

Spoon workshop proposal - teacher training

Title: Research elements in classroom: STEM 2.0 - Stimulating, Team, Experimental and Motivating teaching

Duration: 4 hr

Number of participants: 20

Aims: Realize how research practice and research values can be implemented in teaching within classroom environment. Realize that pupils high cognitive activation can be achieved with low budget materials and approaches. Introduce the concept of backward teaching design. Realize the importance of model development in research practice. Realize importance of observation, assumption, exploration, discovery, testing and communication in scientific method. Inspire the teachers to reshape their teaching backwards in order not to serve to them what they they should know but to motivate them to want to know. Realize the importance of errors and its impacts in teaching and learning processes.

Materials:

- pack A4 papers in various colors,
- pack of felt tip pens in various colors,
- set of whiteboard / flipchart markers,
- pack of flipchart papers,
- pack of PVC cups 0,2 dcl in various colors, minimum 25 pieces,
- 0,5 kg of raw rice,
- 10 matchboxes,
- 1l of cold water,
- 7 syringes with measuring scale 20 ml,
- 20 x paper measuring tape (IKEA style)

Technical backline:

- projector with VGA connector
- speakers with stereo connector
- presenting surface
- room with moveable chairs and tables
- Kitchen weight scale

Announcement (for public):

One of the most beautiful elements of the teaching profession is to inspire students to want more. Sometimes it looks hard to flip the teaching practice in order for the curriculum to come as a fulfillment of pupils wishes and needs and not just like the next bullet point in rigid teaching plan and program. Inquiry-based teaching, teaching with self-discovery, teaching based on research - all are modern terms which are sometimes extremely difficult to achieve in the classroom. Ask yourself how can I teach my students effectively but cheap, short but correctly what is scientific research? Do I know what would that be? How can I show them what is the scientific approach, what is a theoretical model and what is the purpose of the experiment? How is a model developed and why are some complicated while others have simplifications? How to design an experiment to test the hypothesis and how to control the variables? Why is it important to make mistakes and learn from them? On this workshop, you will go through exercises and activities which can be used to refresh and spice up your teaching. You will refresh your approaches to present to your students all the beauty and at the same time complicated process behind scientific research. By guiding your student to explore their needs and making them want to know students are growing into active accomplices in building their own knowledge and skills.

Step-by-Step instructions

- **Energizer: lost instructions** (~ 15 - 20 min)

Keywords: creativity, improvisation, interpretation, instructions, guidelines, expression, reflection, valuing differences

Subaims: Ease up the atmosphere; Laugh; Reflect how same instructions and guidelines can be interpreted differently; Become aware how it is difficult to follow simple rules and teachers often underestimate the student capacities.

 - Individual: Each person receives one A4 blank (random colors) piece of paper.
 - Guidelines: Close your eyes and keep them closed. Do this in silence. No questions! Fold the paper in half. Make a hole on top right corner. Rotate paper for 90 degrees. Make a hole on bottom middle edge. Fold a paper in half. Rotate for 180 degrees. Open the paper once. Flip the paper. Make a hole on bottom left corner. Rotate 270 degrees....and so on...
 - Open the paper, raise it above your heads.
 - **KODAK moment:** from behind
 - Open your eyes and observe.
 - Couple of volunteers (up to four) reflect what they see. And propose what could have I done in order to make it more "similar". Guidelines:
 - Why does everyone's creation look different?
 - What was the first question you wanted to ask, if you could have? What was the second, etc?
 - Whose design is the right one?
 - What might this result suggest in terms of how teaching processes work?
 - What are the strengths and limitations of everyone being different?
 - What impact does this knowledge have on your preparation for teaching / analysis after / repeating the same teaching scenario after a year or two / note taking, questioning, lab books?
 - **Punchline:** no battle plan will survive the encounter with the enemy & there are always holes in a plan
- **Lecture: teaching and learning** (~ 10 min)

Keywords: Learning methods: Trial and error, model based, punishment and award, inquiry based learning;
Teaching approaches: frontal, demonstration, facilitation, self - organization
Cognitive activation: listening, reading, taking notes, exercise alone, discussion, problem solving

Subaims: Reminder about learning methods and cognitive activation theory. Raise awareness how teaching process should be as research process: investigation and teacher learning from mistakes

 - Lecture / presentation
 - **Punchline:** teaching should be combination of various approaches and methods
 - **Punchline:** don't tell them what they are supposed to know, make them want to know
- **Brainstorm: Elements of research** (~ 20 - 30 min)

Keywords: self reflection, individual work, group work, elements of research practice, teaching problem solving

Subaims: Analyse research elements; Reflect on research practice; Share points of view

 - Individual: make a list of research elements
 - Group (up to 6) share your lists, agree on elements and write down one element per paper (¼ A4 ribbons in various colors)
 - With masking/painter tape each group creates a collage on a wall
 - Collages are analysed and discussed
 - **Note:** expectation/ problems
 - teachers presents OCD with their collages
 - The linear approach to solving a problem is visible. Single path from a problem to a solution. Cookbook
 - **Debriefing:** we tend to find excuses in others, curriculum, materials, system while the real problem is in us. We have to teach inquiry, thinking outside of the box, critical skills while we haven't been taught that
 - **Punchline:** you are better in sharing the things you experienced
- **Model & Experiment** (~ 20 - 30 min)

Keywords: brainstorm; scientific model; experiment; self reflection, individual work

Subaims: Self Reflection on importance and meaning of model, model development and experiment in research practice and scientific approach;

- Individual work: Define/explain what is the model - write explanation on postit
Additional guidelines: how do you explain to your students what is the model in science
- Individual work: Define/explain what is the experiment - write explanation on postit
- Group work: Place all postits on a wall, observe, analyse and reflect what is written on them

● **Rice in a box** (~ 45 min - 60 min)

Keywords: Practical work, guesstimation, team work, experiment, modeling, measuring

Subaims:

- In groups of (up to) five. Each group receives empty match box, 10 - 15 rice grains, colored papers, felt-tip pens, paper measuring tape.
- Group assignment: estimate how many rice grains fit in matchbox
- **Model development (~20 min):** Each group presents the estimated number, developed model, good and bad sides of the model, approach in model creation
 - Estimates are written on a flipchart
 - Reflection on errors
 - *Guidelines for discussion/ debriefing:*
Development of model: What is the estimation? What was your approach in solving the problem? Do you have notes? Are your thoughts clear from those notes (reproducibility)? Have you estimated the error, how? How sure you are in your number?
Model assumptions: All grains of the same size; Equal distribution/order in a matchbox; model faults and shortages;
- **Experiment development (~20 min):** Groups receive half a cup of rice and they have to set up experimental protocol in order to answer the original question (find evidences for their hypothesis - model estimations)
- Materials at their disposal water, analytical scale, syringes. They have to decide which measuring equipment they will use, think of justification for those specific equipment, and prepare for measuring so it is optimized and within allocated time frame.
 - Measurements are written on a flipchart
 - Reflection on errors
 - *Guidelines for discussion/ debriefing:*
What was your approach in developing experimental protocol? Do you have notes? Is your experiment reproducible from your lab-book? What are the good / bad sides of your protocol?
- **Analysis of learning/ teaching goals (~10 min):**
 - What are your open questions? In other words what do you want to know?
 - On a paper individually reflect and write down what are the official / curriculum learning-teaching goals of rice in a box activity. Why that activity was developed and what was I trying to teach them?
Official: middle year program (12 yr olds) their first contact with physics - defining and measuring length, surface area & volume. It can be used as introduction to density.

● **Movie: Dan Meyer - Math class needs a makeover @ TEDx NYED** (~ 12 min)

https://www.ted.com/talks/dan_meyer_math_curriculum_makeover

Keywords: Motivation; Example of classroom activities; Backward teaching; video

Subaims: Example of classroom-tested math exercises that prompt students to stop and think.

● **Reverse your teaching** (~ 45 - 60 min)

Keywords: Outcomes, Evidence, Experiences, Instruction, Backward Design, group work

Subaims: Develop ideas for backward courses; Practice the design process with the focus on desired results

- Teams (of four) are given certain problem/ task/ learning outcome - **yet to be defined which one or should the participants choose by themselves**
Rather than beginning the planning process with a focus on supporting exercises, resources or long-used textbooks, the participants focuses on the learners/students and begins the design

process by asking what learners should be able *to understand and do* after the provided instruction.

○ **1: Identify Desired Outcomes:**

Individually within the team: Articulate what learners should be able to understand and do after provided instruction.

Thinking guidelines: what should they learn? What should they remember next year? What is important to teacher about the material/content? About the way you plan to teach the material/content? About how the students interact with the content?

- Share your thoughts with the rest of the team. Analyse and merge to consensus.
- Frame the challenge: Write up a short “brief” that clarifies the challenge you would like to address. Write it as if you were handing it to someone else to design with. Write down the statement/ articulation on the paper with big letters and leave it in the center of the group. Keep rewriting your statement until it feels approachable, understandable and actionable to everyone in the team.

Additional guidelines if some groups are faster: use P.O.V. statements (Points Of View) - meaningful and actionable problem statement, which will allow you to ideate in a goal-oriented manner. Articulate the statement by combining these three elements – user, need, and insight. You can articulate your POV by inserting your information about your user, the needs and your insights (experience and personal knowledge) in the following sentence:

[User . . . (descriptive)] needs [need . . . (verb)] because [insight. . . (compelling)]

AIM: a clear design challenge expressed in one sentence

EXAMPLE from rice in a matchbox:

- Student needs to understand the importance of international agreement on names of variables and measuring units because of easier collaboration and sharing of insights.
- Student needs to perform specific measurements of length, surface area and volume.

○ **2: Identify Acceptable Evidence:**

Individually within the team: Determine what types of assessments and measures would clarify (or serve as evidence of) when and whether students can perform the desired outcome.

Thinking guidelines: Skip directly to the end of the course. Distill five (or fewer!) major learning outcomes. (If this number is too small for comfort, you can add more later if you really must... but stick with 5 or fewer now. This is the way to get to the underlying, often unifying, themes of your course/material/content.)

- Share your thoughts with the rest of the team. Analyse and merge to consensus. Write down the assessments/outcomes on postits and place them around the central statement. Think broadly about these outcomes/assesments. Content or foundational knowledge is but one broad category in which you might have specific goals.

EXAMPLE from rice in a matchbox:

- Measured the length, surface area and volume with the usage of personal vocabulary
- Presented approaches and the model development
- Analysed acquired results and discussed possible errors
- Students are involved and eager to find the solution

○ **3. Open brainstorm:**

Individually write ideas (idea per postit) as much as possible. Don't worry about feasibility and materials. Be crazy and wild. Propose options on what one can do once when that/those specific skill/knowledge is acquired. Write your proposals as a questions which are not implying the

solution. Work backwards. What skills will demonstrate achievement of the learning goals? What content is required to support those skills?

- Share your thoughts/ideas/proposals with the rest of the team. With couple of rules for the team:
 - Don't judge
 - Don't question
 - Don't comment
 - There are no bad ideas
 - Ideas can be crazily huge
 - Build on other ideas (if you are inspired by something write it down on a postit and add it on the table on your turn or at the end)
 - You can make a drawing of your idea
 - The more the merrier
- After each member of the group presented ideas work collaboratively to refine/reshape/organize and structure ideas on post it. Cluster them and sort them. If some ideas are to abstract or to heavy place them on the side.

EXAMPLE from rice in a matchbox:

- How can you tell which planet is larger?
- If you want to completely renovate your house, hardwood floor, electrical lines, plumbing, painting how much would it cost?
- How many ping-pong balls can fit in this classroom?
- **3: Plan Learning Experiences and Instruction:**
Develop exercises, materials and instruction around the desired outcomes and evidence.
- **4. Team presentations:**
Each team presents conclusions as a question/problem which could be introduced to students. List of learning goals and assessments. List of materials needed to perform it. And couple of bullets on how they would proceed with the activity.
- Inspiration & resources:
 - [Backward design by Grant Wiggins and Jay McTighe](#)
 - [Designing courses backwards by Stanford teaching commons](#)
- **Feedback** (~ 10 min)
 - Open ended survey with guiding questions
 - Individually & anonymously write down on a paper...
 - I was surprised by/ liked/ learned/ became aware of/ reminded
 - I could/ should/ would use this In
 - I would like to change about this workshop