PROTOTYPING RUBRICS

RUBRICS DESIGNED TO ASSESS PROTOTYPES OF THREE DIFFERENT LEVELS, WITHIN UTRECHT UNIVERSITY

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I. WHAT IS A RUBRIC?

A rubric is an assessment tool that outlines specific criteria used to evaluate or grade a student's performance, project, or work. It serves as a framework for educators and students by specifying expectations and establishing benchmarks for quality. Rubrics are widely used in educational and professional contexts to ensure consistency, fairness, and transparency in evaluations (Reddy & Andrade, 2010).

A typical rubric includes:

- Criteria: Aspects of the work that will be assessed.
- Performance Levels: Varying degrees of quality, such as "good," "sufficient," or "insufficient."
- Descriptions: Detailed explanations of what each performance level constitutes.

II. UNDERSTANDING PROTOTYPE RUBRICS

Prototyping is a fundamental aspect of design and innovation. As such, it is a central element in design-based education, allowing students to iteratively develop, test, and refine ideas. The choice of prototyping approach—***rapid, low-fidelity (Lo-fi), or high-fidelity (Hi-fi)***—depends on the course goals, students' prior knowledge and experience, available time, and the desired depth of understanding.

For instance:

- Introductory courses may prioritize *rapid* or *Lo-fi* prototypes to accommodate students with limited prior exposure, focusing on the basics of design thinking and problem-solving.
- Advanced courses may include *Hi-fi prototyping* to deepen understanding and develop technical skills.

Similarly, the extent of available course time for iterative processes affects whether students can progress from basic prototypes to detailed models or instead focus on one stage of the prototyping cycle *(Gerber & Carroll, 2012; Snyder, 2003)*.

1. Rapid Prototyping

Rapid prototypes are quickly developed models used to test concepts and explore functionality with minimal investment of time and resources. They can be created within a single workshop or over the course of a working day. Common tools include sketching materials, theoretical models, paper, lego, clay, simple mockups, or quick 3D prints.

The primary goal of rapid prototyping is to generate ideas and identify potential flaws early in the design process. This makes rapid prototypes suitable for short-duration tasks or courses focused on creativity and ideation *(Camburn et al., 2017)*. Research by Snyder et al. (2003) highlights that paper prototypes foster creative thinking, involve users and stakeholders in the design process, and promote teamwork and communication (Snyder et al., 2003).

In educational contexts, rapid prototyping allows students to experiment and iterate without the pressure of delivering a fully developed product. Moreover, it also serves as a valuable first step in larger projects, helping to identify design challenges before progressing to more refined low-fi or high-fi prototypes.

Key elements of Rapid Prototyping:

a. Rough, quick, and low-cost models (e.g., paper sketches, theoretical concepts, or basic physical models)
b. Emphasis on basic concepts, structure, or layout with minimal detail.
c. Aimed at exploring concepts and collecting early feedback.

2. Low-Fidelity (Lo-Fi) Prototyping

Lo-fi prototypes use simple and readily available materials to explore ideas during the early stages of the design process. They focus on structure and workflow about the mechanism rather than refined visuals or full functionality. This approach encourages experimentation, collaboration, and feedback, making lo-fi prototyping particularly suitable for beginners or situations where multiple directions are being explored.

Lo-fi prototypes are typically rough but tangible representations of a concept. While they may not function fully, they can simulate key elements—such as a moving part, a display screen, or interaction between components—often with the aid of the presenter or demonstrator. These prototypes help to explore ideas, test functionality, and gather feedback early in the design process before investing time in detailed development.

While not limited to paper, *Lo-Fi* prototyping often includes a paper-based model or sketches, for example a process sketched on paper. Research by Sefelin et al. (2003) shows that the informal and less polished nature of such prototypes encourages users to provide more feedback, supporting a more collaborative and iterative design process (*Sefelin et al.,2003)*.

Key elements of Low-Fidelity Prototyping:

a. Rough, medium-term mock-ups or digital models that balance speed and detail,

b. Focus on workflow and design with functionality being less important.
c. Useful for simulating potential functionality and exploring use cases with minimal time investment.

3. High-Fidelity (*Hi-fi*) Prototyping

Hi-fi prototypes are highly detailed models that closely resemble the final product in both appearance and functionality. They are built using appropriate materials and advanced construction techniques to simulate a realistic user experience. Rather than simply illustrating an idea, *Hi-fi* prototypes are used to refine and test its feasibility, usability, and overall design quality.

This level of prototyping is most suitable for advanced learners or capstone projects, where sufficient time and expertise are available to refine the design. By providing a realistic user experience, *Hi-fi* prototypes play a critical role in usability testing, aesthetic validation, and performance analysis *(Walker et al., 2002; Drezner & Huang, 2009)*.

The decision to use *Hi-fi* prototyping depends on factors such as students' prior knowledge, the learning goals of the course, and the available time for development. When integrated thoughtfully, *Hi-fi* prototyping allows educators flexibility in scaffolding learning experiences while aligning with the indented learning goals.

Key elements of High-Fidelity Prototyping:

a. Closely mirrors the final product in both appearance and functionality.
b. Includes realistic user interactions, advanced visuals, and all critical features.
c. Used for final validation and detailed testing.

How to choose between Hi-fi or Low-fi?

When deciding whether to use a low-fidelity (*Lo-fi*) or high-fidelity (*Hi-fi*) prototype, consider your design goals and the level of your target group. A comparative study by Walker et al. (2002) found that both *Lo-fi* and *Hi-fi* prototypes are equally effective in identifying usability issues.

Lo-fi prototypes are quick and inexpensive to produce, making them ideal for early-stage exploration, brainstorming, and gathering rapid feedback. They allow for flexible iteration without significant investment.

Hi-fi prototypes, on the other hand, closely resemble the final product in look and interaction. They are better suited for testing detailed user interactions, evaluating aesthetics, and presenting to stakeholders who may need a clearer picture of the end result.

In short, choose the level of fidelity that best supports your current design questions and constraints.

Stressing the natural fit of CBL to prototyping:

Prototyping fits naturally into Challenge-Based Learning (CBL), where students work on authentic, often complex problems that require creative, practical solutions. In this context, prototyping

becomes a key method for ideation, testing, and refining ideas. It encourages a learner-driven, learning-by-doing approach that fosters critical thinking, adaptability, and collaboration.

III. RUBRICS WITH LEVEL INDICATION

We have developed three rubrics for prototype education: **Rapid prototyping** (level 1; rough quick and inexpensive models), ***Lo-fi* prototyping** (level 2; conceptualization, rough prototypes, early-stage design validation)), and ***Hi-fi* prototyping** (level 3; detailed design, usability testing and final validation).
For all three rubrics we have provided an example student project, and how the rubric could be interpreted when that project would be assessed. The example rubrics provide feed forward for the project (how to take the design to the next level). Teachers can use these rubrics 1:1 or take parts and use these as inspiration for their courses.

If needed, our teachers in Lili's Proto Lab (LPL) can think along with you on your final project requirements. If you want to make use of LPL during your course, go to 'get started' and fill out a course or project application form on the website.

[link]

IV. REFERENCES

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