implementations that meet classroom needs and foster shared ownership amongst participants (Ogata et al. 2024; E. B-N. Sanders and Stappers 2008). Both LXD and codesign are informed by user experience (UX) design practices such as contextual inquiry and analysis, design thinking (DT), rapid prototyping, and evaluation (user-based, expert-driven, heuristic, etc.) (Fu and Lin 2014; Schmidt et al. 2020; Vann and Tawfik 2020).

In this study, we adopt a *design case* research paradigm to offer a narrative lens on the relationship between designers and researchers and what is being designed (Moore et al. 2023). Rather than aiming at generalised and 'replicable truths' that are typical of traditional scientific research, design cases provide rich contextual insights from the designer's perspective – that would otherwise be inaccessible – and serve as precedents for others to draw upon in their own design contexts (Gray 2020; Smith 2010).

Our design case documents the synthesis and enactment of a model that integrates theoretical and methodological foundations from codesign, LXD and UX design to meet specific design goals, in contrast to more high-level, generalised frameworks (Moore et al. 2023). It illustrates how this model was applied to the *design* and *analysis* of the EdTech tool under study, and defines the key elements of the process, in the form of *phases*, *dimensions*, *activities*, *roles* and *objects* (artefacts), to support others engaged in similar efforts. The overarching research question of this work is as follows:

*What are the key aspects of a model-based codesign process that enable effective learning experience design for an Edtech tool?*

This study is part of a larger body of design-based research (DBR) work, with parallel studies addressing contextual data collection and analysis (Ioannou et al. 2024), the tool's pedagogical framework (in progress), the interaction design requirements and respective tool features (Mavri, Ioannou, and Kitsis 2025), and its evaluation with an extended user sample (Ioannou et al. 2024).

## 2. Related work

### 2.1. User experience (UX) design

User experience (UX) design focuses on the investigation, analysis, and design of human-centred needs to enhance the experiential aspects of the use of a product or service. It focuses on the user *interaction* going beyond conventional usability which explores the *effectiveness*, *efficiency*, and *user-satisfaction* - with which users interact with a system (ISO 9241-11 2018; Nielsen 1994; Pellas, Mystakidis, and Christopoulos 2021; Vredenburg et al. 2002). UX design takes a more holistic approach to human-computer-interaction (HCI), to consider – aside of the usability effects – the user's feelings, emotional impact, memory, findability, desirability, credibility, and value (Petrie and Bevan 2009; Tosi 2019).

It is canonically linked to methods like interviews, questionnaires, user scenarios, flows, and prototypes to support the design and evaluation of the interaction. It is also specification driven. In fact, Hartson and Pyla (2012) go on to classify typical different UX specifications into: a) *Interaction specifications*, which define the product features that support the user's tasks, b) *functional specifications*, that determine the product's technical functionality, and c) *phenomenological specifications*, that describe the user's perceptions, intentions, needs, as well as the emotions that the tool is expected to address (Hassenzahl 2013). Importantly, UX is a highly iterative process, involving cycles of inquiry, design, and evaluation (Petrie and Bevan 2009; Sonalkar et al. 2016).

### 2.2. Learning experience design (LXD)

LXD blends instructional design, human-centred design, and UX to ensure that learning technologies are effective, engaging, and empathetic to user contexts (Schmidt and Huang 2022a). Unlike traditional UX, LXD targets the affective, cognitive, and social-emotional aspects of *learning*, to help motivate and engage learners in reaching their

learning goals faster and better (Georgiou and Ioannou 2021; Quintana et al. 2020; Robinson et al. 2017).

An emergent phenomenon, LXD is broadly defined as a transdisciplinary process that aims to align the design of learning to the design of the user interface (UI), to support knowledge construction through meaningful interaction (Vann and Tawfik 2020). LXD is often used interchangeably with *pedagogical usability* which differentiates itself from traditional *usability* (Jahnke et al. 2020). While traditional usability concerns a broad range of technologies, tools and users, pedagogical usability focuses only on the *learning* technology tools, and the learners and educators as the users of the learning technology. Going further, LXD, is not merely concerned with the learning interface design, or the pragmatic aspects of the interaction (i.e. effectiveness, efficiency, satisfaction) but has an expanded scope, to address the complex needs, social aspects, and emotional impact of the interactions, as part of the user's entire experience (Chang and Kuwata 2020; Gregg et al. 2020; Tawfik et al. 2022). In effect, LXD is a 'human-centric, theoretically grounded, and socio-culturally sensitive approach to learning design, intended to propel learners towards identified learning goals, and informed by UXD methods' (Schmidt and Huang 2022).

LXD as an evolving widely recognised field, defined through three core dimensions in the literature: a) *design* dimension focused on UX in technology-rich learning contexts; b) *learning* dimension, emphasising instructional design and learning theory; and c) *standard* (or *evaluation*) dimension, concerned with assessment, analytics, and project management (Phommanee, Plangson, and Siripipattanakul 2023).

Adopting LXD is essential for EdTech researchers and designers, as it promotes *holistic* learner-centred approaches for 21st-century education. Yet, experts caution that LXD remains 'more of an ideal' rather than a fully understood phenomenon, calling for more concrete methodologies to fulfil its potential (Howles 2024; Schmidt and Huang 2022). Few efforts explicitly operationalise LXD, primarily blended with other frameworks (i.e. user-centred design) or in the context of broader objectives, like digital transformation (Howles 2024).

### 2.3. Codesign

Codesign is a collaborative design process involving stakeholders in different roles (i.e. researchers, practitioners, users) who iteratively generate a design intervention to meet the users' needs (Barbera, Garcia, and Fuertes-Alpiste 2017; McDonnell 2009; Saad-Sulonen et al. 2018). Roschelle, Penuel, and Shechtman (2006) describe pedagogy-oriented codesign as 'a highly-facilitated, team-based process in which teachers, researchers, and developers work together in defined roles to design an educational innovation (...) for addressing a concrete educational need'. Education-oriented codesign initiatives have predominantly focused on curriculum and learning design reforms (Kyza and Agesilaou 2022; Leary et al. 2016; Mäkelä et al. 2018; Wu et al. 2021), and developing new programs (Barbera, Garcia, and Fuertes-Alpiste 2017; Cober et al. 2015), with fewer initiatives targeting the design of EdTech tools (Albó and Hernández-Leo 2019; Alhumaidan, Lo, and Selby 2015; Prieto-Alvarez, Martinez-Maldonado, and Buckingham Shum 2018).

These initiatives were driven by varied objectives. For example, Barbera, Garcia, and Fuertes-Alpiste (2017) codesigned a reformed online course, in a team of researchers, teachers, and students, identified ‘the moments of change’ in the process, and explained their triggers. From a methodology perspective, Prieto-Alvarez, Martinez-Maldonado, and Buckingham Shum (2018) reported on a codesigned intervention with learners, which generated learner journey maps that were later used to involve more codesigners in the data-gathering practice. From a technology perspective, (2019) co-created an authoring tool for creating blended learning designs with a team of high-school teachers, revealing the number of cycles needed to *propel* the development, and documenting the challenges related to the diverse feedback and the participants’ time management. Alhumaidan, Lo, and Selby (2018) involved primary school children in creating an AR textbook for collaborative learning, and presented the resulting design features.

Despite the growing body of evidence on codesign, the field still lacks systematic frameworks to guide EdTech initiatives (Ambrosetti et al. 2025). While, notable attempts to frame codesign are discussed in the following section, our study draws on the ‘Staging Negotiation Spaces’ framework (Pedersen 2020), as the foundation for developing a new integrated model, discussed next.

#### 2.4. Codesign and UX models

Pedersen (2020) frames codesign through the *staging*, *negotiation*, and *reframing* spaces framework. These dimensions support investigation on what happens *before*, *during*, and *after* the main design activities. Specifically, *Staging* involves the setup of the *space* to host the codesign activities (co-activities). This requires framing and interpreting the problem, ‘inscribing’ the outcomes of this process onto *objects* (i.e. documents), and setting up the space for the *negotiation* dimension. *Negotiation* refers to the co-activities, such as the discussions, debates, networking, and mutual translations, as the transformed understandings and propositions, generated between the involved actors (codesigners) and orchestrated by the stage-director (principal designer). *Reframing* is, in essence, like *staging* but works mainly on the results of prior negotiation cycles. The framework also emphasises codesign *objects* (sketches, documents, prototypes, images, cards, apps) used as stimuli, to mediate designer negotiations, or as the outputs of the process.

In this study, we deduced that this framework could best support the objectives of our project. For example, Roschelle, Penuel, and Shechtman (2006) and Penuel, Roschelle, and Shechtman (2007) identified seven core codesign *components* in educational initiatives, offering valuable insights. However, this model does not delve into the *types of or relationships between* the design elements in the process, which can be challenging in long, multiphase, and multistakeholder projects requiring transparency in the process. L. Sanders and Stappers (2014) advanced this discussion by examining the relationships between *probes*, *generative toolkits*, and *prototypes*, focusing on the ‘*designing for*’ (users) and ‘*designing with*’ (partners) mindsets – nonetheless – without explicitly looking into how co-activities unfold across the *before*, *during*, and *after* stages of codesign.

Meanwhile, UX design which is integral to the purposes of our research, offers relevant foundations to work with. Hartson and Pyla’s (2012) UX lifecycle model organises various design activities into four iterative stages: *Analyze*, *Design*, *Prototype*, and *Evaluate*. *Analysis* entails the exploration and understanding of user contexts and

needs. *Design* concerns the generation of artefacts that model user behaviour (e.g. personas, task flows, conceptual maps). *Prototype* involves the design and development of low, medium, and high-fidelity sketches (fidelity implies similarity to the final product). *Evaluation* refers to assessing the interaction experience by using the deliverables from previous phases (i.e. wireflows, prototypes).

Similarly, other UX models aim to simplify complex design phenomena, enhance understanding, and structure the *design* and *analysis* processes. Noteworthy approaches include the Lean UX model (Gothelf 2013), a three-stage framework (*Think-Make-Check*), valued for MVP (minimum viable product) development with minimal resources and quick decision-making (Aarlien and Colomo-Palacios 2020). Garret's (Garrett 2010) 'Five planes of UX' also serves to organise design from abstract to concrete, through five distinct stages. For the purposes of our project, we selected Hartson and Pyla's (2012) UX lifecycle model, as it presented a clear and practical iterative approach, with strong attention to *evaluation* and *analysis*, as well as detailed documentation across the entire process. A full account of the rationale behind our decision can be found in parallel work (Mavri, Ioannou, and Kitsis 2025).

## 2.5. Integrated models

For the purposes of this work, we also examined frameworks that integrate theoretical and methodological characteristics from different fields to address the specific demands of EdTech interventions. For instance, in their study, Tavares, Vieira, and Pedro (2020) proposed a participatory model that merges three phases of educational design research (*preliminary research-prototyping-assessment*) with four stages from user-centred software development (*specification-design-&-development-validation-evaluation*) for the development of educational mobile applications. Their model was effectively applied in the *preliminary research* phase, to implement storytelling and drawing sessions with primary school students, helping to generate the mobile app concept. Similarly, Kucirkova (2017) introduced a *research-practice-design* model for educational app design, grounded in five core principles: *triple collaboration*, *shared epistemology*, *affordance awareness*, *social interconnectedness*, and *child-centered pedagogy*. This model aimed to foster co-creation among researchers, designers, and educators and extracted mutual benefits for all stakeholders, and further informed the *educational research* landscape.

More recently, Ogata et al. (2024) defined a six-phase ICT-driven codesign process (*motivate-pilot-implement-refine-evaluate-maintain*) for developing data-driven (analytics) EdTech. Drawing from six case studies, they demonstrated how iterated collaboration between stakeholders enhances EdTech tools, emphasising the value of codesign in merging *theory* and *practice-driven* approaches and in "bridging the gap between 'real-world education' and the researchers' perspectives" (Ogata et al. 2024). Finally, Phommanee, Plangson, and Siripattanakul (2023) derived a common pattern of a five-step process from the systematic review of LXD literature: *researching learners and goals*, *design ideas*, *prototyping*, *validity testing*, and *launch and Follow-up*, noting that LXD is rooted in design thinking and user-centred design, with particular emphasis on the *empathy* stage of design.

Collectively, these emerging efforts – amongst others (Mäkelä et al. 2018; Noorbergen et al. 2021; Prieto-Alvarez, Martinez-Maldonado, and Buckingham Shum 2018) – underscore the need for integrated frameworks that draw support from relevant areas (e.g. software development, UX design, game-based design, ICT implementation), to suit the unique requirements, characteristics and constraints of specific contexts rather than relying on a ‘one-size-fits-all’ approach (Noorbergen et al. 2021). In response, we propose an integrated model – combining codesign, UX and LXD perspectives – that is contextualised to the design of EdTech in large, multi-stakeholder and multicultural initiatives.

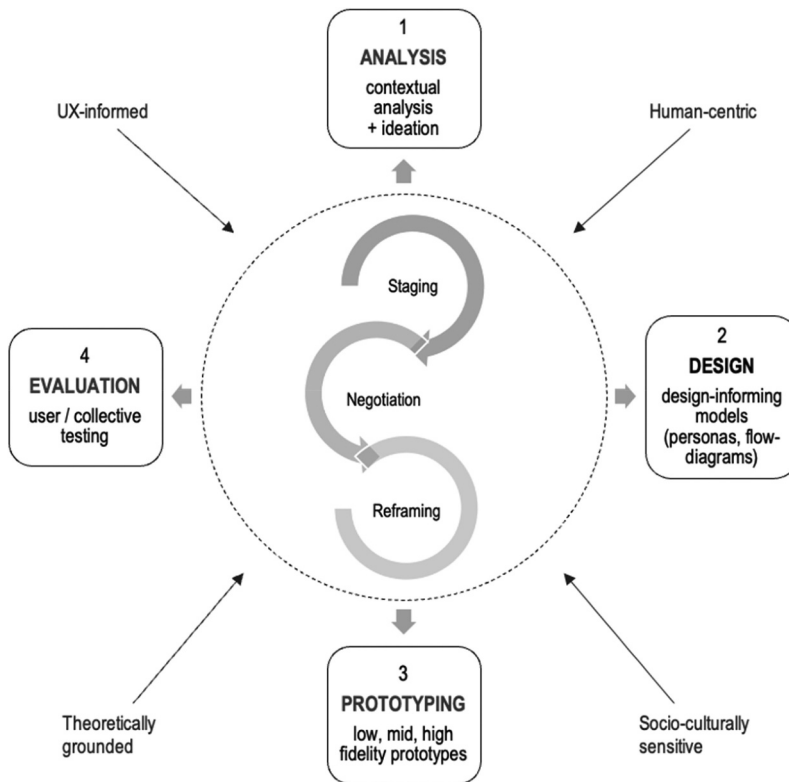
### 3. The design model of the study

From a methodological aspect, the UX lifecycle model (Section 2.4) conceptualises each UX phase as comprising internal cycles and micro-evaluations, to produce impactful outcomes (Hartson and Pyla 2012). Pedersen’s (2020) framework complements this by organising the co-activities in each cycle into three *dimensions* (*staging, negotiation, reframing*). This nested approach adds structural clarity to the objectives, boundaries, involved roles, and objects of these *internal cycles*, which can recur as many times as possible until the design outcomes are met.

The *staging* dynamic of the compound model is crucial, as it expands the role of the designer beyond creative production, to act as a ‘stage director’ in each *UX phase*, and each *codesign cycle*. This involves understanding and framing the ad-hoc *problem*, making dedicated preparations for the socio-material space to host the key ‘negotiations and translations between multiple actors’ (Pedersen 2020), and then re-framing and re-interpreting the problem, through – not only cognitive reasoning but – prior collective negotiation cycles. To do so, decisions about the stakeholders invited to participate and the specific artefacts used (or generated) in the main negotiations depend on: a) the *objectives & outcomes* of the UX phase (e.g. *Analysis*), b) the *orientation* of each internal cycle (e.g. user-driven or expert-driven), c) practical considerations like participant *availability* and *access* to tools and objects, alongside d) *organizational* or *project values* (e.g. community inclusion or sociocultural reach). Thus, this multilayered approach addresses the inherent complexity and ambiguity of multiphase and multistakeholder design cases (Bødker, Dindler, and Iversen 2017), offering three-dimensional design or analysis support. Anchored in LXD principles, the integrated model advocates for codesign that is theoretically grounded, inclusive of all human perspectives, responsive for diverse designer and user needs, and aligned with rigorous UX methodologies.

The model thus integrates: (a) the four-stage UX Lifecycle (Hartson and Pyla 2012) - *Analyze, Design, Prototype, Evaluate*; (b) the three codesign dimensions - *Staging (preparatory), Negotiation (core design), Reframing (post-analysis)* (Pedersen 2020), and (c) an LXD Lens (Schmidt and Huang 2022) which emphasizes *human-centred, theory-driven, socioculturally sensitive, and UX-informed* learning design. These components comprise different *activities, roles, tools, and design objects*. The model can be used both for prospective planning and/or retrospective analysis (Figure 1).

A supporting guide aims to enhance transparency and facilitate transferability across design cases (Table 1). This outlines *what* happens (activities), *who* is involved (roles), and *what* artefacts are used, under each *UX phase* and *codesign dimension*,



**Figure 1.** Integrated model: collaborative activity across UX phases, codesign dimensions & LX design perspectives.

demonstrating the interplay between these *elements*, across the ‘*frontstage*’, ‘*onstage*’, and ‘*backstage*’ stages. It aims to help others working on similar incentives understand how to shape or analyse their codesign negotiations, based on context-relevant *activities* (intended/performed), and *objects* (mediating/expected/produced). It can also be adapted to a varied degree of modelling detail – as demonstrated in [Appendix A](#) (Tables A1–A4), to ensure inclusion of all codesign elements.

## 4. Methods

### 4.1. The design case approach

Unlike traditional scientific research approaches, design cases focus on providing a design precedent based on the subjective, situated true and real experience of the designer(s)-author(s), reflecting their unique insights (Nelson and Stolterman 2014). While theory may be used to explain findings, the designer’s reflections, reasoned judgements and speculations constitute equally, if not more, reliable evidence to justify the design case (Moore et al. 2023). Thus, instead of adhering to systematic and objective research standards, design cases intend to maintain closeness between the design and its designer(s) by allowing their own perspectives to be heard in a more direct voice (Gray

**Table 1.** Model guide integrating UX phases, codesign dimensions, & LXD principles.

UX phase	CoDesign dimensions		
	Stage (prepare)	Negotiate	Reframe
Analysis: <i>Objective: Theoretical &amp; Contextual Inquiry</i>	<i>Activities:</i> run user/contextual & theoretical research: literature review, existing solutions/ technologies, document useful features, gaps, benchmarking, plan session/data protocol <i>Roles:</i> researchers, design leads, domain experts <i>Objects:</i> research findings, initial requirements, negotiation session protocols	<i>Activities:</i> facilitate shared sessions, gather multi-stakeholder insights on findings (workshops, interviews, focus-groups) <i>Roles:</i> all stakeholders* <i>Objects:</i> idea boards, interview notes, needs list	<i>Activities:</i> analyse findings, synthesize needs, refine problem definition, develop pedagogical foundations <i>Roles:</i> researchers, design leads, domain experts <i>Objects:</i> needs analysis summary, design requirement definitions, pedagogical framework reports
Design	<i>Activities:</i> develop initial design concepts to characterize users/ use scenarios, plan session/ data protocol <i>Roles:</i> UX/UI designers, researchers/technologists, domain experts <i>Objects:</i> design informing models (personas, user journeys, storyboards, scripts)	<i>Activities:</i> run codesign review session(s) to evaluate models & gather feedback <i>Roles:</i> all stakeholders* <i>Objects:</i> design artifacts annotated with feedback, session observation notes	<i>Activities:</i> integrate feedback & finalize design specifications & models <i>Roles:</i> researchers, UX/UI, design leads, designers, domain experts <i>Objects:</i> revised design specifications & models, agreed tool feature set
Prototype	<i>Activities:</i> produce prototypes, plan tests, demo scenarios, plan session/data protocol <i>Roles:</i> UX/UI designers, developers <i>Objects:</i> low-mid fidelity prototypes, testing plans	<i>Activities:</i> test prototypes & gather feedback (demo sessions, UX testing) <i>Roles:</i> all stakeholders*, end-users <i>Objects:</i> draft usability reports, issues list, feedback	<i>Activities:</i> refine prototypes, iterate design & functionality <i>Roles:</i> design leads, designers, developers, domain experts <i>Objects:</i> revised high-fidelity prototypes, iteration reports
Evaluate	<i>Activities:</i> stage final evaluations, prepare instruments, plan protocols <i>Roles:</i> UX/UI designers, researchers <i>Objects:</i> evaluation protocols, demo materials (i.e. prototypes, videos, shared boards)	<i>Activities:</i> conduct evaluation sessions (field tests, interviews, surveys, observation) <i>Roles:</i> all stakeholders*, end-users <i>Objects:</i> evaluation data (interview transcripts, survey submissions, observations, feedback, usage logs, recordings)	<i>Activities:</i> analyse data, conclude design outcomes, create guide for development <i>Roles:</i> UX/UI designers, design leads, designers, developers, domain experts <i>Objects:</i> final design prototypes, handover documentation
LXD	<p><i>Theoretically grounded:</i> Ground the tool design in established learning theories, pedagogical frameworks and principles.</p> <p><i>Human-centred:</i> Involve interdisciplinary expertise with minimum representation from education, design &amp; engineering. Understand the use context, test with end-users, use agile <i>test-redesign</i> process.</p> <p><i>Socio-culturally sensitive:</i> Incorporate multiple perspectives, practices, diverse learner contexts, limit bias, adaptable outputs, avoid <i>one-size-fits-all</i> solutions</p> <p><i>UX-informed:</i> Apply user research techniques, UX design methods, employ iterative macro/micro evaluations, aim to gather rich insights.</p>		

\*All stakeholders: educators, researchers, technologists, practitioners, (UX/UI) designers, developers, domain experts.

2020). This presupposes that the designer's role in the design is explicitly stated, as an indicator of rigour of the study (Smith 2010).

In this study, the case was authored by two UX/UI and two EDT members (UX-EDT: 4 members) of the project (Table 2). The lead author, a UX/UI designer, a Designer academic and educational researcher, shares similar credentials with another team member. The other two members brought expertise from the educational research and LXD areas. All members were actively involved in the first intellectual output, and less in the evaluation outputs of the project (*Assessment and UX-UI design*).

The study has ethical clearance for the IRB (ethics/bioethics committee) of Cyprus.

## 4.2. Participants in the design process

Twenty-nine participants from four European countries contributed, including: UX/UI designers, educational researchers, software developers, Makerspace practitioners (Table 2). This represents a sample of convenience, since participants were selected due to their involvement as European partners. While the entire team includes all 29 members, the *core* team refers to a group of seven experts who actively steered and managed the codesign process, comprising project management members and representation from all areas of expertise and countries. Yet, all members of the entire team were invited to participate in the main negotiation activities across all project phases.

## 4.3. Data collection

We adopted an exploratory approach to document the codesign process using multiple methods (Table 3), including semi-structured interviews with educators (cycle 1 and cycle 2), observations and field notes from design thinking workshops and team sessions, analysed inductively (Chi 1997). We also classified digital design artefacts – texts, personas, learner journeys, wireframes, charts, prototypes, notes, feedback logs – by *phase* as illustrated in Table 3. To structure the analysis, all data were examined through the proposed model.

**Table 2.** Participants in the design process.

Team	Members	Core team members	Roles/Activities	Organizations	Gender	
					F	M
DEV	4	1	Engr team: Engineering, software development	University & research centre	–	4
UX-UI	5	2	UI/UX team: UX-UI research & design	University & research centre	3	2
EDT	7	2	EdTech team: Educational research, educational technology, education	Educational technology research labs, K12 & Higher education	5	2
MS	10	–	Maker team: Maker learning practitioners: teaching, facilitation & practice	Private, public K12, university-based makerspaces, FabLabs	5	5
PM	3	2	Management team: Project management & coordination	University & research centre	1	2

**Table 3.** Data collection methods and objects by phase.

Phase	Codesign activities objects	Qty	Sessions
<i>Analysis</i>	Design Thinking Workshop sticky notes (Figure 2a)	213	3
	Interviews cycle 1	10,716 words/ 55 codes	5
<i>Design</i>	Miro board wireframes/Design informing models level 1 (e.g. Figure 2c)	59	6
<i>Prototyping</i>	Miro board feedback sticky notes (e.g. Figure 2b)	52	-
	Miro board mid + high fidelity prototypes	30	5
	Design informing models level 2 (e.g. Figure 2c)		
<i>Prototyping/ Evaluation</i>	Miro board feedback sticky notes (e.g. Figure 2b)	16	-
	Flows of learner's journey (Figure 2d)	3	2
	Interviews cycle 2	10,334 words/ 59 codes	6
	Adobe XD interactive high-fidelity prototypes (Figure 2d)	179	7
<i>Evaluation General</i>	Adobe XD feedback comments (Figure 2e)	75	-
	Team sessions	-	10

#### 4.4. Data analysis

All data were organised by UX phase and codesign dimension using the model. Thematic analysis was applied to identify recurring themes, role dynamics, and critical design incidents.

## 5. Results

### 5.1. Phase 1: analyse

Educators and researchers defined key 21st-century skills through interviews and literature review. Workshops facilitated shared understanding of learner contexts. A semantic conflict emerged over the term 'life skills', prompting a reframing discussion using Greenstein (2012) and Bloom's (1956). Phase 1 (Appendix A: Table A1) included the following activities:

*Review of the literature (staging).* The EdTech and UI/UX teams conducted a thorough review of the literature on 21st-century skills, exploring their role and development in maker education, their key dimensions for self-reflection and assessment, alongside gamification theories.

*Exploration and consideration of existing tools (staging).* team studied similar technology tools to become familiar and adopt/adapt useful features or rethink elements that posed challenges.

*Design-thinking workshops (negotiation space & reframe 1).* The core team organised three design thinking workshops (approx. nine participants each), allowing ample time for the contribution of each participant to discuss maker-specific 21<sup>st</sup>-century skills.

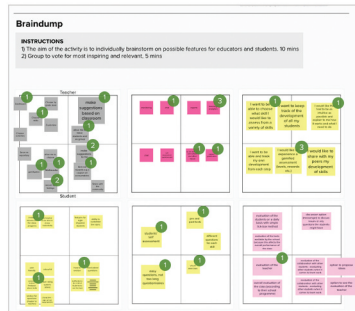
*Group and one-to-one Interviews – cycle 1 (negotiation space & reframe 2)*

The core team conducted five one-to-one and group interviews with 13 makerspace-associated designers (individuals and small groups) to gather detailed information on

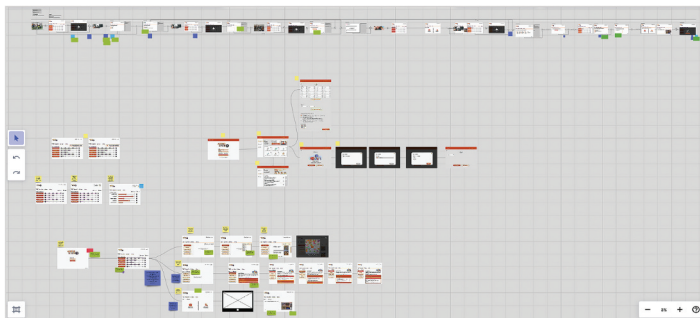
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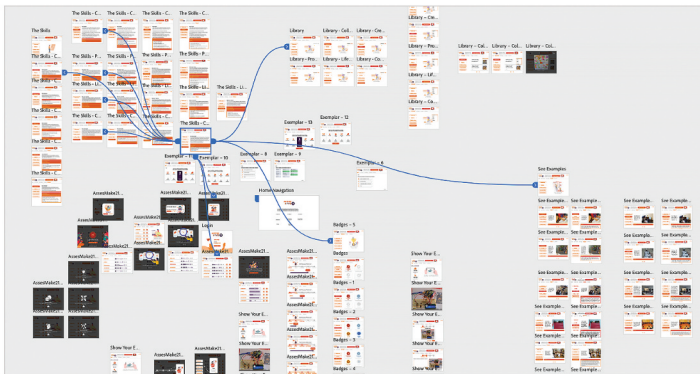
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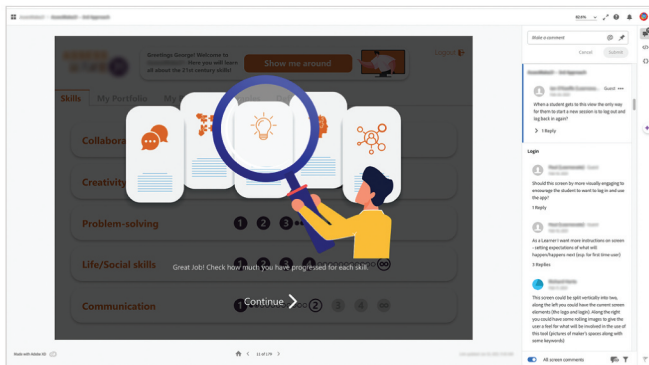
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**Figure 2.** (a) Design thinking board examples, (b) sticky-notes comment threads in Miro, (c) Miro board mid + high fidelity prototypes, (d) interactive high-fidelity prototypes on Adobe XD platform, (e) example of comments on high-fidelity a prototype screen.

their distinct makerspace settings and experiences, as well as their insights on 21<sup>st</sup>-century skills use and assessment.

## **5.2. Analysis (reframe)**

Following the above, the core team worked collectively to align insights, create a common understanding of the ‘problem’, analyse the teaching and learning needs, convert these into tangible UX design specifications. The core team identified knowledge gaps and decided to actively involve more educators in this process to support the: a) operationalisation of the key 21st-century skills in the tool, b) customisation of the tool and key requirements needed to address the diverse cultural, instructional, technological, and social contexts of different makerspaces, d) discovery of innovative approaches (in terms of gamification) to engage and sustain learner engagement with the tool. An overarching set of five interaction design, three functional, and four phenomenological specifications were generated through this process (Mavri, Ioannou, and Kitsis 2025).

## **5.3. Phase 2: design**

The team created learner personas, journey maps, and scripts for gamified reflection tasks (Appendix A: Table A2). These were aligned with pedagogical objectives such as scaffolding and progressive complexity as elaborated in Miliou et al. (2023). In sum, the UX-EDT team worked on producing:

*Personas*: hypothetical – yet – specific profile descriptions of potential users drawing from collected data, with the aim to design for ‘real people’ and understand their personality, preferences, aims, and limitations in relation to the tool’s behaviour.

*Hierarchical task flows*: diagrammatic flows of the user’s activities, tasks, decision points, and rewards supplemented by low fidelity wireframes.

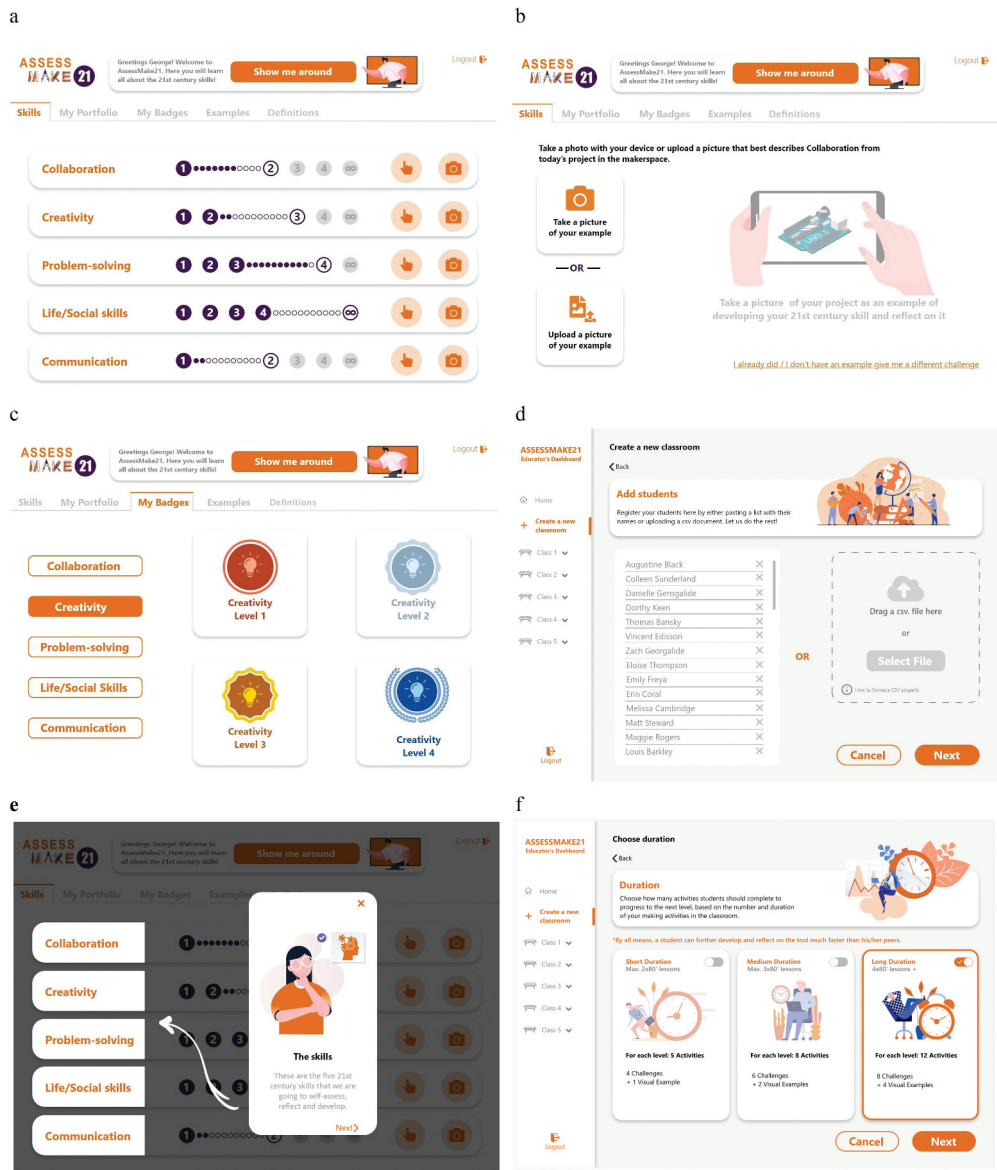
*Learner’s journey*: narrative of the user activities, tasks, decision points, and rewards drawing from Bloom’s (1956) revised taxonomy and gamification techniques, based on the pedagogical framework that underpins the tool’s design as described in Miliou et al. (2023).

*Learner’s journey script*: the (text) content for each task, challenge, and reward in the learner’s journey.

*Initial sketches and wireflows*: a visual combination of diagrammatic flows combined with UI-design sketches to help orient the participants

## **5.4. Phase 3: prototype**

The UX-EDT team members developed low, mid, and high-fidelity prototypes using tools like Figma and Miro (Appendix A: Table A3). Several iterative feedback loops included both live reviews and asynchronous annotations. Prototypes were adapted based on the entire team’s and particularly the educators’ input (e.g. visual clarity, flexibility of feedback mechanisms). Several concerns and decisions were made on topics that concerned the orientation of the user in the tool’s concept and interface, prior to its use, communicating the definition of each skill with clarity, the various levels and tasks of self-assessment, the rewards, and the need for different usage (i.e. durations) modes (Figure 3).



**Figure 3.** (a) Student's dashboard page, (b) picture-taking page, (c) Student's badges overview, (d) multiple classes, class list file import, & creation of login codes, (e) Student's badges overview, (f) duration (short/medium/long).

### 5.5. Phase 4: evaluate

Evaluation activities included usability testing, educator interviews, and expert reviews (Appendix A: Table A4). The feedback emphasised the need for adaptable language, scaffolded reflection prompts, and customisable learning paths. These insights were integrated into the final prototype designs. The negotiation activities were hosted in Miro, Adobe XD and Google Drive platforms, to steer discussions, collect feedback and,

respectively, inscribe the results back into the deliverables. The core team navigated the mid and high-fidelity prototypes, as well as the *learner's journey*, across several evaluative synchronous and asynchronous iterations involving demos, problem reframing, and resolutions. Features that needed revisiting concerned the user's onboarding tour, open-ended learner reflections, the level-ascending rewards system, customised teaching-learning approaches, and graphical visualisations for quick progress monitoring.

### 5.6. The EdTech tool

The resulting EdTech tool is a web-based digital tool designed for students' self-assessment of 21st-century skills in maker education. The tool features a 'definitions' section that provides students with both conceptual ('what') and functional ('how') information of the skills to be assessed, alongside practical examples of their self-assessment. The definitions and skills are based on well-established 21st-century skills frameworks such as the P21 (*P21 Resources | 21st Century Learning Resources 2024*) and include five key skills involved in making: collaboration, creativity, problem-solving, life/social skills and communication (Ioannou et al. 2024).

To invite and sustain student engagement in reflection and self-assessment, the tool includes gamification elements like *challenges*, *level progression*, *badges*, and visual feedback (e.g. thumbs-up). Students are encouraged to self-reflect on the skills used during their making activities, by 'tagging' them in the tool, prompting a series of challenges as a result. For instance, a challenge might involve a multiple-choice question of the creation of a 'visual portfolio', where students upload photos of their work and explain how the tagged skill helped them achieve this. As students complete these challenges and advance through levels, they can request 'badges' from their educator.

Educators manage this process through a dashboard, allowing them to set up classrooms, generate login codes, and select one of three use approaches for students: (i) Parallel tagging during activities, (ii) 'tagging' during activities while completing challenges at the end of session, or (iii) 'tagging' and completing challenges, both at the end of session. The dashboard also provides a comprehensive overview of the individual or group progress, including visual representations of the data. Extensive reporting on the tool's design is discussed in parallel publications (Mavri, Ioannou, and Kitsis 2025), see Figure 3 (a-f) for screenshots from the digital tool.

## 6. Discussion

This work proposes a model to support the process of learning experience design for EdTech tools. The tool examined in this study aimed to foster learner reflection on 21st-century skills development within maker education environments. The key research aim was to define the *key aspects of a model-based codesign process that enable effective learning experience design for an Edtech tool*.

Our design initiative addressed a complex and multi-faceted ecosystem, across formal and informal K12 makerspaces in four European countries, involving the structured five-month collaboration of a multidisciplinary set of stakeholders. The diversity of pedagogical practices, cultural contexts, and stakeholder perspectives warranted a more targeted model, over a generalised high-level alternative. This aligns with research arguing that

codesign still ‘lacks structured methodologies and theoretical grounding’ (Ambrosetti et al. 2025) that would benefit from *integration* with complementary frameworks and typologies (Mäkelä and Leinonen 2021), as well as *contextualization* to the specific foundations, disciplinary scope, socio-cultural dynamics, and practical conditions of each design initiative, to effectively work in practice (Carlos et al. 2024; Noorbergen et al. 2021).

In response, this study produced a tailored model situated to our case and similar initiatives – one that: a) emphasises the *design* dimension of LXD practice, focussing on the learner’s experience in *technology-rich* contexts, like makerspaces Phommanee, Plangson, and Siripipattanakul (2023); b) prioritises *UX design*, over full implementation-centric approaches, like software development; c) centres on *empathy* and understanding of user needs across every *phase* and *activity*; and d) addresses the inherent complexity of long *multicultural* and *multistakeholder* projects (Bødker, Dindler, and Iversen 2017), requiring, both transparency and structured guidance, alongside sensitivity for the socio-cultural diversity of the codesigners and the end users alike (Schmidt and Huang 2022).

The resulting model integrated Pedersen’s (2020) three-dimensional model (*Staging-Negotiation-Reframing*), into Hartson and Pyla’s (2012) UX phase model (*Analyse-Design-Prototype-Evaluate*), guided by the four LXD perspectives (Human-centric-Theoretically-grounded-Socio-culturally sensitive-UX-informed) (Schmidt and Huang 2022). The model aims to support others in similar initiatives through practical proactive and reactive steps to create spaces that facilitate meaningful negotiations to advance the design forward.

The contribution of our model lies in the way that it complements and extends the frameworks reviewed in this paper (section 2.5). While integrative, human-centred and learning-oriented, these often presented different design orientations (e.g. software implementation, learning analytics, digital transformation) (Ogata et al. 2024; Tavares, Vieira, and Pedro 2020), provided *high-level* recommendations with limited practical guidance (Kucirkova 2017), and were not explicitly oriented towards *LXD* or codesign approaches (Phommanee, Plangson, and Siripipattanakul 2023). Importantly, they overlooked key *codesign dimensions* which account for the *pre-stage* preparations, *on-stage* negotiations (hosting and facilitating), and *post-stage* reframing (reconceptualising outcomes) (Pedersen 2020). Moreover, while stakeholder *roles* were considered, they did not clearly map their relationships to the *objects* involved in the process.

The proposed model offers a targeted approach to LXD that explicitly incorporates codesign *dimensions*, *roles* and *object* relationships, across all phases and activities of the design process, alongside practical guidance from its implementation. Our findings are elaborated in the form of practical implications that can benefit other researchers and practitioners engaged in similar projects, offering a structured approach to the design of EdTech tools.

### 6.1. Process transparency

Our model allowed transitions across phases and design dimensions. It supported tracking of *decisions*, *artifacts* (objects), and participant *roles* and helped structure what is often an ambiguous, non-linear process (Bødker, Dindler, and Iversen

2017). To illustrate this, we take *Phase 1. Analysis* as an example, where the *staging* dimension concerned our need to gain basic contextual understanding of the problem (*21<sup>st</sup>-century skills in maker education*) and transfer (inscription) our collective interpretations onto various *objects* that would be required next (*literature review report, workshop and interview protocols*). In turn, these prepared the *staged spaces* for facilitating the upcoming *negotiations* with the *core* or *entire* team (design-thinking workshops, interviews). In these spaces, the negotiations of such a diverse socio-disciplinary team were definitive in uncovering underlying issues, as in ‘the problem behind the problem’ (Pedersen 2020); these being, the highly divergent making contexts and learning conditions, and the lack of clarity on 21<sup>st</sup>-century skills assessment, as perceived by teachers. This led us to *reframe* our perceptions of the *problem* and transfer new propositions onto *objects* that were to be used in the subsequent phases, to move the design forward.

We would argue that the effectiveness of codesign initiatives lies equally in the *before* and *after* activities. Consistent with Pedersen (2020), a well-coordinated sequence of *proactive* and *reactive* steps carried out by different roles, ‘moulding the outcomes through [their] different perspectives’ can help stage and safeguard conducive spaces for *negotiations* that eventually make definitive design advancements.

## 6.2. Role fluidity

In agreement with Leary et al. (2016), we observed that codesigners contributed to the process in ways that went beyond their roles and expertise. For example, the educational experts’ role in communicating the key learning practices, needs and skills-development in STEM subjects was fundamental. They assisted the core team in defining and operationalising the important maker-relevant 21st-century skills. Likewise, the UX experts played a crucial role in the contextual inquiry and the creation of UX design specifications in the Analysis phase.

Nonetheless, drawing on theoretical knowledge and empirical insights, the *educators’* contribution was valuable for UX outcomes, as they helped confirm or reject design decisions in ways that minimised prior uncertainty, putting ‘assumptions on the side’ (Cober et al. 2015; McDonnell 2009). At the same time, software engineers worked closely with UX experts and educators to collectively evaluate requirements, convert them into *functional* specifications, and confirm their practicability (Penuel, Roschelle, and Shechtman 2007). Their support also extended to LXD matters, drawing on prior experiences with EdTech development. These roles and their cross-boundary exchanges were thus definitive for design progress.

This finding agrees with literature suggesting that the codesigners’ input often emerges from individual ‘matters of concern’ and context-specific dynamics (Pedersen 2020). While defined roles are important (Penuel, Roschelle, and Shechtman 2007), we also recognise the value of ‘hat-changing’ moments, especially in diverse settings, where ‘the situatedness of the negotiations’ (Pedersen 2020) drives richer, more responsive design outcomes.

### 6.3. Inclusive spaces

In our codesign initiative, the aim was to stage ‘fertile’ discursive spaces for negotiation. Supporting a diverse team of designers with varying perspectives, intentions, and experience was important. A sense of *inclusion* and *ownership* in the process is critical in shaping *negotiations* - especially in computer-supported settings - which are highly influenced by socio-affective dynamics (Bandura, Freeman, and Lightsey 1999). In this study, we staged healthy ‘socio-technical’ spaces with tools like Miro and Adobe XD, to foster inclusive and active participation by everyone. In Miro, participants could follow collective design presentations, explore boards independently, leave comments on objects (translations), and create or modify content (inscriptions). This enabled both *macro* (overview) and *micro* (detailed) *negotiations*, with shared artefacts serving as *intermediary objects* in the process.

The core design team also approached *time* with sensitivity to individual needs, aiming to foster inclusion and balanced participation (Farnsworth, Kleanthous, and Wenger-Trayner 2016). While synchronous sessions had obvious merits, they could also limit reflective practice due to time constraints and group dynamics. Codesigners often asked for ‘more time’ to review design outputs at their own time and pace, prompting a few asynchronous feedback rounds. These generated rich insights (Figure 2) via sticky notes, discussion threads and shared documents. This experience underscored the importance of autonomous and inclusive participation in codesign, across both - synchronous and asynchronous modes, to ‘support the flexibility and continuity of communication’ (Cober et al. 2015) throughout the design process.

### 6.4. Evolution of design objects

In this study, we followed the proposed model (Figure 1) which emphasises *iterative* design, a core feature of HCI, human-centred and participatory design processes (Fu and Lin 2014). As previously noted, different project phases call for different *types* and *frequencies* of iterative design, being also influenced by the *objects* involved (Saad-Sulonen et al. 2018). Specifically, in our early shared sessions, co-activities were more experimental and fluid, often triggering unplanned adjustments (*re-staging*), like brainstorming and sketching. Entire team sessions (*staging*) were also less frequent, to allow smaller teams time to understand the problem first and plan accordingly.

We also observed the evolving and interconnected role of *objects* across *phases*. Agreeing with Cober et al. (2015), we found that early-phase materials (i.e. introductory videos, workshop cards, sticky notes) were used as ‘props’ for generating creative discussions and decision making. These became more concrete as the project progressed (Figure 3). For instance, the development of the learner’s journey, its contents, the wireflows, and high-fidelity prototypes required more structured *stage-negotiate-reframe* cycles and systematic reviewing, evaluation, and adjustments as they concerned the project’s final deliverables (McDonnell 2009). Ultimately, all *objects* - ranging from borrowed references to solid project outcomes - and their interplay *across* and *within* design iterations, played a crucial role in shaping the codesign process, as they gained specificity over time and drove more conclusive negotiations towards the end (Pedersen 2020).

## 6.5. Linking research and practice

The design process in this study bridges research and practice divides. It builds directly on prior work, namely by combining directions from Bloom's (1956) revised taxonomy and gamification techniques, as outlined in Miliou et al. (2023) and enabled their enactment through a repeatable design process. These pedagogical foundations were contributed by EdTech experts and Maker education experts. The educational members informed the design with pedagogical and technology-enhanced learning insights, while makerspace practitioners provided contextual evidence – ranging from instructional and technological setup to social dynamics – across diverse makerspace environments. They also offered critical insights on the cultivation and assessment of 21st-century skills in maker education. Guided by the proposed model, this resulted in a truly integrated process, blending iterative cocreation, with research-driven and evidence-based pedagogical contributions, addressing known gaps in the development of EdTech solutions (Feldstein 2016; Howles 2024; Schmidt and Huang 2022).

### 6.5.1. Limitations

The study presents limitations that must be acknowledged. Firstly, learners did not participate in the initial phase of this work (tool UX design). Rather, their perspectives were represented through their educators and makerspace facilitators at the time. However, learners became actively involved in the evaluation phase (Pilots and Evaluation) (Miliou et al. 2023).

Additionally, this study – as part of a larger body of work – takes a horizontal approach to the codesign process, emphasising the *procedural*, rather than the conceptual or pedagogical dimensions of the design, which the authors plan to present in a parallel publication. It is important to note that the current study is driven by an emergent research methodology in the field of educational technology, the Design Case, which focuses on documenting the creation process through the designer's (or design team's) perspective, versus knowledge derived and discussed from a 'strongly held theoretical bases'. As such the work's trustworthiness is judged based on criteria that are different to those in traditional social science research, such as, transparency in reporting, writing style, indicating the designer's point of view, rich representations and descriptions of the design, data triangulation, and the breadth and scope of the case (Gray 2020; Smith 2010). It is nonetheless understood that design cases are not expected to meet all criteria fully.

## 7. Conclusion

This study contributes a structured model that can support the process of learning experience design (LXD) for EdTech tools. By aligning UX and codesign approaches through an LXD perspective, the model scaffolds collaborative activity across *phases, dimensions, roles, and objects*. It provides both the necessary conceptual clarity and practical direction, drawing on empirical evidence from its enactment in a real-world project, as warranted by gaps in the literature. The study addresses limitations in existing design practice, offering a pathway for inclusive, research-informed EdTech

development. Future work may explore the model's use in other contexts and applications in EdTech tool design.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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## Appendix A

**Table A1.** Phase 1 – analysis: dimensions, activities, goals, decisions, participants, objects and tools.

Phase 1: Analysis		
Stage	Negotiate	Reframe
[UX-EDT] <ul style="list-style-type: none"> <li>Review related frameworks for 21st cent. Skills, Maker education, reflection, self-assessment, gamification</li> </ul>	[CT] <ul style="list-style-type: none"> <li>Discuss literature findings</li> <li>Detect conceptualisations + perceived dimensions of 21st-cent. skills</li> </ul>	[CT] <ul style="list-style-type: none"> <li>Define key 21st-cent. skills + dimensions for Maker education + possible ways of reflection, self-assessment</li> </ul>
[UX-EDT] <ul style="list-style-type: none"> <li>Explore and consider existing relevant tools</li> </ul>	[CT] <ul style="list-style-type: none"> <li>Brainstorm on tool features to consider or avoid</li> </ul>	[UX-EDT] <ul style="list-style-type: none"> <li>Define tool features to adapt to match MS contexts + learner ages:12–18</li> <li>Identify UX design specifications (interaction, functional, phenomenological) <i>Further evidence needed</i></li> </ul>
[UX-EDT] <ul style="list-style-type: none"> <li>Prepare Design-thinking (DT) workshops: protocol + materials</li> </ul>	[ET] 3 ×DT workshops <ul style="list-style-type: none"> <li>Extract information on learning spaces, teaching approaches, access to tools, and sessions</li> <li>Brainstorm + elicit insights on relevant 21st-cent. skills + assessment methods in makerspace (MS) contexts</li> </ul>	[CT] <ul style="list-style-type: none"> <li>Analyse + define teaching + learning needs</li> <li>Analyse initial 21st-cent. skills perceptions + assessment <i>Further evidence needed</i></li> </ul>
[UX-EDT] <ul style="list-style-type: none"> <li>Prepare one-to-one + group interviews – cycle 1:</li> </ul>	[ET] 5 ×interview sessions <ul style="list-style-type: none"> <li>One-to-one/group interviews (cycle 1)</li> <li>extract contextual MS needs</li> <li>detect 21<sup>st</sup>-cent. skills frequently developed in MS education</li> <li>discuss assessment/self-reflection methods</li> </ul>	[UX-EDT + CT] <ul style="list-style-type: none"> <li>Define key MS-related 21st-century skills + dimensions</li> <li>Situate design requirements to suggested MS environments, instructional, technological + other characteristics and proposed assessment/self-reflection methods</li> </ul>
Objects & Tools Journal articles & books, 21st-century skills software tool, DT protocol, interviews protocol, questions list	Video presentation, question cards, brainstorming boards, post it notes	Literature review summary, needs analysis list, diagrams, UX design specifications report
Miro, MS Teams, Google Drive		
Teams:UX-EDT: UX-UI and educational research & technology, CT: core team, ET: entire team.		

**Table A2.** Phase 2 – design: dimensions, activities, goals, decisions, participants, objects and tools.

Phase 2: Design		
Stage	Negotiate	Reframe
[UX-EDT]	[ET]	[CT]
<ul style="list-style-type: none"> <li>• Draft personas</li> <li>• Draft hierarchical task flows</li> <li>• Draft learner's journey</li> <li>• Compose learner's journey scripts</li> </ul>	<ul style="list-style-type: none"> <li>• Synchronous/asynchronous Iterated reviews + discussions on design informing models (level 1)</li> <li>• Review learner's journey script</li> <li>• Record decisions, propositions, + changes</li> </ul>	<ul style="list-style-type: none"> <li>• Inform personas + hierarchical task flows to be used as the basis for sketches, wireflows + consider development team handover requirements</li> <li>• Consolidate reviews for learner's journey + scripts, inform deliverables <i>Further review needed</i></li> </ul>
[UX-EDT]	[ET]	[UX-EDT]
<ul style="list-style-type: none"> <li>• Sketches, initial wireflows</li> </ul>	<ul style="list-style-type: none"> <li>• Iterated reviews, discussions + hands-on co-creation of sketches + wireflows</li> </ul>	<ul style="list-style-type: none"> <li>• Inform sketches + wireflows as the basis of following phase activities <i>Further review needed</i></li> </ul>
Objects & Tools		
Design informing models (level 1): Flow charts, personas, sketches	Design informing models (level 1): Personas cards, PowerPoint presentation, diagrammatic drawings + written content for learner's journey	Final set of consolidated personas, flow charts, revised learner's journey + written scripts report
Miro, MS Teams, Google Drive		
Teams:UX-EDT: UX-UI and educational research & technology, CT: core team, ET: entire team.		

**Table A3.** Phase 3 – Prototype: dimensions, activities, goals, decisions, participants, objects and tools.

Phase 3: Prototype		
Stage	Negotiate	Reframe
[UX-EDT]	[ET]	[CT]
<ul style="list-style-type: none"> <li>• Create mid + high-fidelity prototypes</li> <li>• Convert to interactive simulations</li> <li>• Set-up asynchronous feedback (negotiation) platform + content</li> </ul>	<ul style="list-style-type: none"> <li>• Iterated reviews + discussions + feedback on mid, high + interactive prototypes</li> <li>• Extract changes + propositions</li> <li>• Provide guidance for using Adobe XD platform for feedback</li> </ul>	<ul style="list-style-type: none"> <li>• Revise + finalise mid, high- fidelity + interactive prototypes <i>Further evaluation needed</i></li> </ul>
[UX-EDT]	[ET]	[CT]
<ul style="list-style-type: none"> <li>• Prepare learner's journey for final revisions</li> </ul>	<ul style="list-style-type: none"> <li>• Revisions of learner's journey scripts</li> </ul>	<ul style="list-style-type: none"> <li>• Consolidate reviews + finalise learner's journey + written scripts</li> </ul>
Objects & Tools		
Design informing models (levels 2,3): page design system, detailed UX-UI design layout, information architecture and behaviour	Design informing models (levels 2,3): mid, high-fidelity, interactive prototypes	Evaluation-ready for entire-team high-fidelity + interactive prototypes, learner's journey + scripts documents.
Miro, Adobe XD platform, MS Teams, Google Drive		
Teams:UX-EDT: UX-UI and educational research & technology, CT: core team, ET: entire team.		

**Table A4.** Phase 4 – evaluation: dimensions, activities, goals, decisions, participants, objects and tools.

Phase 4: Evaluation		
Stage	Negotiate	Reframe
[UX-EDT] <ul style="list-style-type: none"> <li>Identify most important tool elements to include in video presentation</li> <li>Create walk-through video</li> </ul>	[ET] <ul style="list-style-type: none"> <li>Present walkthrough video</li> </ul>	[UX-EDT] <ul style="list-style-type: none"> <li>Analyse results, integrate into high-fidelity prototypes + new educator's platform section + revise tool</li> <li>Document final learner's journey scripts</li> </ul>
[UX-EDT] <ul style="list-style-type: none"> <li>Prepare one-to-one + group interviews – cycle 2:</li> <li>Discuss requirements for handover to software development team</li> </ul>	[ET] 6 × interview sessions <ul style="list-style-type: none"> <li>One-to-one/group interviews (cycle 2)</li> <li>Elicit qualitative views on positive/negative tool features</li> <li>Collect propositions for <i>educator's dashboard</i></li> </ul>	[CT] <ul style="list-style-type: none"> <li>Consolidate all materials for software development team handover</li> <li>Preparation of detailed documentation + reports</li> </ul>
<b>Objects &amp; Tools</b> Interviews protocol, questions list, walkthrough video	Video, questions cards, learner's journey scripts documents	Design system (colour, layout, typography specifications), graphics + illustrations + general guidelines for software development team, final reports
Miro, Adobe XD platform, MS Teams, Google Drive		
Teams:UX-EDT: UX-UI and educational research & technology, CT: core team, ET: entire team.		