

Prototyping and Experiential Knowledge

UNFOLDING SHIFTING VIEWS ON THE USE OF PROTOTYPES
IN DESIGN RESEARCH

Edited by

Nithikul Nimkulrat, Silvia D. Ferraris, and Francesca Mattioli

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Contents

- 7 **Foreword**
Pieter Jan Stappers
- 13 **Transitioning from abstractness to concreteness
through prototyping**
Silvia D. Ferraris, Nithikul Nimkulrat
- Part 1**
 Envisioning through prototypes
- 33 **1. Beyond prototyping: demonstrators, provotypes,
and the narrative turn in design research**
Aleksandra Sviridova, Jouke Verlinden
- 49 **2. Deliberately abstract: the tactics of low-fidelity
prototyping**
Paula L. Schuster, Rolf Brändle
- 75 **3. Prototyping collaboration: managing collaborative
projects in design education**
Martina Labarta Labrador, Francesca Mattioli
- Part 2**
 Exploring through prototypes
- 97 **4. Graft-games: investigative prototypes for the
cumulative exploration of similarities between craft
and the play of videogames**
Gemma Potter
- 115 **5. Experiential substance: tactile translations using
digital materials**
Elizabeth Meiklejohn, Felicita Devlin, Caroline Silverman,
Dani Epstein, Yue Xu, Joy Ko

135	6. Slow prototyping in biodesign: designing with the living in hybrid laboratories Francesco Cianfano, Tommaso Celli, Marco Marseglia, Valentina Rognoli
	Part 3 Comprehending through prototypes
157	7. Turning abstract data concrete: drawing and tinkering with data Ayşe Özge Ağça, Jacob Buur
177	8. Hands-on thinking: prototyping as a pathway to theoretical understanding Sisse Schaldemose
193	9. Prototyping-as-debate: exploring the situated nature of politics in design Rose Dumesny, Dorian Reunkrilerk
	Part 4 Developing the design process through prototyping
215	10. Rethinking assistive technologies through hybrid manufacturing: a case study on designing for amyotrophic lateral sclerosis (ALS) Yash Bohre, Purba Joshi, Rowan Page
235	11. A virtual reality experiential prototyping tool for the application of anthropometry in complex, confined human environments Peter Schumacher, Francois Fraysse, Brandon Matthews, Simon Modra, Dominic Thewlis, Geoff Langridge, Jack Beven
253	12. Urban vision: AI-driven spatial analytics for walkability in Barcelona's superblocks Aldo Sollazzo
273	Contributors

3. Prototyping collaboration: managing collaborative projects in design education

Martina Labarta Labrador, Francesca Mattioli

3.1 Introduction

Collaborative learning is a “complex team dynamic, asking for high interdependence, shared comprehension and a definition of common objectives” (Tessier, 2021, p. 215). Precisely because of this complexity, design students in higher education are considered especially well-suited to engage in it (Mattioli, 2022; Tessier, 2021). Through developing collaborative skills, students also gain greater autonomy and enhance their social and teamwork abilities (Matthews *et al.*, 1995; Tessier, 2021). Moreover, collaborative learning is often integrated into project-based pedagogy, which prepares students for real-world challenges by fostering problem-solving, decision-making, and inquiry skills – core competencies for design engineers (Deighton *et al.*, 2024). This pedagogical approach also increases student motivation and engagement by bridging theoretical knowledge with practical application. When combined with collaborative learning, project-based pedagogy effectively equips students to tackle complex projects that demand diverse expertise, a clear division of tasks, and

strong interpersonal and teamwork skills. These elements contribute to a well-rounded education that prepares students for professional practice.

However, collaborative learning is rarely systematically embedded in design curricula despite its potential, especially concerning teaching strategies, learning methods and assessment practices (Deighton *et al.*, 2024; Green *et al.*, 2022). In this context, integrating project management or agile principles (i.e., a collection of practices aimed at enhancing group collaboration) into project-based learning can help address this gap by providing concrete methods and tools to support effective collaboration (Barbosa, 2022; De Los Ríos-Carmenado *et al.*, 2015; Pokharel, 2023). Agile approaches, for instance, can promote better communication and adaptability while aligning with the iterative and evolving nature of design projects (Hulshult & Krehbiel, 2019; Stewart *et al.*, 2009). Both agile and project management frameworks can provide design students with real-world methods and tools for planning, tracking, and managing complex projects (Cruz *et al.*, 2021). Within project-based learning environments, where students face realistic challenges, these approaches not only improve the outcomes and quality but also reinforce the objectives of design education by preparing students for dynamic, collaborative, and multidisciplinary professional settings (Cruz *et al.*, 2021; De Los Ríos-Carmenado *et al.*, 2015; Hulshult & Krehbiel, 2019). Furthermore, it positively affects team dynamics and individual well-being by reducing stress, preventing misalignments, and mitigating competition (Green *et al.*, 2022), which, being opposite to collaboration and equally learned, creates an unfavourable condition for learning about collaboration (Kohn, 1992).

The role of design educators is fundamental in embedding collaborative and project-based learning within academic curricula. In particular, the teaching staff are responsible for clarifying the purposes and complexities of collaborative learning and for providing tools to support it (Mattioli, 2022). Continuing to integrate further collaborative methods into a project-based course within the MSc in Design & Engineering at Politecnico di Milano (Mattioli *et al.*, 2020, 2023; Mattioli & Ferraris, 2021; 2024), we developed a low-fidelity prototype of a management platform using Notion that was tested in one of the two parallel sections of the Final Project Work (FPW) course during

the first semester 2024/2025. This platform was designed to offer a structured framework for student teams to document and reflect on various dimensions of their collaboration and to share these insights with the teaching staff.

This chapter presents the process of designing the platform, the criteria used for its selection, how it addresses different aspects of project management and the diverse ways student teams engage with it. The aim of developing the platform prototype was to offer students a method for navigating collaborative and project-based processes while raising awareness of its relevance to their work as current and future design engineers and professionals.

3.2 Designing a low-fidelity prototype for collaboration

By designing and developing a low-fidelity prototype using Notion, we aimed to provide design and engineering students with an appropriate and intuitive method for navigating project-based learning and design team-based projects more confidently, steadily, and stress-free while developing stronger interpersonal and organizational skills. In the next section, we will explore the rationale behind the selection and design of the prototype and describe the outcome.

3.2.1 The competencies-methods-tools pyramid

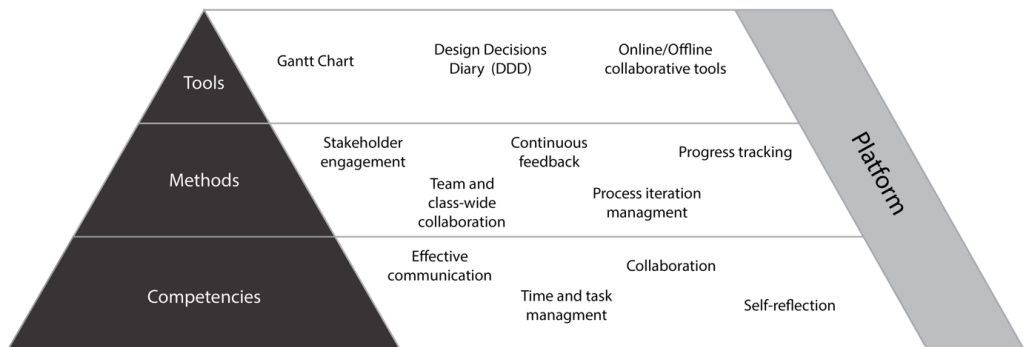
Our method involved adapting project management best practices to a design project-based learning course, Final Project Work, in the second year of MSc Design & Engineering. Several examples across disciplines of project management frameworks adapted to learning environments (Cruz *et al.*, 2021; De Los Ríos-Carmenado *et al.*, 2015; Fioravanti *et al.*, 2018; Krehbiel *et al.*, 2017; Marnewick, 2023; Molinari, 2021; Parsons & MacCallum, 2019; Zhang, 2022) show how the value of integrating project management knowledge into project-based learning environments is starting to be recognized.

For the methodological design of the platform, we were inspired by the pedagogical model proposed by Parsons & MacCallum (2019), which adapts agile and lean methodologies to education. The model

is a pyramid comprising three interrelated components: *values*, *processes*, and *techniques*. At the pyramid's base, values emphasize agency, outcomes, and continuous improvement, aligning with agile's empowerment of individuals and lean's focus on value generation (Parsons & MacCallum, 2019). As the pyramid's central element, processes incorporate learner-paced, iterative, and reflective cycles akin to agile sprints and lean pull-flow systems, fostering ownership and adaptability (Parsons & MacCallum, 2019). Lastly, at the top, techniques centre on collaboration, problem-solving, and visibility – translating agile tools like stand-ups and story cards and lean tools such as Kanban and gemba walks into educational practices (Parsons & MacCallum, 2019).

Inspired by the framework, we reframed this hierarchical categorization to align with our goals. In our reinterpretation, values are translated into a set of core student *competencies* (i.e., collaboration, self-reflection, time and task management, and effective communication), processes become the *methods* we aim to instil (i.e., stakeholder engagement, team and class-wide collaboration, continuous feedback, process iteration management, and progress tracking) and techniques are expressed as a focused set of *tools* designed to support these practices (i.e., Gantt Chart, Design Decisions Diary). Figure 3.1 illustrates our adaptation of Parsons & MacCallum's pyramid, reorganized around competencies, methods, and tools essential to our scope of fostering alignment and shared understanding of the collaborative process among design engineering students, and key in defining the required functionalities and layout of the chosen platform for our prototype.

Figure 3.1. Our reinterpretation of Parsons and MacCallum's (2019) pyramid into the competencies-methods-tools pyramid and definition of all the components to be embedded within the prototyped platform.



3.2.2 Selecting the right fit

We evaluated seven broadly used collaborative and project management platforms (i.e., Notion, MS Project, Planner from MS Teams, Loop, Click-Up, Headrush Learning, and Asana) listed in Table 1. Based on our competencies-methods-tools pyramid, we crafted a list of functional criteria for supporting the appropriate tools (i.e., Gantt chart, design decisions diary or DDD, and offline/online collaborative tools). These tools needed to support a range of methods (i.e., stakeholder engagement, team and class-wide collaboration, continuous feedback, process iteration management and progress tracking), which, in turn, were intended to foster the identified competencies (i.e., effective communication, time and task management, collaboration, and self-reflection). We also defined accessibility as the primary exclusion criterion for the tools. To be considered, each platform had to be accessible on Macintosh and Windows Operating Systems, allow access through the institutional email account, and offer an active free or educational plan. Based on these criteria, Headrush Learning was excluded due to accessibility (i.e., lack of an active free or educational plan).

Gantt chart

We included a Gantt chart (i.e., a visual project management tool that illustrates a project schedule over time) to support the acquisition of time and task management competencies through progress tracking. Students had to assign tasks within their team, create subtasks and task dependencies, and pinpoint milestones (e.g., concept delivery). Notion, MS Project, and Click-Up were the only platforms supporting these features. For these reasons, Planner, Loop, and Asana were discarded at this stage. Moreover, to reduce complexity for students, we decided to look for a platform that could ideally embed all the listed requirements.

Design decisions diary (DDD)

DDD is an ever-updating document inspired by changelogs, where teams keep a report of their design choices over the entire project. Here, student teams collect project review feedback and observations from the teaching staff, re-elaborate them, and define the

next steps. It is also a tool for the teaching staff to assess students' awareness and ability to deal with and manage the complexities of design projects.

Hence, the DDD is a tool that, through effective communication and stakeholder engagement (i.e., between teaching staff and students), aims at honing self-reflection and process iteration management competencies. First, we needed the possibility of creating templates to facilitate an initial standardization of the required contents in the DDD. Secondly, to support the assessment process, exporting the DDD file in a fixed and standard format was also a requirement. We kept Notion and Click-Up as options based on our inclusion criteria, while MS Project was directly discarded. Whereas it offers the possibility to create productivity reports, it does not provide a solution with the flexibility and adaptability we were looking for.

Offline/online collaborative tools

One of the main objectives was to make the collaborative process tangible for students and visible to the teaching staff. Collaboration is, in fact, the most fundamental competence in our framework. To help design engineering students understand and learn what a collaborative process entails, we developed our platform around team and class-wide collaboration – aiming at eradicating unhealthy competitive attitudes between teams and stakeholder engagement (e.g., between students, teaching staff, and the partner company), and continuous feedback – both from staff to teams and peer-to-peer.

To support these practices, we defined the offline/online collaborative tools as requiring the ability to allow real-time collaboration, file sharing, the creation of enough teams and team members for the number of students in our course, and the capacity to host enough participants, including students and the teaching staff team. The course included 51 students, divided into eleven groups of four to five members, and a teaching staff of five professors and one teaching assistant, totalling 57 participants. Click-Up had limitations on the number of participants, which required a plan upgrade and was discarded. Notion met all our inclusion criteria and was thus selected.

Table 3.1. Platform selection is based on the requirements of the competencies-methods-tools pyramid. It refers to free or educational plans only.

COMPETENCE	METHOD	TOOL	REQUIREMENTS	PLATFORM							
				Notion	MSProject	Planner (MS Teams)	Loop	Click-Up	Headrush Learning	Asana	
Time and task management	Progress tracking	GANITTCART	Gantt view	✓	✓	-	-	✓	-	-	
			Assign tasks	✓	✓	✓	-	✓	✓	✓	
			Create subtasks	✓	✓	✓	-	✓	✓	✓	
			Create task dependencies	✓	✓	-	-	✓	✓	-	
			Create milestones	✓	✓	-	-	✓	✓	✓	
Effective communication	Stakeholder engagement	DDD	Export to PDF	✓	✓	-	✓	✓	-	✓	
			Self-reflection	Process iteration management	Create templates	✓	-	-	✓	✓	-
Collaboration	Stakeholder engagement	OFFLINE/ONLINE COLLABORATIVE TOOLS	Real-time collaboration	✓	-	-	✓	✓	✓	✓	
			Team and class-wide collaboration	File sharing	✓	-	-	-	✓	✓	✓
			Continuous feedback	Create 11 teams of 4-5 members each	✓	-	-	✓	-	-	-
	Host 57 members		✓	-	-	✓	✓	✓	-		

3.2.3 Final Project Work collaborative platform

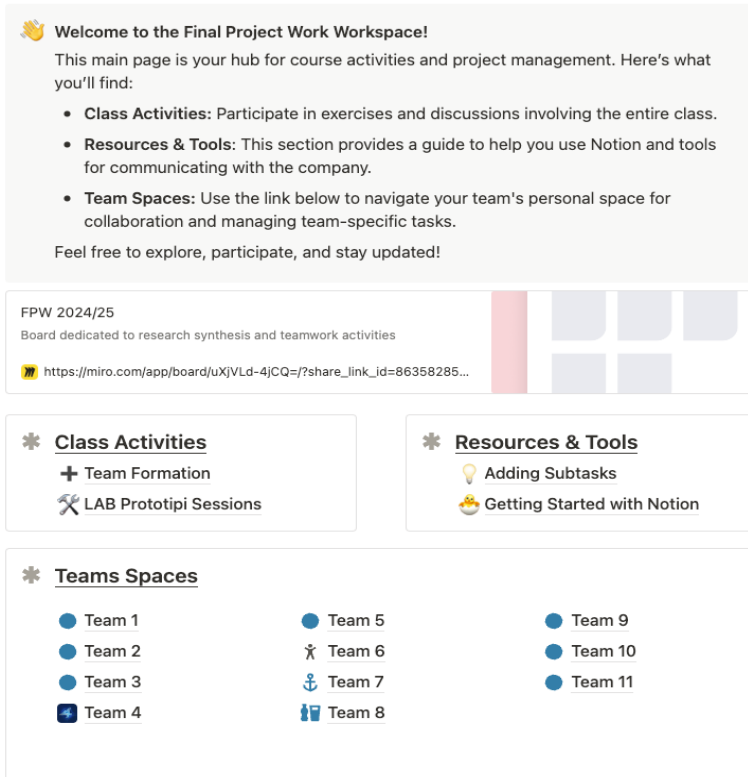
Notion is a highly customizable digital workspace with functionalities ranging from notetaking to managing teams, projects, and collaboration. Using Notion, we could integrate all the requirements to provide a comprehensive platform for design engineering students. We could also support them in managing their design projects more effectively while they learn project management methods and develop collaborative competencies.

When designing the Notion layout and pages (i.e., blank spaces that can be shaped according to one's needs and filled with a wide

variety of elements such as images, text, checklists, tables, or databases, to name a few), our objective was to provide a specific space for each competence, i.e., collaboration, self-reflection, effective communication, and time and task management.

Course Dashboard

Figure 3.2. Screenshot of the course dashboard.



Course dashboard

The course dashboard (Figure 3.2) is the main entry point to the course – the home page. From here, students can access three key areas: Class Activities, Resources and Tools, and Team Spaces. The Class Activities section includes pages for class-wide collaboration, such as group formation at the course launch or collaborative tasks that do not require specific team divisions (e.g., booking a reverse engineering session in the lab). Notion's database feature proved to be remarkably flexible. For example, a database was created to support team formation by documenting patterns of past collaborations.

This enabled the teaching staff to gain insights into existing group dynamics and to encourage students to explore new collaborative opportunities, without collecting or storing any personally identifiable information.

The Resources and Tools section is a collection of custom help guides (e.g., Getting Started with Notion) and practical resources (e.g., Adding Subtasks) to support students as they navigate the platform. This section is designed to be dynamic and can be updated in response to emerging topics and students' questions or suggestions, providing more space for teaching staff-student communication.

A link to a collaborative Miro board was also integrated into the course dashboard. This board functions as a tool to support the development of a team agreement, wherein students first share individual expectations for teamwork and subsequently collaborate to draft a formal team contract. The team contract establishes shared norms, delineates acceptable and unacceptable behaviours, and assigns roles and responsibilities within each team. Working simultaneously on the same board promotes transparency, mutual learning, and a sense of alignment across all teams.

The last section is populated with the team spaces. These are managed by each team and contain all the information on team collaboration, project management, review feedback, and communications with the partner company.

Team spaces

A team space is a virtual private environment for each team dedicated to teamwork and project management¹. Each team has a default set of core pages organized into sub-sections (i.e., project management, teamwork & collaboration, reviews grading, and partner company), as per Figure 8.3.

The Project Management section includes the design decisions diary (DDD), where teams document discussion topics for meetings with the teaching staff and collect, synthesize, and respond to feedback. At each milestone, the DDD can be exported as a PDF and submitted to account for the team's ability to make decisions, manage process iteration, and interpret feedback constructively and assertively. The second element is the Gantt chart, where

Note 1.
A work-in-progress
version of the FPW
Notion space can be
accessed and viewed at
the following link:
bit.ly/course_dashboard.


teams plan and assign tasks and milestones related to specific modules and deliverables. Notion's Gantt chart view enables the creation of task dependencies and subtasks intuitively and allows individual tasks to be assigned to one or more team members. Two additional pages were included to support collaboration and team alignment (i.e., Team Meetings and Files). The Team Meetings page serves as a log for meeting frequency and meeting notes, so all team members are always aligned. A separate page named Files was also provided, where teams can upload files for safekeeping and progress tracking.

The Team Agreement and private collaborative tools (e.g., Miro board), part of the Teamwork and Collaboration section, represent a central pillar of the overall process. Here, each team declares and agrees on how to face the project collaboratively.




Figure 3.3. Screenshot of Team 1's Space.


Team 1





 **Welcome to Your Team Space!**


We've provided a template with **essential pages (that should not be deleted)** and subpage templates to get you started.


 **Notion Tip:** If you wish to prevent unwanted changes on this or any other page, you can lock it from the ... option in the upper right corner by selecting *Lock page*.


Happy managing and collaborating!


 **Project Management**


-  Design Decisions Diary (DDD)
-  Gantt chart
-  Team meetings
-  Files


 **Teamwork & Collaboration**

-  Team Agreement
- Team's Miro Board:**
You can insert your Team's Miro Board here by creating a Link Block as a Bookmark.

 **Reviews Grading**

-  Team 1

 **Partner Company**

-  Questions

Create any new pages here...

The Reviewing and Grading section provides students direct access to monitor their progress based on the teaching staff's qualitative and quantitative review assessments. Students can also immediately see their tendency ups and downs over the semester through a graphical view. At the same time, the teaching staff has access to all teams' performance and can identify the stages in which teams struggle or excel.

Finally, the Partner Company section is a centralized space where students submit questions or technical concerns weekly to be forwarded to the partner company that provides the initial design brief. The teaching staff compiles the submissions and forwards them to company representatives.

The FPW Notion space, encompassing competencies, methods, and tools, is designed as a scaffold or an adaptive and supportive platform for student teams as they develop their project management and collaboration skills. It is not intended to be a compulsory or rigid infrastructure but rather a flexible resource that supports students in discovering what works best for them to navigate project complexity and collaborative learning throughout the design process. The following section explores how each team engaged with the platform and how it influenced their understanding of the collaborative processes in design.

3.3 Engaging with and making sense of collaborative tools

In this part of the chapter, we examine how students engaged with the platform in practice and how they reflected on it. Between September 2024 and January 2025, the 51 students divided into 11 teams engaged with using the FPW Notion as part of the course. The analysis unfolds in two parts. First, we explore how different teams appropriated the Notion environment, identifying four distinct modes of engagement – from immersive use to reluctant uptake – highlighting how teams navigated the same platform in significantly different ways. These modes reflect varying levels of integration, perceived usefulness, and alignment with team workflows. Second, we turn to

students' written feedback on the course evaluation to understand how they perceived and internalized the collaborative method by the end of the course. Thematic coding and mapping of their comments show how project management and team collaboration emerged as central concepts, anchoring a broader set of competencies.

3.3.1 Four levels of student engagement

Looking at how student teams used Notion throughout the course reveals four distinct patterns or levels of engagement (i.e., immersive, selective, passive, and reluctant), each reflecting different ways of understanding and applying project management within a collaborative design process.

Immersive teams approached Notion as a fully functional project management environment. They extensively used its features (i.e., tasks, subtasks, deadlines, priorities, assignments, and task dependencies). A few teams went further, creating clear responsibility structures by assigning primary and support roles and consistently keeping track of meetings and shared files. For these groups, the Notion space became a working infrastructure, actively supporting the unfolding of their project work from start to finish.

Instead, *selective* teams made more targeted use of the platform. These teams added what they needed (e.g., a calendar to manage deadlines or a task list to clarify roles) but did not integrate the platform across the whole project. In some cases, they moved parts of their planning to other platforms like Figma or turned to paper-based methods for milestone tracking. In these situations, Notion served more as a temporary scaffold than a core structure. This partial engagement may be related to perceived limitations in the platform itself. One student suggested "considering other tools for the Gantt and task assignment" as "it wasn't very easy to use". Another student shared that the Notion Gantt chart was "not so handy to use" and "a bit overstimulating".

A third set of teams, which we labelled as *passive*, barely engaged with the platform. Their Notion spaces remained almost as the original template, with minimal modification. Some added a calendar or draft notes, while others abandoned the platform early on, suggesting either a lack of interest or a preference for different organizational

tools. This low level of engagement resonates with some of the more critical student reflections. One student described project management in the course as “nearly useless” and “just a waste of time”, while another argued that “forcing everyone to use Notion didn’t seem right or fair”. These comments point to a misalignment between the intended scope of the platform and how these students perceived their own needs and working styles. In some cases, the issue extended beyond the platform itself. A student described how “some persons eventually would disappear or just decline responsibility”, pointing at deeper challenges in team collaboration. Here, a passive approach to Notion may not reflect a rejection of the platform per se but rather a broader breakdown in collaborative practices.

Finally, the only *reluctant* team used Notion primarily for internal documentation. They uploaded research summaries or scattered notes but barely interacted with the platform’s planning or coordination features, focusing solely and superficially on the Gantt chart. In these cases, the space operated more as a passive archive than an active management platform.

These engagement levels highlight the adaptability and versatility of such a platform to meet various needs, workflows, and cognitive structures. At the same time, it reflects how unevenly the tools embedded within the platform are interpreted and taken up. This raises questions on how much structure is needed to make an effective and meaningful management platform across different teams. We discovered that even when starting with a shared baseline framework, the same tools could become essential for some and irrelevant for others. Nevertheless, despite this uneven engagement, many teams developed their own strategies for managing the project and acknowledged the value of integrating project management and collaborative learning within the course curricula.

3.3.2 Making collaboration tangible

To understand how students perceived and internalized the method proposed in the FPW course, we thematically analysed their feedback and mapped the relationships between recurring topics. We gathered input from students through a dedicated Microsoft Form questionnaire, which was distributed immediately after the course,

and collected responses from 24 students (approximately 47% of the class). The form included four open-ended questions (Table 3.2) aimed at capturing students' key learnings (i.e., Q1), perceived strengths and weaknesses of the course (i.e., Q2 and Q3), and suggestions for improvement (i.e., Q4).

Q1	What have you learned in this course?
Q2	Which was the thing you liked the most?
Q3	Which was the thing you liked the least?
Q4	Any suggestions for next year?

Table 3.2. Questions asked to students in the dedicated Microsoft Form distributed by the teaching staff.

We generated a visual map (Figure 3.4) based on the main topics or codes identified in students' responses (Table 3.3). This map illustrates how students interpreted collaboration as a workflow and a learning network, with "effective communication" as a pivotal anchor. Around this central node, three clusters of frequently co-occurring topics emerged: (1) "project management", "managing complexity", and "team collaboration"; (2) "task management" and "time management"; and (3) "progress tracking". "class-wide collaboration" was the only isolated topic addressed independently in students' reflections and was thus not included in the visual map.

In terms of effective communication, several students highlighted how they learnt "to present [their] ideas and thoughts more effectively" and to "better communicate a project". Communication was not limited to interpersonal exchanges, though. It also included documentation and traceability, with one student mentioning the value of "creating documents and design process documentation [...] to have

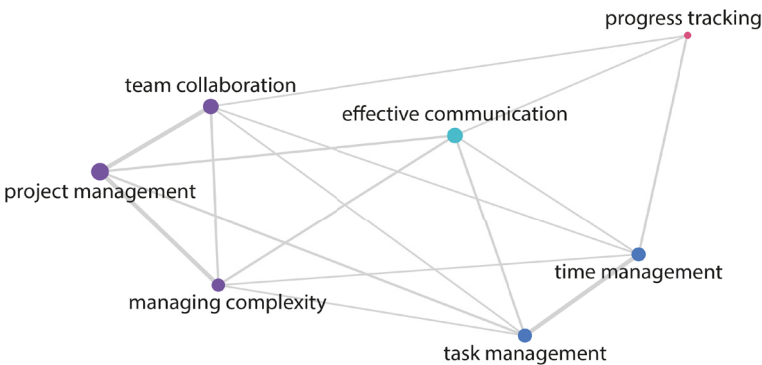


Figure 3.4. Code relation map of key topics emerging from students' responses. It represents the frequency of concurrent codes in the same response. The size of the dots is directly proportional to the number of responses containing those topics. The thickness of the joining lines is directly proportional to the number of times two connected codes appear in the same response.

a trackable design trajectory”. Another described learning to manage review meetings by “writing objectives beforehand, taking notes, and outlining next steps”. All these practices consequently contributed to more informed decision-making.

Table 3.3.
Code system and code frequency per response to each question.

Code	Q1	Q2	Q3	Q4	Total
Class-wide Collaboration	0	6	1	4	11
Effective Communication	4	0	2	1	7
Managing Complexity	6	0	0	1	7
Professional Approach	2	1	0	0	3
Progress Tracking	2	0	0	0	2
Project Management	14	2	0	0	16
Task Management	5	1	0	2	8
Team Collaboration	10	0	3	1	14
Time Management	3	0	3	2	8
Total	46	10	9	11	76

A significant number of students identified project management as their main takeaway. They reflected on having learnt “how to better structure, organize, divide, and communicate a project” and how relevant it was to grasp “how to develop in-depth a project of [...] technical complexity”. Project management was often discussed alongside team collaboration and managing complexity, suggesting that mastering project management tools and methods enabled students to understand the fundamental role of team dynamics in “juggling different disciplines at the same time” and addressing technically demanding tasks. These practices further supported the acquisition of time management and task management competencies. Comments such as “[I learnt] team and time management, especially using Notion, to plan and track progress” or “[I learnt] how to organize the workflow in a precise and well-scheduled way” reinforce how this approach helped shape students’ working strategies. Another theme that surfaced from the analysis was progress tracking, which students framed as a method for both “team and time management” and for ensuring accountability and “finding fault” in the design process.

Although class-wide collaboration did not appear in the code relation map, several students described it as one of the course’s most

distinctive and appreciated aspects. The possibility of exchanging feedback between groups was often mentioned as a valuable learning opportunity – “the idea of exchanging feedback between groups was really interesting” – especially compared to previous experiences. One student praised the class environment by saying that “the atmosphere in the classes with the rest of the classmates was great, and helping each other was fantastic”, and another described it as an “environment that permitted the exchange of ideas and opinions”.

These clusters of topics reflect a multi-layered understanding of collaborative design projects, from competencies such as time and task management or effective communication to methods like team collaboration, class-wide collaboration and progress tracking. The code relation map helps visualize how students navigated collaboration's strategic, organizational, and interpersonal dimensions, with effective communication competence at the centre. This centrality highlights communication as the underlying structure, enabling students to make informed decisions, coordinate tasks, and collaborate on their projects. These insights suggest that the FPW course did more than familiarize students with project management tools and methods – it facilitated a shift in how students conceptualized collaboration, making it tangible, structured, and transferable.

3.4 Towards a collaborative design education culture

This chapter explored how collaborative learning and project management can be meaningfully integrated into a design project-based course through designing, developing, and testing a low-fidelity prototype of a management platform using Notion. Drawing from and adapting Parsons & MacCallum's (2019) pyramid, we reframed collaborative project-based learning around a hierarchy of competencies, methods, and tools. Based on this reinterpretation, the platform served not only as a digital organization tool but also as a pedagogical environment for making collaboration tangible and transferable. It provided a space for students to engage with the complexities of teamwork in design projects, supporting progress tracking, team and class-wide collaboration,

continuous feedback, and direct stakeholder engagement. In doing so, it operationalized the principles of project-based learning while reinforcing key competencies such as communication, time and task management, collaboration, and self-reflection.

Despite uneven engagement, students recognized the platform's value in improving their project management strategies. Feedback analysis indicated that students acknowledged key concepts like team collaboration and project management as essential and actively internalized by many as part of their evolving design practice. The course experience helped shift the perception of collaboration from a requirement to a strategic and professional competence essential for navigating the complexities of real-world design projects.

The prototype also revealed opportunities for improvement. Usability limitations, particularly regarding the Gantt chart, hindered a generalized immersive adoption. Future iterations could explore hybrid integrations with more specialized tools or enhanced personalization to support diverse working styles. In addition, students' selective and passive engagement patterns suggest that a one-size-fits-all solution may not be ideal. Offering more flexible paths of engagement could help better align with team dynamics and organizational preferences.

In conclusion, the design and implementation of the Notion platform proved its potential as a pedagogical environment that does more than support coordination – it can foster a culture of collaboration in design education. Making the tacit dimensions of teamwork and project management visible can encourage students to engage more critically with these processes. Balancing structure with adaptability, the platform becomes a prototype for future models of integrated learning environments, where collaboration is not an add-on but a central, designed experience.

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References

- Barbosa, M. W. (2022). Using blended project-based learning to teach project management to software engineering students. *International Journal of Mobile and Blended Learning*, 14(1). <https://doi.org/10.4018/IJMBL.291978>
- Cruz, G., Dominguez, C., & Cerveira, A. (2021). Enhancing engineering students' project management skills in the middle of the COVID-19 pandemic: An online project-based learning experience. In *Proceedings of the 4th International Conference of the Portuguese Society for Engineering Education (CISPEE 2021)*. IEEE. <https://doi.org/10.1109/CISPEE47794.2021.9507213>
- De Los Ríos-Carmenado, I., López, F. R., & García, C. P. (2015). Promoting professional project management skills in engineering higher education: Project-based learning (PBL) strategy. *International Journal of Engineering Education*, 31(1), 184–198.
- Deighton, K., Kuys, B., & Tyagi, S. (2024). Industrial design education in Australia: A competence analysis across primary, secondary and tertiary education levels. *International Journal of Technology and Design Education*, 34(1), 427–460. <https://doi.org/10.1007/s10798-023-09822-0>
- Fioravanti, M. L., Sena, B., Paschoal, L. N., Silva, L. R., Allian, A. P., Nakagawa, E. Y., Souza, S. R. S., Isotani, S., & Barbosa, E. F. (2018). Integrating project based learning and project management for software engineering teaching: An experience report. In *Proceedings of the 49th ACM Technical Symposium on Computer Science Education (SIGCSE '18)* (pp. 806–811). Association for Computing Machinery. <https://doi.org/10.1145/3159450.3159599>
- Green, S., Orwell, S., Page, F., Chiu, T., & Patel, A. (2022). Agile: Where vuca and affective factors meet. In *Proceedings of the 24th International Conference on Engineering and Product Design Education (E&PDE 2022)*. The Design Society. <https://doi.org/10.35199/EPDE.2022.98>
- Hulshult, A. R., & Krehbiel, T. C. (2019). Using eight agile practices in an online course to improve student learning and team project quality. *Journal of Higher Education Theory and Practice*, 19(3). <https://doi.org/10.33423/jhhetp.v19i3.2116>
- Kohn, A. (1992). *No contest: The case against competition* (Revised). Houghton Mifflin Harcourt.
- Krehbiel, T. C., Salzarulo, P. A., Cosmah, M. L., Forren, J., Gannod, G., Havelk, D., Hulshult, A. R., & Merhout, J. (2017). Agile manifesto for teaching and learning. *The Journal of Effective Teaching*, 17(2), 90–111.
- Marnewick, C. (2023). Student experiences of project-based learning in agile project management education. *Project Leadership and Society*, 4. <https://doi.org/10.1016/j.plas.2023.100096>
- Matthews, R. S., Cooper, J. L., Davidson, N., & Hawkes, P. (1995). Building bridges between cooperative and collaborative learning. *Change*, 27(4), 34–40. <https://doi.org/10.1080/00091383.1995.9936435>
- Mattioli, F. (2022). *Learning and teaching global cooperation skills in culturally plural design teams: Collaborative learning practices and experiences in plural classes* [Doctoral dissertation, Politecnico di Milano]. <https://hdl.handle.net/10589/183704>
- Mattioli, F., Fabio Antonio Figoli, & Wilhelm, G. (2023). Peer as experts to cooperate with: A case study of teaching activities to switch from inter-group competition to collaboration in a design studio. In L. Buck, H. Grierson, & E. Bohemia (Eds.), *DRS 123: Proceedings of the 25th International Conference on Engineering and Product Design Education, Responsible Innovation for Global Co-Habitation* (pp. 463–468). The Design Society. <https://doi.org/10.35199/EPDE.2023.78>
- Mattioli, F., & Ferraris, S. (2021). Never take teamwork for granted! A tutoring experience of soft-skills. In H. Grierson, E. Bohemia, & L. Buck (Eds.), *DS 110:*

Proceedings of the 23rd International Conference on Engineering and Product Design Education, Meeting 21st Century Challenges in Further and Higher Education. The Design Society. <https://doi.org/10.35199/EPDE.2021.59>

Mattioli, F., & Ferraris, S. D. (2024). *Designing with the other. Collaboration and plurality as a growth potential for designers*. ITA. <https://re.public.polimi.it/handle/11311/1263849>

Mattioli, F., Ferraris, S., & Rampino, L. (2020). *Diverse together: Learn by collaborating*. <https://re.public.polimi.it/handle/11311/1151927>

Molinari, A. (2021). Towards a project management-enabled learning environments: A case study. *Journal of Visual Language and Computing*, 2, 21–32.

Parsons, D., & MacCallum, K. (2019). Agile education, lean learning. In D. Parsons & K. MacCallum (Eds.), *Agile and lean concepts for teaching and learning: Bringing methodologies from industry to the classroom* (pp. 3–23). Springer. https://doi.org/10.1007/978-981-13-2751-3_1

Pokharel, S. (2023). Providing project management knowledge and skills through scaffolding and project-based learning strategy. *Journal of Engineering, Design and Technology*, 21(4), 1153–1172. <https://doi.org/10.1108/JEDT-07-2021-0343>

Stewart, J. C., DeCusatis, C. S., Kidder, K., Massi, J. R., & Anne, K. M. (2009). Evaluating agile principles in active and cooperative learning. In *Proceedings of Student-Faculty Research Day* (pp. B3.1–B3.8). Pace University.

Tessier, V. (2021). Integrated studio approach to motivate collaboration in design projects. *Design and Technology Education: An International Journal*, 26(3), 213–229.

Zhang, R. (2022). Design of an authentic project-based learning course using project management approach. *International Journal of Fashion Design, Technology and Education*, 15(1), 57–66. <https://doi.org/10.1080/17543266.2021.1992799>

This volume examines the evolving role of prototypes in design research, emphasizing their function as intentional and transient objects that facilitate the transition from abstract concepts to concrete design outcomes. Through a range of disciplinary and methodological perspectives, the book investigates how prototyping contributes to knowledge generation, design process development, and the articulation of experiential understanding. The chapters are organized into four thematic parts – Envisioning, Exploring, Comprehending, and Developing the Design Process – each addressing distinct aims and contexts of prototyping. Contributions include studies on low-fidelity tactics, collaborative learning environments, multisensory material translation, biodesign practices, data engagement, and political dimensions of design. These inquiries foreground prototyping as a situated, relational, and epistemic practice. The volume concludes that prototyping in design research extends beyond technical validation to encompass pedagogical, ecological, and speculative dimensions. It demonstrates that prototypes can serve as vehicles for interdisciplinary collaboration, critical reflection, and the negotiation of complex design challenges.