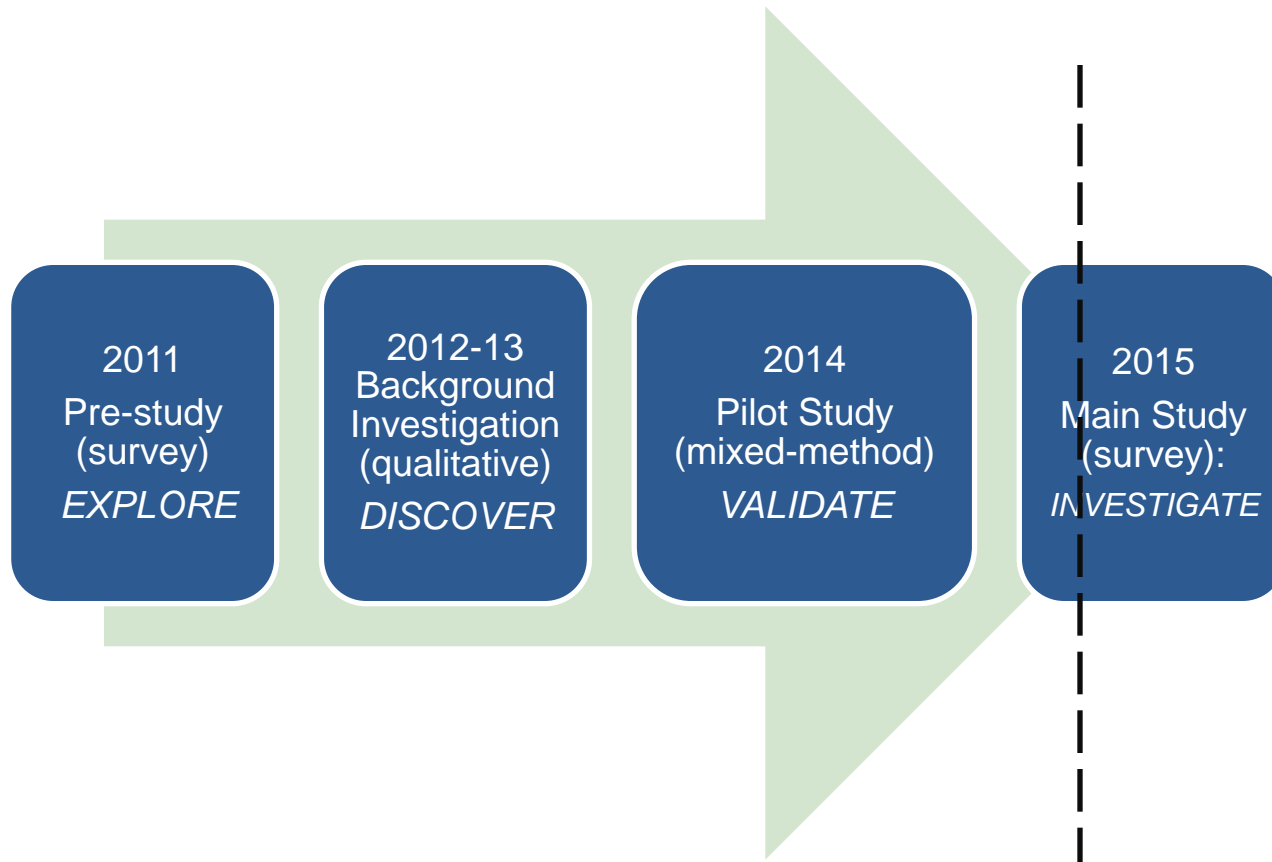# Advancing informal MINT learning: preparation & novelty at a mobile laboratory

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New Perspectives in Science Education Conference, Florence, March 21,2015
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Timeline for the mobiLLab study

2011
Pre-study
(survey)
EXPLORE

2012-13
Background
Investigation
(qualitative)
DISCOVER

2014
Pilot Study
(mixed-method)
VALIDATE

2015
Main Study
(survey):
INVESTIGATE

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TODAY

- INTROUCTION TO MOBILLAB

- PILOT STUDY DESIGN & RESULTS

- MAIN STUDY DESIGN

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Meet mobiLLab

Experimental Posts
School Visits
Preparation Resources

MobiLLab purpose

- *designed to interest youth in S&T careers*

- part of strategy to promote MINT learning
(Mathamatik, Informatik, Naturwissenschaft, Technik)

Worum geht es?

Die Pädagogische Hochschule St. Gallen PHSG (Studiengang Sek 1) kommt mit einem Fahrzeug auf Bestellung ins Oberstufenzentrum. Das Fahrzeug ist bestückt mit modernsten technischen Geräten. Schülerinnen und Schülern erfahren unter der Anleitung von Studierenden, wie in der Industrie heute bestimmte Aufgabenstellungen v.a. solche mit Bezug zur Lebenswelt gelöst werden können.

mobiLLab geht also zu den Schulen und nicht umgekehrt. Damit ist die Auslastung der teuren Investitionen gross und rechtfertigt sich.

Ziel und Zweck

Die Schweiz sucht Techniker

Selbst in wirtschaftlich schwierigen Zeiten fehlen den Unternehmen Zehntausende von Mathematikern, Informatikern und Naturwissenschaftern. Jetzt schlägt auch der Bundesrat Alarm

Wir alle schöpfen die scheinbar unbegrenzten Möglichkeiten und Annehmlichkeiten moderner Technik voll aus. Aber paradoxerweise hat die Vermittlung von naturwissenschaftlichem Basiswissen, das sowohl zu deren Weiterentwicklung wie auch einer sinnvollen Nutzung zugrunde liegt, zunehmend an Bedeutung verloren. Dies äussert sich unter anderem auch im mangelnden Nachwuchs von begabten Jugendlichen und Studierenden in naturwissenschaflich-technischen Berufen und Studienrichtungen. Die Auswirkungen auf die Versorgung mit Nachwuchskräften der Natur- und Ingenieurwissenschaften in Forschung, Industrie und Wirtschaft werden bereits schmerzlich sichtbar. Diese ist jedoch für ein Land wie die Schweiz ohne nennenswerte Ressourcen unabdingbar für unsere Ökonomie!

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Deliver experiments

- 13- to 16-year-olds in secondary (1) schools
- Visit: Half-day; 4 of 12 experimental posts
- Pupils in pairs, no frontal instruction

Infrared camera Is our classroom well insulated?	**Pyrometer** Is the „cold metal" in our classroom really colder than the „warm wood"?
X-ray Fluorescence Does my tongue ring contain any poisonous metals?	**Visible Light Analysis with Spectrometer** Why do colors from a fluorescent light look differently than sunlight?
Exhaust Analyses Does my moped produce the same exhaust when idling as when accelerating?	**Spiroergometry: Respiratory Gases** At what level of physical exertion does my body burn only carbohydrates?
Ultraviolet Protection Do my sunglasses protect my eyes from the sun's ultraviolet radiation?	**High-speed camera** Do air- and water-filled balloons burst in the same way?
Industrial Microwave Synthesis Can I produce a perfume in a few minutes?	**Household Microwave Applications** Is it possible to produce popcorn in a microwave?
Ion Chromatography Is our tap water as "pure" as mineral water?	**Gas Chromatography** What is the chemical composition of the gas from a lighter?

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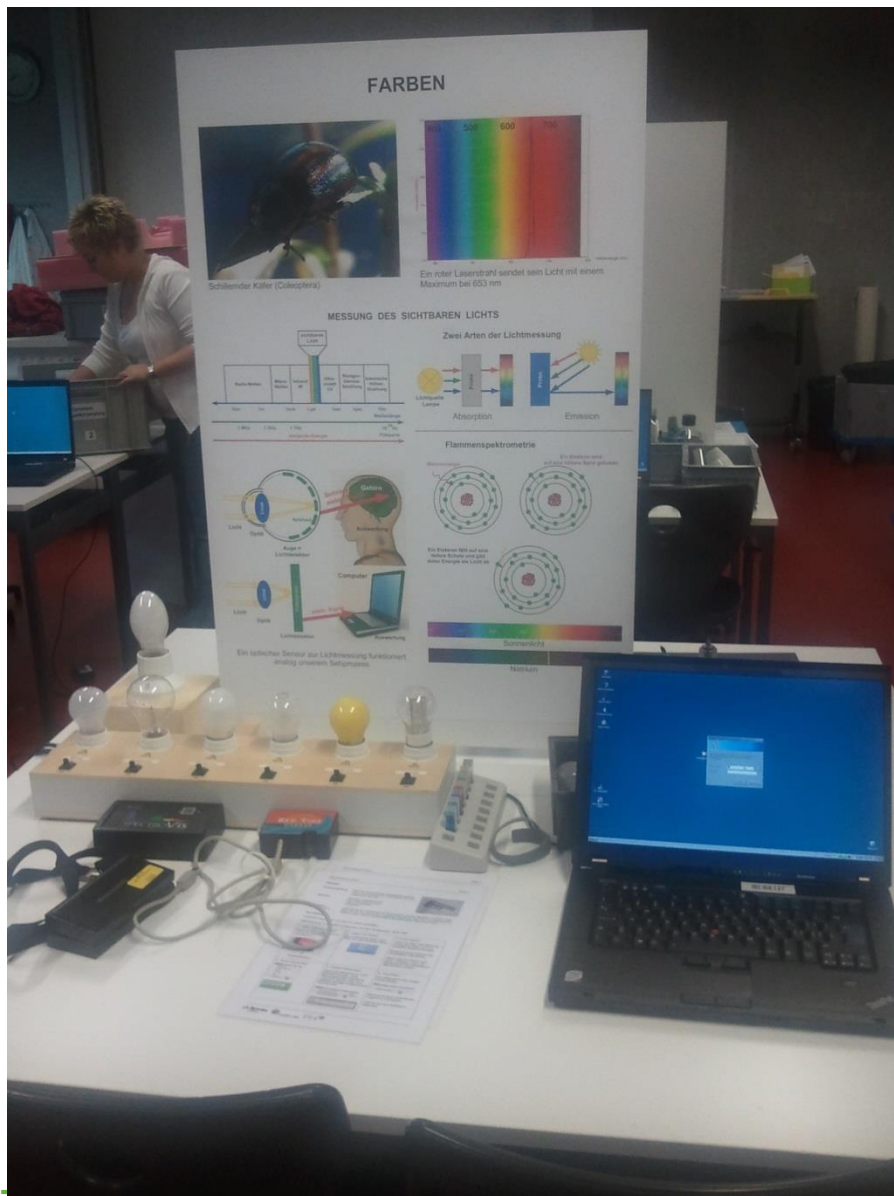
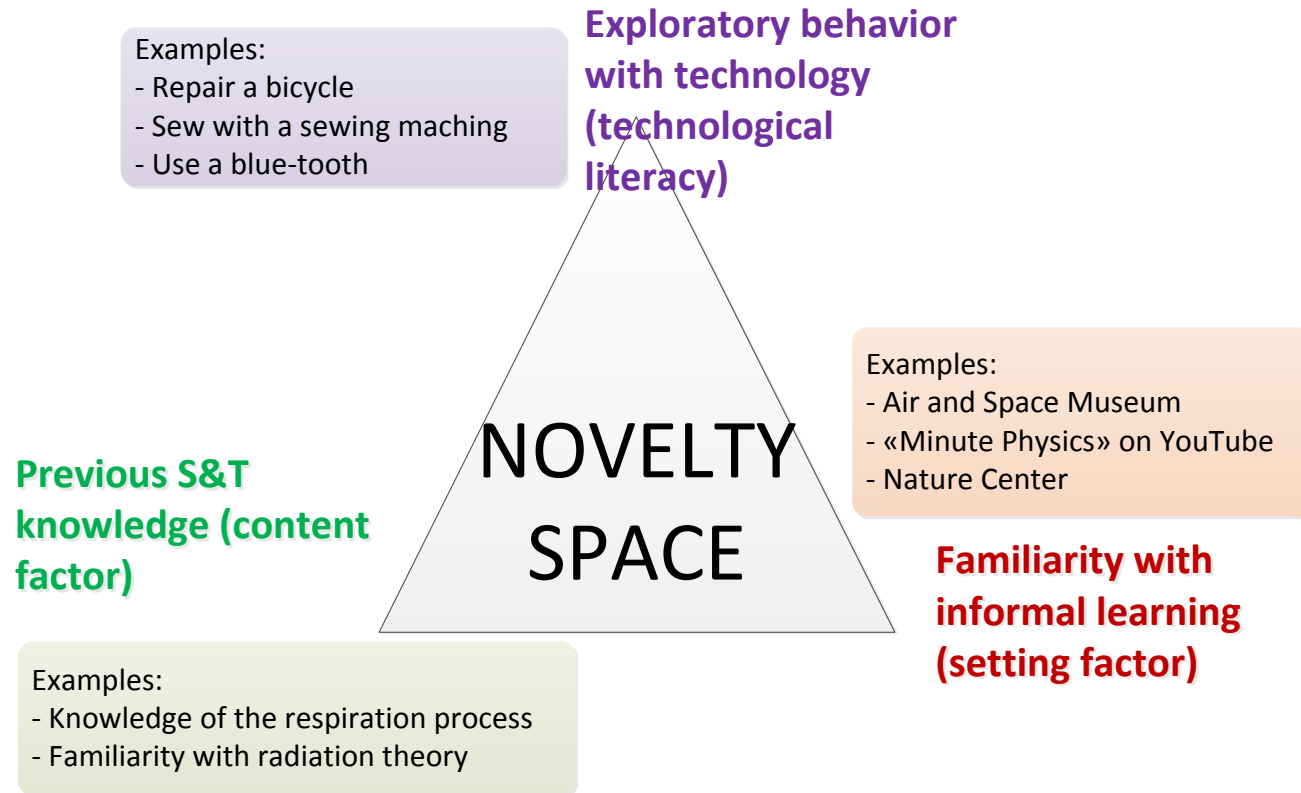# Experimental Posts

Experimental Posts

Design
Results

Pilot Study Research Questions

How do differences in pupil novelty space and classroom preparation explain variations in pupil S&T outcomes (interest, attitude, self-concept)?

What moderating role do teachers' attitudes play?

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Pilot Study Research Frame: Novelty Space

Adapted from Orion's Novelty Space Theory 1989

Exploratory behavior with technology (technological literacy)

Examples:
- Repair a bicycle
- Sew with a sewing maching
- Use a blue-tooth

NOVELTY SPACE

Previous S&T knowledge (content factor)

Examples:
- Knowledge of the respiration process
- Familiarity with radiation theory

Examples:
- Air and Space Museum
- «Minute Physics» on YouTube
- Nature Center

Familiarity with informal learning (setting factor)

Pilot study example survey items

Survey Scales	Example Item
Exploratory behavior ('Tendency to tinker')	Ich lasse lieber andere ein technisches Gerät bedienen, denn ich könnte etwas falsch machen. *I'd rather let someone else work with technical equipment, because I could make a mistake.*
Oriented	Der mobiLLab-Besuch war gut organisiert. *The mobiLLab visit was well organized.*
Perceived peer interest in natural science.	Meine Mitschülerinnen und Mitschüler interessieren sich im Allgemeinen für Naturwissenschaften. *My schoolmates are generally interested in natural science.*
Perceived teacher interest in S&T.	Die Lehrperson geht auf die Bedürfnisse der Schülerinnen und Schüler ein. *The teacher responds to the needs of the pupils.*

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Pilot study sampling plan

PH SG

early January 2014	late January 2014	February 2014	March-May 2014	March-May 2014
Teacher pre-survey		Pupil pre-survey	Observation	Pupil post-survey
Te S&T professional development		Pu novelty space		Pu S&T outcomes
Te attitudes: situated learning, contextualization	**Intervention**	Pu S&T outcomes	Classroom Preparation	
Te interest in ML	=Extra materials to treatment teachers	Pu perceptions of Te, peer interest		Teacher post-survey and interviews
	- What is an optimal prep?		mobiLLab visit	preparation activities
	- Additional organizing tools.			feedback on materials
	- Additional ES materials.			Te attitudes: situated learning, contextualization
				Te interest in ML

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9 teachers, 15 classes

208 pupils (completed both surveys)

Pupils

- tendency to tinker high, perceived teacher interest high;
- S&T oucomes moderate, with no or slightly negative change.
(interpret effect per Cohen (1988): small (d=0.2), medium (d=0.5), large: (d=0.8.))

Results from Pupil Surveys

German: 1=stimmt gar nicht; 2=stimmt wenig; 3=stimmt ziemlich; 4=stimmt völlig
English: 1=never true; 2=sometimes true; 3=often true; 4=always true

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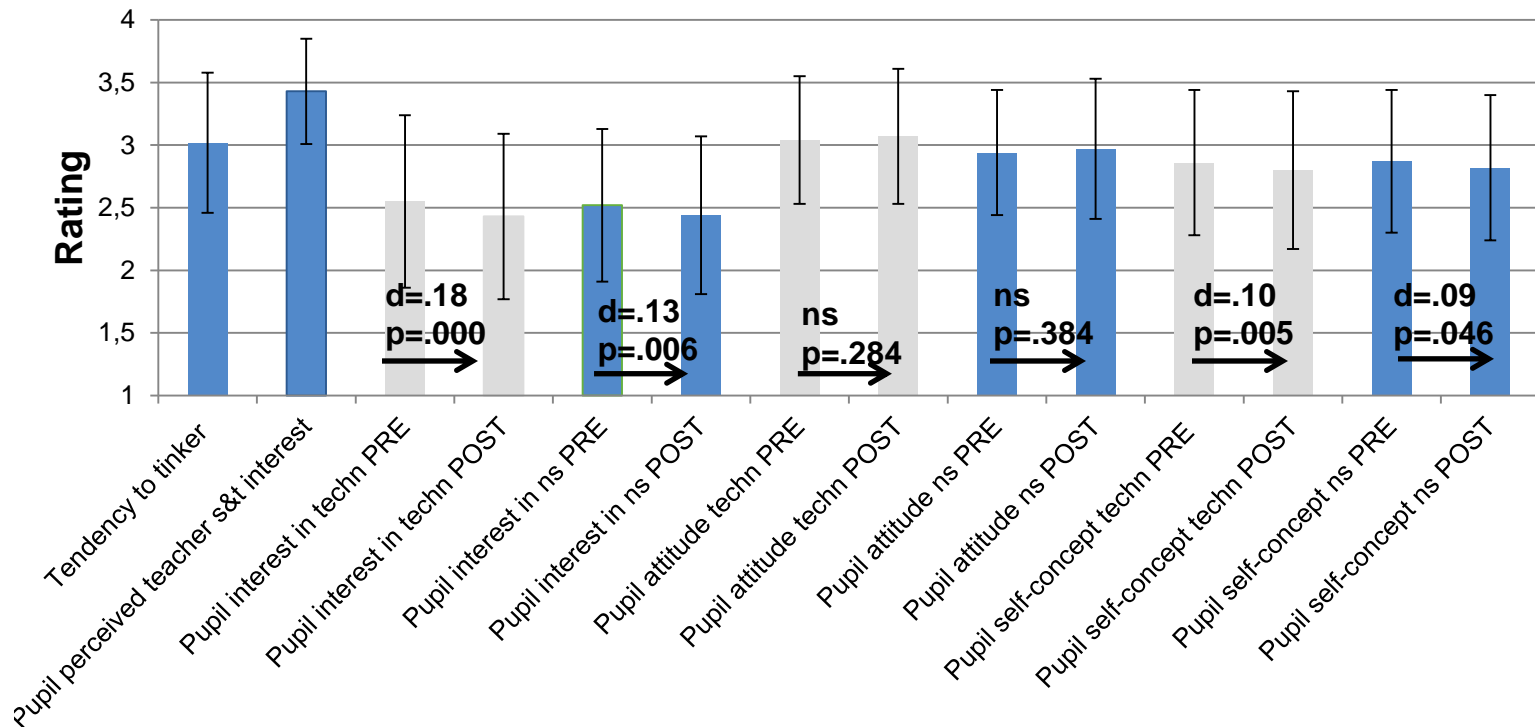
Characterizing preparation practices

Teachers reported similiar
- use of resources
- post assignment
- assignments for the visit.

So only *time* could be used for a typology:

	Lesson time high (> 8 lesson-hours)	Lesson time low (< 8 lesson hours)
Started earlier (>15 days before mobiLLab)	2 teachers	3 teachers
Started later (<15 days before mobiLLab)	2 teachers	2 teachers

Pilot Results:
what factors predicted differences in S&T outcomes?

Quantitative: Novelty factors, gender are strongest predictors

Multivariate effects (MANCOVA)
Interpret per Cohen (1988): small (ηp^2=.01), medium: (ηp^2=.06), large: (ηp^2=.14.)
OSLeP= out-of-school learning place

Factor (Independent Variable)	Pupils' technology outcomes				Pupils' natural science outcomes			
	df	df error	F	η_p^2	df	df error	F	η_p^2
Between-group comparisons: multivariate effects (p<0.05)								
Explores vs seeks direction	3	197	32.3	.34	3	195	13.0	.17
Experience: techn OSLePs	3	195	25.1	.28	3	193	11.4	.11
Experience: nat.sci. OSLePs	not significant				3	193	8.3	.15
Math grades	3	195	4.0	.06	3	193	5.2	.07
Science grades	3	194	4.2	.06	3	192	11.0	.15
Preparation type	9	566	4.2	.06	9	467	2.2	.03
Gender	3	191	25.4	.29	3	189	5.7	.08
Perceived peer interest	3	191	4.4	.06	not significant			
Within-subject changes from pre-to post-survey: multivariate effects (p<0.05)								
Explores vs seeks direction	3	197	3.4	.05	not significant			
Preparation type	not significant				9	462	2.4	.03

Teacher Interviews: links to classroom, novelty are important

A good preparation

1. Encourages pupils to bring materials to test
2. Relates classroom activities to mobiLLab
3. Reduces unfamiliarity/ timidity with experimental equipment:

   - Pupils need to 'lose their fear of the equipment'

   - 'It is important to tell pupils that they can touch the equipment and try things out and they won't break down.'

4. Orients pupils to the plan for the day.

Focus: 'tendency to explore' factor

– Identified through both statistical analysis and interviews.

– Pilot data provided dispositional/character measure: 'TRAIT.'

– What about their at-visit experience?: 'STATE'

– What (intervention) could promote pupils' familiarity w/ lab equipment?

From Pilot Study to Main Study

PILOT STUDY

EVALUATION

Prep practices

Prep materials

RESEARCH INVESTIGATION

Preparation

Teacher attitude

Pu novelty space
(hi tech)

Pupils' S&T outcomes: interest, attitude, self-concept

- *Teacher attitude ns.*
- *Classroom prep: low sign., valid?*
- *Novelty traits: strong relationship to outcomes*
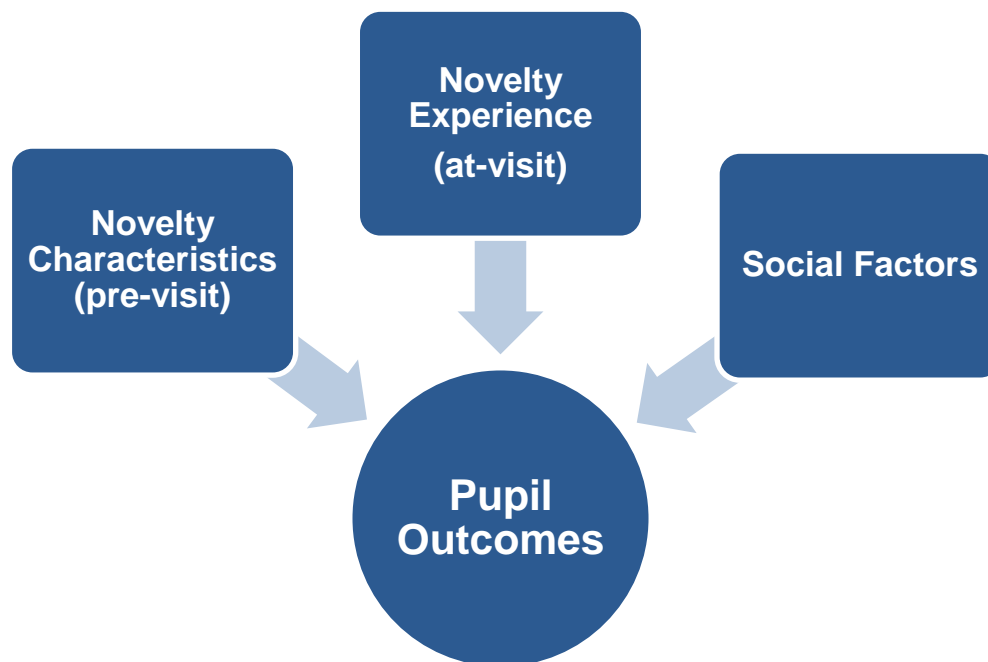- *Curious about NS state'*

mobiLLab program improvements

MAIN STUDY
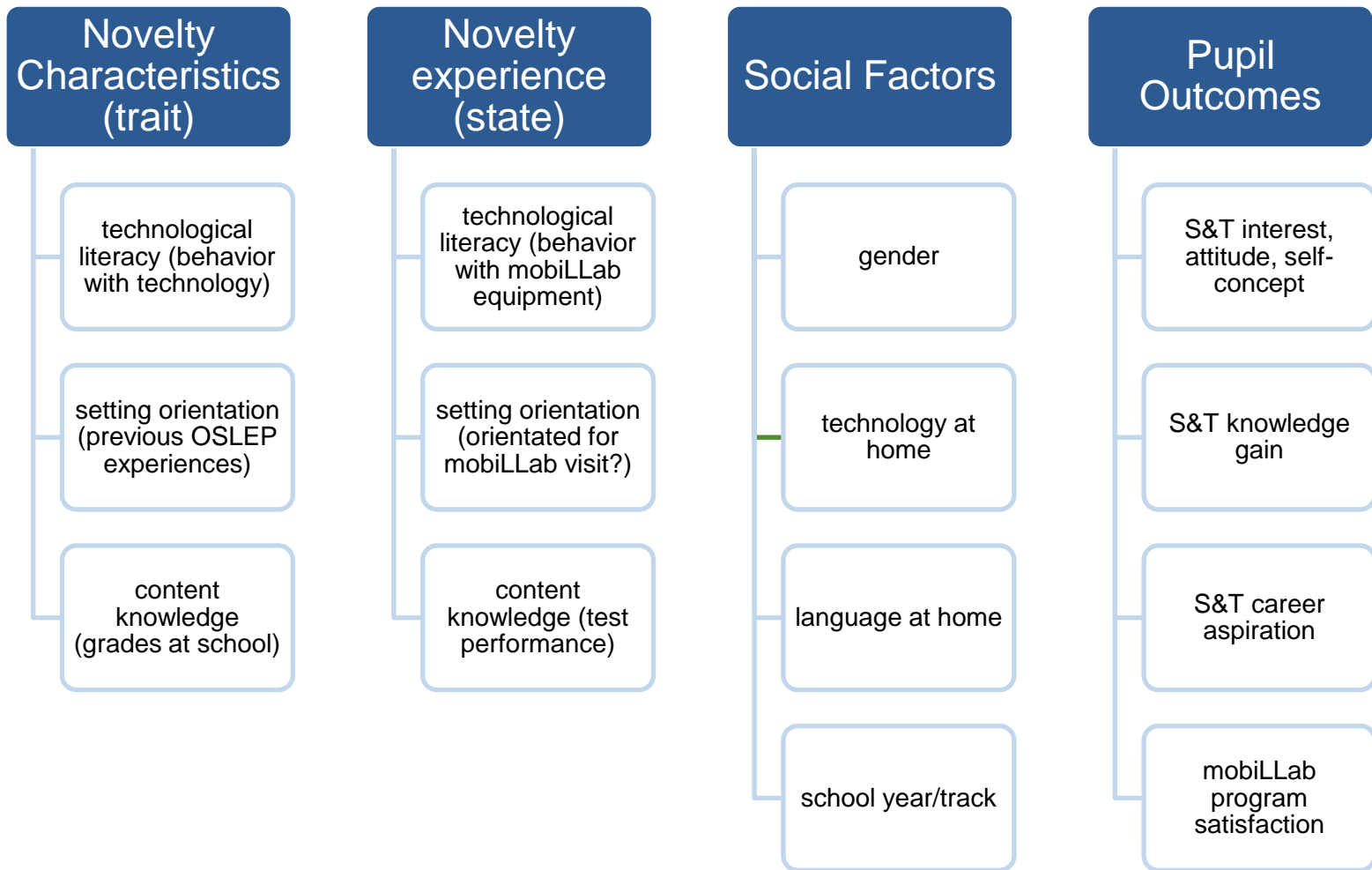
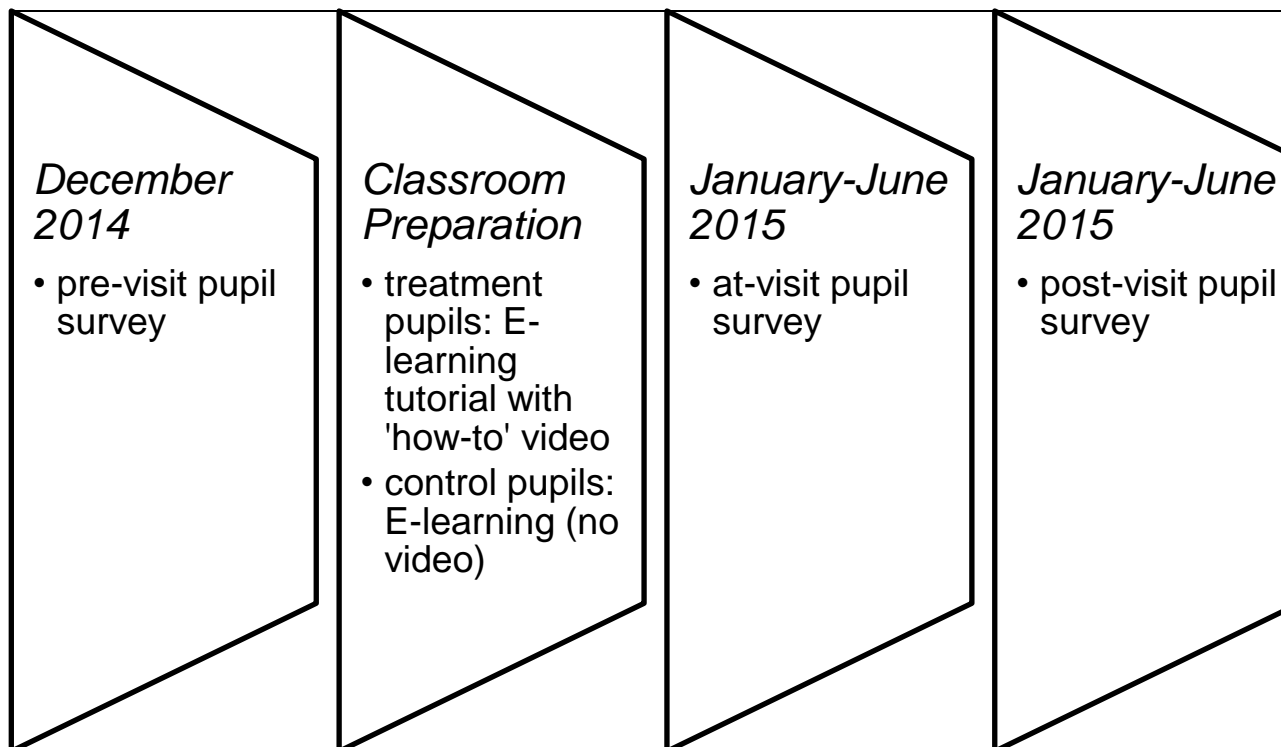Pu novelty space ⟶ Pu S&T outcomes

Research structure
Sampling plan

Research structure

Contructs

Novelty Characteristics (trait)	Novelty experience (state)	Social Factors	Pupil Outcomes
technological literacy (behavior with technology)	technological literacy (behavior with mobiLLab equipment)	gender	S&T interest, attitude, self-concept
setting orientation (previous OSLEP experiences)	setting orientation (orientated for mobiLLab visit?)	technology at home	S&T knowledge gain
content knowledge (grades at school)	content knowledge (test performance)	language at home	S&T career aspiration
		school year/track	mobiLLab program satisfaction

Main study sampling timetable

December 2014	Classroom Preparation	January-June 2015	January-June 2015
• pre-visit pupil survey	• treatment pupils: E-learning tutorial with 'how-to' video • control pupils: E-learning (no video)	• at-visit pupil survey	• post-visit pupil survey

Discussion

Questions about the Pilot Study?

Suggestions about Main Study data analysis and interpretation?

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Thank you for listening

Vielen Dank für eure Aufmerksamkeit

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Your questions and ideas are welcome…

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