Design-Based Research: Uncovering the Interplay between Theory and Practice

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The gap between educational research and praxis

- Teachers tend to express opposition to the innovations suggested by researchers. (cf. Fullan, 1991).

- Teachers appreciate research results obtained from quasi-experimental design because they think that it proves whether a new learning environment or a new pedagogical approach is better in some way than previous ones (Ratcliffe et al., 2005).

The gap between educational research and praxis

- In the field of educational technology or curriculum or even continuing professional development there is much design not based on research (Randolph, et al., 2005).

- design perhaps, is based on a designer's own experiences and beliefs of effective learning or design is purely technology driven. Even if the design is based on theory, (i.e. research-based practice), teachers' may think that the introduced artefact may work well in the designers' context, but not at all in an authentic real-life setting i.e. their school context .

Thinker versus Tinker
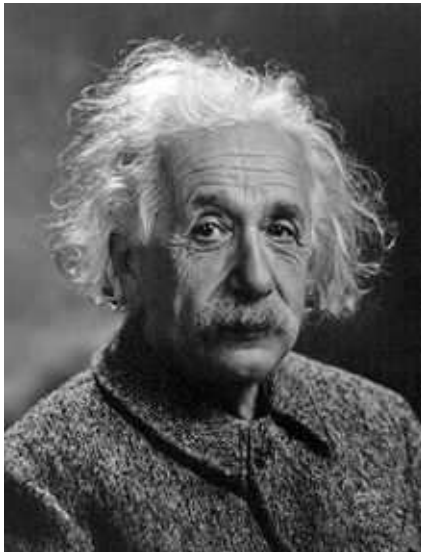
Albert Einstein (1879-1955)

"I never think of the future. It comes soon enough."

"We can't solve problems by using the same kind of thinking we used when we created them."

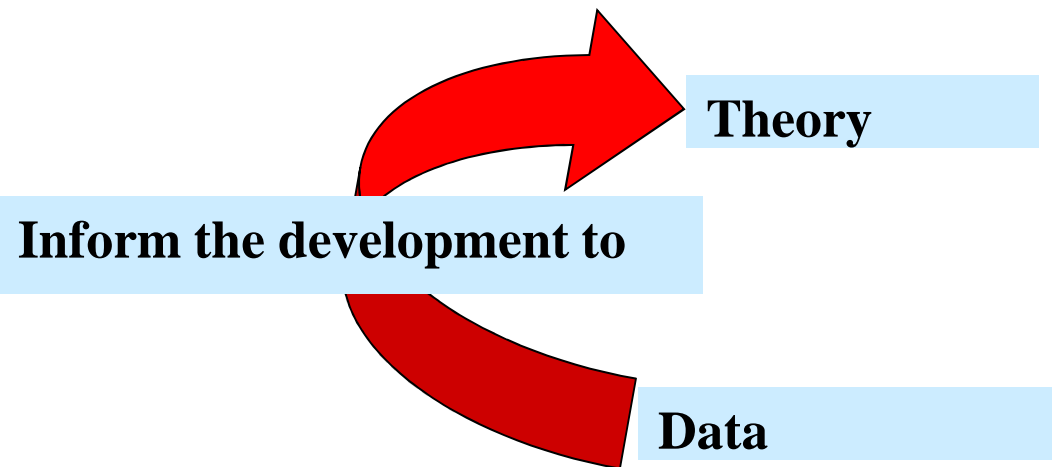"The whole of science is nothing more than a refinement of everyday thinking."

"Don't worry about what anybody else is going to do… The best way to predict the future is to invent it. Really smart people with reasonable funding can do just about anything that doesn't violate too many of Newton's Laws!" (1971)
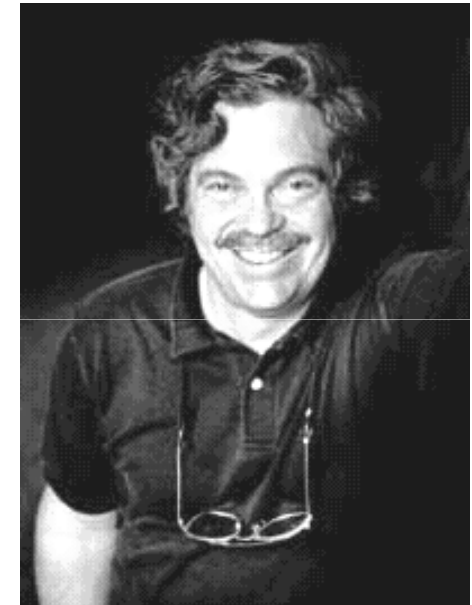
Alan C. Kay (1940-) age 70

How do we get theories?
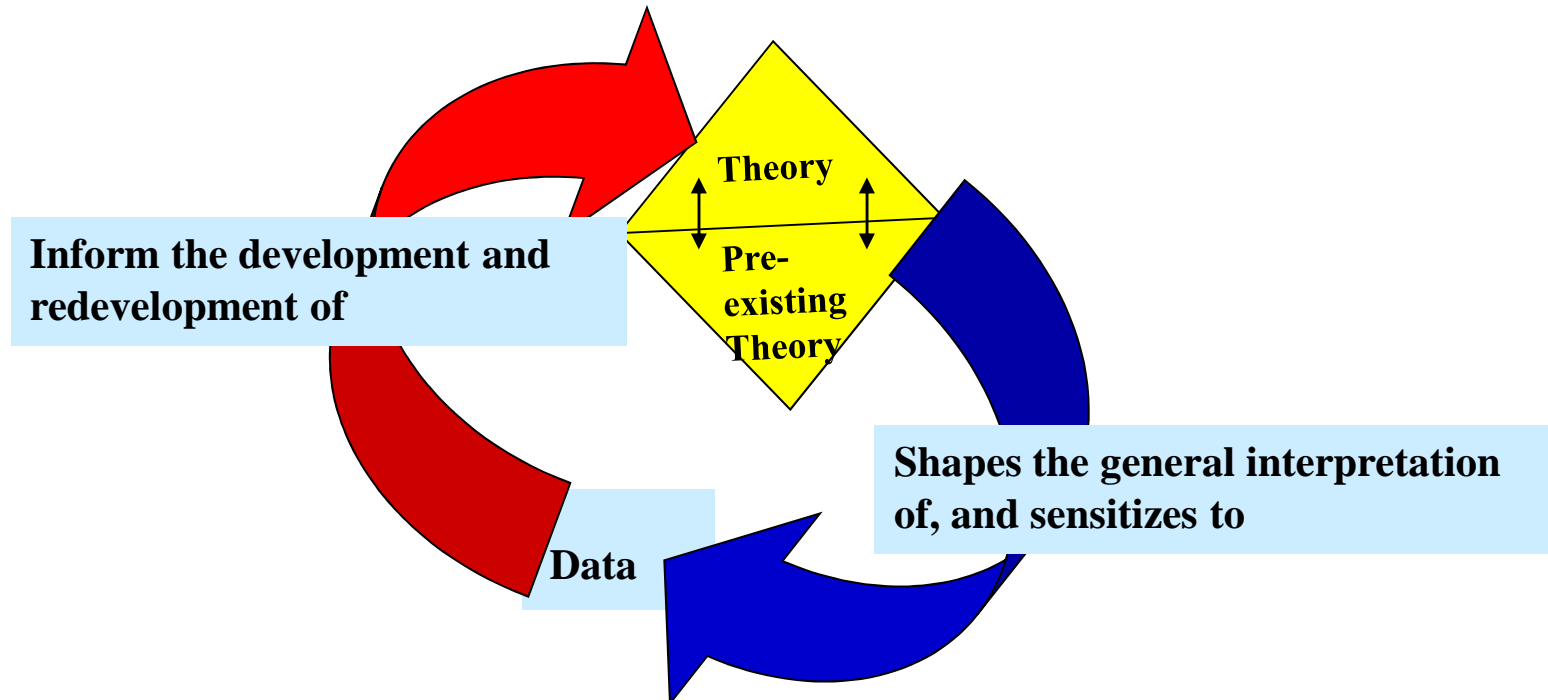
Simplistic inductive theory Building

Theory

Inform the development to

Data

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Deductive Theory Building

Theory

Used to deduce hypotheses

Used to test hypotheses

Data

Sophisticated model

How do we get theories?

theories and models

abstracting ⊙   ⊙ concretisation
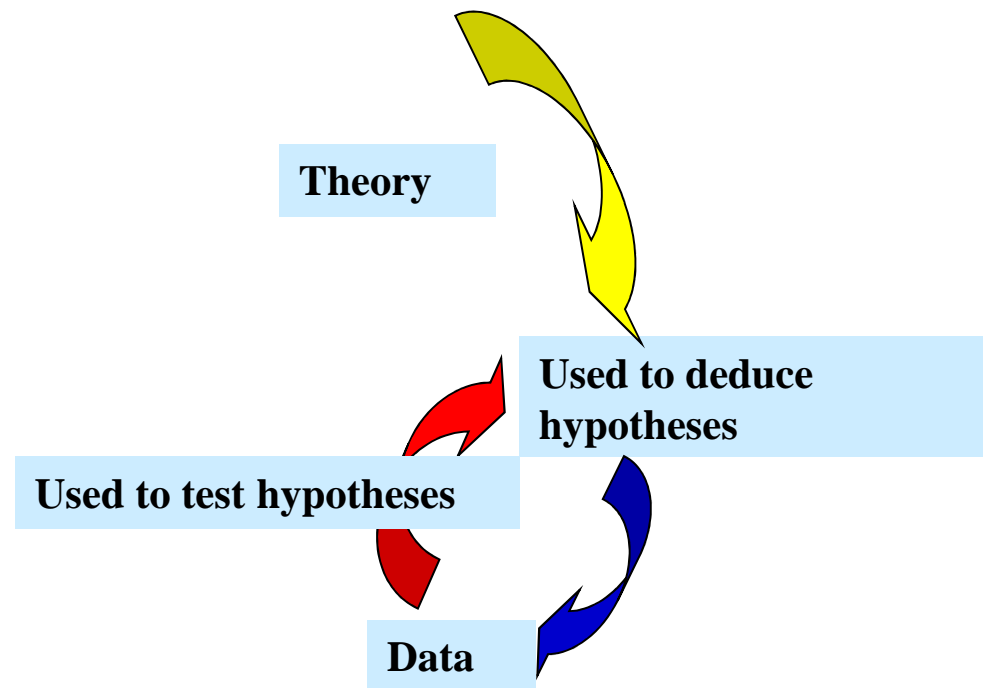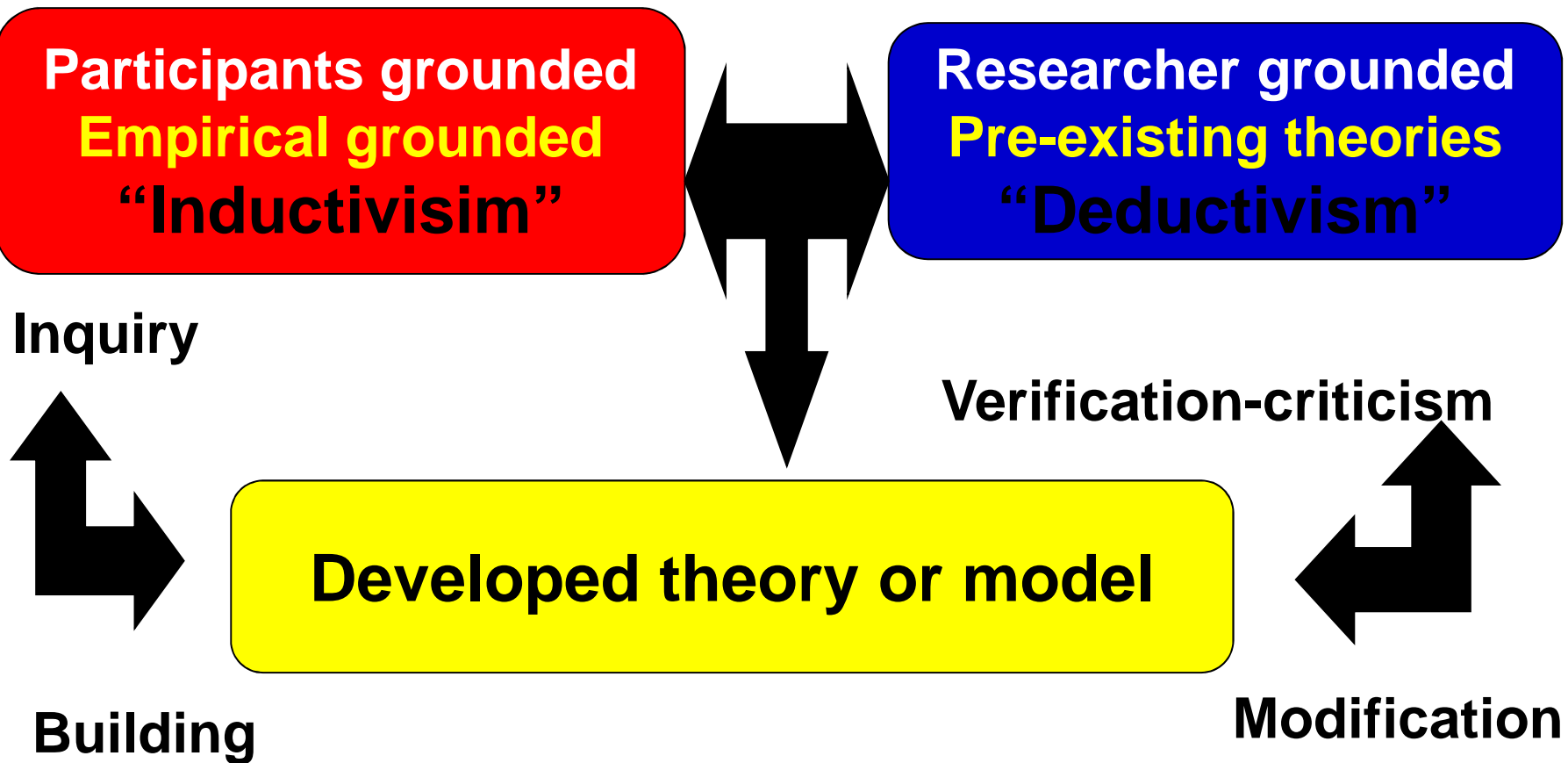
reality (t_1) ──────────────▶ reality (t_2)
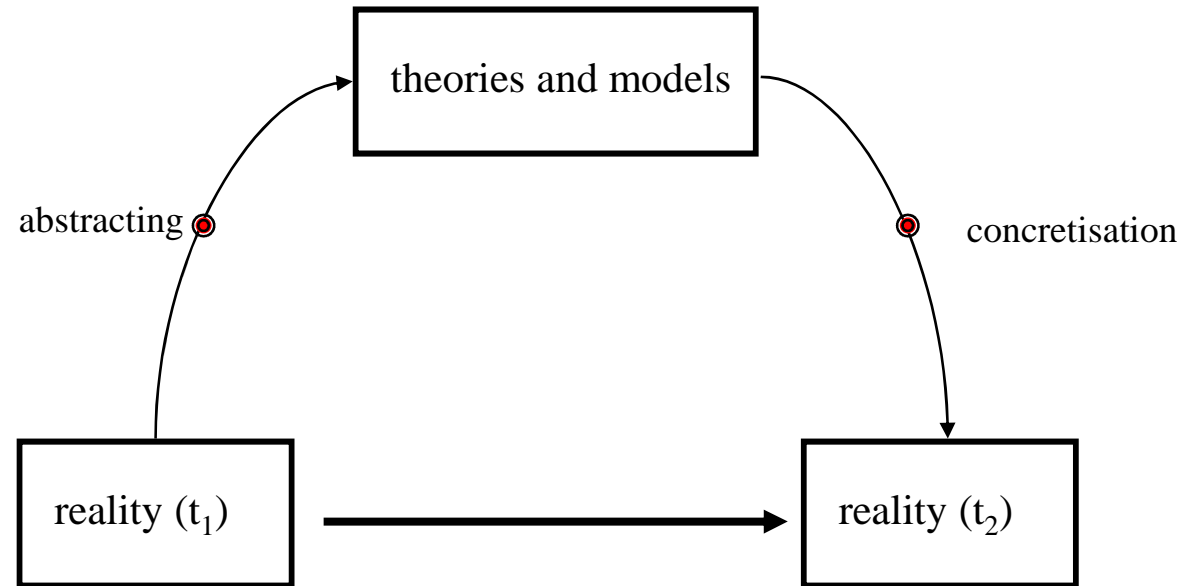
positivism :

{theory, model} $\notin$ reality

reality (t_1) $\approx$ reality (t_2)

constructionism :

{theory, model} $\in$ reality

reality (t_1) $\neq$ reality (t_2)

[REFERENCE: Rauterberg M. (2006). HCI as an engineering discipline: to be or not to be!?. *African Journal of Information and Communication Technology*, vol. 2, no. 4, pp. 163-184]

What kind of knowledge?

Model-T

Model-D

Bloom's Taxonomy

Higher Order Thinking Skills
Evaluation
Synthesis
Analysis
Application
Comprehension
Knowledge
Lower Order Thinking Skills
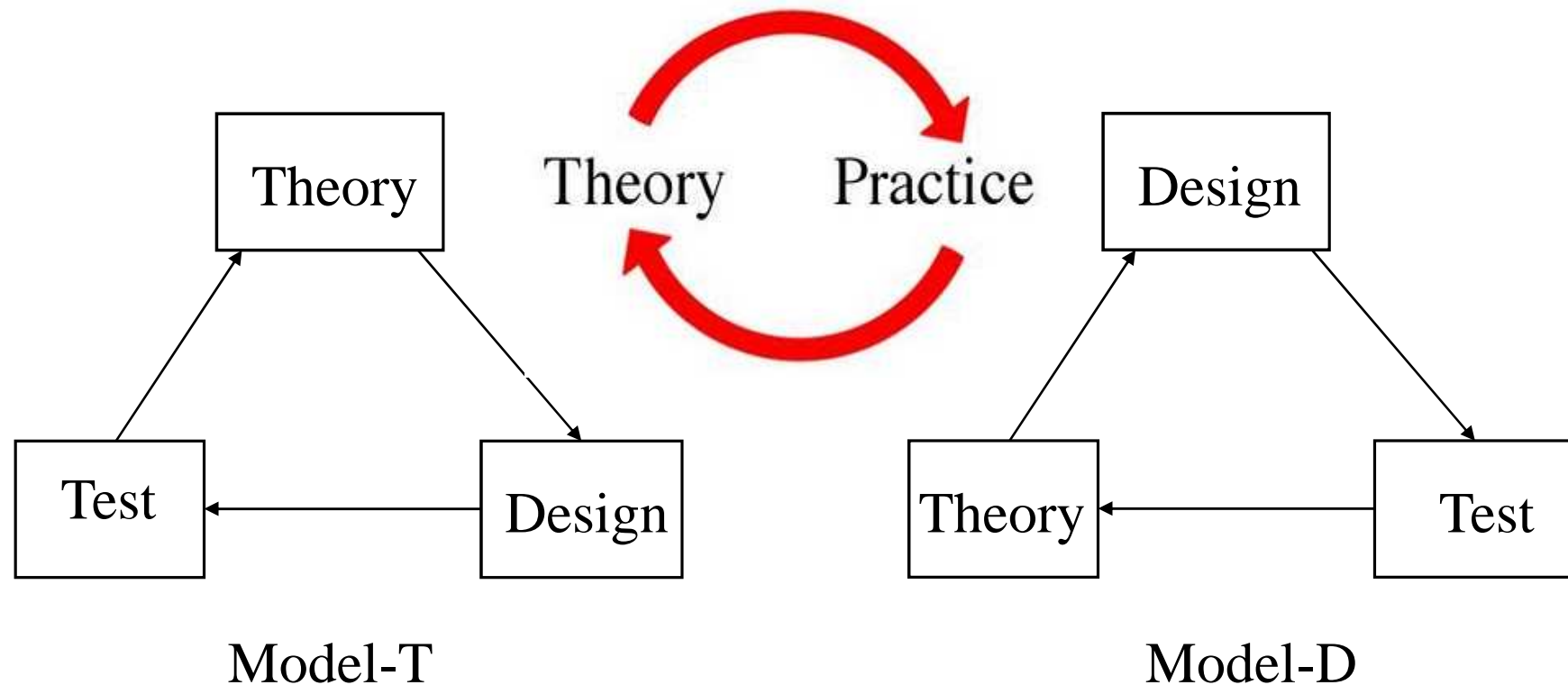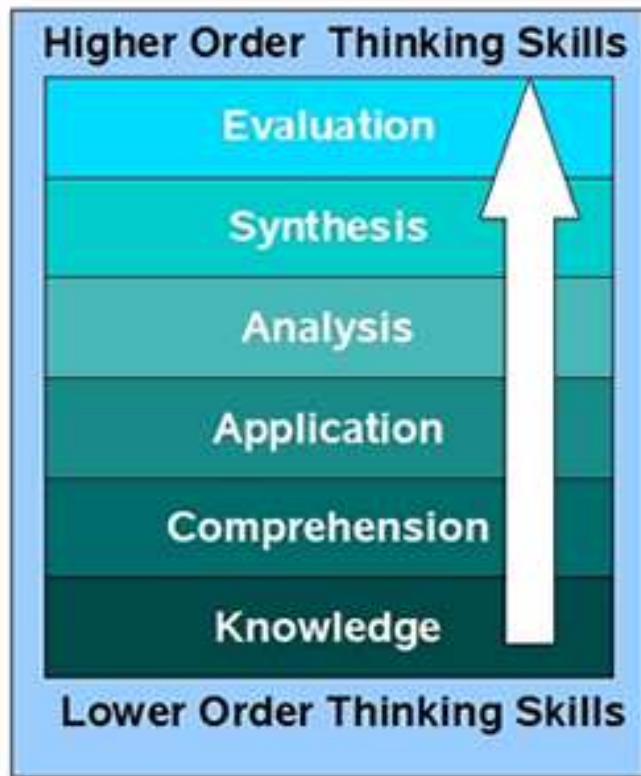
Bloom's Revised Taxonomy

Higher Order Thinking Skills
Creating
Evaluating
Analysing
Applying
Understanding
Remembering
Lower Order Thinking Skills
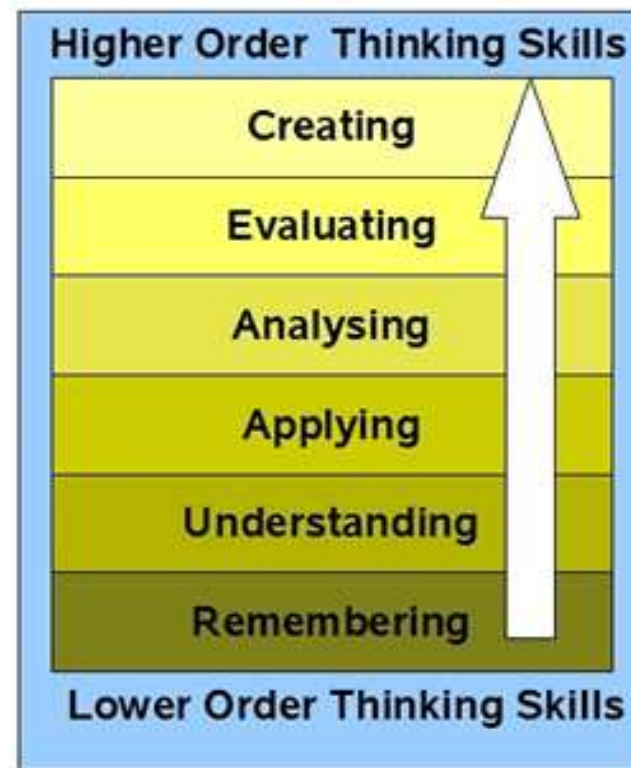
Taxonomy of Educational Objectives: The Classification of Educational Goals; pp. 201–207;
B. S. Bloom (Ed.) Susan Fauer Company, Inc. 1956.

A Taxonomy for Learning, Teaching, and Assessing — A Revision of Bloom's Taxonomy of Educational Objectives;
Lorin W. Anderson, David R. Krathwohl, Peter W. Airasian, Kathleen A. Cruikshank, Richard E. Mayer, Paul R. Pintrich, James Raths and Merlin C. Wittrock (Eds.) Addison Wesley Longman, Inc. 2001

Design-Based Research Methods in Education

What is design research?

"A systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories." (Wang & Hannafin, 2005, p.6)

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Overview of DBR

- Design Research is increasingly
  less research *about* or *for* design and
  more research *through* design.

- Research *about* design

  – Researching designers/teams and their practices

- Research *for* design

  – Original (primary) research into stakeholders' needs,
  wants, aversions, aspirations etc., technical
  opportunities, trends, etc.

Overview of DBR

- **Research _through_ design**
  - Using design practices and artefacts to create knowledge that are beyond existing research methodologies
- Least secure design research currently
  - cannot solely borrow mature research methodologies from established academic disciplines
  - research about/for design can adopt/adapt approaches from human sciences and technical foresight/audit
  - seeing increasing use of methodologies from Arts and Humanities in (Interaction) Design Research

The Name(s) of BDR

Design-based Research: It combines the designing of an educational artefact and research concerning the learning in the designed settings. Recently, several groups have been active in endeavour combining the design of an artefact (at least a teacher guide or a synopsis of a teaching sequence) and educational research using several names

    Design-based Research Collective - Northwestern (2003)

Design Experiments: emphasises the comparison of several versions of designed artefact

    Ann Brown – Berkeley (1992)

    Allan Collins – Northwestern (1990/92)

    Paul Cobb – Vanderbilt (2003/2006)

Educational Design Research (book): emphasises the process, the features of an artefact and educational knowledge (theory) development .

    Van den Akker – The Netherlands (2006)

Design & Development Research: emphasises the analysis an artefact or a successful design process

    Richey & Nelson, 1996

    Richey & Klein (2007) book

Formative and Design Experiments (book)

    Reinking & Bradley (2007)

    user-design research: emphasises the role of user and focus on information system (software) design Carr-Chellman & Savoy (2004)

(Typical) Three Phases

- Phase I
  - Preparing for a Design-based Research study
- Phase II
  - Conducting a Design-based Research study
- Phase III
  - Conducting a Retrospective Analysis

(Typical) Three Phases

Phase I - Preparing for a Design-based Research study

Ground study in literature establishing theoretical intent

If possible engage in ethnographic study of the existing learning ecology

Specify researcher assumptions about the design

- Are you proposing an alternate view of the curriculum domain?

Set out as clearly as possible the envisioned form of learning

Develop an "embodied" design conjecture – one that is testable (starting point/trajectory/end point)

- "How do you think your design/model will work?"
- "What shifts do you anticipate and what will influence them?"
- "Do you have to invent something to make it function properly?" (e.g. software)

(Typical) Three Phases

Phase II - Conducting a Design-based Research study

Iterative micro-cycles of planning/action/analysis

- Researchers continuously communicate **(document)** how the conjectured design *was to* function and how *it is* functioning

- Researchers and practitioners **interact** around the evolving design

- Contextual influences incorporated into the design

Selected data used to inform these micro-cycles

Regular references to conjectured design – which can change as the study moves forward

(Typical) Three Phases

Phase III - Conducting Retrospective Analysis

Pool all data sources

Systematically work through the data focusing on the effectiveness of the conjectured design

"How did it function, when did it have difficulties, why did these things happen to it?"

Produce a "thick description" of how the study proceeded - "What did the research team learn?"

Core design principles are developed and refined

Ultimately yields a description of the "design in practice" (Collins, 1999)

Develop a Humble Local Theory of Instruction (Cobb, 2003)

The difference bw ER and DER

Empirical Research

| Hypotheses based upon Observations and/or Existing Theories | → | Experiments Designed to Test Hypotheses | → | Theory Refinement based on Test Results | → | Application of Theory by Practitioners |

Specification of New Hypotheses

Development Research

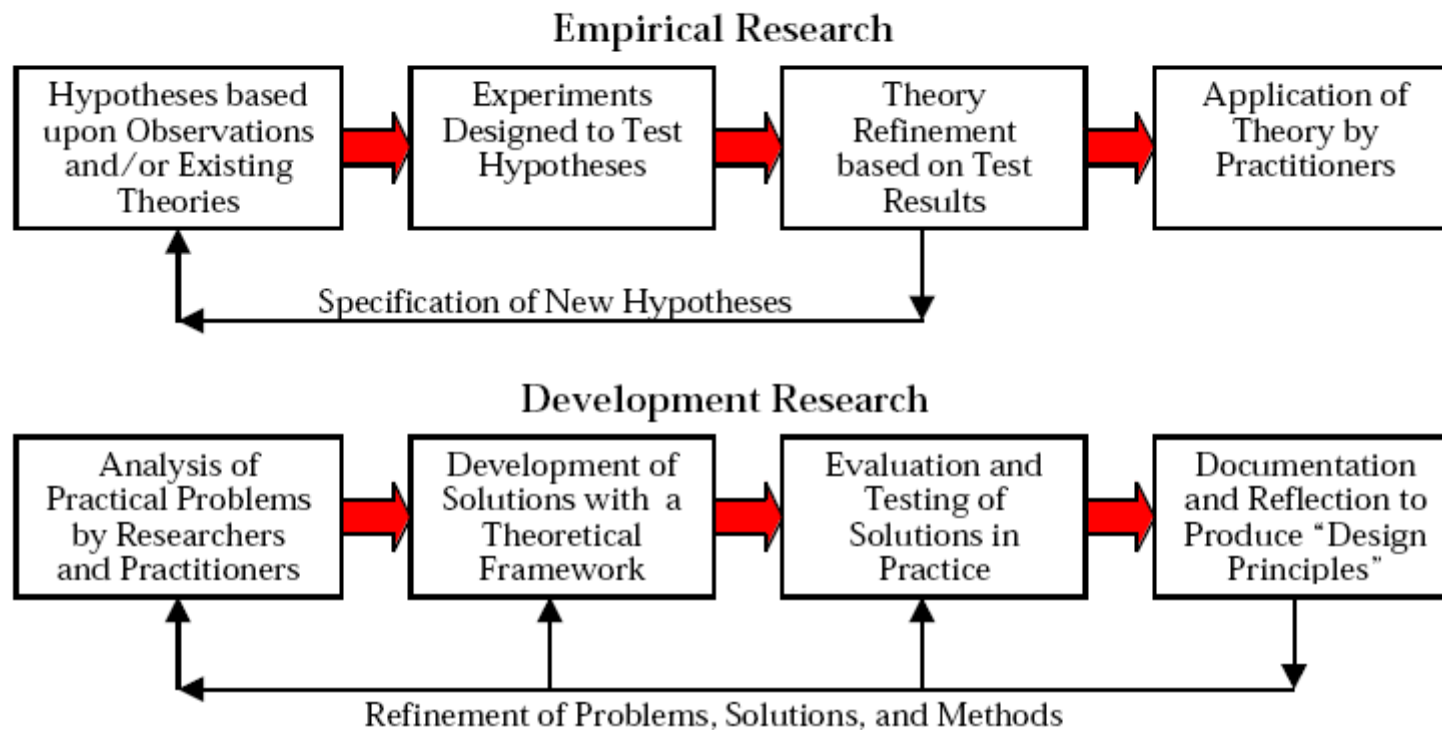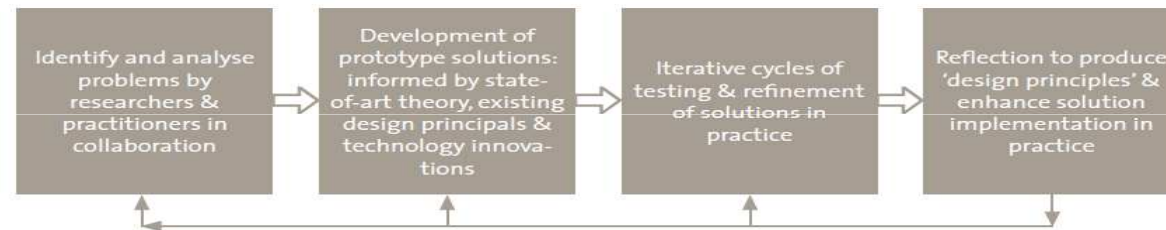| Analysis of Practical Problems by Researchers and Practitioners | → | Development of Solutions with a Theoretical Framework | → | Evaluation and Testing of Solutions in Practice | → | Documentation and Reflection to Produce "Design Principles" |

Refinement of Problems, Solutions, and Methods

Figure 3. Empirical and development approaches to IT research.

PRD Model by Reeves

Reeves (2006) depicts the design research approach as follows:

| Identify and analyse problems by researchers & practitioners in collaboration | Development of prototype solutions: informed by state-of-art theory, existing design principals & technology innova-tions | Iterative cycles of testing & refinement of solutions in practice | Reflection to produce 'design principles' & enhance solution implementation in practice |

Figure 1: Refinement of Problems, Solutions, Methods, and Design Principles (Reeves, 2000, 2006)

The cycles/time of the DBR

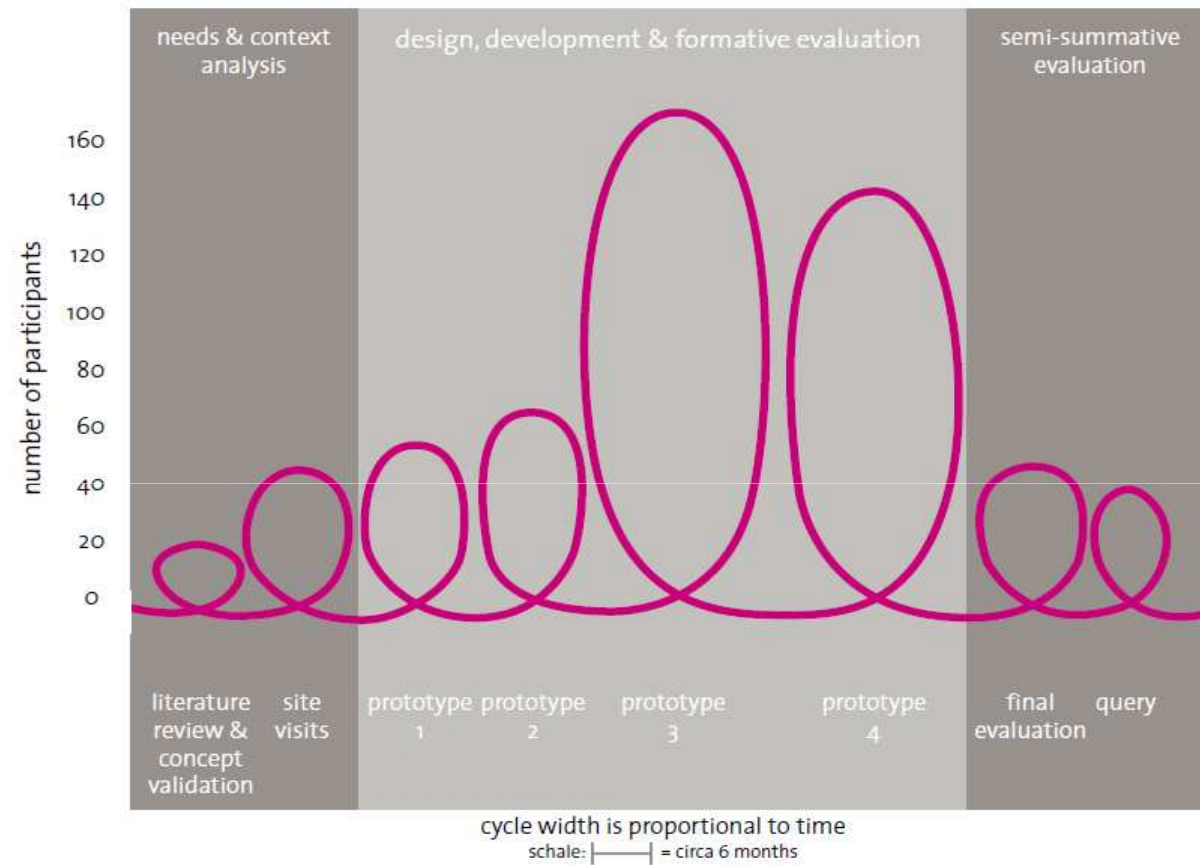McKenney (2001) illustrates in her study this cyclical process as follows:

Figure 2: Display of the CASCADE-SEA study (McKenney, 2001)
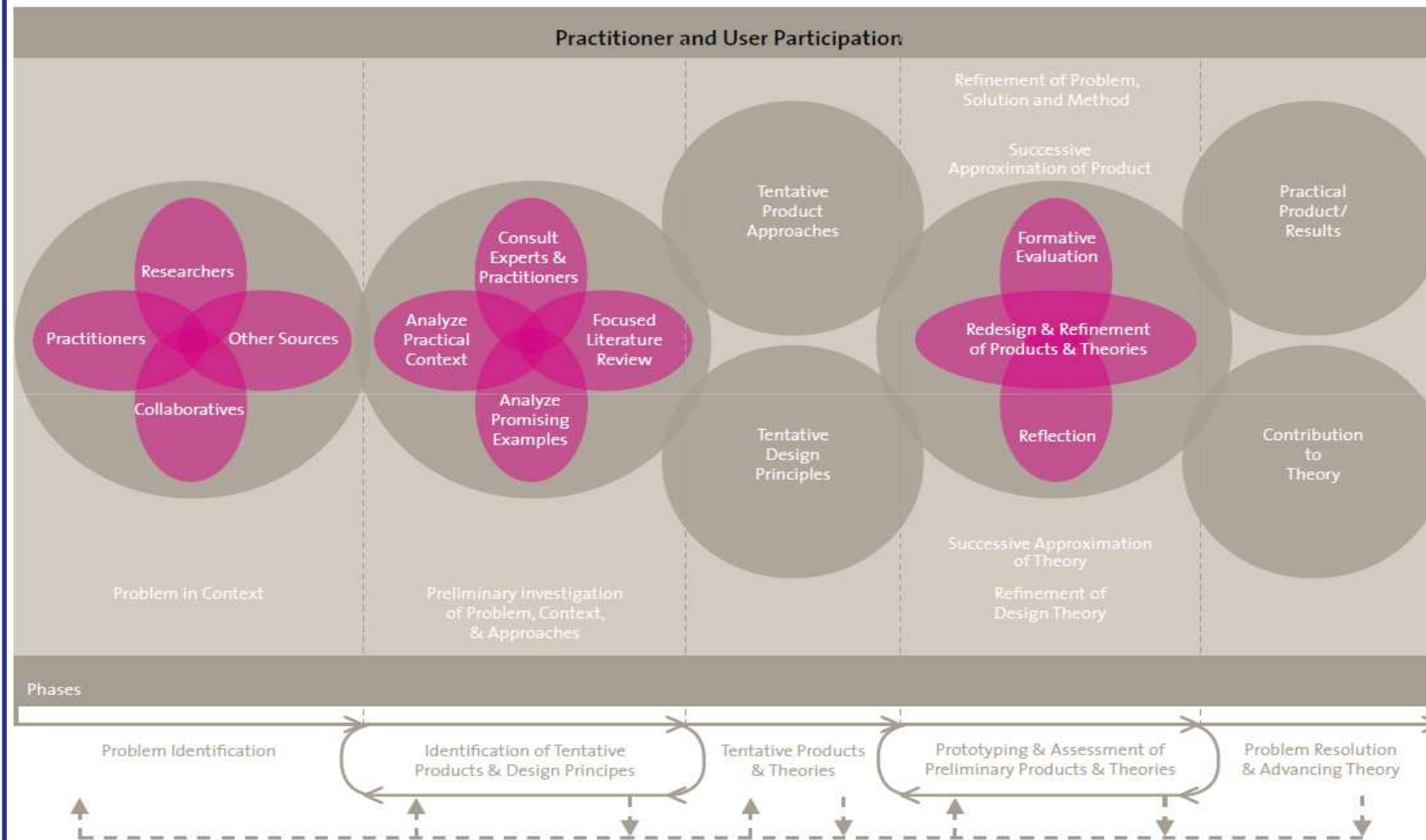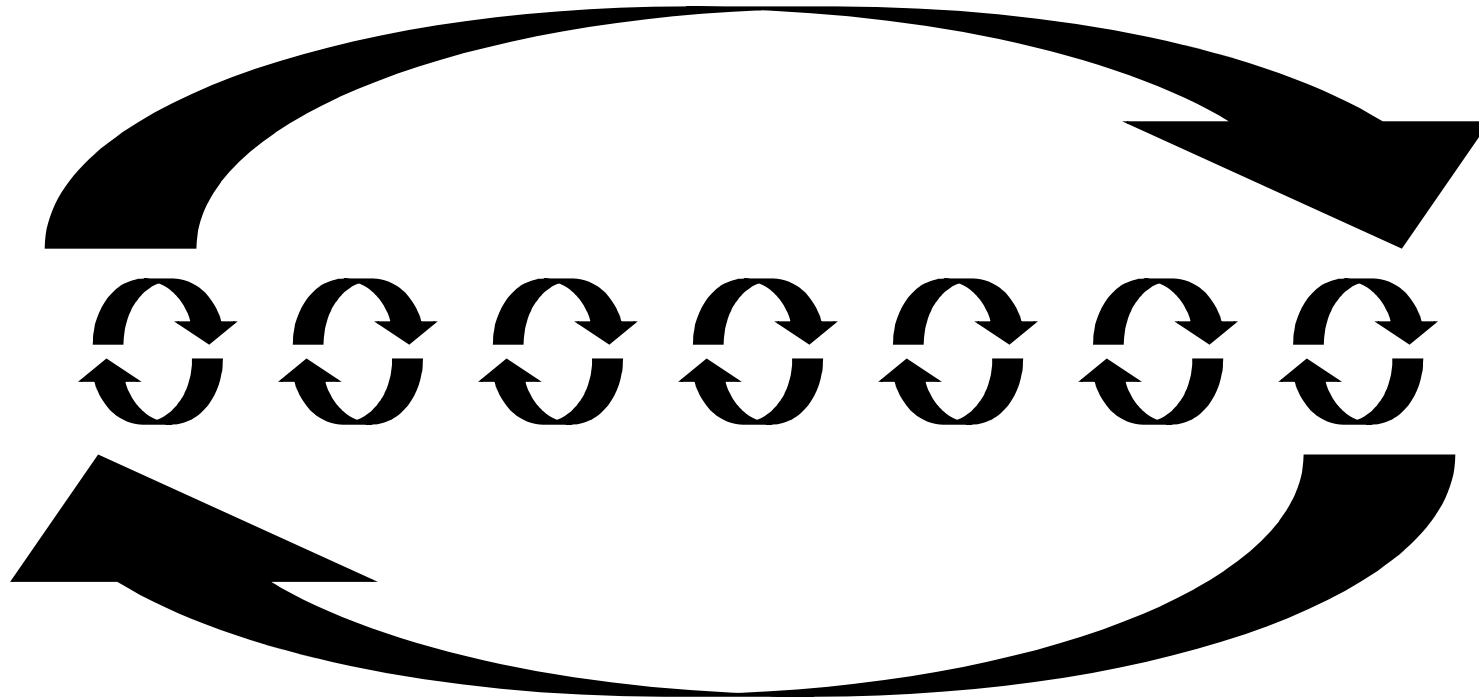
Generic Design Research Model

Figure 3: Generic Design Research Model (Wademan, 2005)

Time scales of design-based research

Micro-cycles of analysis during implementation
Macro-cycles of retrospective analysis
(from Cobb, 2001)

The SED partners

Participant no. *	Participant organisation name	Part. short name	Country
1 (Co-ordinator)	University of Exeter		UK
2	Homi Bhabha Centre for Science Education		India
3	Pamukkale University		Turkey
4	Department of Education American University in Beirut		Lebanon
5	Eindhoven University of Technology		The Netherlands
6	Tunku Abdul Rahman College		Malaysia

What is Science (Education) for Diversity About….

science & Labs

science & Food

science & networking

science & Industry

science & Cloth

Science for all Users of science

Work and research in science Scientists-technologists

science classroom and diversity

the science of making babies

science beauty

Science &The LCD TV Tech

Science & War

The SED Aspects
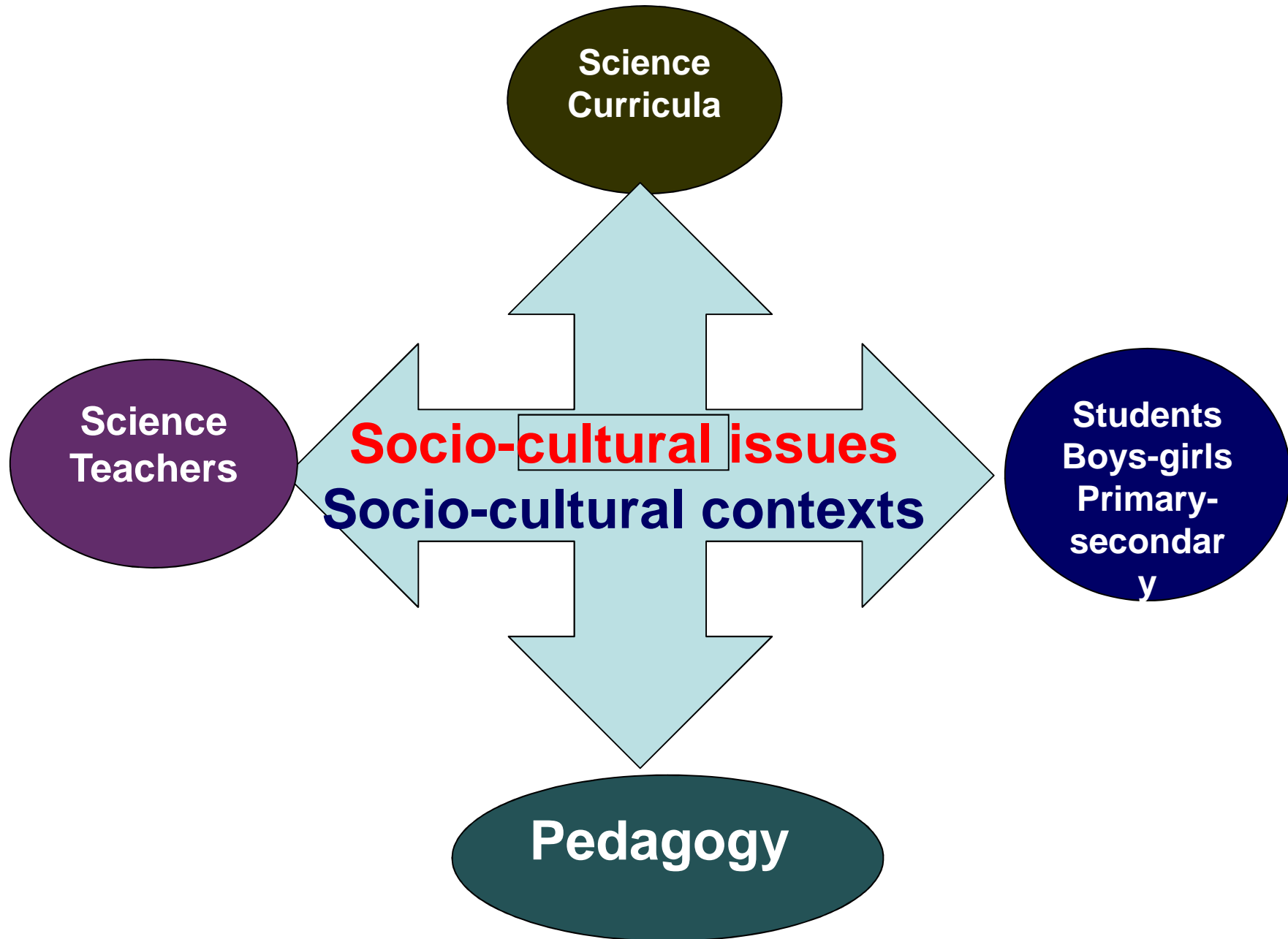
Issues to explore on SED across the partners

Policy in place for science Ed. & diversity	**Understanding educational policy across the partners regarding attracting both girls and boys to study science**
Ethnicity and Science	**Exploring how the current science Education help young people from minority populations to realise their aspirations and raise awareness about the range of careers in science**
Culture and Science	**Exploring students' views with diverse cultural backgrounds on science and the teaching and learning of science**
Scientific Literacy and Science	**Measuring shifts on students' scientific literacy (e.g. nature of science, science as away of thinking, nature of science, etc.)**
Teachers	**Exploring science teachers' understandings of diversity, worries, concerns about teaching science to diverse learners; Etc.**
Career in Science	**Exploring students' views about their future career and how science influence their choice**
Good practices and case studies	**Exploring the range of science education policies in, the partners countries, Europe and the world in relation to the issue of multiculturalism and the range of innovations and initiatives that have been tried and what evidence there is**
Guidelines and programmes	**Develop theoretical frameworks including pedagogy teacher training, and science curricula seeking to make science an interest to diverse students and develop their scientific literacy**

valorisations

Disseminations &

Exploration Phase → **Students and teachers' perceptions about ICT and Teachers' TPACK** ← Base Line assessment

Development Phase → **ICT-CPD for teachers**

1st Research cycle

CPD/Initiative Design & refinement

Reflection

Analysis

Implementation/ Evaluation

← Questionnaires, Interviews & observations

Implementation Phase

2nd Research cycle

CPD/Initiative Design & refinement

Reflection

Analysis

Implementation/ Evaluation

← Questionnaires, Interviews & observations

Students and teachers' perceptions about ICT and Teachers' TPACK

Assessment phase → **A recommendation for a new research cycle** ← Questionnaires, Interviews & observations

Research Design

Teachers' pedagogical and ICT needs

Students' levels of 21st skills

Base Line Assessment

Exploration Phase

CPD for the teachers in developing classroom dialogue and 21st century skills

Quantitative & Qualitative

Development Phase

Implementation Phase

Thinking together:

Phase 1. Face-to-face collaborative talk: thinking together activities

Phase 2: ten ICT-based collaborative talk activities

Interviews and observation

Project-Based Learning (PBL)

Recycle project for science lessons

Business project for mathematics lessons

Interviews and observation

Project-Based Learning (PBL) approach with school XX & School XX

Interviews and observation

Assessment Phase

21st century skills assessment

Quantitative & Qualitative

Back to Theory vs. Practice

Principles of Design Based Research

– Designing learning environments intertwined with developing theories (proto-theories) Cycles of design, enactment, analysis & redesign.

– Respond to emergent features

– Must lead to sharable theories (plausible causal accounts)

– Must account for how designs function in authentic settings (document success, failure and interactions)

– Relies on methods that can document and connect processes of enactments to outcomes of interest

The concept of rigor

How can we achieve "rigor" when we collect
and interpret the data????

To summarise ......

Authors about design research also agree a number of characteristics of this type of research. These are summarized by Van den Akker et al. (2006: 5):

Interventionist: *the research aims at designing an intervention in a real world setting;*

Iterative: *the research incorporates cycles of analysis, design and development,* evaluation, and revision;

Involvement of practitioners: *active participation of practitioners in the various stages* and activities of the research

Process oriented: *the focus is on understanding and improving interventions (a black* box model of input – output measurement is avoided);

Utility oriented: *the merit of a design is measured, in part by its practicality for users in* real contexts; and

Theory oriented: *the design is (at least partly) based on a conceptual framework and* upon theoretical propositions, whilst the systematic evaluation of consecutive prototypes of the intervention contributes to theory building.

An Introduction to Educational Design Research

HANDBOOK OF
DESIGN
RESEARCH
METHODS
IN EDUCATION
Innovations in Science, Technology,
Engineering, and Mathematics
Learning and Teaching

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Thank you!

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