eROBSON design methodology

A methodology for teaching Educational Robotics at schools in an online and blended formats using Augmented Reality

General principles

- eROBSON methodology supports design of AR-enriched use of ER in STEM contexts
- A systematic design (SAM model) is combined with Design Thinking Approach
- Teacher is the problem owner, eROBSON expert supports and guides throughout preparation, design and development phases / iterations
- Teacher training is a live activity with a possible online component

Educational Robotics (ER)

Educational Robotics is an innovative interdisciplinary learning methodology which combines the elements of sciences (Physics, Math, Engineering), new technologies (Information Technologies, Software / Coding, Artificial Intelligence) and social skills. The combination of sciences and project-based learning creates a creativity space in the classroom that has significant positive effects on the learning process. ER has gained ground in the last years and many approaches have been proposed and implemented in classrooms, providing to the students and teachers a variety of educational robotics platforms based on controversial educational approaches.

Augmented Reality (AR)

Augmented Reality (AR) is a technology that enhances human perception with additional, computer-generated sensorial input to create a new user experience. Most of the current AR systems provide visual experience, blending digital graphics with the features of the real physical space around the user. AR experience can be delivered to the users on mobile devices, smartphones and tablets, and on specialized smart glasses. AR applications for these devices use the camera of the device and other sensors to detect and track some features of the physical space around the user and use them as anchor points for the digital content.

Theoretical grounding:
SAM model + Design Thinking

1. Inspiration Phase: Initial ideas, inspirations and thoughts

2. Preparation Phase: Empathize & Define (Needs, ambitions and aspirations, challenges and barriers)

Design Thinking: A 5-Stage Process

Empathize → Define → Ideate → Prototype → Test

BACKGROUND

PROTOTYPE
DESIGN   REVIEW

IMPLEMENT
DEVELOP   EVALUATE

ROLLOUT

Information Gathering | Savvy Start | Project Planning | Additional Design | Design Proof | Alpha | Beta | Gold

Preparation Phase | **Iterative Design Phase** | **Iterative Development Phase**
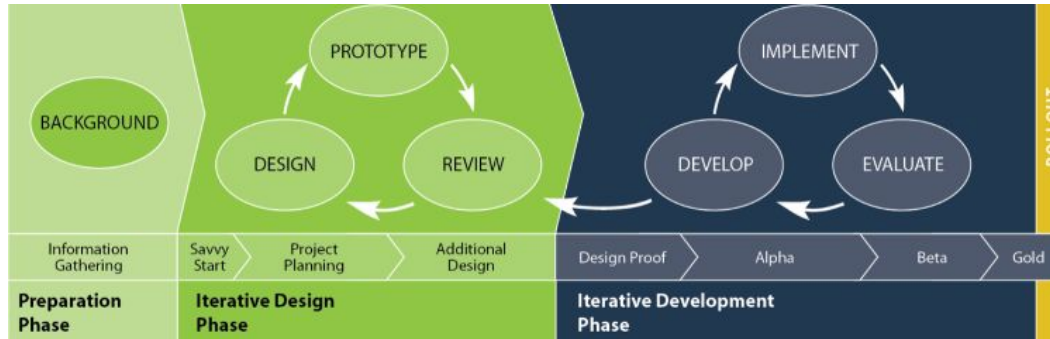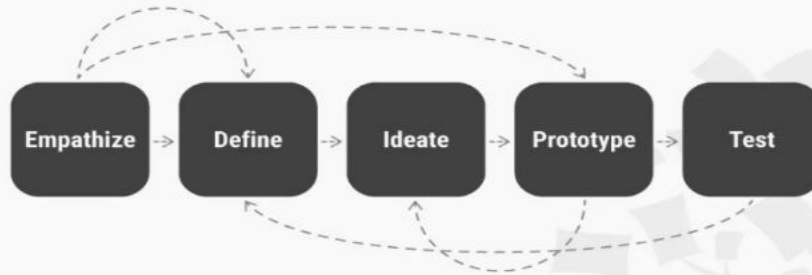
3. Iterative Design Phase (design-prototype-review): Define & Ideate (Learning objectives – activities - content – technology (AR) - learning outcomes)

4. Iterative Development Phase (develop-implement-evaluate): DT (Prototype & Test)

eROBSON

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Preparation Phase — **Iterative Design Phase** — **Iterative Development Phase**
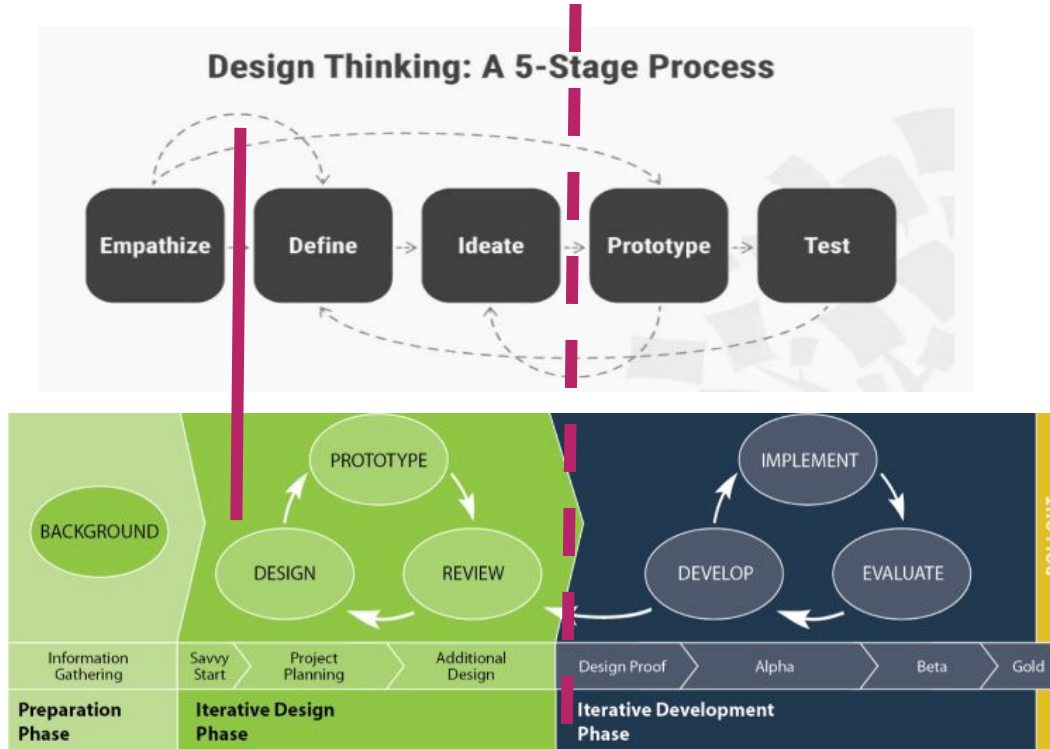
Teacher training in f2f (3 hours - 3 days)   A follow-up (f2f, online or blended)

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Scenario 1

- **Teacher with ER competence**
- **AR expert**

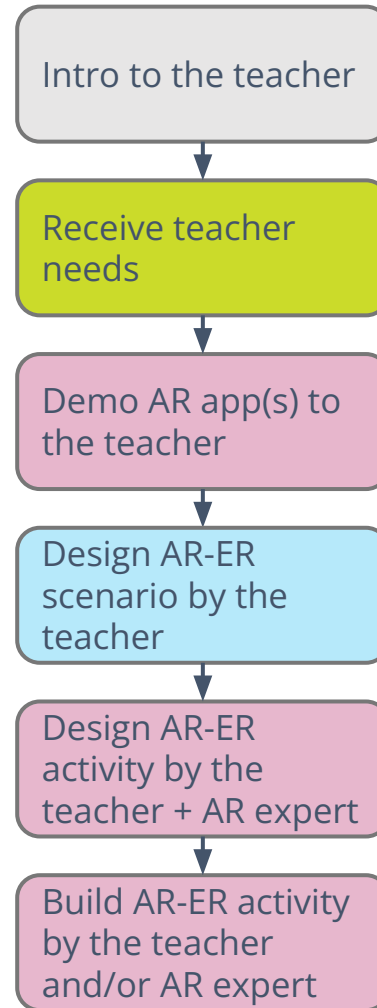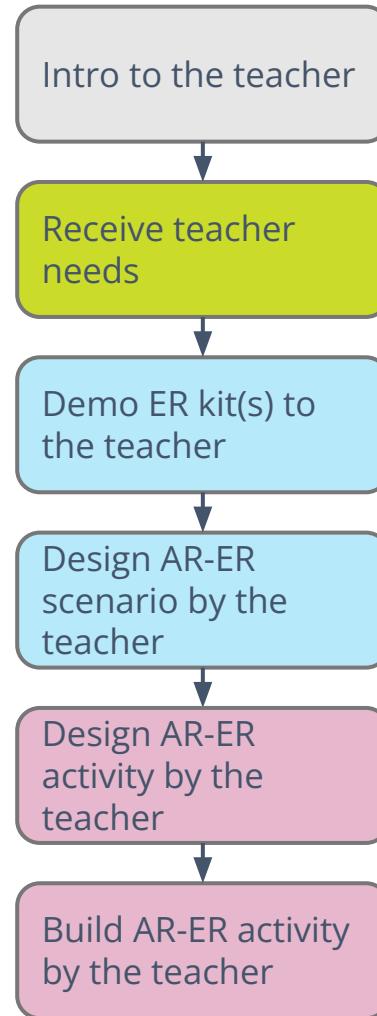In this scenario, the teacher can design a scenario and needs assistance in understanding AR and implementing the scenario in AR.

```
┌─────────────────────────────┐
│ Intro to the teacher        │
└─────────────────────────────┘
              ↓
┌─────────────────────────────┐
│ Receive teacher needs       │
└─────────────────────────────┘
              ↓
┌─────────────────────────────┐
│ Demo AR app(s) to the teacher │
└─────────────────────────────┘
              ↓
┌─────────────────────────────┐
│ Design AR-ER scenario by the teacher │
└─────────────────────────────┘
              ↓
┌─────────────────────────────┐
│ Design AR-ER activity by the teacher + AR expert │
└─────────────────────────────┘
              ↓
┌─────────────────────────────┐
│ Build AR-ER activity by the teacher and/or AR expert │
└─────────────────────────────┘
```

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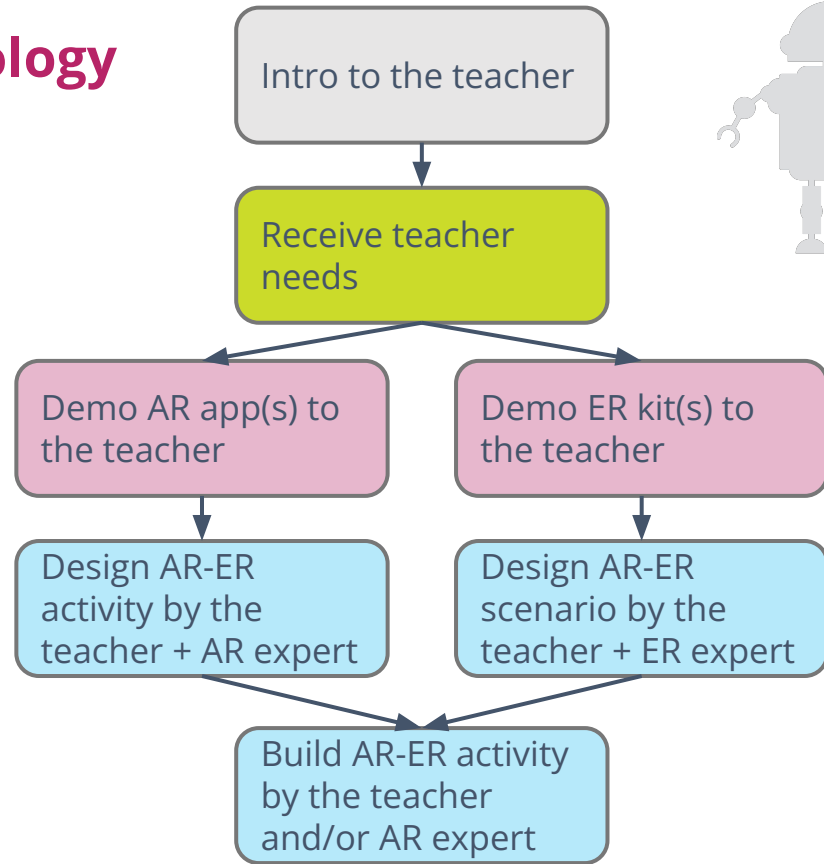
Scenario 2
- **Teacher with AR competence**
- **ER expert**

In this scenario, the teacher can design and implement an AR activity and needs assistance in understanding ER and creating an ER scenario.

Intro to the teacher

↓

Receive teacher needs

↓

Demo ER kit(s) to the teacher

↓

Design AR-ER scenario by the teacher

↓

Design AR-ER activity by the teacher

↓

Build AR-ER activity by the teacher

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Scenario 3 eROBSON methodology

- **Teacher**
- **ER expert**
- **AR expert**

In this scenario, the teacher needs assistance in all aspects and goes through all stages with one or the other expert.


```
Intro to the teacher
        ↓
Receive teacher needs
      ↙        ↘
Demo AR app(s)     Demo ER kit(s)
to the teacher     to the teacher
      ↓                ↓
Design AR-ER       Design AR-ER
activity by the    scenario by the
teacher + AR       teacher + ER
expert             expert
      ↘            ↙
     Build AR-ER activity
     by the teacher
     and/or AR expert
```
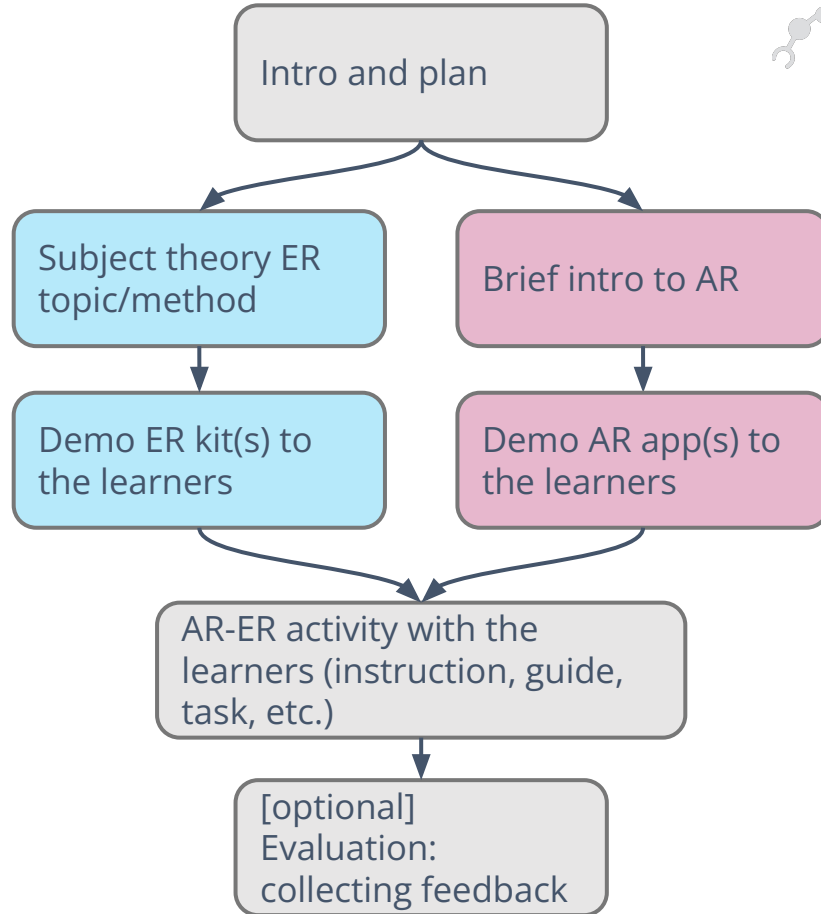
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Scenario 4
- **Teacher**
- **Learners**

In this scenario, the teacher already has expertise in both ER and AR and can apply the materials created using the eROBSON methodology.


```
Intro and plan
    ├──────────────────────────┐
    │                          │
Subject theory ER          Brief intro to AR
topic/method                    │
    │                          │
Demo ER kit(s) to          Demo AR app(s) to
the learners               the learners
    │                          │
    └──────────┬───────────────┘
               │
    AR-ER activity with the
    learners (instruction, guide,
    task, etc.)
               │
    [optional]
    Evaluation:
    collecting feedback
```

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eROBSON Methodology: Detailed view

1. Inspiration Phase

Intro to the teacher

Demo ER kit(s) to the teacher

Demo AR app(s) to the teacher

Teacher impressions, inspirations and ideas for learning designs

2. Preparation Phase

Teacher needs, ambitions & wishes

3. Iterative Design Phase

Teacher: translates needs in a design solution

ER expert supports translating needs to a feasible design

AR expert helps distill ideas to AR design

Design of AR-ER activity in iterations by the teacher [optionally supported by ER and/or AR expert]

Validation by the experts

4. Iterative Development Phase

Development of AR-ER activity in iterations by the teacher

Using the AR-ER activity in teaching with students

Evaluation: collecting feedback

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eROBSON methodology details and template structure

We will now present how to apply the eROBSON design methodology. The phases of the eROBSON design methodology will be presented on slides with a blue background, while the corresponding sections of the design methodology template will follow on slides with white background.

eROBSON

eROBSON methodology
Phase 1. Inspiration

Demonstration of eROBSON approach as a source of ideas and inspirations

This phase is meant to frame design activities of participating teachers. Therefore the approach and the tools are first introduced and demonstrated to participants. Hands-on exercises might be a welcome addition if it is feasible (!). Filling in the provided template has two goals: to ensure understanding of the approach and to trigger participants in the direction of their own solutions, be a point of departure in their own design (phases 1 and further).

eROBSON methodology
Phase 1. Inspiration

- Preparation and inspiration
  - An **introduction** of ER, AR, and AR for ER (eROBSON approach)
  - A **hands-on task** with the specific ER kit - Littlebits (goal – new ideas and inspirations, what is possible with this package in my lessons, what concepts, what skills etc)
  - A **demonstration** of the specific AR platforms MirageXR and ARTutor
  - A **hands-on task** with MirageXR or ARTutor
- A discussion of the possibilities and possible caveats

eROBSON methodology template
Phase 1. Inspiration

1.1. Upon the **introduction** to eRobson approach

Write down your first impressions, thoughts and ideas based on the introduction of the eRobson approach in keywords or full sentences. Also write down questions raised by this introduction.

1.2. Upon the **demonstration** of ARTutor and/or MirageXR and **a hands-on session**

Write down your first impressions, thoughts and ideas based on the demonstration and hands-on session in keywords or full sentences. Write down your questions.

1.3. Ideas for my own lessons (optional at this stage)

What (new) opportunities do you see for applying the eRobson approach and/or the demonstrated tools? Write down any idea or thought, however fleeting, that this demonstration gave you? Write down questions to the eRobson experts. If you have a particular problem or issue in mind you can describe it here as well.

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eROBSON methodology
Phase 2. Preparation

Empathize & Define: Needs, ambitions and aspirations, challenges and barriers

In this phase, you will work on your own design based on and/or inspired by demonstrated eROBSON tools and solutions. You choose the scope of this design activity (i.e., a unit) yourself - it can be a lesson, part of a lesson or a lesson series. You will be asked to describe a broader context of this activity and some basic pre-requirements.

eROBSON methodology
Phase 2. Preparation

1. How can eRobson help?
2. Design scope
3. Context
4. Target group
5. Pedagogy
6. Specific pre-requirements and considerations

eROBSON methodology template
Phase 2. Preparation

2.1. Scope of my design

Write down if you want to design a series of activities with a common instructional goal, a single activity. You can have a lesson, a series of lessons or a part of a lesson in mind.

2.2. Context, target group, pedagogy (fill in what is applicable)

Describe the broader context of your design (the greater whole your design will be a part of). It can be a particular course or a module, intended for a specific target group or several target groups. If applicable, indicate what pedagogical approach you would like to follow in your design

2.3 "How can eRobson help?"

Please, check all relevant boxes and indicate in your own words what you plan to do differently from what you are doing now. Are you looking for substitutes of the current design? Are you looking for changes (improvements, modifications) to the current design? You might find points jotted down in phase 1 helpful.

2.4. Specific pre-requirements and considerations

Are there any specific considerations or pre-requirements that need to be taken care of prior to design activities /to ensure success?

eROBSON methodology
Phase 3. Design

Define & Ideate: Learning objectives – activities - content – learning outcomes

In this section, the teacher works closely with a designer/developer (or development team) with eRobson expertise. The teacher takes the lead in formulating the design and provides details on how the design will be used or should be used. An eROBSON expert supports the teacher with suggestions based on the selected tool (ARTutor or MirageXR) and AR expertise.

This section assumes there is only one learning activity. If there are multiple learning activities, such as in a complete course, there can be several templates filled in for each.

This phase is not linear but is envisaged as a series of iterations.

Each block can be revised, adjusted and extended in a next iteration.

eROBSON methodology
Phase 3. Design

1. Title of the course / activity
2. The learning activity
3. Learning goals
4. Outcomes
5. Content
6. ER components
7. AR in the learning activity: what & how

   Iterate ⬑

eROBSON methodology template (part 1)
Phase 3. Design

3.1. Title of the course / activity

3.2. The learning activity as intended (and to be designed)

Describe the intended learning activity as specific as possible from the perspective of the learner (what does the learner or what do learners do, what does the teacher do to instruct, support, assess this learning?)

You are invited to think out-of-the box, take the ideal situation in mind, try not to be restricted by the available or not available facilities and tools. Feel free to combine f2f, online and blended learning formats to the best of your understanding.

3.3. Aspired learning goals/aspired learning outcomes

What should the student know, understand and/or be able to do (better)?

3.4. The learning activity in detail

List the details (actions of the teacher and student or students in the order you expect them to take place, use a worksheet or construct a schematic representation of the activities in a flowchart or other type of visualization/diagram, if this works for you). Try to be as specific as possible as to what triggers an action and what follows after.

eROBSON methodology template (part 2)
Phase 3. Design

3.5. Content components

List content-related components (information & instruction, when applicable also media used to present information) that you want to use in the learning activity. It can be a theoretical introduction on paper, through video or given by the teacher live. Provide an explanation of the action that will accompany the content presentation (if applicable).

3.6. Intended application of AR in the learning activity

a. Describe (if possible) the intended application and function of AR (check all that apply and add if necessary for what purpose AR will be used. Provide explanation or specifications (if applicable)
b. Explain how you think to use AR for the purpose (or purposes) you indicated above.
c. Select AR-ER mechanics that are necessary for the design idea to be implemented

eROBSON methodology template (part 3)
Phase 3. Design

3.7 ER components (if applicable)
List here which ER components and practices will be used if this is relevant in your design. Consider how these ER components could potentially be supported by means of the application of AR.

3.8. Interaction
How will you describe interaction between teacher and student, teacher and learning materials, student and student, student and learning materials in relation to the use of AR (ARTutor or MirageXR)? You may use steps 3.2. and 3.4. to add relevant information to the flowchart or overview you had created.
Based on the initial design iteration, in consequent iterations it might be useful to further elaborate on 3.6 a & b and specify more in detail the interaction and learning processes with regards to the combination ER/AR and with respect to the AR features, depending on the ER scenarios/activities that the supervisor/teacher wants to implement.

3.9 Formative and summative assessment
How will the learning outcomes be measured? What instruments might be used for formative and/or summative purposes?

eROBSON methodology template (part 4)
Phase 3. Design

Are you satisfied with your design so far? Design in iterations

Go through steps 3.1 to 3.9 reviewing the design-under-construction and specify your description based on your communication with the eRobson expert and/or your improved understanding. Repeat the cycle of design until you are satisfied with the design backbone of the intended learning activity.
Additional components for the design template include but are not limited to the provided components. You may enrich the template with additional fields to specify design.

Finalizing phase 3

After completing phase 3, the teacher(s)/designer(s) will have a prototype design. As part of the design process, experts and colleagues can be included to provide feedback and insights whenever required. As part of the (phase 3) design process, the design can formally be reviewed. Review can be done together with the design(er)/(design team), by independent experts, and by the target audience.

eROBSON methodology
Phase 4. Development

Development is scripting of activities in detail, producing instruction, materials, tools and components, orchestrating and arranging them. In this section, the teacher explains the choices that were made during the development of materials and implementation phase. Also, an elaboration is given regarding the educational opportunities and affordances these choices provide.

Examples of educational materials can be: software and applications, digital/electronic learning environments, paper learning materials, ER platforms, robotic setups and materials, AR applications, teaching/course plans, teaching guidelines, presentations/lecture materials, etc.

eROBSON methodology
Phase 4. Development

1. Detail script of the *teacher-learner(s)-tools* interaction

2. ER-AR materials, tools and components to be developed

3. Learning /teaching materials besides ER/AR : Instruction, guidance, scaffolds ... to be integrated in the tool or provided just-in-time

4. Communication/collaboration between learners (if applicable)

5. (Tools for) monitoring, feedback, formative and summative assessment

6. References and sources (if applicable)

Iterate ⬏

eROBSON methodology template (part 1)
Phase 4. Development

4.1. Detail script of the teacher-learner(s)-tools interaction
Use your design blueprint (flowchart) created in 3.4 to support the development process and check boxes when prototypes are developed and tested.

4.2. ER/AR materials, tools and components to be developed
Select what is applicable and add necessary details. Check when components are in place).

Make it clear where the user can obtain the necessary materials. F.e., for the ER platforms, this will be in the form of physical hardware/software kit that can either be purchased or can be made available via a loan. The required and associated AR application can be obtained via a download.

4.3. Developed learning /teaching materials besides ER/AR materials, tools, components (Instruction, guidance, scaffolds materials (to be integrated in the tool or to be provided by the teacher just in time)
Provide an overview of the other, non-AR materials used. Include details on the developed learning materials when you have them (after the respective iteration).

eROBSON methodology template (part 1)
Phase 4. Development

4.4. Communication between learners /peer collaboration (if applicable)

4.5. Tools for monitoring, feedback, formative and summative assessment

4.6. References and sources (if applicable)

Meta-data (provide keywords that describe your design, this field can be filled in at any point in the process, also at completion)

References and Resources

Over-all studied methodologies

ADDIE-Model:

https://teachingcommons.stanford.edu/explore-teaching-guides/online-teaching-guide/theory-practice/addie-instructional-design-framework

SAM-Model:

https://elmlearning.com/blog/sam-successive-approximation-model-approach/

https://dli.kennesaw.edu/resources/idmodels/sam.php

Design Thinking:

Design Thinking Process — Stephanie Baseman

SAMR-model:

https://www.edutopia.org/article/powerful-model-understanding-good-tech-integration