



Five Steps to Create a TECH2X Course

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1. Summary

This document describes the process of applying the 22 principles for course design to prepare a tech-driven course as provided within the TECH2X framework in a 5-step manner. The principles can be accessed in the report “Design Principles for Tech-driven Innovation Courses - A Condensed Summary “ on the TECH2X project webpage (subpage Resources).

The guidance is targeted for educators that are responsible to set-up this course at their respective university. It provides additional resources that facilitates the course preparation and gives examples of context variables, that influence the course design. As the course follows a challenge-based approach and builds on methods of the design thinking tool kit, we underline that the guidance assumes that educators have a background in these fields.

The five-step approach was developed as part of deliverable D2.1: Course Manual for Educators, for Work Package 2 of the TECH2X project at the end of Phase 1. The full version of D2.1 can be requested via email from the authors.

The partners Technical University of Applied Sciences Mannheim (TH-MA) and Middle East Technical University (METU) followed this approach while creating their courses during Phase 1 of the TECH2X project. A more detailed and improved version of the process guidance will be provided at the end of Phase 2 of the TECH2X project in 2027.

2. Design and prepare a TECH2X Course

The process to create and prepare a course based on our design principles proposes five-steps, as shown in **Figure 1**, and described in the following subsections 3 – 7. Along with the description of the process we point to material that facilitates the set-up of the course. The material listed in the yellow boxes of **Figure 1** are also provided on the TECH2X Webpage (see sub-page: Resources)

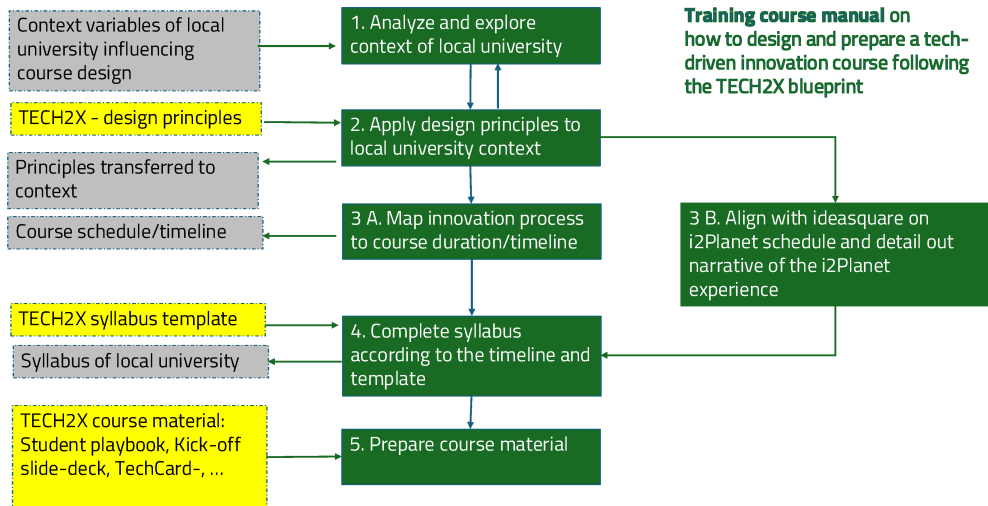


Figure 1: A five-step approach on how to design and prepare a tech-driven innovation course according to the TECH2X framework. **Green boxes** symbolize the steps and **yellow boxes** the supporting material provided as part of the TECH2X project. **Grey boxes** indicate the material/information the university creates/provides while following the five-step approach.

3. Analysis of the Universities' Context

Description: The identification of the universities' context is a necessary first step because the principles are formulated on a level of abstraction that requires to be tailored to a specific context (of the respective universities). However, this tailoring is limited and can only take place in a certain range without losing the core idea of the course concept. At the same time the context of the university poses constraints that may limit the application of the design principles and therefore make it difficult to set up the course in the proposed way. This step helps to determine the overall fit of the course concept to the context of the university. Examples for context variables are the size of the university, the innovation ecosystem of the university, and the local distribution of departments. The clarification of the contextual insights and exploration of the boundaries that make the creation of the course feasible, is necessary to adapt the course to the needs of the university. Potential contextual factors are listed in **Table 1**. Exemplified with contextual factors that have been identified at TH-MA, while analysing the context in respect to the TECH2X course during Phase 1 on the project.

Output: As result of this step, educators should have created a table with context factors valid for the own university. This table will provide information for the second step.

Table 1: Context factors with influence on the course design (first two columns reference context factors and guiding question provided by [1] p.100)

Context factor	Guiding questions for context exploration	Context factor from TH-MA with respect to the TECH2X course
Material context	What facilities, infrastructures, software or other resources are available? Which one could feasibility be made available?	TH-MA is a campus university. All departments are close to each other on one campus. This facilitates the students interdisciplinary project work and organisation of joined lectures. Courses can be conducted at inno.space and in the maker.space.
Organizational/ policy context	What policies and practices are relevant to the introduction of the new course? What explicit and hidden power structures are present? To what extent does the organisation or sub-unit possess the autonomy and jurisdiction to introduce the new course?	Wednesday afternoon is reserved in all departments for interdisciplinary courses. As the course organizer belongs to the department of computer science, and all study programs of the computer science department have the flexibility to introduce 10 ECTS electives, the offer of a new 10 ECTS course can be integrated into the programs. The integration of the course in further study programs is in the responsibility of the respective departments. It takes several weeks in advance to get their

		<p>agreement. It is also possible that some departments refuse the integration.</p> <p>Running the course longer than 15 weeks and during the lecture free time can make the course unattractive for students, as the university has the policy that the three weeks of exams are free of courses and many students need to work during the lecture free time.</p> <p>Courses at TH-MA run within the 15 weeks of semesters. Starting mid-March or end of September.</p>
Educational context	<p>What does the current situation look like (e.g. content, pedagogy, exams ...)?</p> <p>What intercurricular connections deserve particular attention when establishing the new course?</p>	<p>Inno.space has extensive experience in teaching challenge-based and user-centered design courses.</p>
Viability	<p>What are the strengths, weaknesses, opportunities, and threats that would enable or hinder the introduction of the new TECH2X course?</p>	<p>Not all departments are open towards the experiential learning approach.</p> <p>It will be challenging for the university to finance the trip to CERN in the long run.</p> <p>Also, for the university that has several research labs, it is uncertain how suitable their work is for inclusion within a TECH2X course. This will need further clarification.</p>

4. Application of Principles to local University Context

Description: During this step, the design principles are transferred to the context of the own university. We suggest to therefore run a 2–4-hour workshop with a group of 3-5 educators that are experienced in the field and will be responsible to lead or coach the course. They should also be knowledgeable in the context of the university. During this workshop the group should go through the design principles (see supporting material below), principle by principle, while considering the context variables, and note down, how the principles could be instantiated at the own university. During this process, educators might get aware of new contextual factors, that influence the courses design of the tech-driven innovation course and might have been overseen in step1. This is reflected by including an arrow back from step 2 to step 1 in **Figure 1**. This means the list of context variables might be extended during the forementioned workshop.

According to our experience, the timeline of the course is strongly influenced by the duration of the semester and schedule of the university and is therefore, very contextual. We dedicated a separate step (step 3) to creating the timeline of the course. However, this can also be done as part of step 2.

Output: Design principles transferred to the context of the university; List of influencing context factors.

Supporting Material: Design principles for Tech-Driven Innovation Courses (Resource page of the TECH2X Webpage)

5. Mapping the Innovation Process to the Schedule

Description: First, the duration of the course needs to be defined by applying design principle “Ti1 Effort/timespan”, see **Table 2**). As a next step, the timeline and the course schedule can be derived by mapping the three phases of the innovation process (design principle “CO4: innovation process”, See **Table 3** and **Figure 2**) to the duration of the course. This also determines the milestones of the course. In addition to the time dedicated to the three phases of the innovation process, we recommend considering course time for team building at the beginning of the course and time for dissemination at the end of the course.

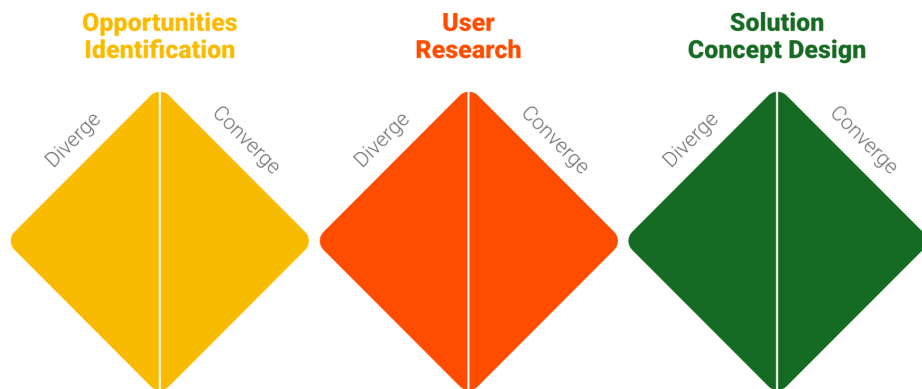


Figure 2: Innovation Process as conducted in the TechForward Course of the University of Bologna. (adapted from [2])

Table 2: Design Principle Ti1- Effort/Timespan

Design Principles Ti1 (Effort/Timespan):
 Courses should span at least one semester (3.5 months). Given the learning goals and transformative character of the courses the expected workload of the students should be covered by 12-15 ECTS. It must be insured, that the students get these credits included in their study records.

Table 3: Design Principle: Innovation Process (CO4)***Design Principles CO4 (Innovation Process)***

During the course, the students are navigated through a tech-driven innovation process which includes the following phases:

- Opportunity Identification (Tech exploration, Identification of societal impact)
- User Research (User need exploration)
- Solution and Concept Creation

Students should be engaged in dedicated learning activities that give them methodological support in the respective phases as they move along the process (compare design principle “learning activities”)

The overall structure of the course should give boundaries within this process by expecting certain intermediate outcomes or reach certain phases at a given schedule in the course (e.g. by providing milestones)

Furthermore, the course schedule needs to consider the trip to CERN, where the “i2Planet” learning unit – a signature element of the TECH2X courses - is provided. This trip does not only have to fit in the universities schedule but also must be aligned with IdeaSquare’s calendar and availability. The timing of the visit might impact the narrative. The duration is about 3-5 days plus time for travelling.

Output: Course schedule/timeline for the new TECH2X course (including schedule for the trip to CERN)

6. Completion of Syllabus

Description: The aim of this step is to finalize the syllabus. The TECH2X syllabus template is provided on the Resources page on the TECH2X Webpage. The syllabus template supports this activity. Annotations for the various subsections of the syllabus refer to the design principles and support the completion and documentation of the syllabus based on the work conducted in the previous steps. The TECH2X Webpage (subpage Resource) also exemplifies the syllabus of TH-MA for the newly established course “TDX - Technology Driven Innovation” that has been documented according to the template format.

Output: Syllabus for the new course

Supporting Material: TECH2X syllabus template, example syllabus of TH-MA

7. Preparation of Course Material

Description: To facilitate the course preparation for educators and to demonstrate the course in a more tangible way to further HEIs, we prepared supporting material, which is accessible via the resources page of the TECH2X Web page. We concentrated on material that is unique for the tech-driven course and conveys its essential properties accordingly. This supporting material will be further extended during Phase 2.

Also, it should be mentioned that the course preparation needs additional resources and requires several months of preparation before the course can start. In particular, the acquisition of deep tech at the university and the roll out of the course over various departments is essential and time demanding.

Supporting Material:

- **A playbook for students** that serves as a guide throughout the course in a language where students can follow. (*Resource page: Student playbook*)
- **A slide deck for the kick-off of the course**, to be used by the responsible course educator to introduce the course concept, the teaching team as well as the technology and researchers. The content of the slides is inspired by the kick-off slide deck of the TechForward Course of UNIBO (*Resource page: Kick-off-Sides*)
- **A tech card template** serves to support the students understanding of the technology. The deep tech that drives the student's innovation work, should be documented in this format before the course starts. (*Resource page: TechCard template*)

Glossary

Deep Tech	
Deep Tech	Technologies based on substantial scientific discoveries and engineering innovations
I2Planet	Special learning format conducted at CERN IdeaSquare as part of the Tech-driven innovation courses
TechForward	Tech-driven innovation Course at UNIBO
TeSI	Technology for Social Innovation course led by Esade as part of the Fusion Point partnership between Esade, UPC (engineering school) and IED (design school)

References

- [1] S. McKenney and T. C. Reeves, *Conducting educational design research*, Second edition. London New York: Routledge, Taylor & Francis Group, 2019. doi: 10.4324/9781315105642.
- [2] N. Cocchi, C. Dosi, and M. Vignoli, "TECH TO MARKET. FINDING AND DESIGNING SUITABLE TECHNOLOGY APPLICATIONS WITH DESIGN THINKING," *Proc. Des. Soc.*, vol. 3, pp. 3315–3324, July 2023, doi: 10.1017/pds.2023.332

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