Scientific Creativity in the STEM subjects

Kurt Haim & Wolfgang Aschauer

April 2023

Block 2 / Friday

Co-funded by the European Union

Scientific Creativity in the Classroom

Original Associations

with

CLUSTERING & WoSeCo

Kurt Haim & Wolfgang Aschauer

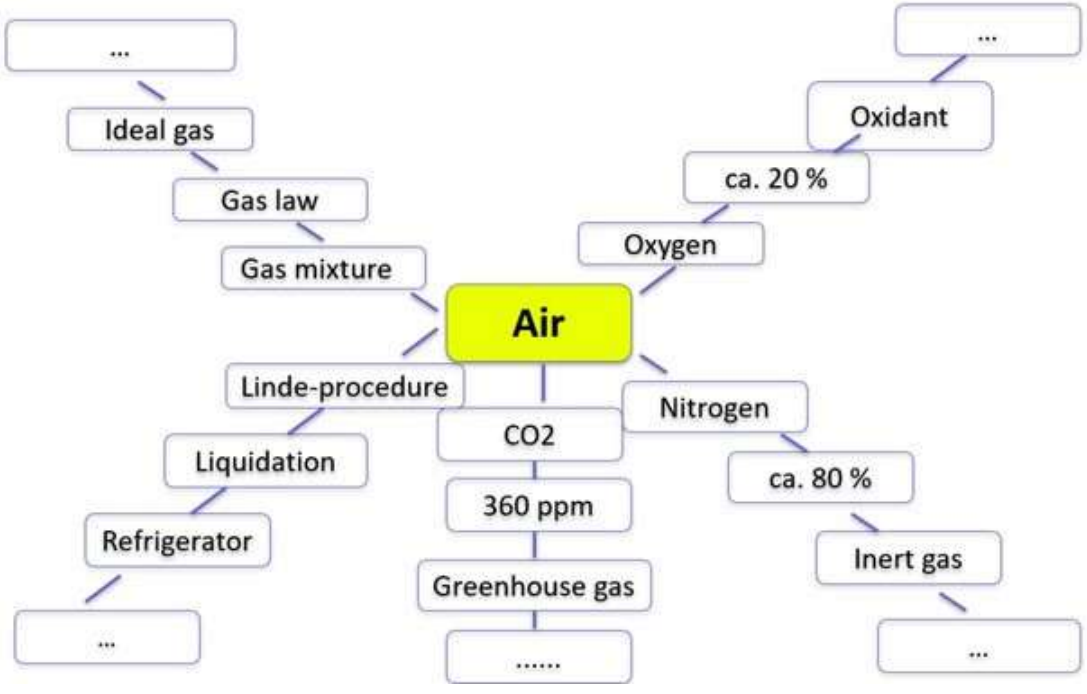
ASSOCIATION is the meaningful linking of terms that originate from a specialized domain.

Example: ***Sulphur*** *is a* ***chemical element.***

ORIGINAL ASSOCIATION is created by combining **distant** terms **within** a subject domain.

Example: In chemistry, the symbol ***S*** *stands for both the element* ***Sulphur*** *and* ***entropy.***

Scientific Creativity in the Classroom



Clustering

Structured & Stormy

Kurt Haim

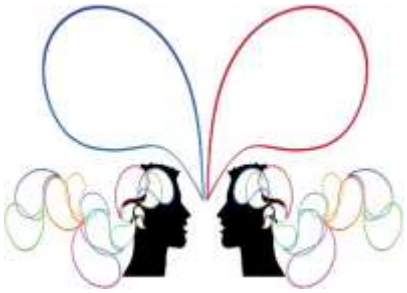
die pädagogische hochschule oberösterreich

flex based learning

Clustering

Goals

- Structuring of the material
- Correct interpretation and assignment of technical terms
- Fluency in thinking (see verbal form)
- Preparation for associative ability in WoSeCo



Structured Clustering
Written Form

Task

Students collect all the terms covered in a chapter and record them written down in the form of a cluster.

Theme

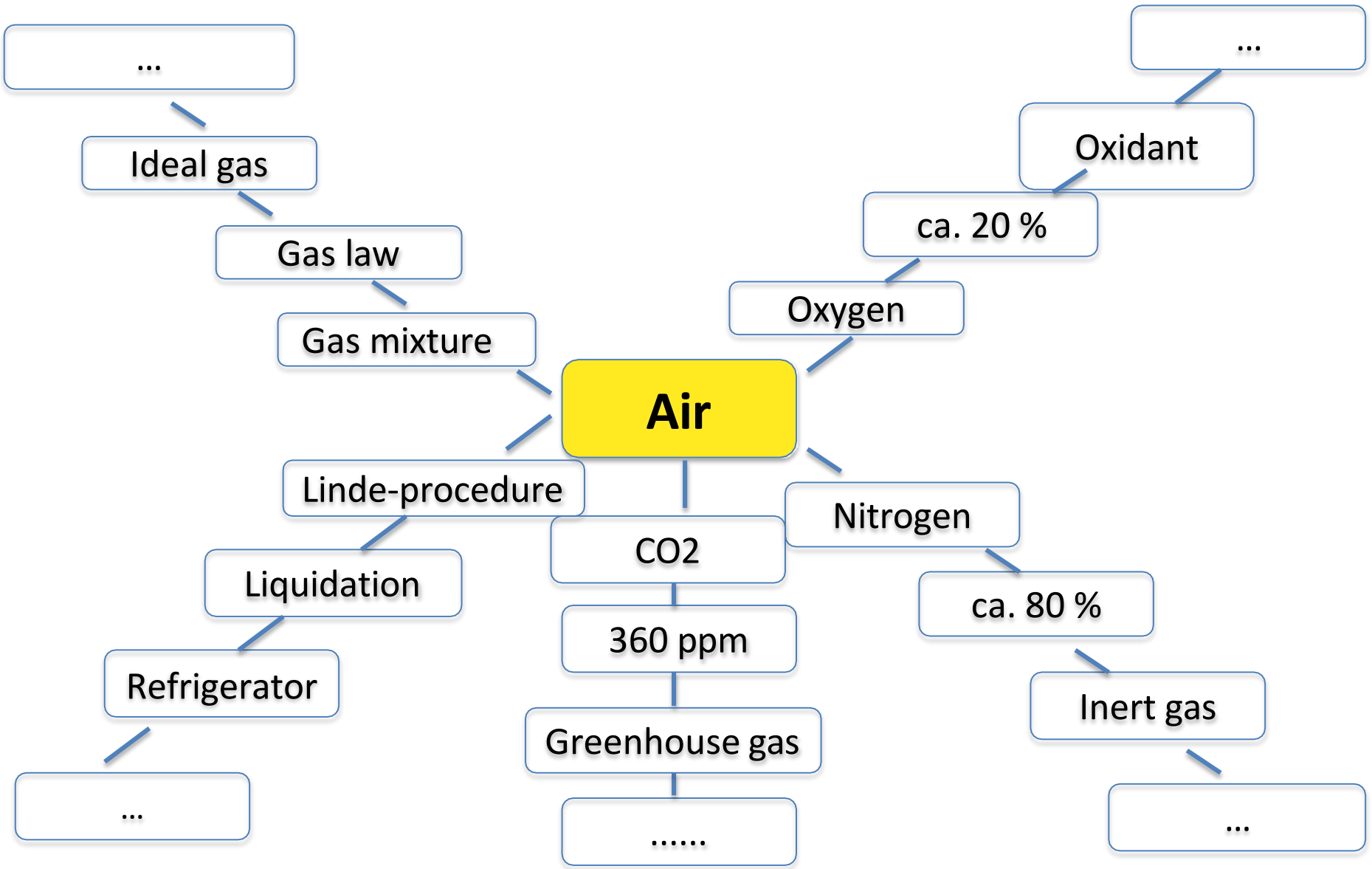
- Within a chapter

Social Form

- Single-Cluster or Team-Cluster

Structured Clustering

Example



Stormy Clustering

Verbal Form

Name as many words as possible for 2 minutes that come to mind intuitively for a certain topic!

Without interruption!

DATA & FACTS

Goal

- Building up a strong semantic network

Requirements

- Technical vocabulary & high concentration

HINT: Verbal form is the basis for effective creativity techniques

Stormy Clustering

Procedure

1. The teacher sets the topic and limits the verbal clustering to a certain time (e.g. 2 min.)

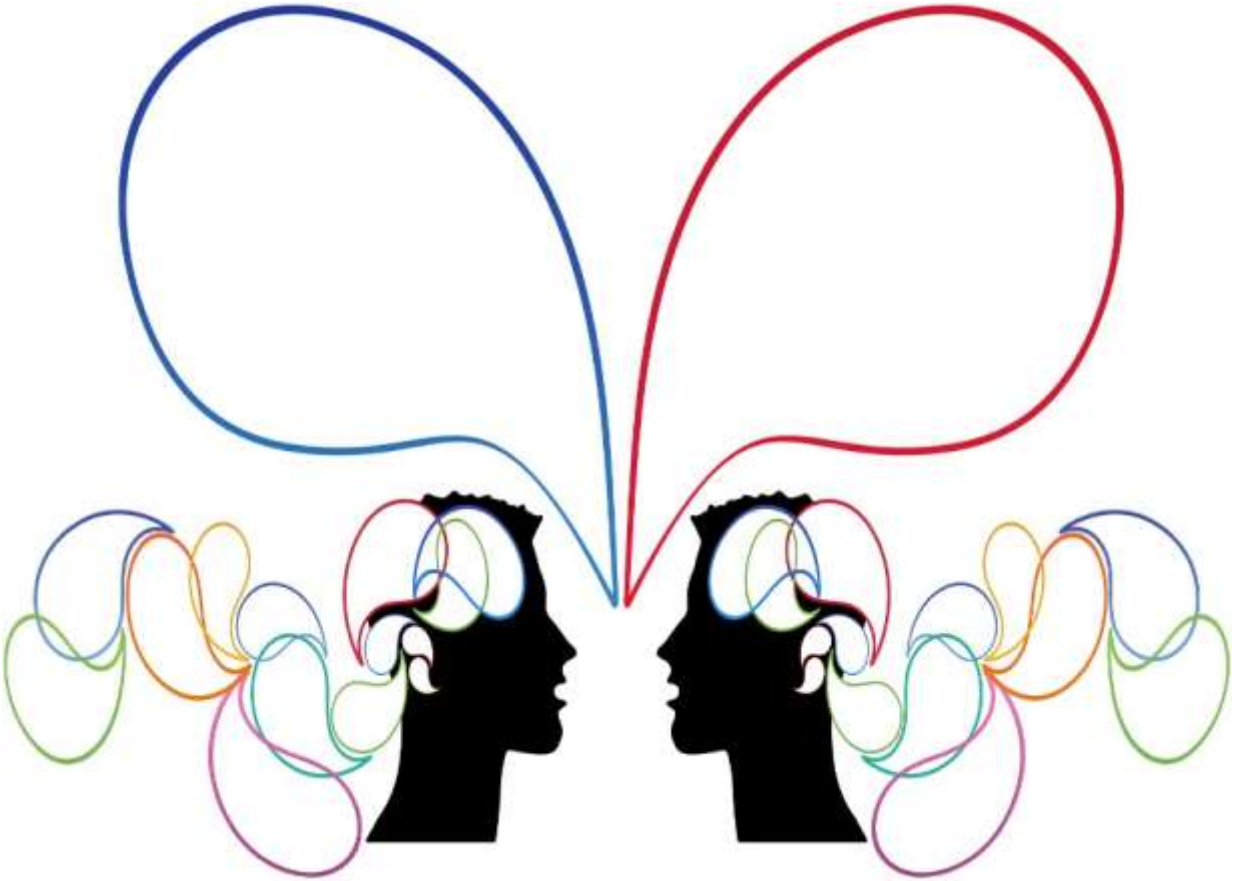
2. Two students line up opposite each other.

3. One student names as many terms as he/she can think of on the topic in 2 minutes.

4. The counterpart counts all the terms mentioned and provides the cluster creator with feedback on the number and quality of the terms mentioned.

Clustering_Video

Let´s do it!



WoSeCo

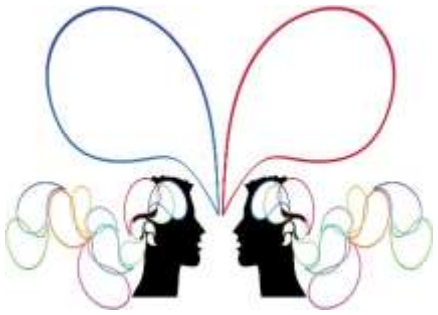
Word-**Se**ntence-**Co**nstruction

Goal

- Promote original associations by linking terms from different chapters of a domain.

Task

- Two students create scientifically correct sentences from technical terms.



WoSeCo Procedure

1. A sentence with a technical word is given.

2. One student takes the subject word, combines it with a second subject word and forms a meaningful sentence from it.

3. The other person recognises the new technical word and repeats the previous step.

The greater the distance in terms of content, the more original!

WoSeCo

Example

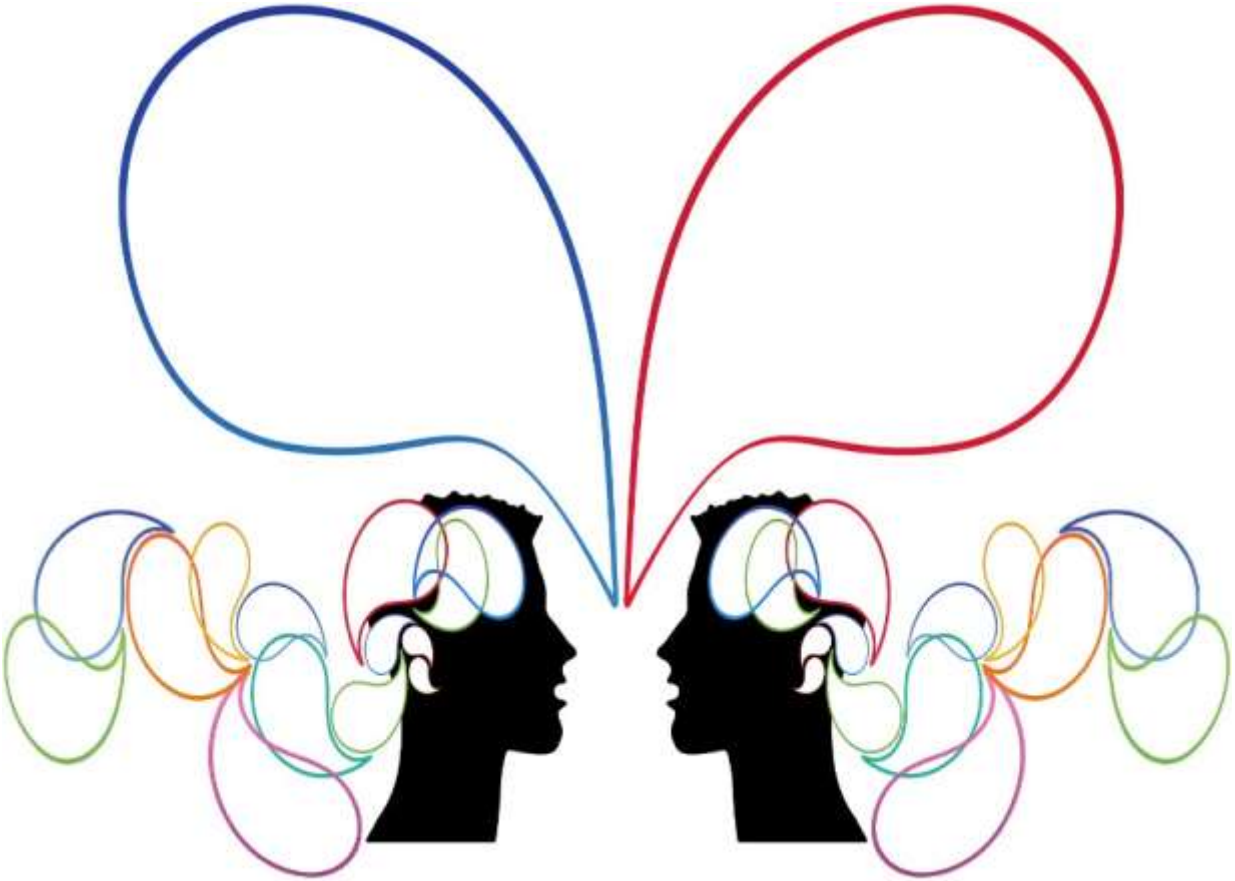
Task: The starting word is **METALS**.

- ✓ Metals are found on the left-hand side of the **periodic table.**
- ✓ The elements are ordered in the periodic table according to the **number of protons.**
- ✓ An element with the proton number 26 is **iron.**
- ✓ Iron can **oxidise** quickly.
- ✓ **Oxygen** is responsible for oxidation.
- ✓ Etc.

Legend: The technical term to be built upon is always underlined and the added technical term is shown in bold.

WoSeCo_Video

Let´s do it!



WoSeCo
Variations

Different partners

- Single-WoSeCo
- Student-Student-WoSeCo
- Teacher-Student-WoSeCo
- Class-WoSeCo

Theme

- Within a chapter
- Between certain chapters
- Between all chapters
  → Annual WoSeCo

Form of communication

- verbal
- written

WoSeCo

Examples for written implementation

- Single-WoSeCo in notebook
- Double variant in notebook
- Double variant with a mobile phone
- Class variant on blackboard

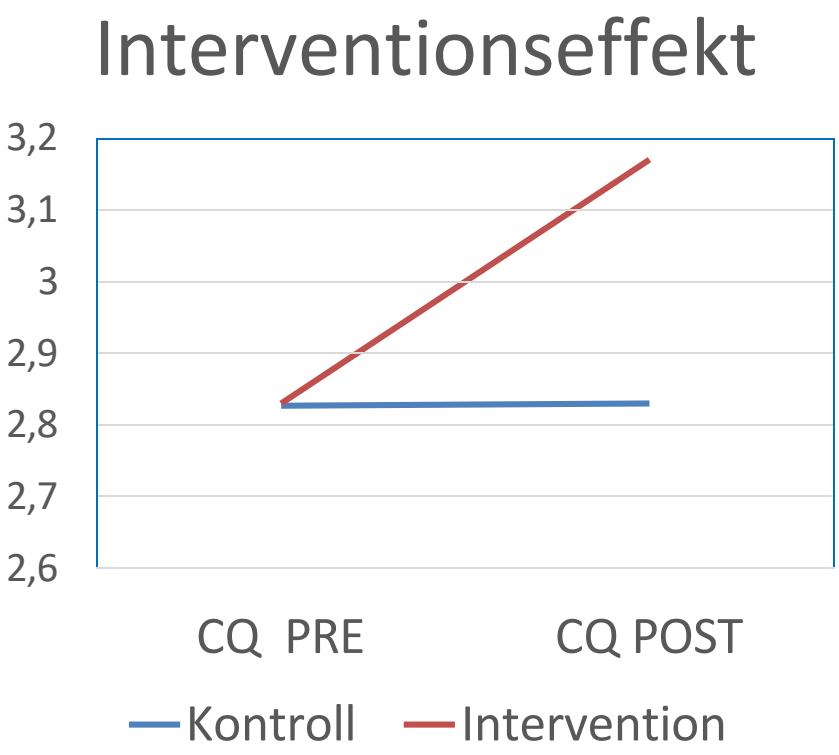
Educating Talents

Innovative FOCUS

Kurt Haim & Wolfgang Aschauer

SCHOOL OF CREATIVE SOLUTIONS

flex based learning



Is divergent thinking = creative problem-solving?

Innovation is a creative idea in action.

flex based learning

Creativity in STEM subjects

Innovative FOCUS

Problem-solving strategies for real challenges

INNOVATIVE FOCUS

A learning program for innovative problem-solving

F	**Flexibility**	Flex-based Learning Tools
O	Originality	Creativity Techniques
C	Creative Personality	Metacognition
U	Unconscious Mind	Embodiment
S	Strategies	Project management

CREATIVE4FUTURE CHALLENGE

Real problem solving – Design Thinking – Entrepreneurship


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS

SCHOOL OF
CREATIVE
SOLUTIONS

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Our Vision

Youths as problem solvers and global change makers

Teachers as initiators for real projects

Schools as think-tanks of creative solutions

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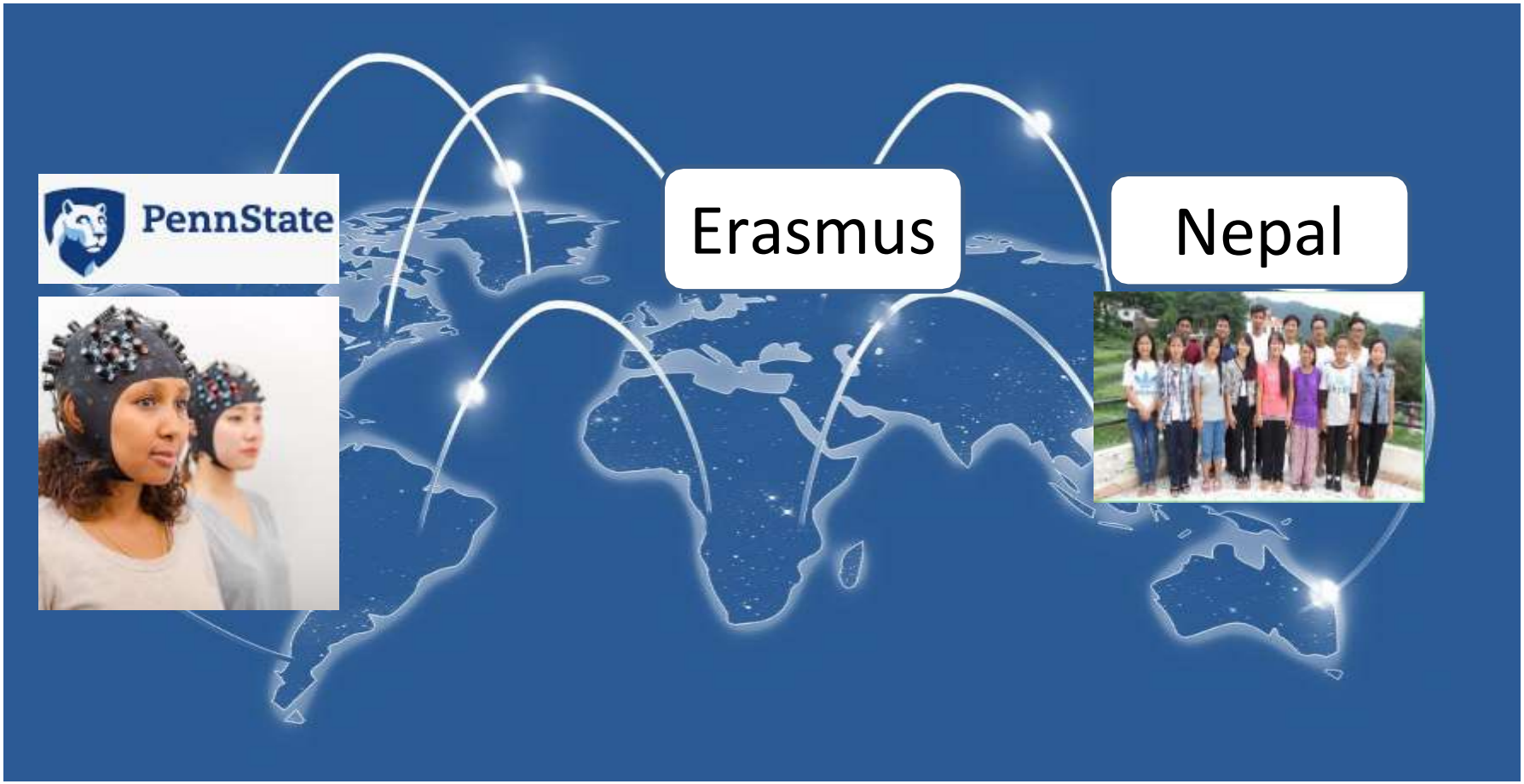
Think Global – Act Local



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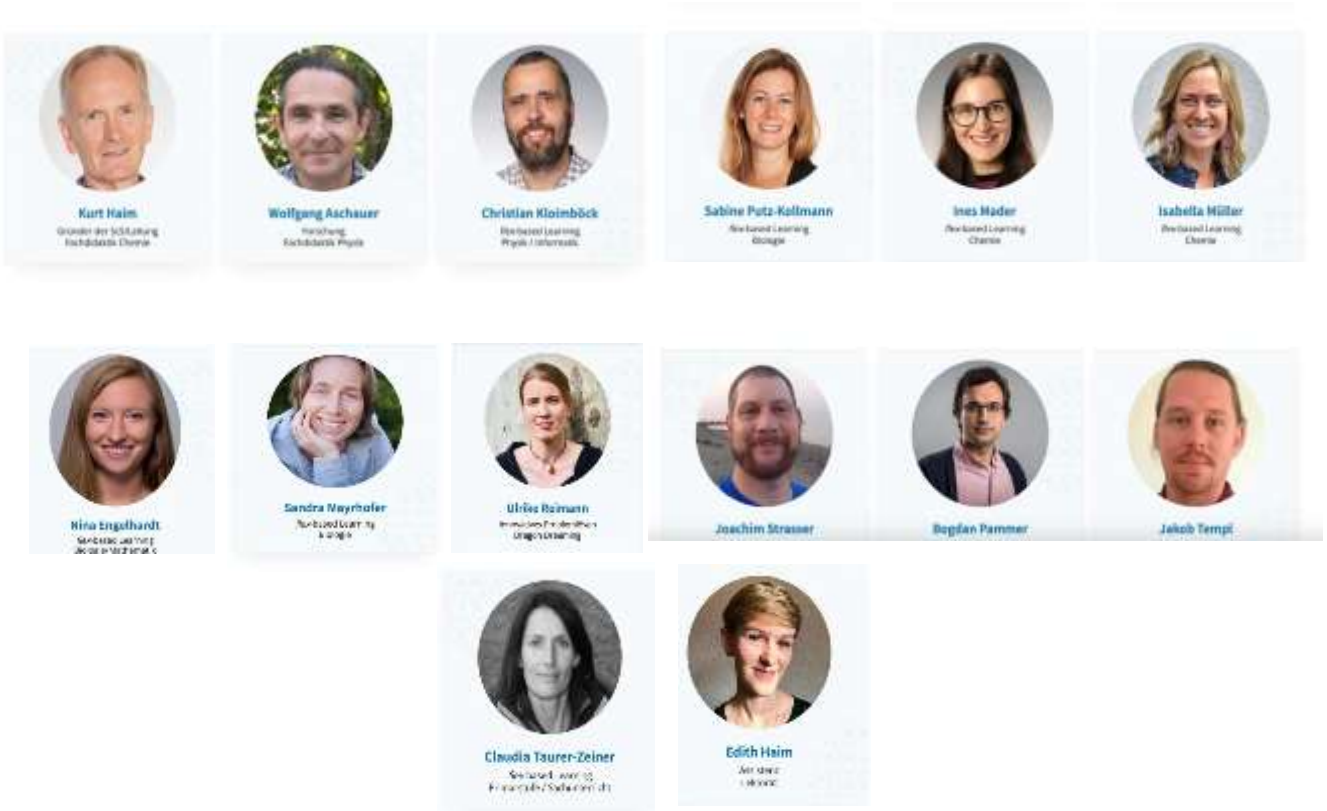
The TEAM



Mission statement

Let's empower students to become creative innovators to solve the challenges of today and tomorrow.

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SCHOOL OF CREATIVE SOLUTIONS

Educating Talents

Innovative FOCUS

APIFOS

Kurt Haim & Wolfgang Aschauer

APIFOS

Analyze Product→ Identify Flaws → Offer Solutions

APIFOS helps to uncover weaknesses,
that other people overlook.

Application:
Targeted search for improvement

- of a product
- of a service

APIFOS
1. **Analyse** the **Product**

The product is examined carefully, analytically and in a non-judgemental way.
The results are noted in a table.

The following questions are helpful:

- *What is its shape?*
- *What material is the object made of?*
- *What properties does the object have?*
- *What is its typical purpose?*

APIFOS
2. Identify Flaws

Search for obvious problems as well as hidden weaknesses.
Results are entered into a table.

The following questions are helpful for this:

- What causes problems with the item?
- What can my item actually not do, although it would be useful?
- What would be useful additional functions?

USE THE PERSPECTIVE CHECK

APIF**OS**
3. Offer **S**olutions

Some weaknesses are selected from the table and different solutions are offered for them.

NOTES

- The solutions are not yet evaluated according to feasibility.
- The more solutions you can offer, the better.

The innovative fire extinguisher

APIFOS

Analyze Product → Identify Flaws → Offer Solutions

- Analyse the fire extinguisher down to the smallest detail.
- (shape, appearance, function, material, ...)
-
- Write all the details on the worksheet.

  – Time: approx. 5 minutes

  – Form: Individual work

APIFOS

Analyze Product→ **Identify Flaws** → Offer Solutions

- 2. Search for hidden weaknesses!
- a. What is not optimal?
- b. What else should the extinguisher be able to do?
- c. What can´t the fire extinguisher do yet?

- USE THE PERSPECTIVE CHECK!
- Imagine different fire situations with different people in your mind's eye!

- *Time: approx. 5 minutes / individual work*

APIF**OS**

Analyze Product→ Identify Flaws → **Offer Solutions**

1) Exchange the weaknesses you have found in the group.

2) Select some weaknesses you want to improve.

- 3) Look for solutions together in the group!

- 4) Select the best ideas.

5) Sketch an innovative fire extinguisher that is better than the current model.

APIFOS
Presentation

- *Present your model to the group!*
  - *Time: 3' per group*
  - *Discussion*
  - *Time: 10'*

SCHOOL OF CREATIVE SOLUTIONS

Scientific Creativity in Classroom

Educating Talents

Be a Comet!

COMET

Personality traits for creatives

C ourageous

O pen for new things

M indful

E nduring

T olerant for failure

COMET
Courage

Being courageous does not mean not being afraid.

It means that you can overcome your fear.

Where is COURAGE needed in creative processes?

Expressing ut… ideas

…ision for a risky …ch

Young people must be motivated to be courageous in the phases of creative processes!

Implementation with uncertain outcome

COMET

Open for new

I always do
what I can't do
so that I learn it.

Pablo Picasso

*Creative personalities are open to **new** .....*

impressions / experiences / findings

Creative personalities are driven by:

curiosity / thirst for knowledge / willingness to experiment

COMET

Mindful

Creative mindfulness means that when solving a Problem …

… you observe your surroundings and yourself with high attention

…and that you do not immediately evaluate or judge your perceptions

COMET

Mindful

Careless people accept the world as it is.

***Mindful** people realize …*

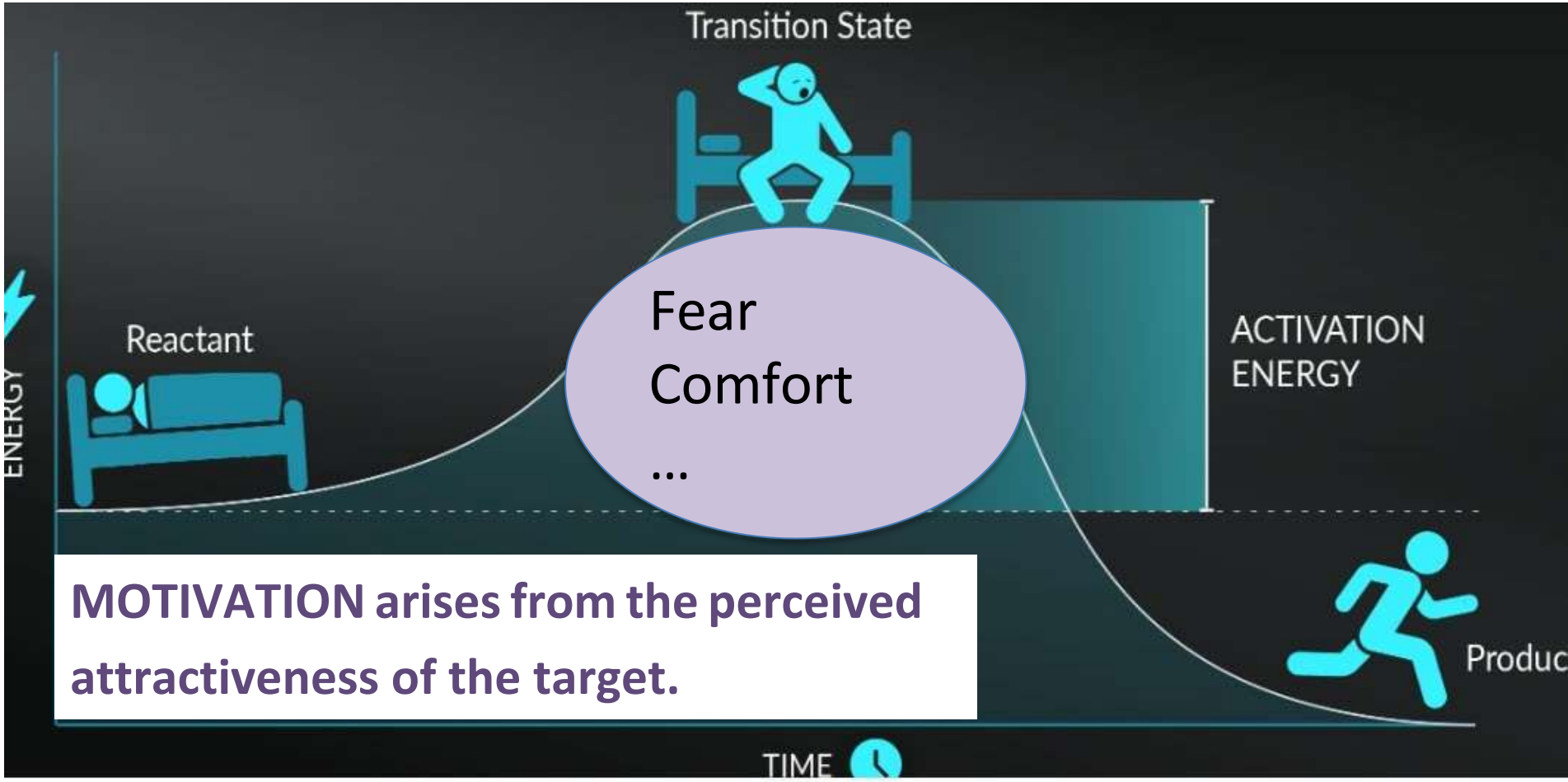
- *weaknesses of a system*
- *potential of unnoticeable things*

Mindfulness helps to recognize blind spots

(Velcro fastener from Georges de Mestral)

COMET

Endurance



MOTIVATION arises from the perceived attractiveness of the target.

COMET
Tolerant for failure

The things we regret later are not the mistakes we made, but the opportunities that we did not grab.

If you always try to do everything right, you may miss the most beautiful mistake of your life.

Can we really afford mistakes?

COMET
Tolerant for failure

Can we really afford mistakes?

Clear distinction between:

Learning phase
Practice phase

Test
Exam
Application

Productive failure

Manu Kapur

Learning paradox:

Not achieving a desired effect can be just as valuable as mastering it.

https://www.youtube.com/watch?v=VOKJmg34wME

Productive failure

Manu Kapur

3 conditions transform failure into an effective, productive process:

1. Problems must be chosen that challenge but do not frustrate.

2. Learners must have the chance to explain or describe their failed process.

3. Learners must have the opportunity to compare or contrast good and bad solutions.

Personality traits of a creative person

C	**Courageous** 	Being fearless does not mean *not being afraid*, but it means that you can overcome your fear.	**Be courageous ...** - to express your original ideas and thoughts. - to try something you have never done before. - to start an experiment when the outcome is uncertain.
O	**Open for new things** 	Openness for new things comes from curiosity and acceptance of the unknown.	**Be open ...** - for unusual ideas from your teammates. - for original ways of solving the problem. - to also work with new colleagues in the team.
M	**Mindful** 	Creative mindfulness means that when solving a problem, you look at your surroundings and yourself with high attention, and that you do not immediately evaluate or judge your perceptions.	**Be mindful ...** - while you try to understand the problem. - while you are brainstorming for solutions. - while you are trying to implement your ideas.
E	**Enduring** 	Endurance means that you are strong-willed and determined to keep at the problem until it is solved.	**Be enduring ...** - even if unexpected difficulties arise. - even if the first attempt at a solution fails. - even if your teammates want to give up.
T	**Tolerant for failure** 	This means that you look at a failure as a positive event. Every failure shows you how not to do it and helps you to be better next time.	**Be tolerant of failure ...** - even if you have no ideas. - even if all your attempts to solve the problem failed. - even if the other teams were more successful.

C	O	M	E	T
Courageous 	**Open for new things** 	**Mindful** 	**Enduring** 	**Tolerant for failure** 
I was courageous 	**I was open** 	**I was mindful** 	**I was enduring** 	**I am tolerant for failure** 
in the ... ○ Problem analysis ○ Idea generation ○ Implementation	**for new ...** ○ Ideas ○ Ways ○ Team colleagues	**while ...** ○ Expressing creative ideas ○ Trying things out ○ Making decisions	**despite ...** ○ Difficulties ○ Setbacks ○ Resistance in the team	**despite ...** ○ Lack of ideas ○ Failed attempts ○ Success of other teams
because ...	**because ...**	**because ...**	**because ...**	**because ...**

SCHOOL OF CREATIVE SOLUTIONS

Educating Talents

Research Results

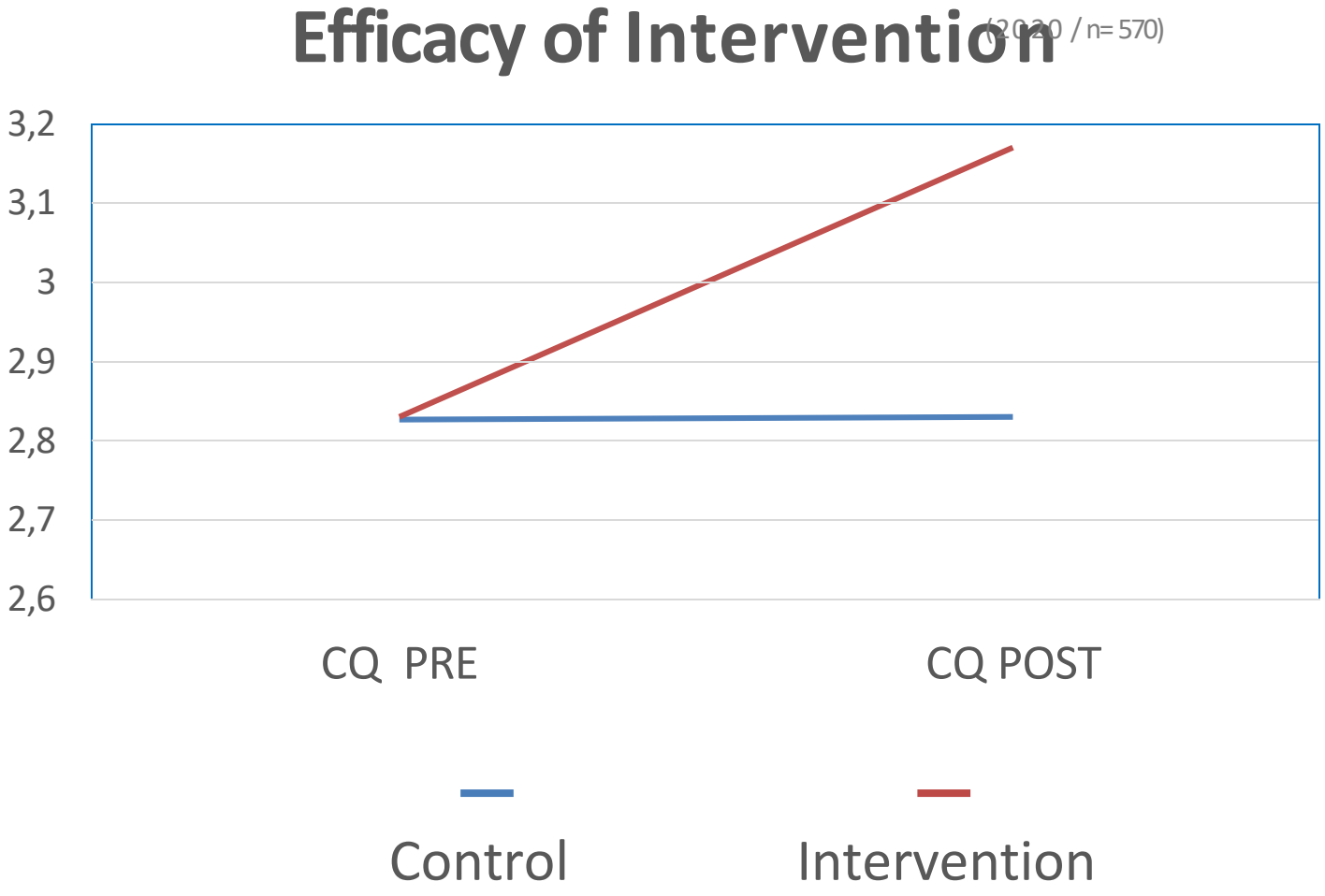
flexbased learning

Research

- Sample
  More than 3000 students (ages 10 to 18)
  Instrument
- Divergent Problem-solving Ability in Science (DPAS) test
  (Aschauer, Haim, Weber 2021)

- Methodology
  Two-group repeated measures design
  Creativity Quotient (CQ) as a composite creativity score
  (Snyder et al., 2004)

Research

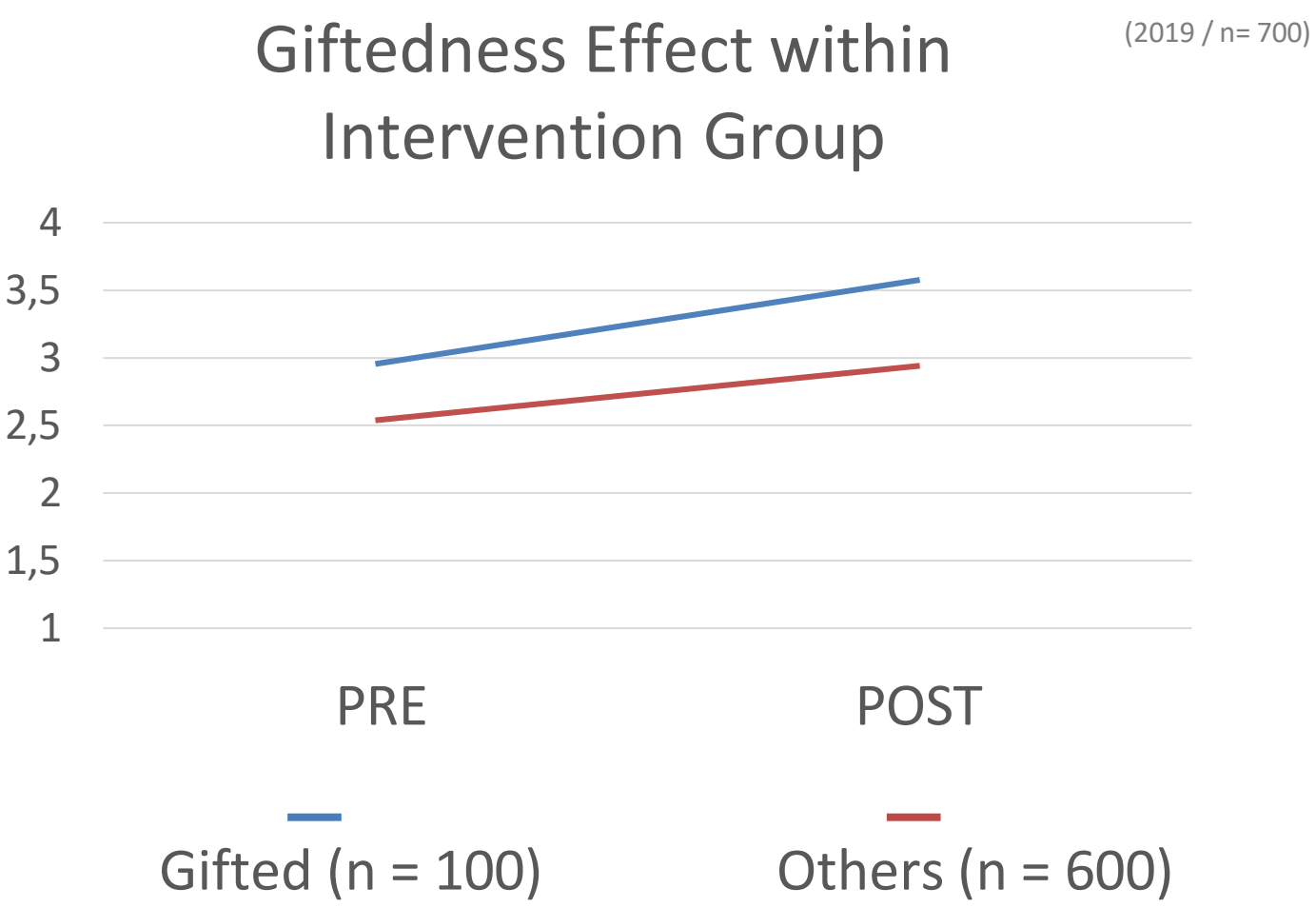

Efficacy of Intervention
(2020 / n= 570)
3,2
3,1
3
2,9
2,8
2,7
2,6
CQ PRE
CQ POST
Control
Intervention

Research

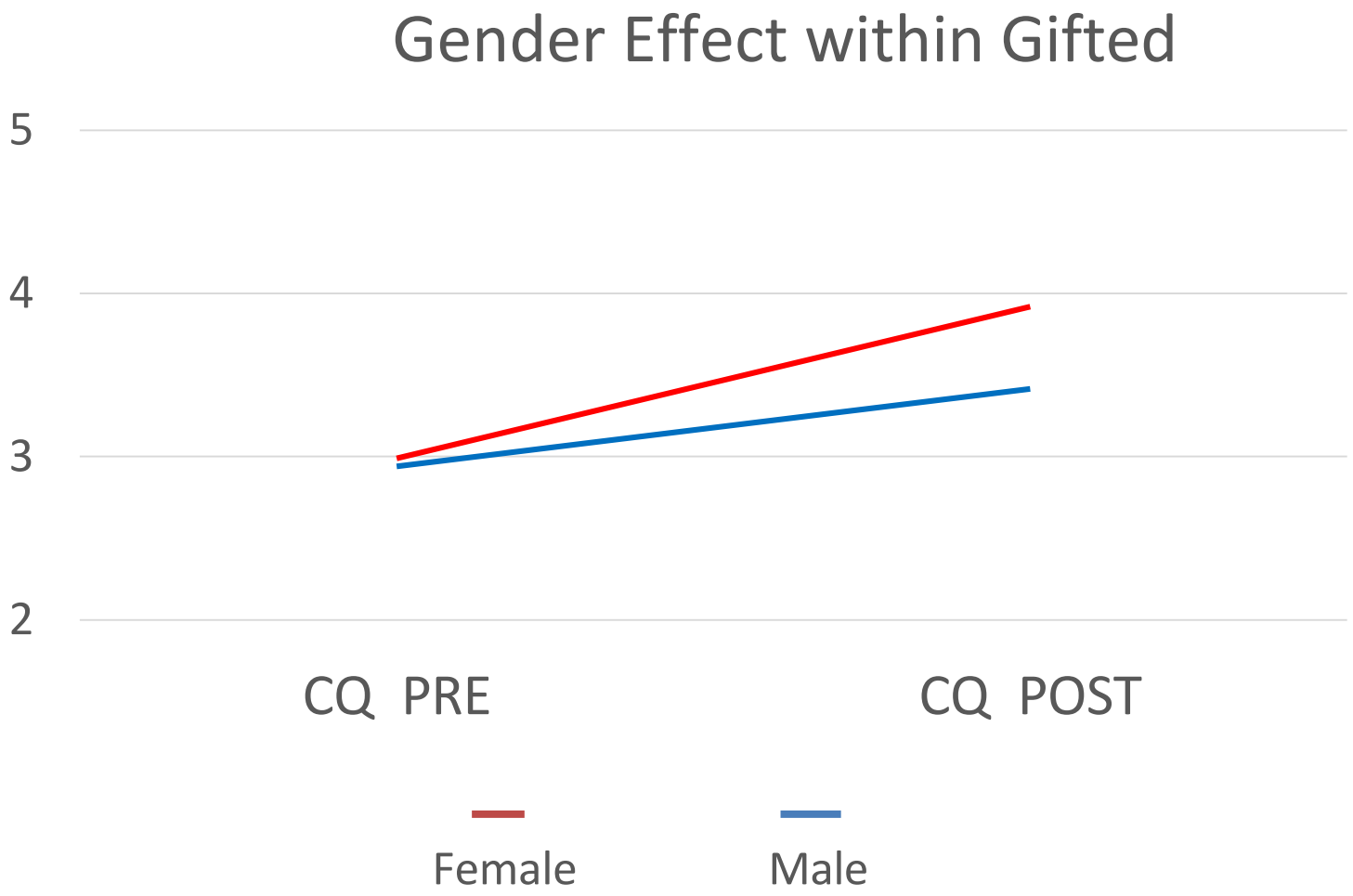
Several authors highlight the urgency of promoting scientific creativity, especially among gifted students (e.g., Heller 2007; Cevher et al. 2014; Kizkapan & Nacaroğlu 2021; Karademir 2016; Rule & Olsen, 2016; Stoltz et al. 2015).

Gifted students benefit more than others from special support programs promoting scientific creativity.

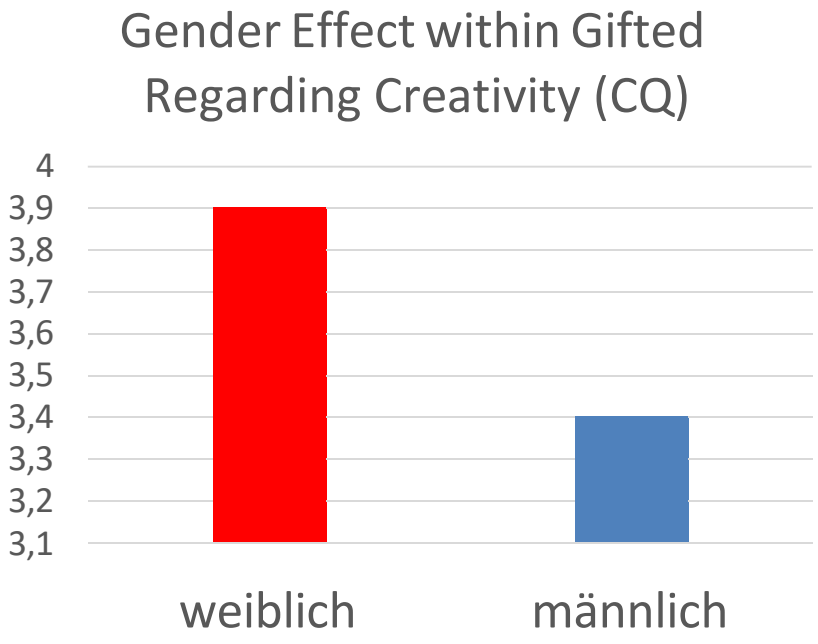
Research

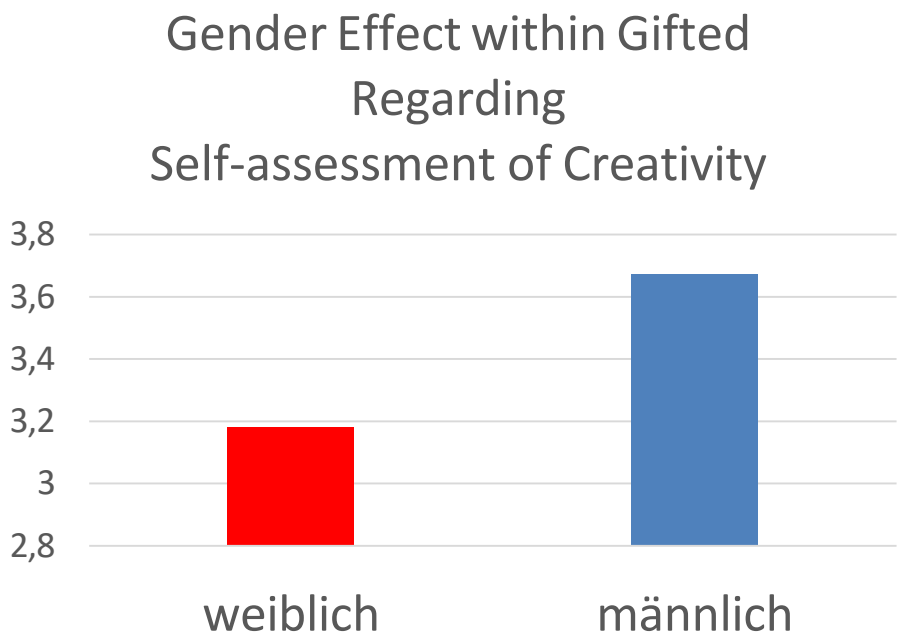

Giftedness Effect within Intervention Group
(2019 / n= 700)
4
3,5
3
2,5
2
1,5
1
PRE
POST
Gifted (n = 100)
Others (n = 600)

Research



Research


Gender Effect within Gifted
Regarding Creativity (CQ)
4
3,9
3,8
3,7
3,6
3,5
3,4
3,3
3,2
3,1
weiblich
männlich


Gender Effect within Gifted
Regarding
Self-assessment of Creativity
3,8
3,6
3,4
3,2
3
2,8
weiblich
männlich

SCHOOL OF CREATIVE SOLUTIONS

To meet future challenges, young people must learn to solve problems for which there are no ready-made strategies. Let's use the potential of youth and turn school into a place of creative solutions.

THE VISION

a „School of Creative Solutions“ …

- ✓ educates students who look forward to the future with confidence.
- ✓ has teachers in its ranks who take on current challenges with student teams.
- ✓ is a think tank for innovative solutions and is in exchange with the S.C.S. school network.

OUR GOALS

a „School of Creative Solutions“ …

- ✓ increases the creative problem-solving skills of young people and teachers.
- ✓ establishes creative spaces for action and solutions in her school.
- ✓ implements innovative ideas in the focus of the Sustainable Development Goals.
- ✓ offers Creative4Science courses for their students.

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SCHOOL OF CREATIVE SOLUTIONS

THE S.C.S.-CERTIFICATE

THE WAY

The path to the School of Creative Solutions leads through **2 training modules:**

Module-1: University course *"flex-based Learning"*

Module-2: University course *"innovative problem solving"*

Both modules can also be attended independently of each other.

CRITERIA

- ✓ Teachers who have completed the flex-based learning and innovative problem solving module teach at the school.
- ✓ Conduct STEM projects with innovative problem solving at regular intervals.
- ✓ Making the projects visible in the school area (school homepage, etc.) as well as on the S.C.S. homepage.
- ✓ The certificate is valid for 3 years and can then be re-applied for.

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SCHOOL OF CREATIVE SOLUTIONS

University course „*flex*-based Learning“

Creative problem-solving skills in STEM lessons

THE TARGET GROUP

Teachers, ….

- ✓ … who teach biology, chemistry, computer science, mathematics or physics at secondary level I and II.
- ✓ … who want to teach in an innovative and competence-oriented way.
- ✓ … who want to teach their young people creative problem solving with new teaching techniques.
- ✓ … who want to carry out exciting and interesting experiments.
- ✓ … who would like to become part of a nationwide community.

OUR CONTENTS

- Didactic concepts for the diagnosis and promotion of creative problem-solving competence
- Concrete teaching techniques and experiments for science lessons
- Techniques to strengthen team processes and self-efficacy

ORGANISATIONAL

- Course with 9 ECTS in two semesters
- Alternating input and implementation phases
- Presence and online appointments
- Year-round support in implementing the new techniques in their own teaching

REGISTRATION

https://ph-ooe.at/lehrgang-anmeldung

01 March 2022 until 18 June 2023

For questions please mail to:

jakob.templ@ph-ooe.at

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SCHOOL OF CREATIVE SOLUTIONS

University course „*flex*-based Learning“

Creative problem-solving skills in STEM lessons

TIMELINE

Input-Phase 1	Mo.	25.09.23	15:00 – 17:30	Online
	Mo.	02.10.23	15:00 – 17:30	Online
	Mo.	09.10.23	09:30 – 20:30	Presence
	Di.	10.10.23	09:00 – 13:00	Presence

Implementation phase 1	Winter semester 23/24			
1. Team reflection	Mo.	04.12.23	15:00 – 17:30	Online

Input-Phase 2	Mo.	15.01.24	14:30 – 18:00	Online
	Mo.	22.01.24	14:30 – 18:00	Online
	Mo.	29.01.24	09:30 – 20:30	Presence
	Di.	30.01.24	09:30 – 13:00	Presence

Implementation phase 2	Summer semester 24			
2. Team reflecion	Mo.	15.04.24	15:00 – 17:30	Online

Degree	Mo.	17.06.24	15:00 – 18:00	Online

DESCRIPTION

The course includes both face-to-face workshops (at the Upper Austrian University of Teacher Education) and online meetings (Zoom).

Input phases

The two input phases take place in autumn and spring. Central elements are:

- ✓ e-lectures with reflection phases (Online)
- ✓ Workshops (presence and online)

Implementation phase

The implementation phases in the winter and summer semesters include the following elements:

- ✓ Use flex-techniques in your own teaching
- ✓ Reflections on the experience gained

INFORMATION & REGISTRATION

https://ph-ooe.at/lehrgang-anmeldung

University course "Innovative Problem Solving"

School as a think tank for creative solutions

THE TARGET GROUP

Teachers, …

- ✓ … of all subjects in lower and upper secondary education as well as middle management
- ✓ … who are interested in creativity techniques to develop innovative ideas professionally.
- ✓ … who enjoy taking on STEM challenges at school.
- ✓ … who want to know how to plan and implement creative projects with young people.
- ✓ … who are committed to the "Sustainable Development Goals".

OUR CONTENTS

- Creativity techniques
  - Morphological box
  - Irritant word associations
  - Bisociation
  - Passla technique
- Creative project management
  - Design Thinking
  - Dragon Dreaming

ORGANISATIONAL

- Course with 9 ECTS in two semesters
- Presence and online appointments
- Year-round support in implementing the new techniques in their own teaching

REGISTRATION

https://ph-ooe.at/lehrgang-anmeldung

01. März 2022 bis 18. Juni 2023

For questions please mail to:

kurt.haim@ph-ooe.at

die pädagogische hochschule oberösterreich

SCHOOL OF CREATIVE SOLUTIONS

University course "Innovative Problem Solving"

School as a think tank for creative solutions

TIMELINE

1. Presence-Phase Health Resort Lebensquell Bad Zell	Do. 21.09.23 Fr. 22.09.23 Sa. 23.09.23	09:30 – 21:30 09:00 – 21:30 09:00 – 12:30
Reflection meeting (online)	Do. 19.10.23 Do. 30.11.23	14:30 – 17:30 14:30 – 17:30
2. Presence-Phase Health Resort Lebensquell Bad Zell	Do. 29.02.24 Fr. 01.03.24 Sa. 02.03.24	09:30 – 21:30 09:00 – 21:30 09:00 – 12:30
Reflection meting (online)	Do. 04.04.24 Do. 09.05.24	14:30 – 16:00 14:30 – 16:00
Action day at school	April 2024	08:00 – 12:30
Degree (online)	Mo. 17.06.24	16:00 – 18:00

Creative^{4}Innovation-Courses

For the implementation of the course content with student teams, we recommend holding a course lasting several weeks.

GEMMMA Challenge

10 selected school teams are introduced to the world of social entrepreneurship and supported in the implementation of their projects.

Milestones

- ✓ Young people learn proven creativity techniques.
- ✓ Student teams choose a project for their problem solving.
- ✓ A prototype is created using design thinking.
- ✓ Presentation of the prototypes
- ✓ Optional implementation of solution ideas in cooperations

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For questions please mail to:

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