

Webinar Series on
Techno-Pedagogy –Content Creation

Creating Interactive Simulations for Learning

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Which feature makes a digital resource genuinely interactive?

- A. Clicking buttons
- B. Watching animations
- C. Manipulating variables
- D. Making predictions and testing them
- E. Discussing and explaining results

• *Note: simply clicking something does not necessarily mean that learning is interactive. The deeper form of interaction occurs when the learner's action **changes something meaningful and generates information that the learner must interpret.***



Which of these is a simulation?

A. A video of a pendulum

- Fixed. You watch.

B. A pendulum where you change length and gravity

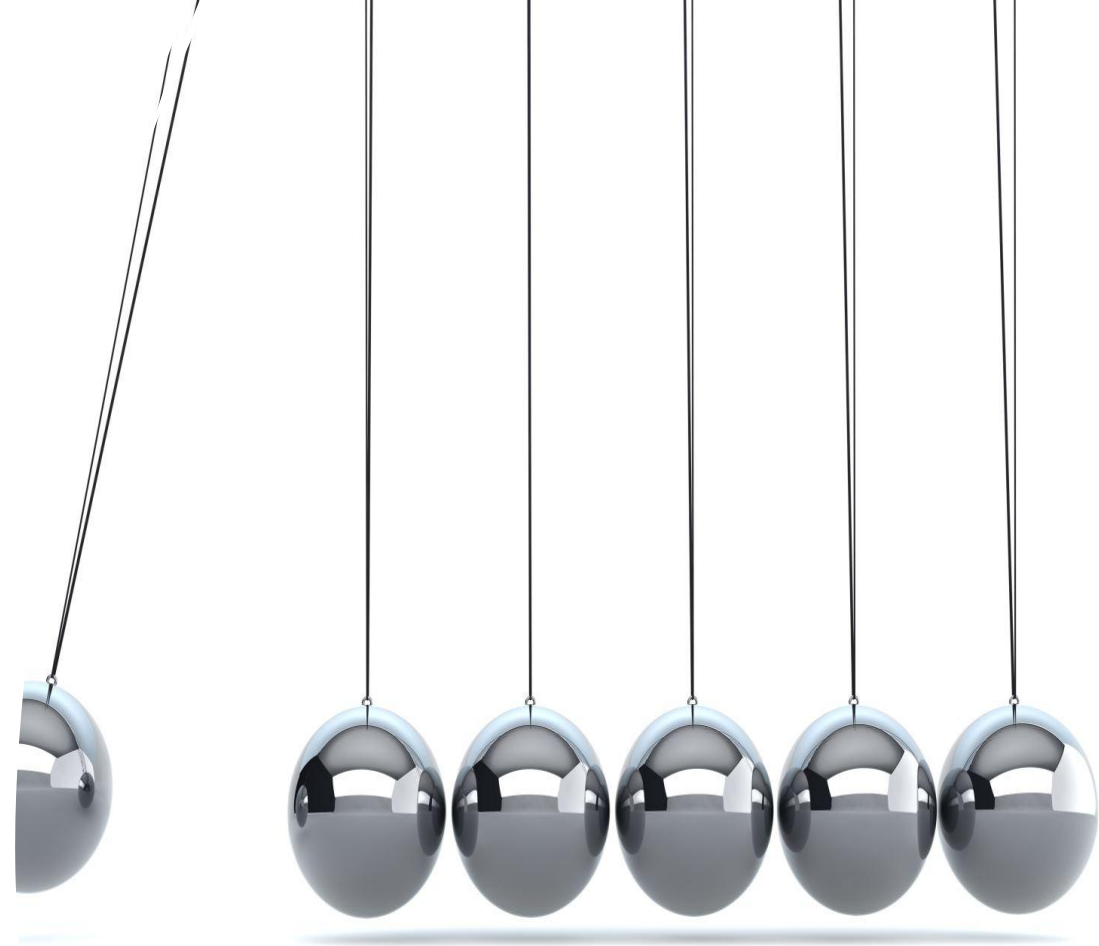
- Model responds to you.

C. A quiz with a pendulum picture

- Picture is decoration.

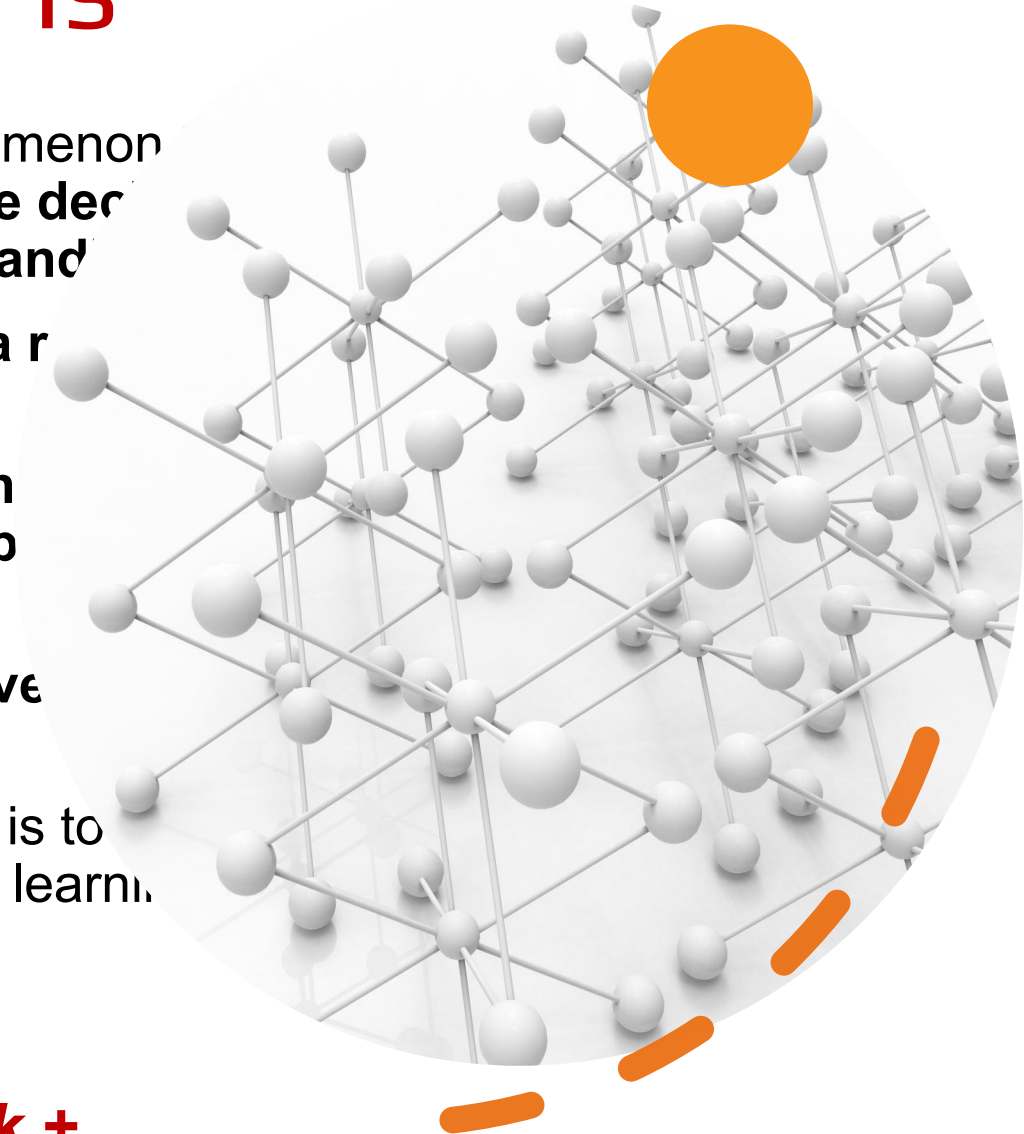
D. A virtual lab with real data fed in

- Model plus real measurements.



An interactive simulation is

- ✓ A dynamic representation of a system, process or phenomenon allows learners to **manipulate selected variables, make decisions, observe outcomes, test ideas and construct understanding**
 - ✓ An interactive simulation is a **digital representation of a real system, process, phenomenon, or situation.**
 - ✓ Simulation is essentially a **model of a system that learners can interact with** and allows learners to explore “What happens if...?” questions.
 - ✓ The focus is not merely on viewing but on interaction, **investigation and learning.**
 - ✓ It doesn't have to reproduce reality perfectly. Its purpose is to represent the aspects of reality that are important for the learning objective.”
- ✓ ***Simulation = Model + Interaction + Feedback + Learning***





Animation/Video Vs Interactive Simulation

VIDEO/ANIMATION	INTERACTIVE SIMULATION
Mainly shows what happens	Allows learners to explore what happens
Learner mostly watches	Learner actively interacts
Sequence is generally fixed	Outcomes can change
Limited learner control	Learner controls variables
Demonstrates a concept	Supports investigation

Simulation vs Animation vs Video vs Virtual Lab

Resource	Learner control	Dynamic response	Experimentation
Video	Low	No	Limited
Animation	Low–medium	Usually predetermined	Limited
Simulation	High	Yes	Yes
Virtual Lab	High	Yes	Yes – experimental context

Why Use Simulations for Learning?

Note: Simulations help most when guided by a task and a question. Free play without prompts often produces fun but shallow learning. The teacher's design matters more than the tool.

“Simulation is particularly useful when the phenomenon is invisible, dangerous, expensive, very fast, very slow, microscopic, macroscopic or difficult to reproduce in the classroom.”

- **Make the invisible visible**
 - Electric fields, population change, particle motion, probability over thousands of trials.
- **Safe to fail**
 - Dangerous, costly or slow experiments become possible, and mistakes cost nothing.
- **Learner as investigator**
 - Changing one variable at a time builds causal reasoning, not memorised answers.
- **Instant feedback**
 - The system answers back within a second, so students test ideas as they have them.

The Pedagogical Power of "What If?"

- What do you think will happen if...?"
- Examples:
 - **Physics:** What happens if force doubles?
 - **Chemistry:** What happens if temperature increases?
 - **Biology:** What happens if a predator population decreases?
 - **Mathematics:** What happens to probability after 1,000 trials?
- *This is where simulation becomes pedagogically powerful.*

Why should teachers use simulations?

1. Visualise abstract concepts.
2. Explore phenomena that are difficult to observe directly.
3. Learn through experimentation.
4. Understand cause-and-effect relationships.
5. Test hypotheses safely.
6. Learn from mistakes.
7. Develop problem-solving and inquiry skills.





Simulation based pedagogica | Approaches



Inquiry-based learning

Experiential learning

Problem-based learning

Constructivist learning

Collaborative learning

Formative assessment

What kinds of concepts are suitable for simulations?



Dynamic processes



Abstract or invisible phenomena



Cause-and-effect relationships



Systems with multiple variables



Processes that are expensive, dangerous or difficult to reproduce



Situations requiring repeated experimentation

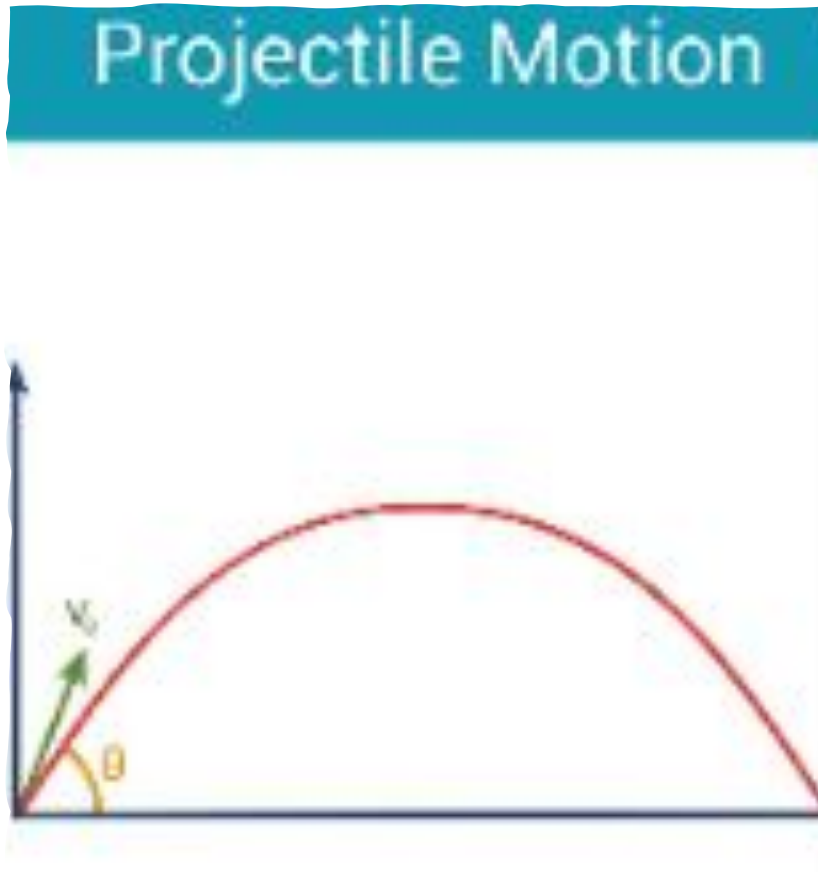
How does simulation make learners active?

- Learners move from **consuming information** to **constructing understanding**.

**Predict → Manipulate → Observe → Compare →
Explain → Reflect**

- What will happen?
- Why did it happen?
- What changes if I modify a variable?
- Was my prediction correct?
- What can I conclude?

Part 1: How to create an interactive simulation — the step-by-step design and development process



Step1: Start with the learning objective

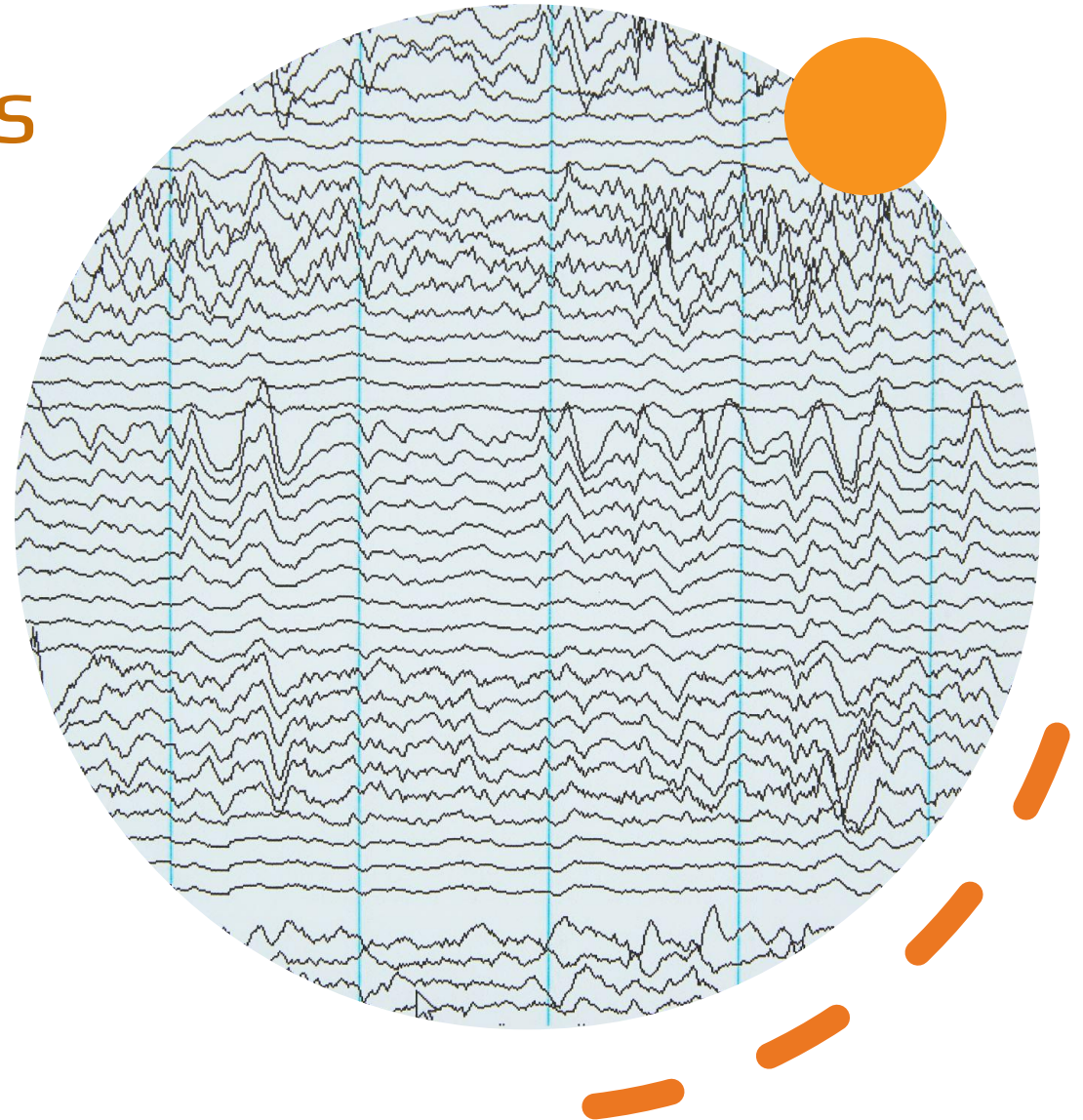
- Define the system that the simulation will represent.
- Identify the key phenomenon.
- Select independent and dependent variables.
- Determine the relationships between them.

Example: Launch angle and initial velocity are inputs; trajectory, height and range are outputs.

Step 2: Identify the phenomenon and variables

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- Identify the key phenomenon.
- Select independent and dependent variables.
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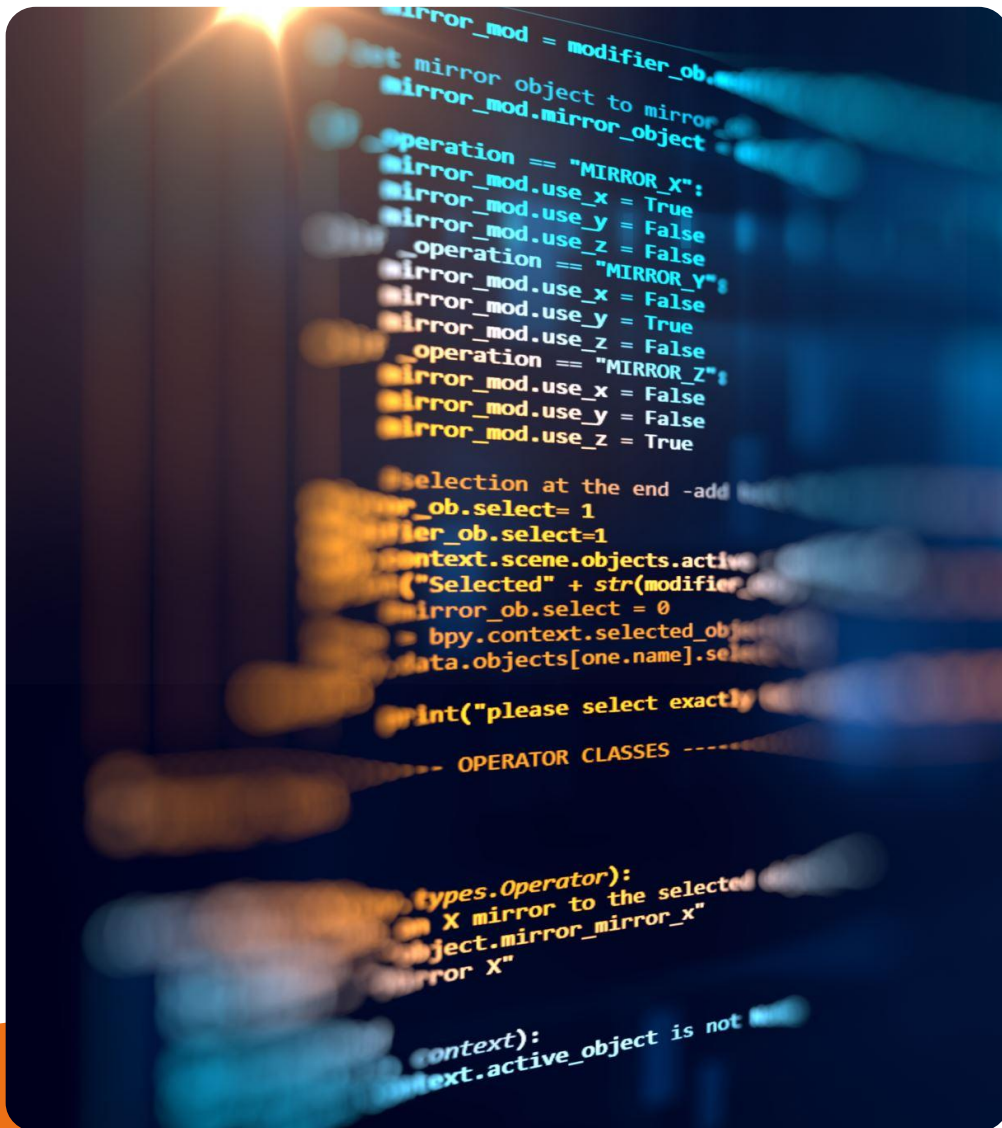




Step 3: Develop a Script and storyboard

- Plan the simulation before using software.
- What will learners see?
- Which controls will they use?
- What changes will appear?
- What questions will guide them?

Example: A projectile, an angle slider, a velocity control and a live trajectory display.



Step 4: Select the technology

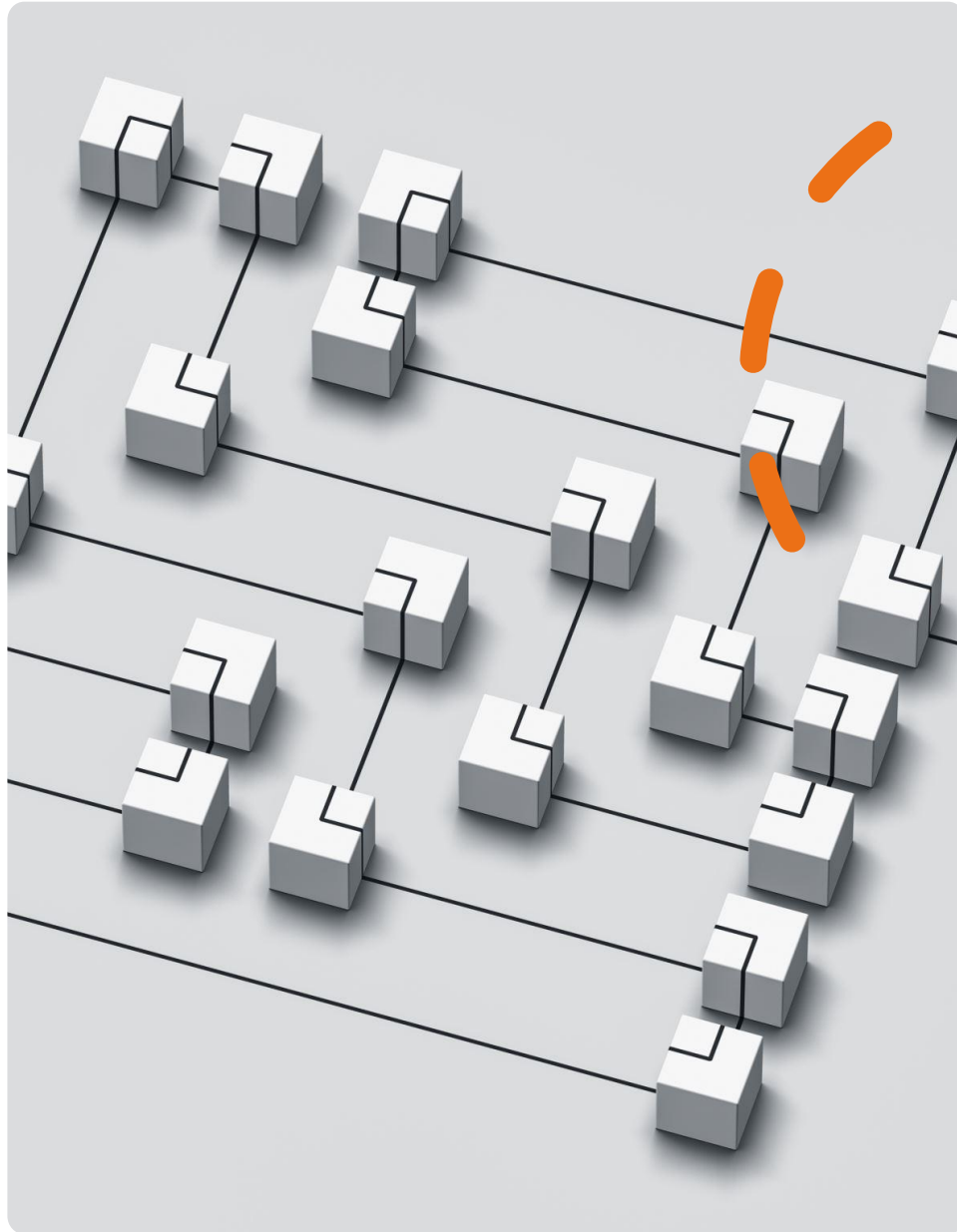
- Choose tools according to the learning objective, technical capacity and available resources.
- No-code interactive authoring tools
- Presentation software with interactive elements
- Browser-based simulation development
- Programming environments, where appropriate

The tool should make it easier to create meaningful learner interaction, not add unnecessary complexity.

Choose a tool by effort and need

Effort	Options (check current availability)	Best for
Use as is	PhET, Concord Consortium, DIKSHA Virtual Labs and ePathshala resources, Desmos	Quick wins, subject-specific concepts
Customise, no code	GeoGebra, Desmos, Google Sheets with sliders, PowerPoint triggers, Genially, H5P	Maths, data, branching scenarios
Low code	Scratch, Twine, NetLogo, Tinkercad	Agent-based models, stories, electronics
Write code	HTML and JavaScript, p5.js, Python notebooks, AI assistants that generate a first draft	Fully custom, shareable web pages

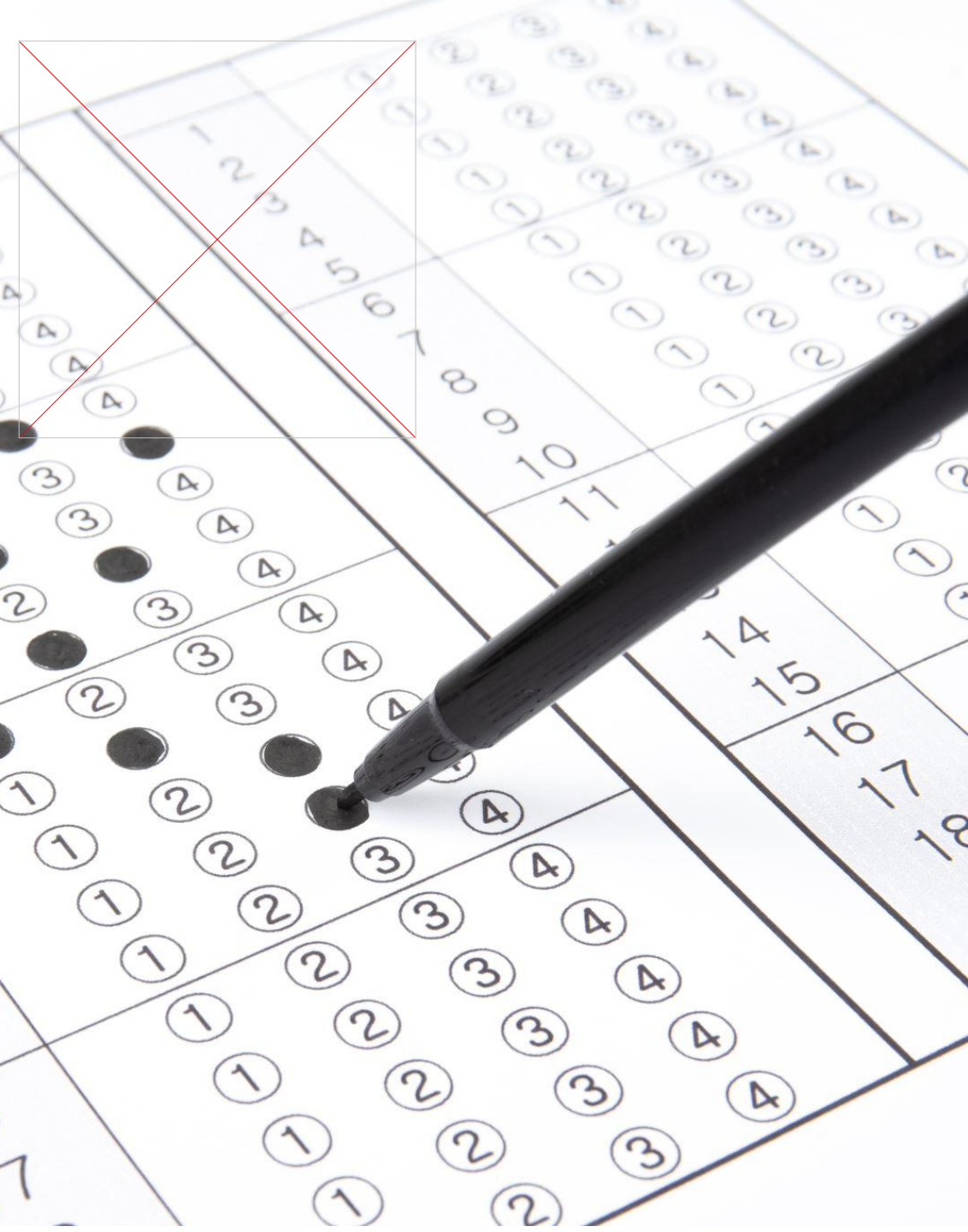
Tip on AI. An AI assistant can draft a simulation from a clear prompt. Always check the underlying science and test every slider extreme before using it with students.



Step 5: Build the interaction

- Develop the relationship between learner actions and system behaviour.
- Add controls such as sliders, buttons or choices.
- Define how the variables affect the model.
- Display the resulting changes.
- Provide relevant feedback.

Example: Changing the launch angle updates the trajectory and calculated range.

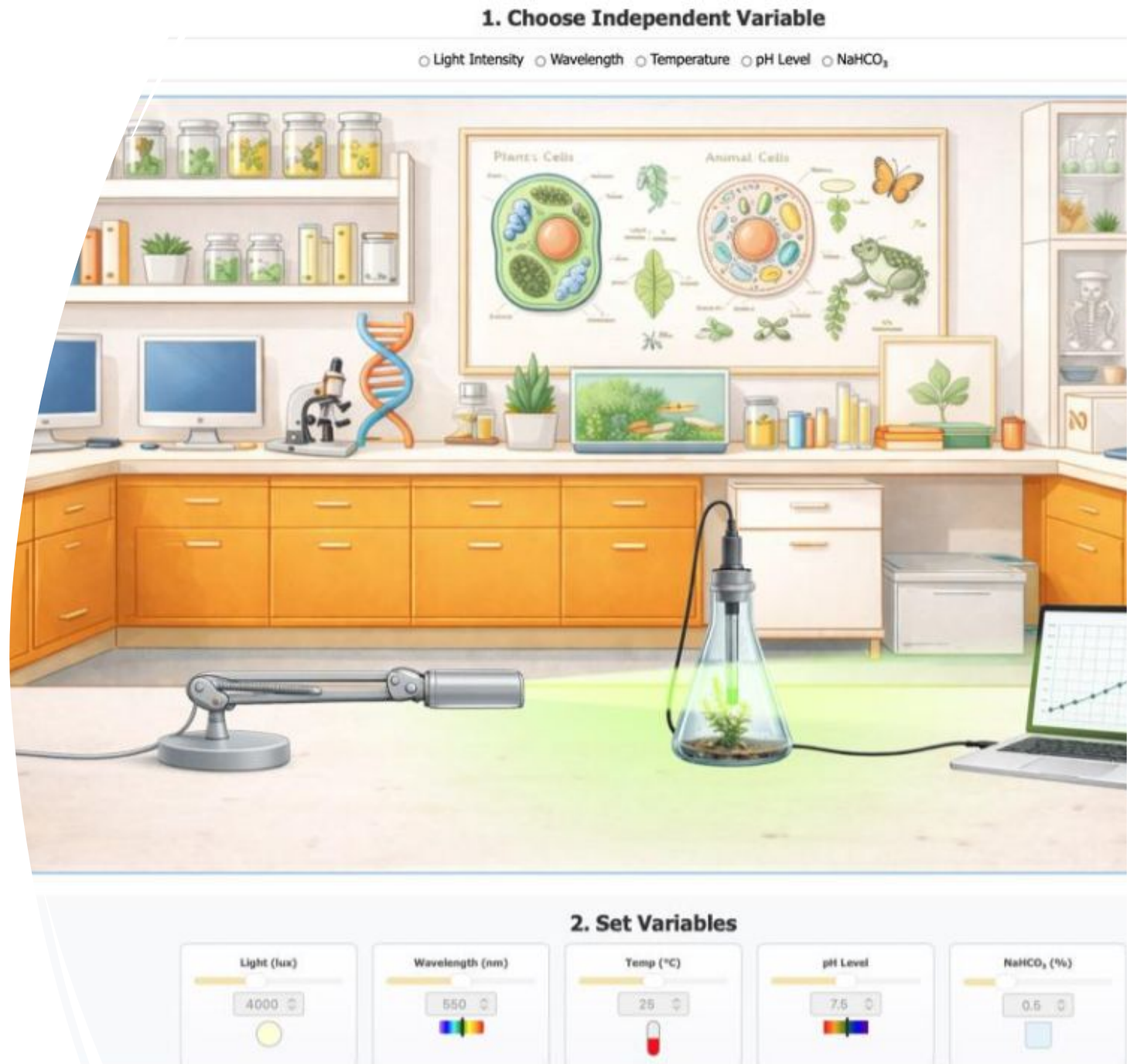


Step 6: Test, refine and evaluate

- ✓ Verify the underlying model.
- ✓ Check the simulation for both scientific accuracy and learning effectiveness.
- ✓ Check whether controls work correctly.
- ✓ Test instructions and accessibility.
- ✓ Ask learners to use it and explain their observations.
- ✓ Revise the design using feedback.

Anatomy of a good interactive simulation

A good simulation is more than an animated screen with buttons. It is a carefully designed interactive learning environment in which every component serves a purpose.



Conceptual layout of the essential elements of a simulation.

Anatomy of a good Simulation

Learning objective: Defines what the learner should understand or be able to do.

Conceptual model: Governed by real rules (a formula, a rule set), not a pre-recorded animation or Represents the real-world phenomenon through rules, relationships or mathematical principles.

Few controls Variables : Represent the factors that can be changed or observed. Two to four variables. Each control maps to one idea you want students to explore.

Controls and interaction: Allow learners to manipulate the model and investigate outcomes. Example: Sliders to adjust the angle and initial velocity.

Visual representation and Visible feedback: Makes system behaviour and relationships visible and understandable. Graphs, numbers and motion update together, so cause and effect are easy to see. Example: A moving projectile, trajectory and range indicator.

Reflection and assessment: Helps learners interpret evidence, articulate understanding and apply concept. Example: Explain why the range changes when the angle is adjusted.

Pre-requisites for creating a Interactive Simulation



State the problem the simulation will solve.

Identify the target audience, including their experience level, context, and accessibility needs.

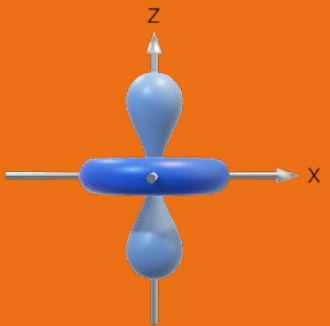
Write two to five measurable learning objectives using action verbs such as **identify**, **diagnose**, **prioritize**, **configure**, or **respond**.

Define what learners should be able to do differently after completing the simulation.

Specify whether the simulation is intended for practice, assessment, onboarding, certification, or decision support.



Select the Right Simulation Type



- **Branching scenario**: Learners choose actions and experience different consequences.
- **Process simulation**: Learners complete a sequence of operational steps.
- **Role-play simulation**: Learners interact with characters, customers, patients, colleagues, or stakeholders.
- **System simulation**: Learners operate a realistic interface, tool, dashboard, or technical environment.
- **Problem-solving simulation**: Learners analyse information, identify risks, and select a solution.
- **Sandbox simulation**: Learners experiment freely and observe how variables affect outcomes.

Sketch your own simulation

Step 1 · Concept (2 min)

Pick one hard-to-picture idea from your subject.

Step 2 · System (3 min)

List the variables. Choose 2–3 inputs and 1–2 outputs.

Step 3 · Task (3 min)

Write the prediction question and one challenge.

Step 4 · Tool (2 min)

Choose the lowest-effort tool that works.

An abstract geometric pattern featuring various shapes in orange and brown on a light gray background. The shapes include a large orange circle at the bottom left, a brown-outlined triangle at the top left, a brown-outlined square at the bottom right, a large orange semi-circle in the center, a small orange circle on the left, a red circle at the top right, and several orange dashed lines of varying lengths scattered throughout.

An abstract geometric composition featuring various shapes in orange and brown on a white background. The shapes include a large orange circle at the bottom left, a brown-outlined triangle at the top left, a brown-outlined square at the bottom right, a large orange semi-circle in the center, a small orange circle on the left, a red circle at the top center, and several orange and brown line segments of varying lengths and orientations scattered throughout.

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Simulation Application

Content (CK)

What should learners understand?

Pedagogy (PK)

How will learners explore and learn it?

Technology (TK)

Which technology can support the learning?

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How can all three work together effectively?

Simulation becomes powerful when technology supports the way the content needs to be learned.

- **Content Knowledge: What Should Students Learn?**
 - Start by identifying the **content concept**.
- **Pedagogical Knowledge: How Will Students Learn? Should students predict? Should they experiment?**
- **Technological Knowledge: How Can Technology Support Learning?** Technology should provide capabilities that are difficult to achieve through static content. Eg. Manipulating variables, Visualising invisible processes, Repeating experiments, Providing immediate feedback, Comparing multiple conditions

When Should We Use a Simulation?

Use simulation when learners need to:

- ✓ Manipulate Variables
- ✓ Observe Relationships
- ✓ Explore “What-if” Situations
- ✓ Investigate Invisible Processes
 - ✓ Repeat Experiments
 - ✓ Compare Scenarios
 - ✓ Test Predictions
- ✓ Understand Dynamic Systems

Avoid simulation when:

- ✗ Simple Explanation Is Sufficient
- ✗ Interaction Adds No Learning Value
- ✗ Technology Becomes The Objective



A good simulation is designed for
thinking, not just clicking.