Hamdan Bin Mohammed e-University

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Slides for the Study book on

Research methods in e-education

1st edition, v1.2, April 2009

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http://edutechwiki.unige.ch/en/

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Use of these slides

Since some persons may not familiar with PDF slides, we provide a few hints here.

Rationale for slide production with Word and PDF

- We used Word 2007 to produce these slides, since reuse of study book elements is much easier that way.
- Other advantages: Students will see similar figures and tables. In addition, you will find a content structure with chapters and sections. Chapters are the same as in the study book.

PDF Production and use for on-line reading

- You can use these slides in the same way as a PowerPoint presentation by saving the Word file as PDF.
- You also can use the table of contents to jump to selected slides or, better, enable the bookmarks view in Acrobat Reader.

To project PDF in full-screen mode for teaching:

- Open the PDF file with Acrobat Reader (e.g. save this file on your desktop and click on it). Then hit CTRL-L (or Menu View->Full Screen).
- You then can use the Left/Right or the PageUp/PageDown arrows on your keyboard to navigate.
- To configure the full screen viewing options of the Acrobat PDF Reader: Use Menu Edit -> Preferences -> Full Screen.

Geneva, April 12 2009 - DKS

Chapter 1: Introduction

This course unit introduces research methods in e-education. We will introduce research designs, research methodologies, research techniques, as well as practical considerations like planning and writing a master thesis.

E-education is better known as educational technology. Other popular names of this interdisciplinary field of research and development are Instructional technology, Educational communications and technology, Learning technology, e-learning or technology-enhanced learning. However, the latter usually refer to specific sub-fields of educational technology.

Educational technology in general can be defined as a design science or as a collection of different research interests addressing fundamental issues of learning, teaching and social organization.

Research methodology draws from all the other social sciences plus from some of the engineering sciences.

1. A first look at research

Research = ask a question and answer

Ask a question

- define the boundaries
- work out details

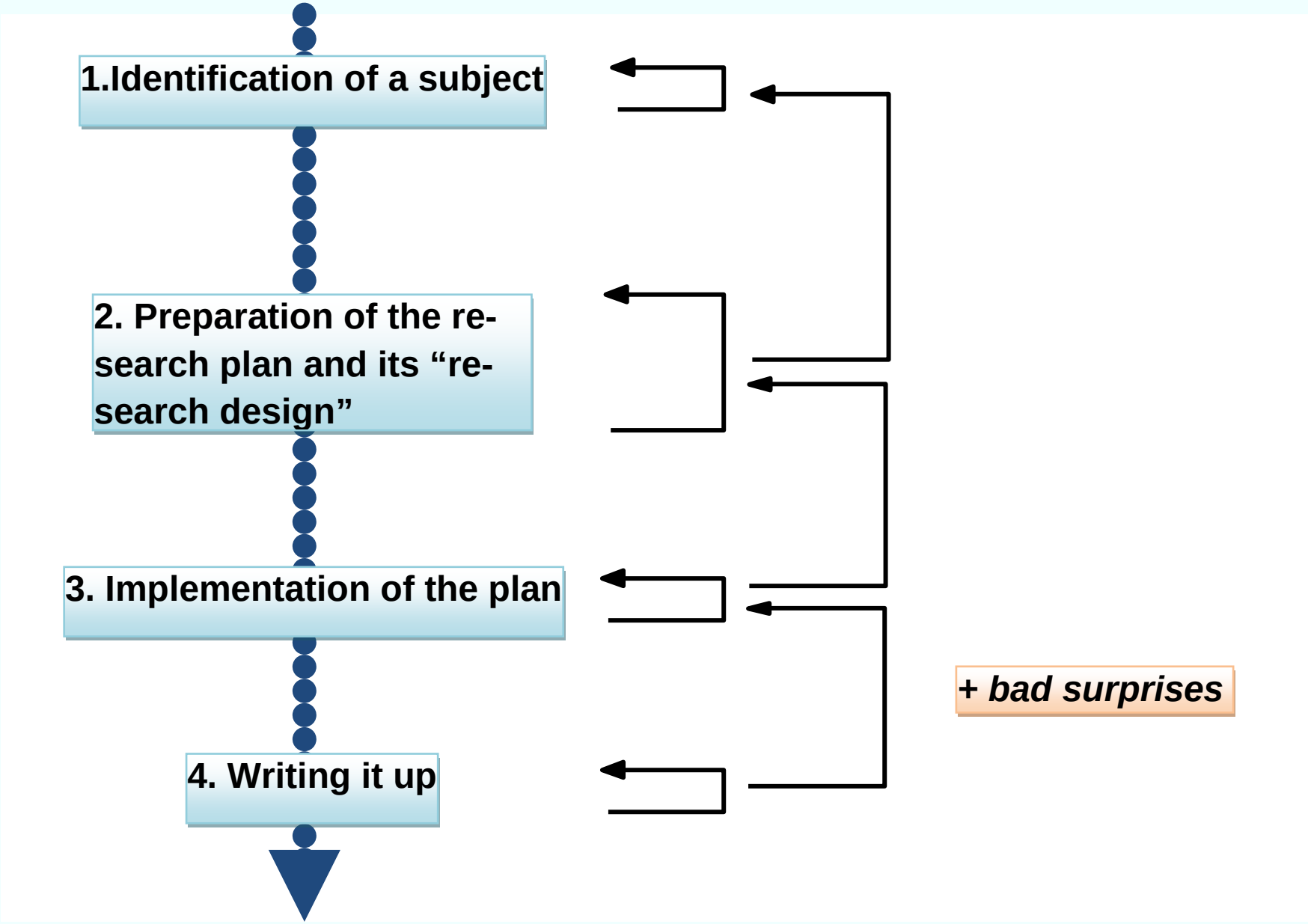
Dig

- use clear concepts and definitions
- use the appropriate tools (methods)
- compare with existing knowledge

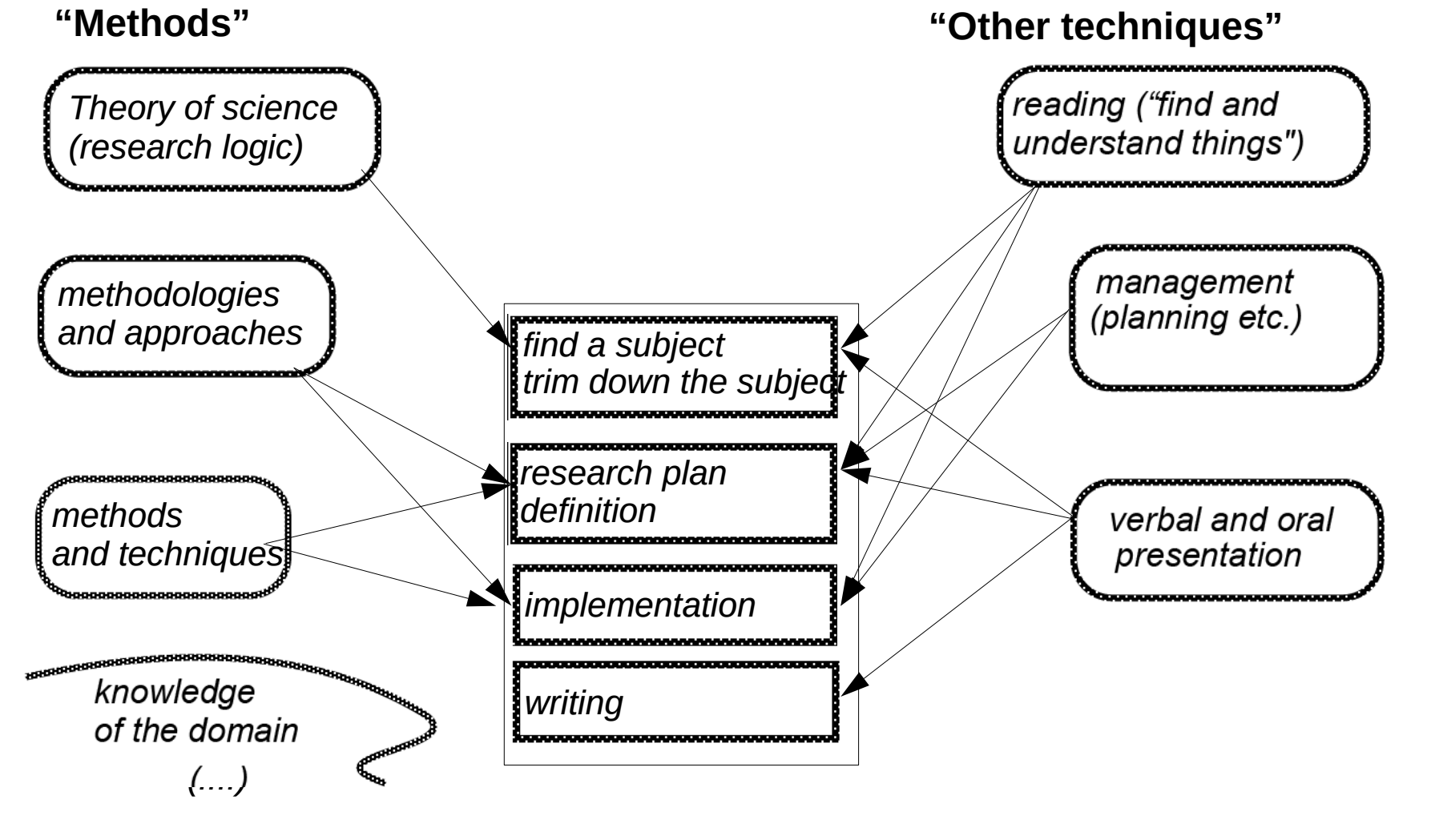
Answer

- with a clearly structured text (argumentation)

2. Major stages of a research project



3. What do you need to learn (1) ?



4. What do you need to learn (2) ?

"conceptual"

Academic research

....Understanding of what it means

Research Methodology

.... Basic principles like causality and validity

.... Quantitative and qualitative methods

Research design

....Create a research plan

.... Operationalize research questions

Techniques

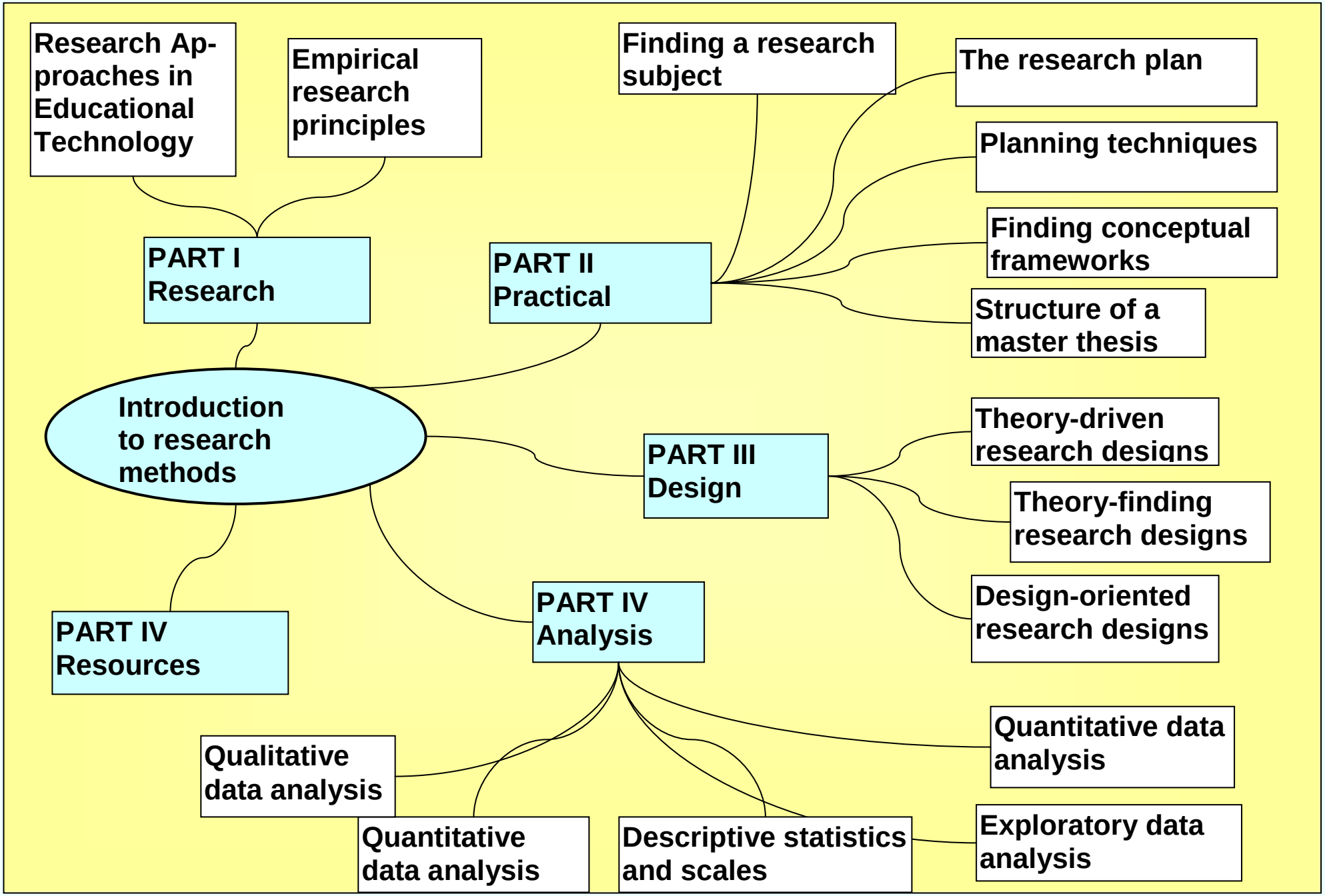
.... Find ideas, write, plan, etc.

.... Quantitative and qualitative data gathering

Data analysis techniques

"practical"

5. Course program



6. Learning goals

Main Learning goals

1. Know about some fundamental principles of academic research
2. Become familiar with three major classes of research designs:
   a) Theory-testing approaches
   b) Qualitative and theory-finding research
   c) Design-science research
3. Understand the fundamental elements of a Research Design:
   a) Definition of a subject
   b) Research Goals and Questions
   c) Literature review and selection of theoretical and conceptual frameworks
   d) Approaches and Methodologies: Operational Research Questions, Analysis frameworks and methodological techniques.
4. Master the fundamental concepts and procedures of a few selected research methodologies, e.g. data gathering, sampling, and simple quantitative and qualitative data analysis.
5. Learn some practical skills like finding a research subject or planning
6. Learn how to structure a thesis paper (i.e. a dissertation)

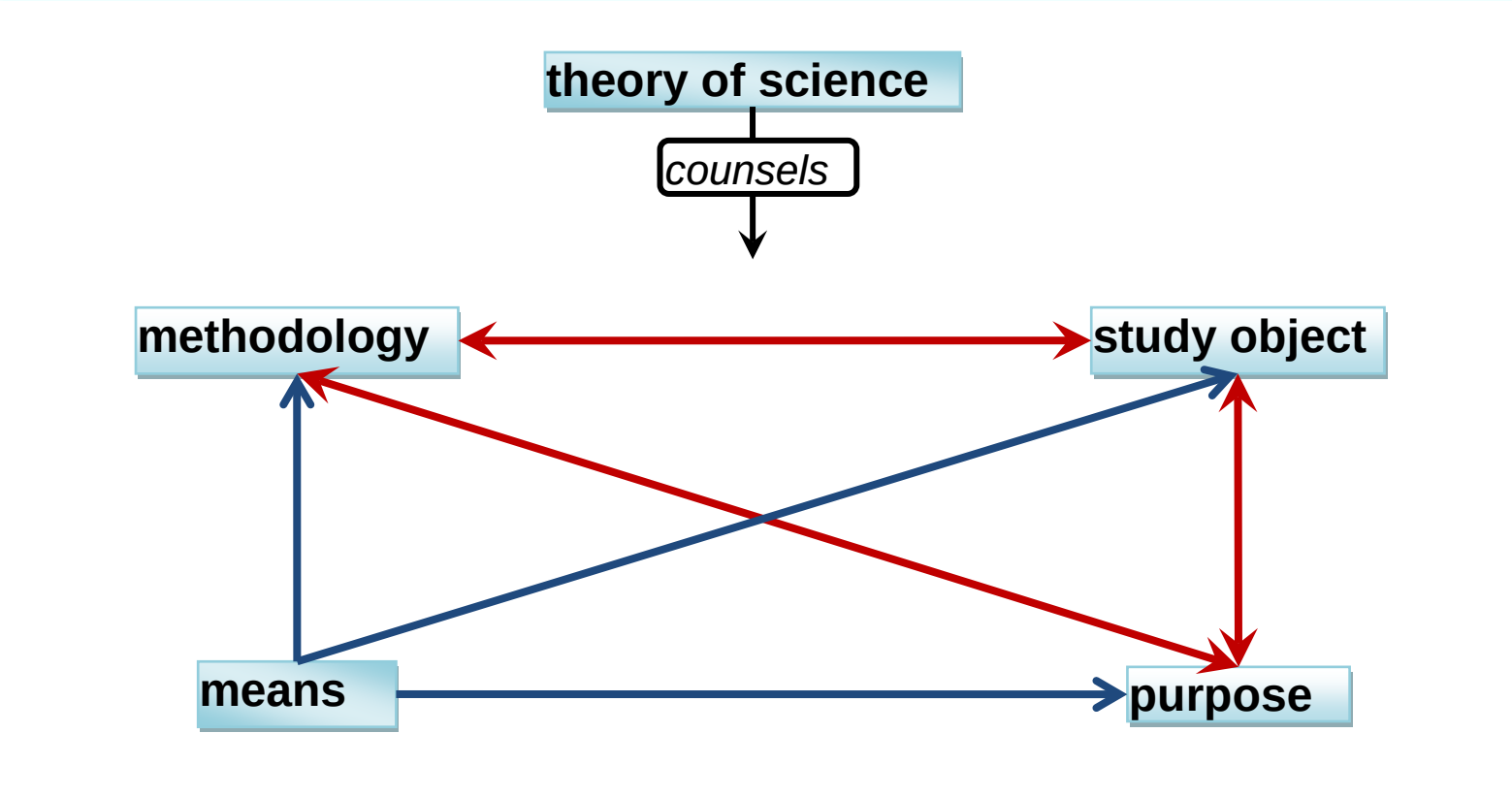
Chapter 2: Research approaches in Educational technology

Learning goals

1. Which elements define a given piece of research ?

1. Theory of science:
   - what is knowledge ? academic knowledge ?
   - how should you reason ? deduce ? induce ? model ?
2. The methodology:
   - should fit your research subject
   - ..... legitimated by some theory of science.
3. The research object
   - you need to define exactly what you want to study
4. The research goals
   - what's the purpose of your study?
   - Who will use it ?
5. Your means
   - time, money,
   - knowledge,
   - data access

An equilibrium between methods, object, goals and means:



What does this figure tell ?

- In educational technology, there rarely is a ready solution for your problem !
- Your study object, methodology, purpose of your research and your means are four different parameters that constrain each other.
- It is wrong to say that there is one good method for studying a given object.
- In other words: You will have to come up with your own research design and its justification !

2. What do we mean by academic empirical research (science)?

1. A systematic activity
   - produced knowledge is a coherent whole
   - it (your results) should integrate with a system of knowledge (build upon literature and compare with literature)
2. centered on reality
   - e.g. nature, la society, people's behavior, people's attitudes
   - in other words: don't just speculate, look at things
3. Precise tools (hypothesis, theories, methods, reliable techniques etc.)
   - be aware of your "confirmation bias", test your conclusions against alternative explanations,
4. generalization
   - contribute to theories by using (and testing) their theoretical statements
   - reuse (and criticize) their instruments (frameworks, analysis grids, etc.)
   - suggest modifications (or even new theories)
5. A belief in determinism
   - phenomena are the necessary consequence of conditions (causes)
   - randomness in explanation is only due to ignorance, complexity, etc.
6. Relativism
   - our knowledge is not perfect,
   - .... in particular in social sciences where man is subject and object, observer and observed and where many variables influence a phenomenon

3. What is an interesting piece of research ?

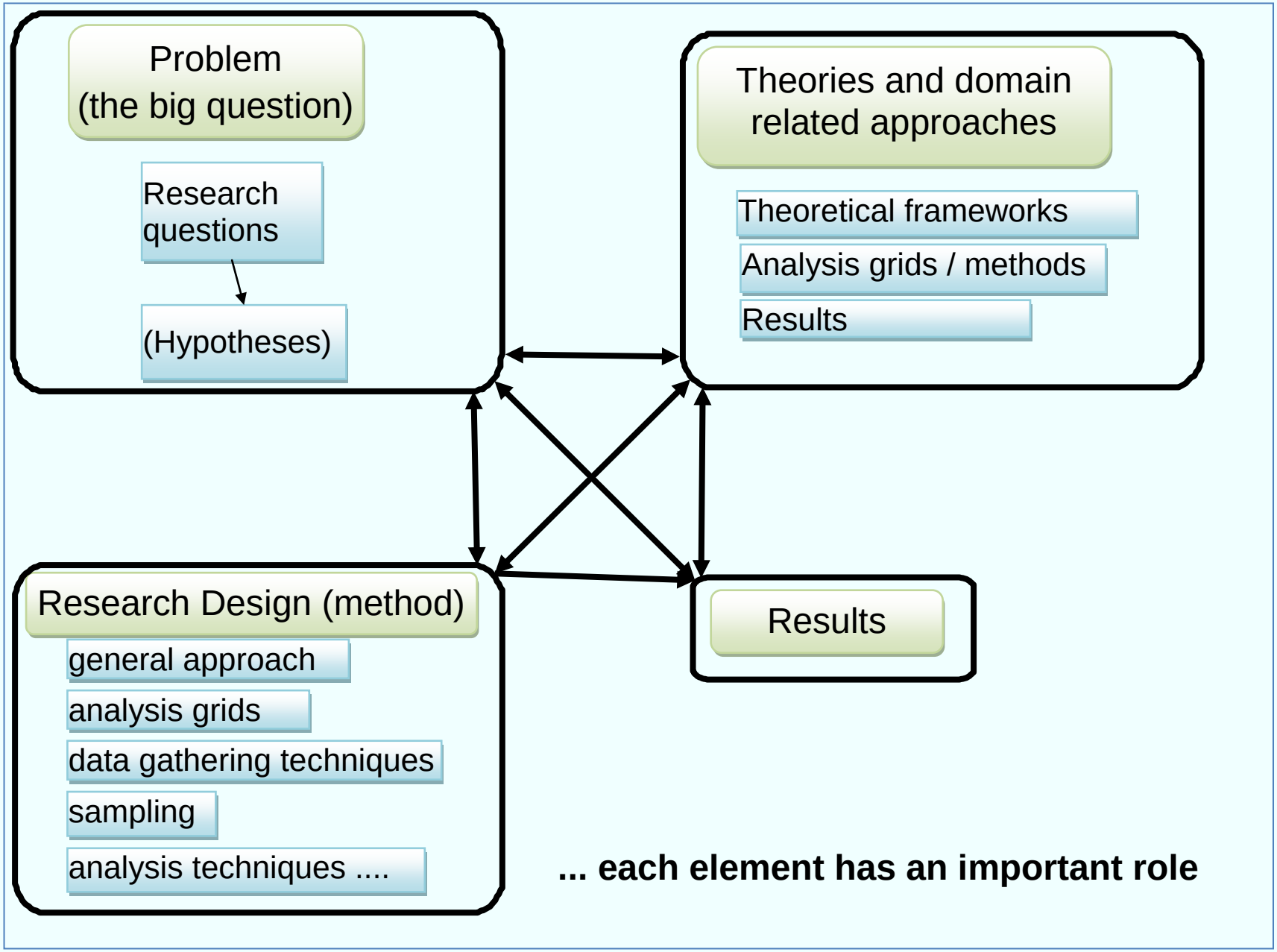
☞ **You will have to produce something that is (somewhat) new**

- answer ***new questions***
- answer ***old questions without good answers***
- answer ***otherwise*** to questions addressed by the literature
- provide support to ***answers*** found in literature with a new argumentation
- apply a theory to a ***new types of cases*** (e.g. does it apply to Mauritius school system ?)

☞ **It produces something that provides "satisfaction"**

- to a certain ***community***
  (you don't write your thesis only for yourself !).
- to you !

4. The role of method and theory



... each element has an important role

5. Epistemological dimensions of research

☞**Theories of science**

- Sets from a ***philosophical perspective*** the ***conditions of scientific knowledge***
- example: "you can't prove a hypothesis" (only evidence, show that alternatives are wrong,...)

☞**Methodologies (also called approaches)**

- ***general recommendations on how you should design a research plan***.
- draws from a theory of science and suggests a set of legitimate methods.
- example "you should draw hypothesis from theory and then test it with quantitative research"

☞**Methods**

- ***general*** recipes to study a given class of phenomena
- examples: "survey research methodology", "participatory software design"

☞**Reasoning Methods**

- how to pass from data to theory and from theory to data ?
- .... (influenced by theories of science and doctrine of approaches)

☞**Techniques**

- ***practical tools*** to gather, manipulate, analyze data, manipulate concepts, etc.

6. The range of theories (not part of this course)

☞ **Big theories**

- go after complex topics (can't fully be tested)
- .... evolution of children's minds, learning, society, ...

☞ **Theories with limited scope**

- concern more restricted domains
- examples: usability guidelines for software, conditions under which multimedia animations are effective, conditions under which e-learning projects can be sustainably implemented, ...

☞ **Formal models**

- based on formal systems, e.g. mathematics, logics, rule systems, formal learning designs
- sometimes tested with empirical data (not always, e.g. micro-economics is not).

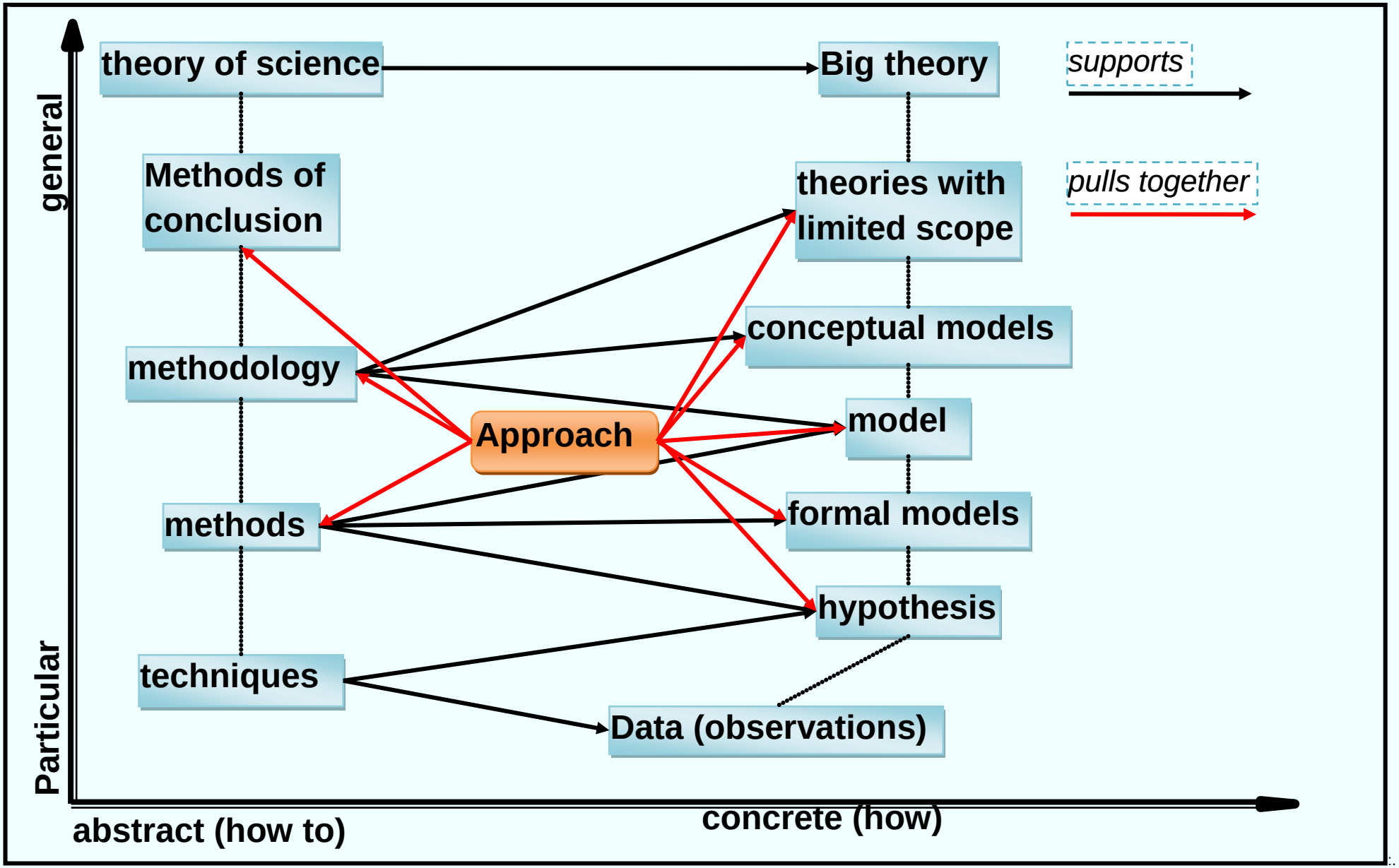
☞ **Conceptual models**

- e.g. "systems analysis", activity theory
- .... conceptual tools that allow you to talk about a phenomenon, to look at them in a certain way

☞ **Hypothesis**

- Are frequently part of a theory or a formal model
- Clear propositions that can be tested
- e.g. "to introduce ICT in schools, you need to provide a pedagogical support structure"

7. Everything together: components of knowledge



Too complicated ? ..... YES !

8. The paradigm concept

- Origin: Kuhn and his studies on “normal science”

1. Major components of a paradigm:
2. a general and “asymptotic” research goal
   - ex: “understand how to teach (instructional design)”.
   - At this level you will find general ideas at what you should look at.
3. Intermediate level: partial theories.
   - Ex: to teach sustainable knowledge, one must engage students in practice and gradually introduce authentic problems that must be solved by themselves
4. Operational level: Empirically tested theories.
   - Ex: how to teach procedural programming, drive a car, solve a geometry problem.
5. Each paradigm favors certain methodologies and provides you with "toolkits"

Why follow a paradigm ?

- 👍 you are much ***more productive*** if you can count on confirmed research methodology
- 👍 different researchers can ***work together***, or at least profit from each other’s results

what happens if you don’t ??

- 👎 people will not understand you and therefore ignore you
- 👎 your results are not comparable

4.5 The approach

There are in fact 2 different definitions

“Approach” + / - = general “methodology”

- a “***way to do it***”
- includes ***a set of useful and tested methods*** for studying a set of phenomena
  e.g. the you could use the quasi-experimental design to study school reforms
- **an approach is often transdisciplinary:**
  example: the quasi-experimental approach was developed in educational science but has been exported to public policy analysis and many other domains

“*Approach” = “paradigm*”.

for example: “activity theory approach” to say

- you believe in a marxist activity-based scheme of looking at social phenomena
- you may adopt Engeström’s related educational theories
- you favor qualitative methodology
- you are interested in change

9. A Word on interdisciplinarity

- General meaning: combinations of approaches or paradigms

Four variants of interdisciplinarity

☞ **multi-disciplinary:**

- juxtaposition on the same object of various research paradigms, each one keeping its own language

☞ **Interdisciplinarity (in the narrow sense):**

- confrontation and exchange of methods and/or adoption of a mix from various fields for a new field

☞ **Trans-disciplinary:**

- usually a high abstraction level, e.g. systems theory

☞ **Cross disciplinary:**

- looking at a problem of one discipline with the tools of another

- Multi-, Inter, Trans, and Cross-disciplinary research is difficult !
- Acceptance rate is low in academia …

10. Types of research

10.1. Classification according to theory level

1. Simple ***description:***
   - forget it, it doesn't have much academic value (unless it is led to prepare further research)
2. ***Classifications and categorizations***: put order in concepts or data:
   - The intelligent case study (exploratory research)
   - Typologies (identify characteristics of classes of cases, e.g. uses of technology in schools, types of teachers according to their beliefs in pedagogy, use of ICT, use of new pedagogies, etc.)
   - Ideal-types (theory-based identification of classes of cases)
   - The systems model (shows interactions between elements)
   - ....
3. Research where ***theory*** plays important role:
   - Theory ***attempts generalization*** and demonstrates ***regularities***.
   - Theory tries to ***understand*** or to ***explain*** or to ***predict***.

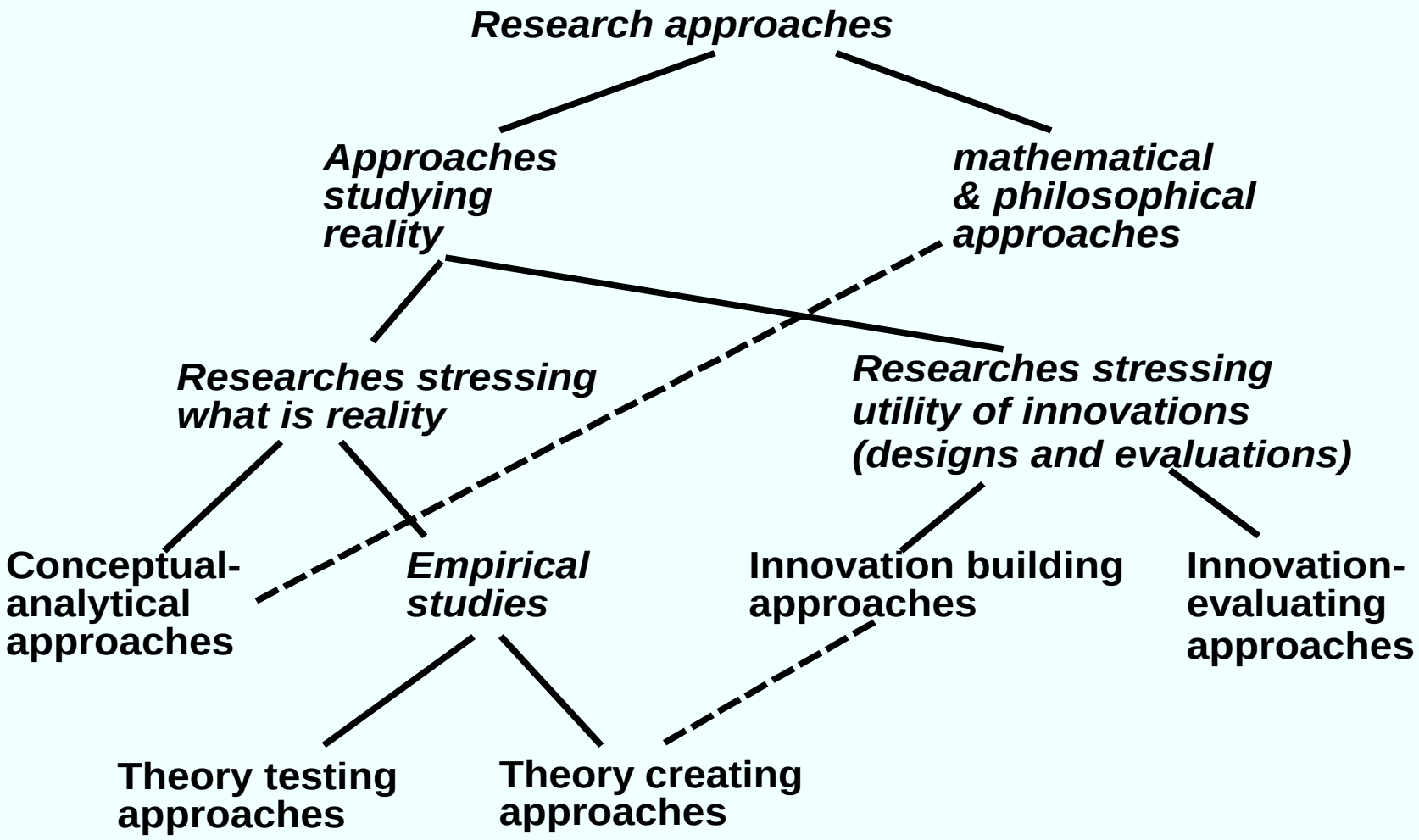
☞ **Research should aspire to level III**

10.2. Scientific ends (modified from Marshall & Rossmann 95: 41)

Finalities	Typical questions	Approaches	Methods
Exploratory • study of new phenomena • preparation of another research	• What happens in this program ? • How does this organization work ?	• case study • field study	• participatory observation • in-depth interviews • information interviews
Explanatory • explain the forces that constitute a phenomenon	• Which events, behaviors, beliefs result in this phenomenon ?	• comparative case study • historical study • field study • ethnography	• (like above) • questionnaires • document analysis • field observations
Descriptive / interpretative • documentation of a phenomenon • comprehension	• What are the events, structures, processes that constitute this phenomenon ?	• field study • case study • ethnography	• (like above) • non-intrusive measures • task observations

Predictive • global predictions • predictions of events, behaviors etc.	• What's the result of X? • How does X influence Y ?	• experiment • quasi-experiment • statistical • simulation	• questionnaires • quantitative content analysis • quantitative obs.
Engineering • delivered product • delivered technical rule • test of a technical rule	• What's the problem ? • How to build something ? • Does it work ? • What are its effects ?	• designs (with user, usability studies) • most approaches above before and after engineering	• application of design rules (technical rule) • rather qualitative • most methods above

11. Typology inspired by Järvinen (2004: 10)



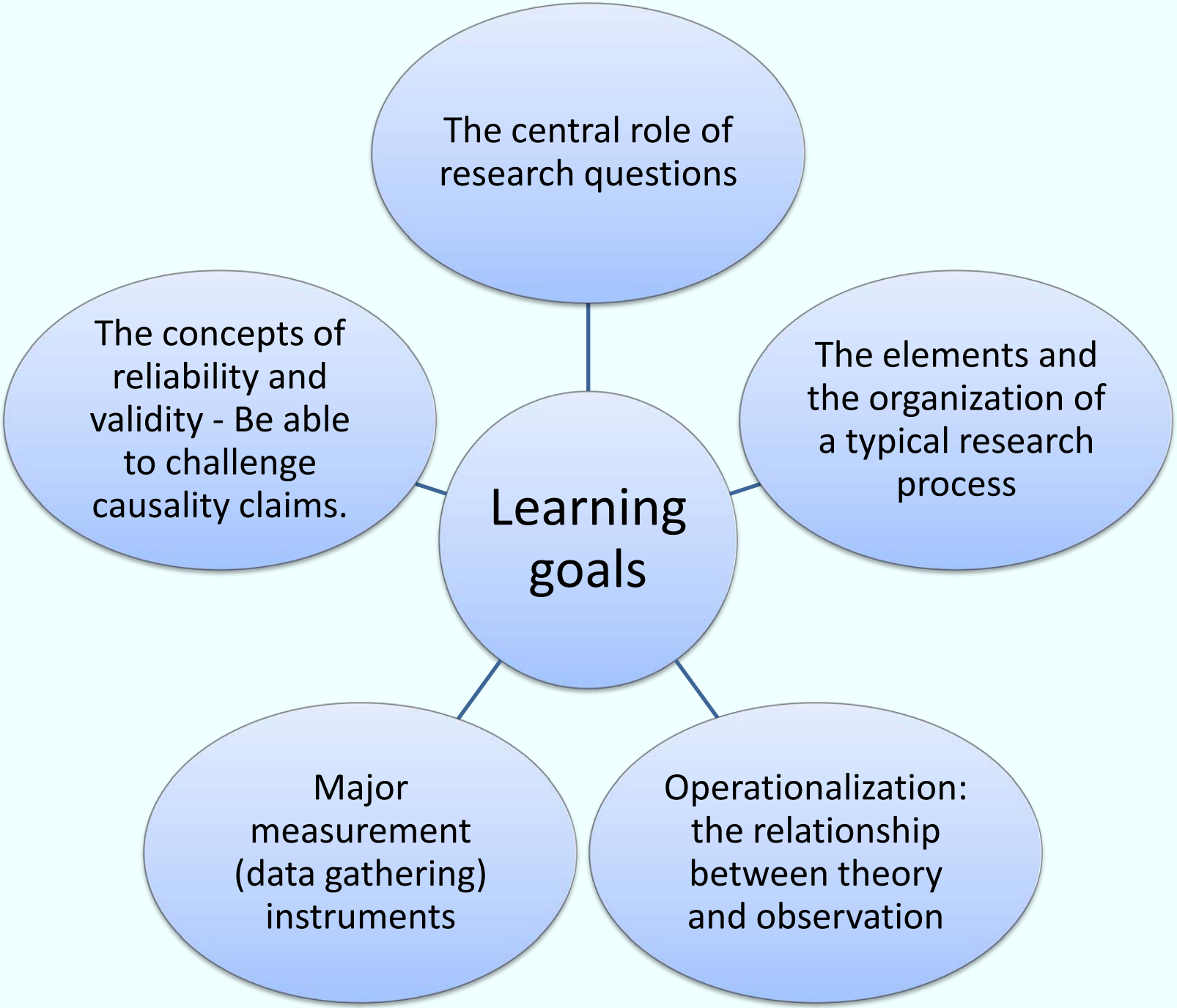
modified par DKS

12. A simple typology at the end

Explanatory (theory-testing)	→	**“test/ elaborate hypothesis”** **“explain by laws/theories”** **“predict with laws”**
Interpretative (theory-creation)	→	**“put forward mechanisms** **“describe & explorer”** **“propose theories”**
Design	→	**“analyze a problem, present a solution and prove it”** **“engineering”** **"create / test" a design rule"**

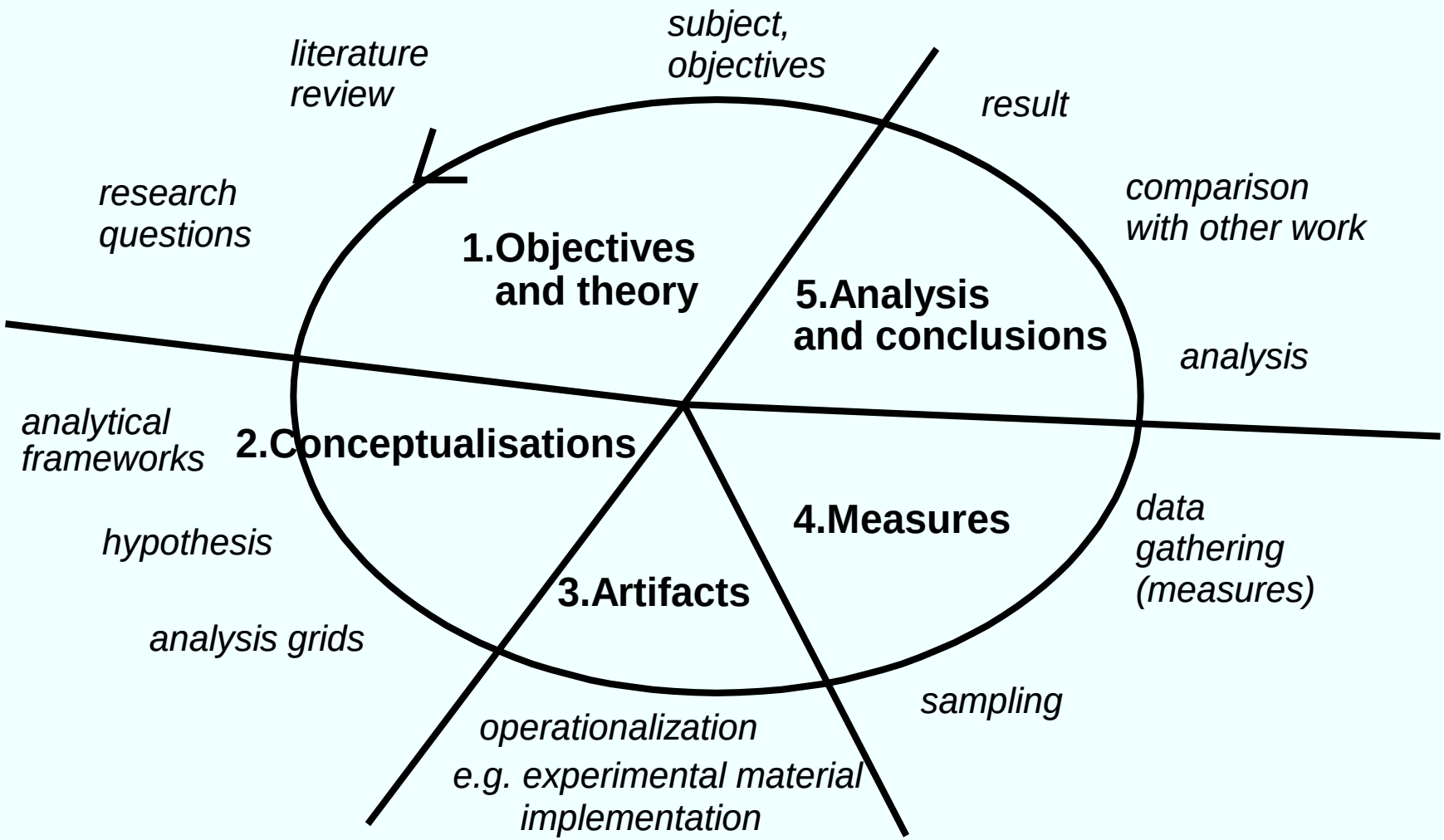
You may combine various types of research, but one type should be dominant

Chapter 3: Empirical research principles



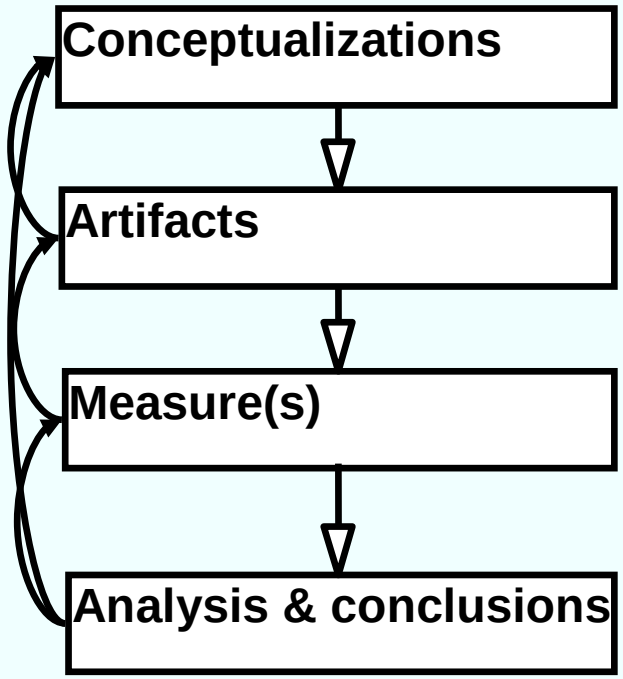
1. Main elements of a typical research cycle

- Details may considerably change within a given approach



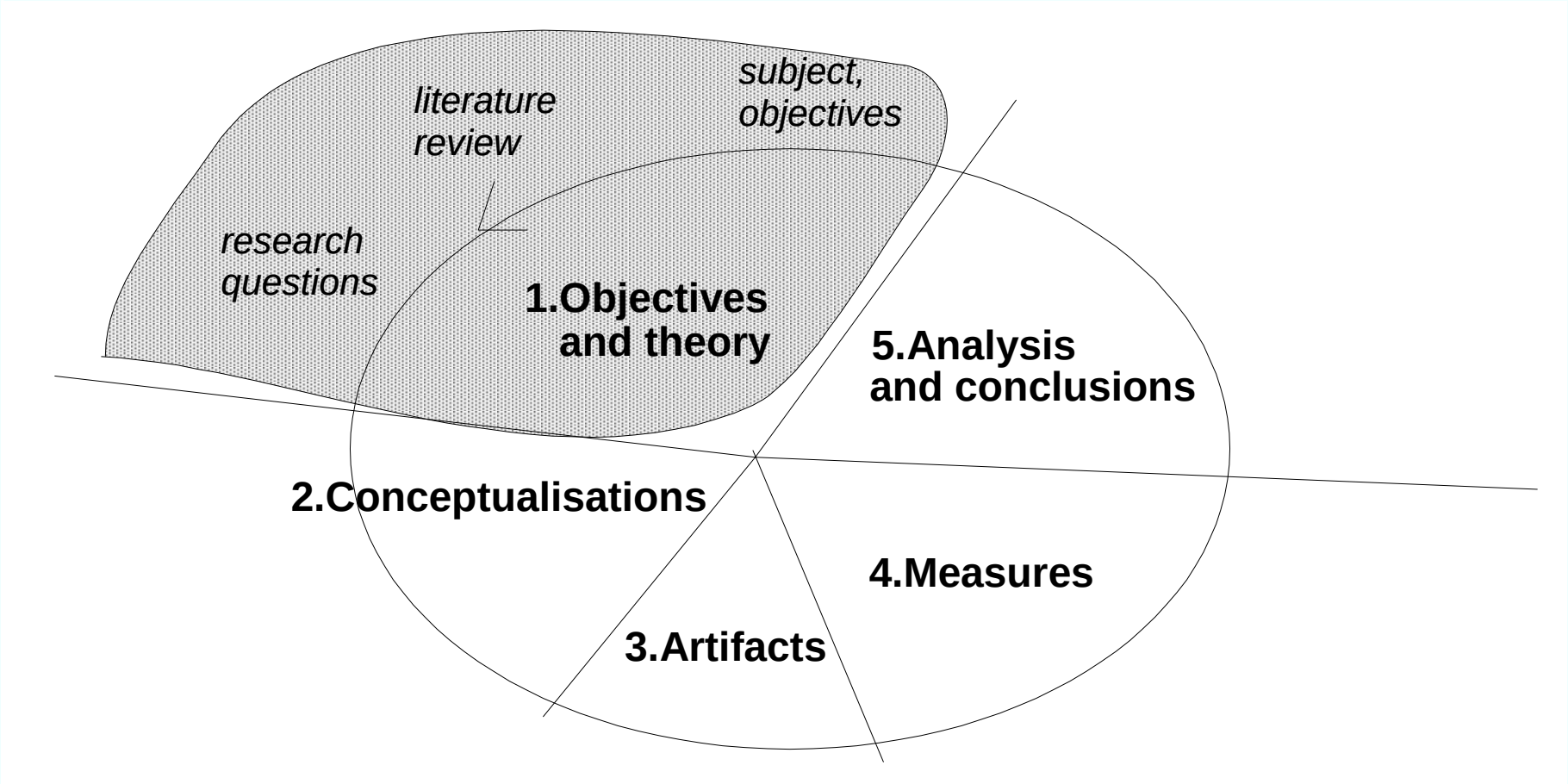
Key elements of empirical research

For a given research question, you usually do:



- ***Conceptualizations***: make questions explicit, identify major concepts (variables), define terms and their dimensions, find analysis grids, define hypothesis, etc,
- ***Artifacts***: develop research materials (experiments, surveys), implement software, etc.
- ***Measures***: Observe (measure) in the field or through experiments (use your artifacts)
- ***Analyses & conclusion***: Analyze the measures (statistic or qualitative) and link to theoretical statements (e.g. operational research questions and hypothesis)

2. Objectives and research questions



Research questions are the result of:

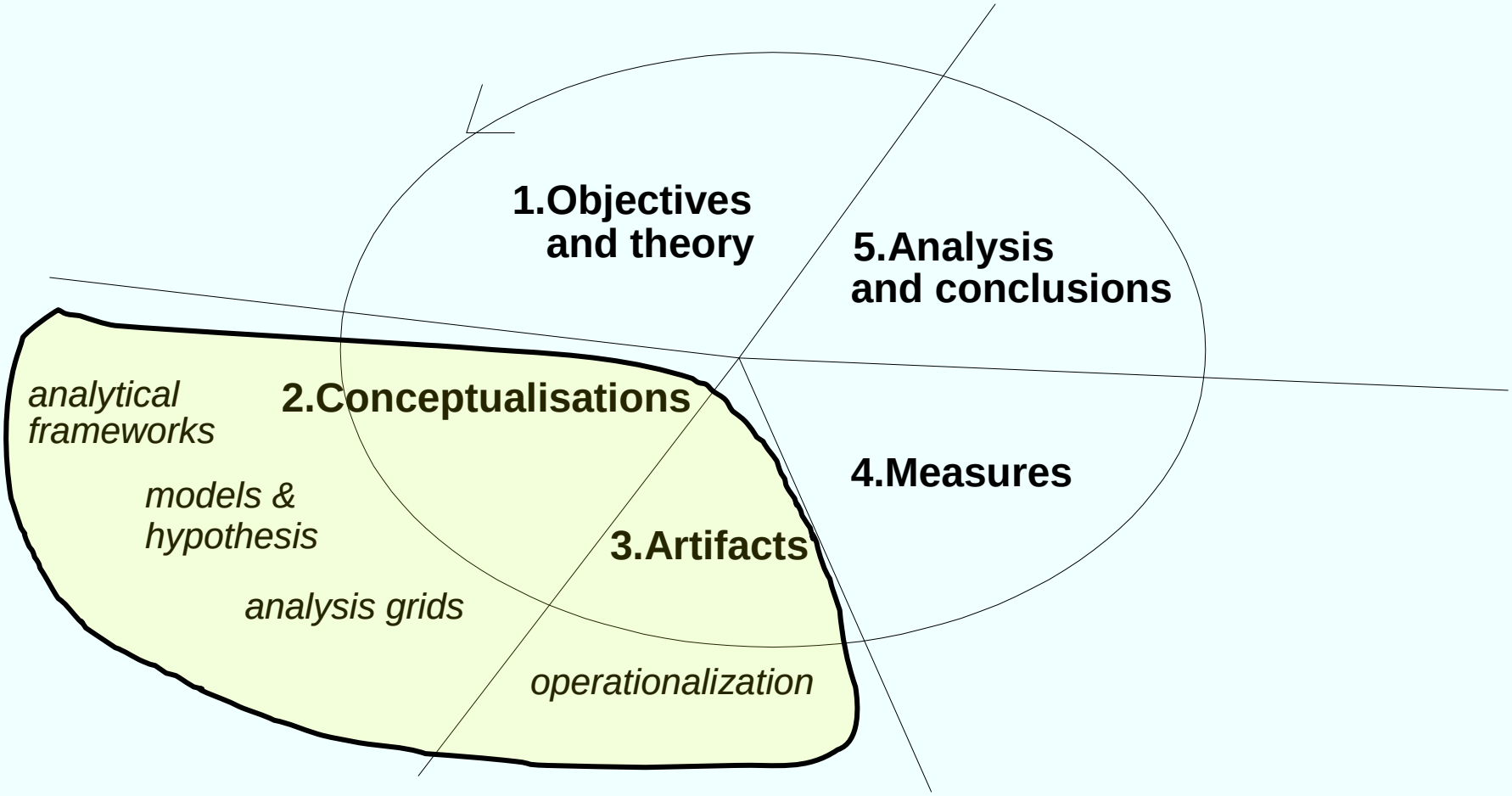
- your initial objectives (which you may have to revise)
- a (first) review of the literature

Everything you plan to do, must be formulated as a research question !

- See "Finding a research subject"

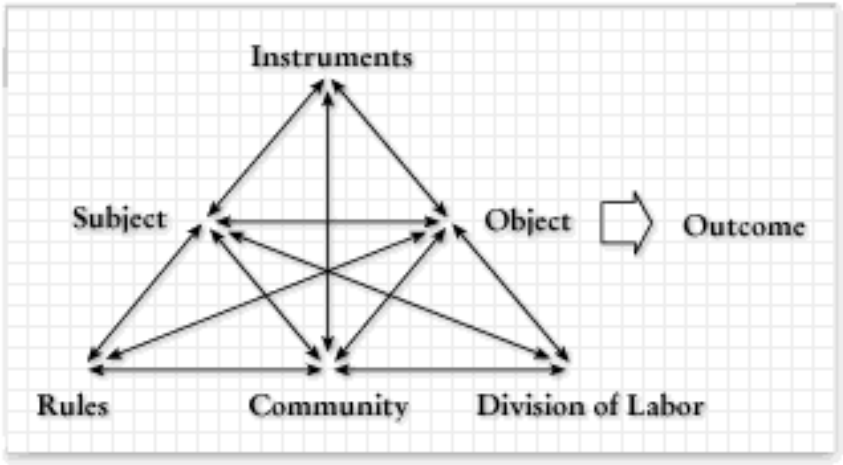
3. Conceptualizations and artifacts

- Elaborate concepts so that they can be used to study observable phenomena
- Build artifacts to measure data or for design purposes



3.1. The usefulness of theoretical analysis frameworks

E.g. activity theory



Quote: The Activity Triangle Model or activity system representationally ***outlines the various components*** of an activity system into a unified whole. ***Participants in an activity are portrayed as subjects interacting with objects to achieve desired outcomes***. In the meanwhile, human interactions with each other and with objects of the environment are ***mediated through the use of tools, rules and division of labour.*** Mediators represent the nature of relationships that exist within and between participants of an activity in a given community of practices. This approach to modelling various aspects of human activity draws the researcher s attention to factors to consider when developing a learning system. However, activity theory does not include a theory of learning, (Daisy Mwanza & Yrjö Engeström)

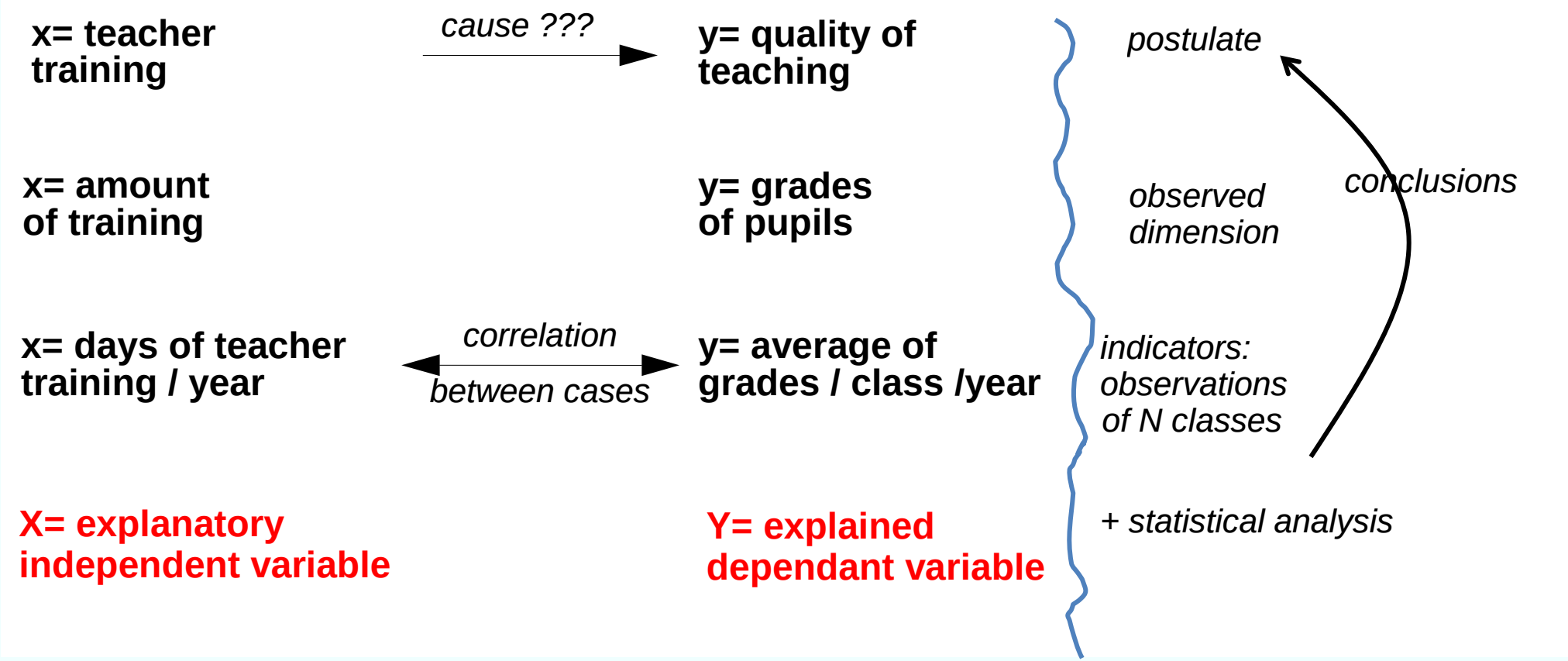
- Translation: It helps us thinking about a phenomenon to study.
- A framework is not true or false, just ***useful or useless*** for a given intellectual task!

3.2. **Models and hypothesis**

- These constructions link concepts and ***postulate causalities***
- causalities between concepts (theoretical variables) do not "exist" per se, they only ***can be observed indirectly***
- Typical statements: "More X leads to more Y", "an increase in X leads to a decrease in Y

Exemple 3-1: Causality between teacher training and quality

Hypothesis (often heard): Continuous teacher training (***cause*** **X**) improves teaching (**Y**)



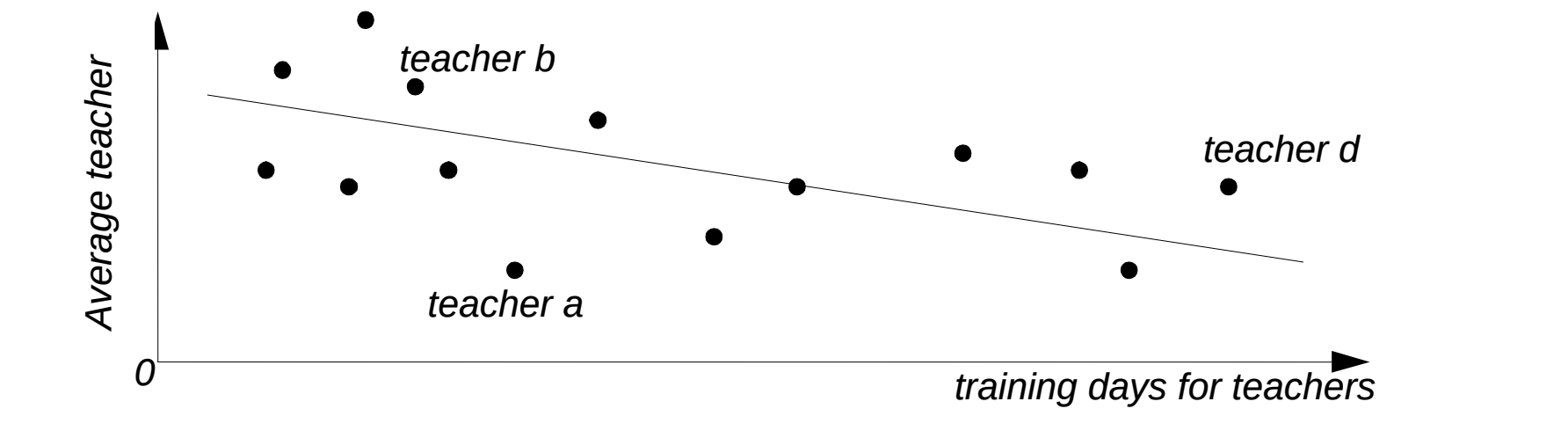
3.3. **The importance of difference (variance) for explanations**

Without variance, no differences .... no explanatory science

we'd like to know why things exist, why we can observe "more" and "less" ....

Without co-variance, no correlations / causalities ... no explanation

Quantitative example:



- We got different grade averages and different training days
  - therefore variance for both variables
- According to these data: increased training days lead to lower averages
  - (consider this hypothetical example false please !)

Example 1. **Introduction of technology in a school**

Imagine that we wish to know why certain schools introduce technology faster than others. One hypothesis to test could be: "Reforms need external pressure".

	Strategies of a school			
Type of pressure	strategy 1: no reaction	strategy 2: a task force is created	strategy 3: internal training programs are created	strategy 4: resources are reallocated
Letters written by parents	(N=4) ***(p=0.8)***	(N=1) ***(p=0.2)***		
Letters written by supervisory board		(N=2) ***(p=0.4)***	(N=3) ***(p=0.6)***	
newspaper articles				(N=1) ***(p=100%)***

N = number of observations, p = probability

- Result (imaginary): increased pressure leads to increased action

3.4. How can we measure general concepts ?

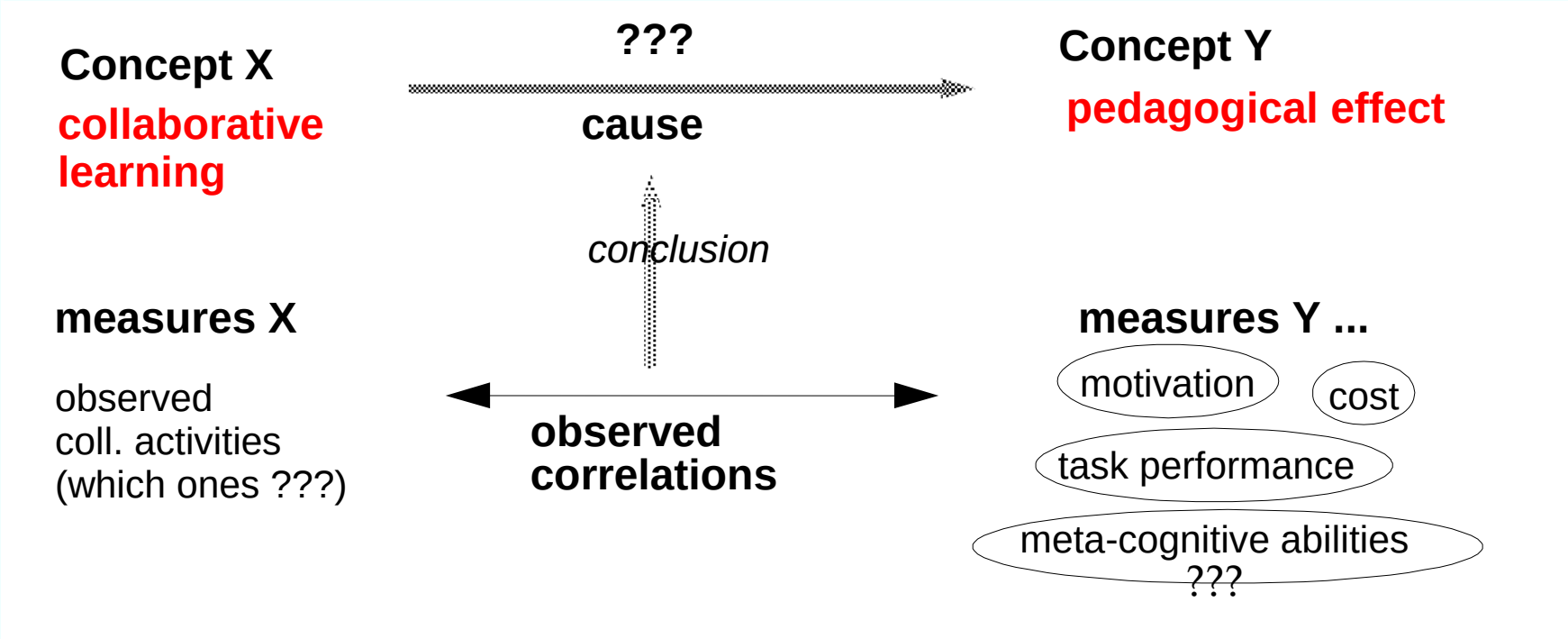
☞ **A scientific proposition contains concepts (theoretical variables)**

- Examples: “the learner”, “performance”, “efficiency”, “interactivity”

☞ **An academic piece links concepts**

- … empirical research requires that you work with data, find indicators, build indices, ..
- because of observed correlations we can make statements at the theory level

Example 2. Collaborative learning **improves** pedagogical effect



- We got a real problem here ! How could we measure "pedagogical effect" or "collaborative learning" ?

3.5. **The bridge / gap between theoretical concept and measure:**

(1) Going from abstract to concrete

- Theoretical concepts must be measured with observables, not always easy ….

Examples of problematic measures

- measure of “student participation” with “number of forum messages posted”
- measure of “pedagogical success” with “grade average of a class in exams”

(2) Inclusion of all dimensions: Whole – part

Some concepts are complex and include several dimensions you must identify

Examples from educational design:

Dimensions you might consider when you plan to measure the socio-constructiveness of some teaching:

- Decomposition of “socio-constructivist design” in (1) active or constructive learning, (2) self-directed learning, (3) contextual learning and (4) collaborative learning, (5) teacher’s interpersonal behavior (Dolmans et. al)
- The Five Es socio-constructivist teaching model: Engagement, Exploration, Explanation, Elaboration and Evaluation (Boddy & al)

Example: the COLLES survey instrument

Constructivist On-Line Learning Environment Survey by Taylor and Maor

The authors define six dimensions of "socio-constructiveness" in a training course:

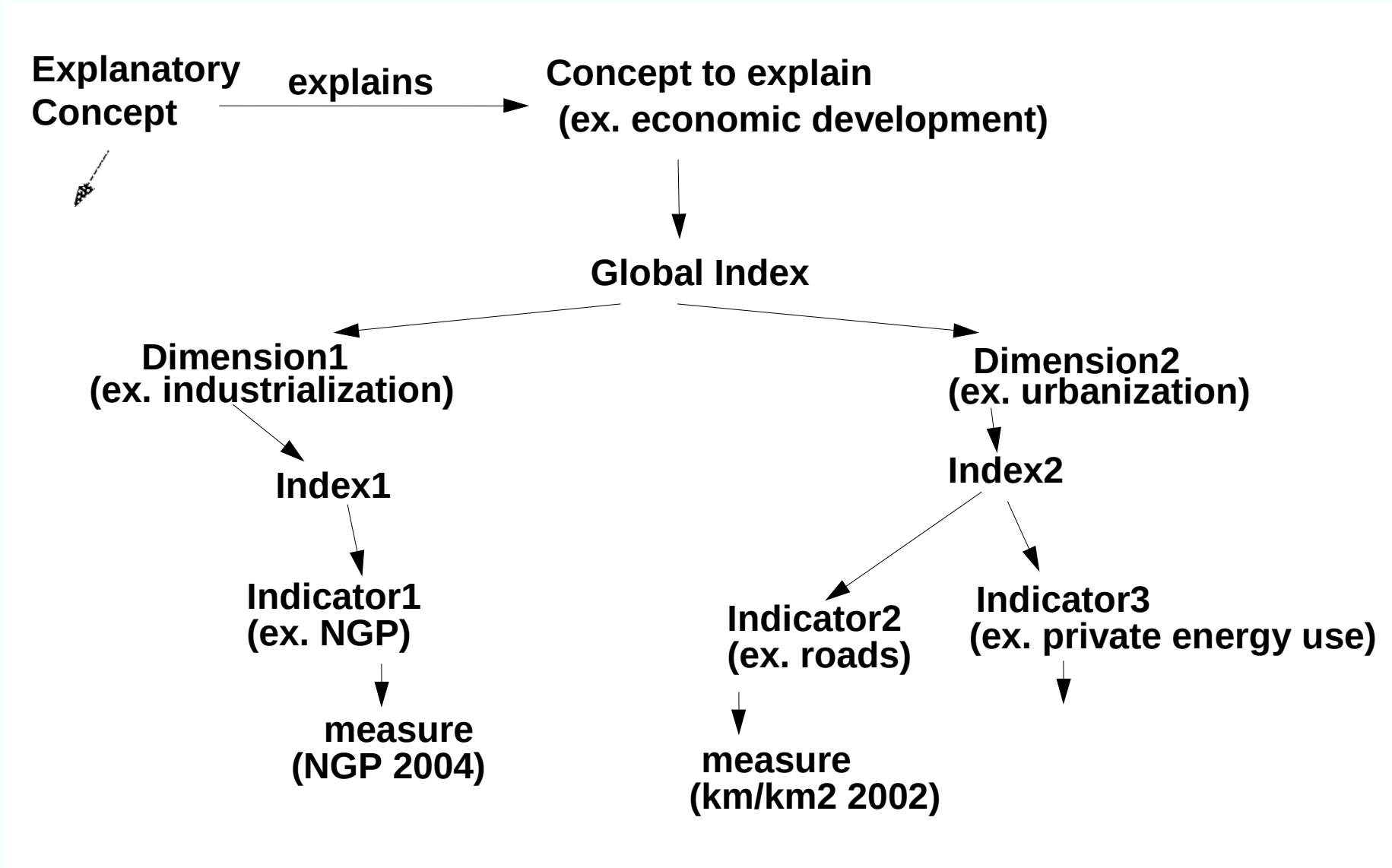
• Relevance	• How relevant is on-line learning to students' professional practices?
• Reflection	• Does on-line learning stimulate students' critical reflective thinking?
• Interactivity	• To what extent do students engage on-line in rich educative dialogue?
• Tutor Support	• How well do tutors enable students to participate in on-line learning?
• Peer Support	• Is sensitive and encouraging support provided on-line by fellow students?
• Interpretation	• Do students and tutors make good sense of each other's on-line communications?

Each of these dimensions is then measured with a few survey questions, e.g.:

Statements	Al-most Nev-er	Sel-dom	Som e-tim es	Of-ten	Al-most Al-ways
Items concerning relevance					
my learning focuses on issues that interest me.	O	O	O	O	O
what I learn is important for my professional practice as a trainer.	O	O	O	O	O
I learn how to improve my professional practice as a trainer.	O	O	O	O	O
what I learn connects well with my prof. practice as a trainer.	O	O	O	O	O
Items concerning reflection					
… I think critically about how I learn.	O	O	O	O	O
… I think critically about my own ideas.	O	O	O	O	O
… I think critically about other students' ideas.	O	O	O	O	O
… I think critically about ideas in the readings.	O	O	O	O	O

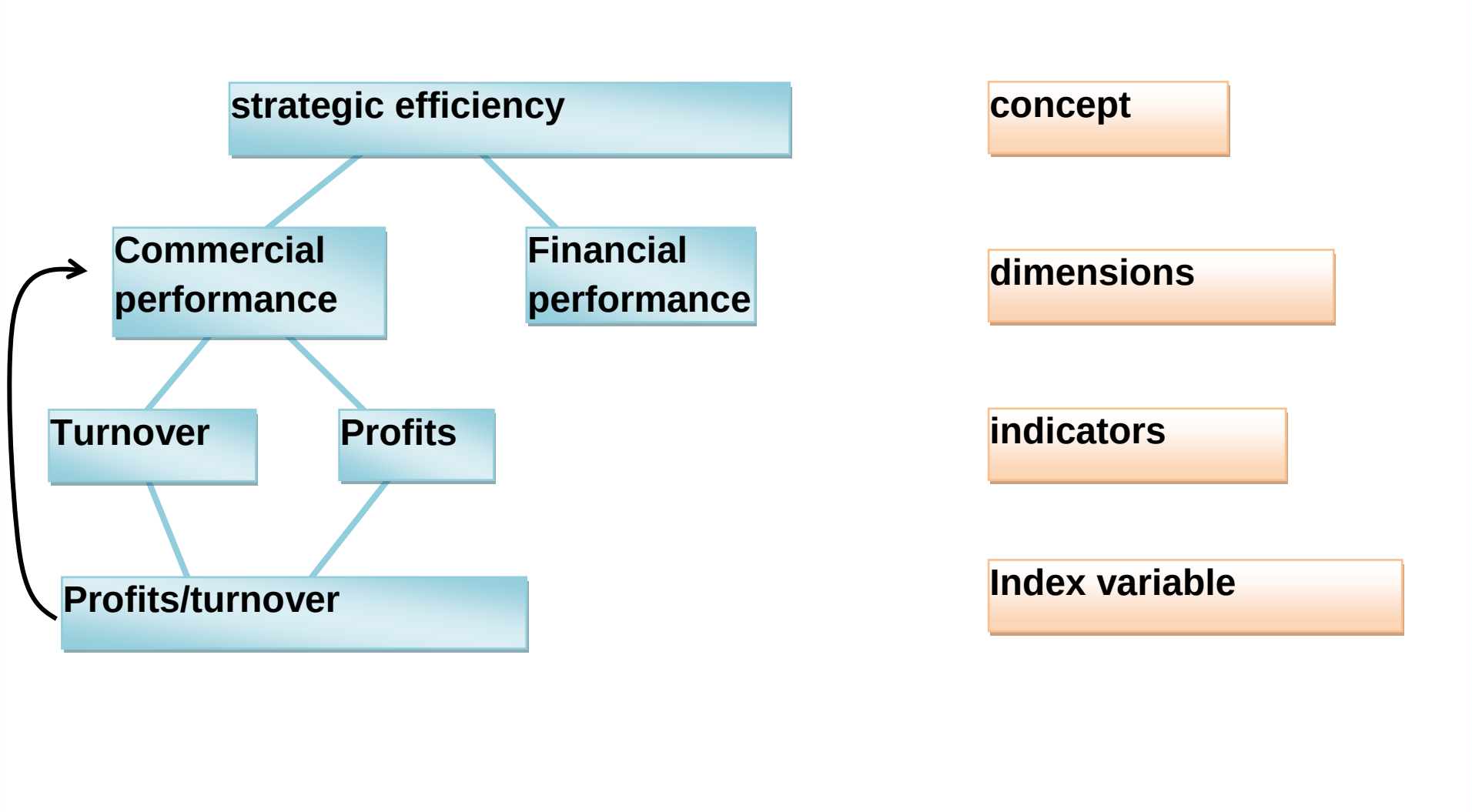
Example: measure of economic development

- An indicator that can be built with of official statistics
- (only part of the diagram is shown)



Example: measure of the strategic efficiency of a private distance teaching agency

- example taken from a french methodology text book (Thiétard, 1999)



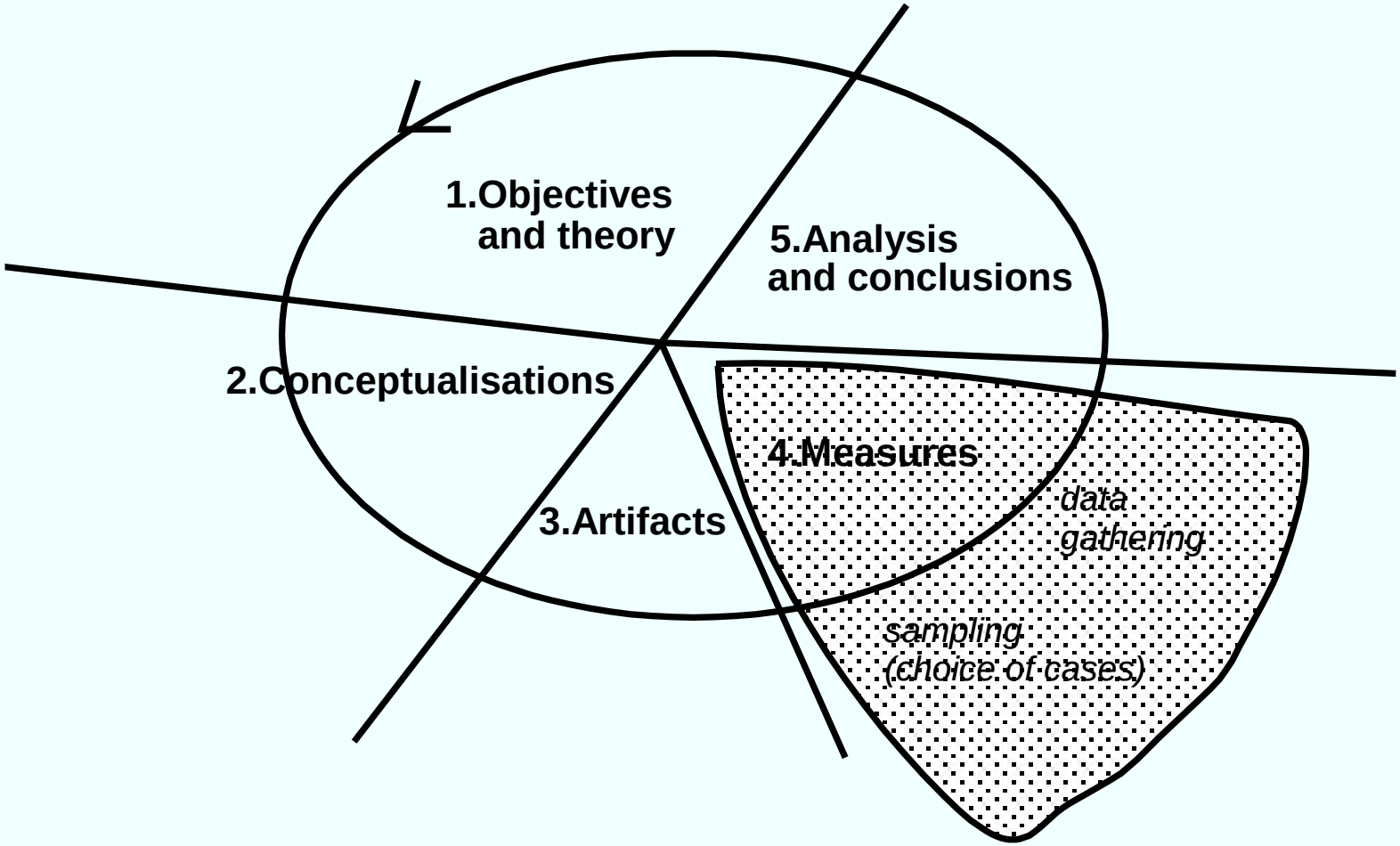
3.6. Summary: Dangers and problems of concept operationalization

1. Gap between data and theory
   - Example: measure communication within a community of practice (e.g. an e-learning group) by the quantity of exchanged forum messages
   - Problem: students may use other channels to communicate !
2. You forgot a dimension
   - Example: measure classroom usage of technology only by looking at the technology the teacher uses e.g. powerpoint, demonstrations with simulation software or math. software
   - Problem: you don't take into account technology enhanced student activities
3. Concept overloading
   - Example: Include "education" in the definition of development
   - Problem: Ot could be done, but at the same you lose an important explanatory variable for development, e.g. consider India's strategy that "overinvested" in education with the goal to influence on development
   - Therefore: never ever collapse explanatory and explainable variables into one concept !!
4. Bad measures
   - (see later)

4. The measure

Includes two aspects

- Observe properties, attributes, behaviors, etc. – i.e. collect data
- Select the cases you study (sampling)



4.1. **Sampling**

General rule:

- Make sure that "operative" variables have good variance, otherwise you can't make any statements on causality or difference .....
- operative variables = dependant (to explain) and independent (explaining) variables

Overview of sampling strategies

Type of selected cases	Usage
maximal variation	will give better scope to your result (but needs more complex models, you have to control more intervening variables, etc. !!)
homogeneous	provides better focus and conclusions; will be "safer" since it will be easier to identify explaining variables and to test relations
critical	exemplify a theory with a "natural" example
according to theory, i.e. your research questions	will give you better guarantees that you will be able to answer your questions ....
extremes and deviant cases	test the boundaries of your explanations, seek new adventures
intense	complete a quantitative study with an in-depth study

- sampling strategies depend a lot on your research design !

4.2. Measurement techniques

- There are not only numbers, but also text, photos and videos !
- Not treated here, see chapters on Quantitative data acquisition methods (e.g. surveys and tests) and Qualitative data acquisition methods (e.g. Interviews and observations) !

Principal forms of data collection

	Articulation		
Situation	**non-verbal and verbal**	**verbal**	
		oral	**written**
informal	participatory observation	information interview	text analysis, log files analysis, etc.
formal and unstructured	systematic observation	open interviews, semi-structured interviews, thinking aloud protocols, etc.	open questionnaire, journals, vignettes,
formal and structured	experiment simulation	standardized interview,	standardized questionnaire, log files of structured user interactions,

4.3. Reliability of measure

☞ **Reliability = degree of measurement consistency for the same object**

1. by different observers
2. by the same observer at different moments
3. by the same observer with (moderately) different tools

Example: measure of boiling water

- A thermometer always shows 92 C. => it is reliable (but not construction valid)
- The other gives between 99 and 101 C.: => not too reliable (but valid)

Sub-types de reliability (Kirk & Miller):

1. circumstantial reliability: even if you always get the same result, it does not means that answers are reliable (e.g. people may lie)
2. diachronic reliability: the same kinds of measures still work after time
3. synchronic reliability: we obtain similar results by using different techniques, e.g. survey questions and item matching and in depth interviews

In short: can we reproduce and replicate, can we trust data?

The “3 Cs” of an indicator

(1) Are your data complete ?

- Sometimes you lack data ....
- Try to find other indicators

(2) Are your data correct ?

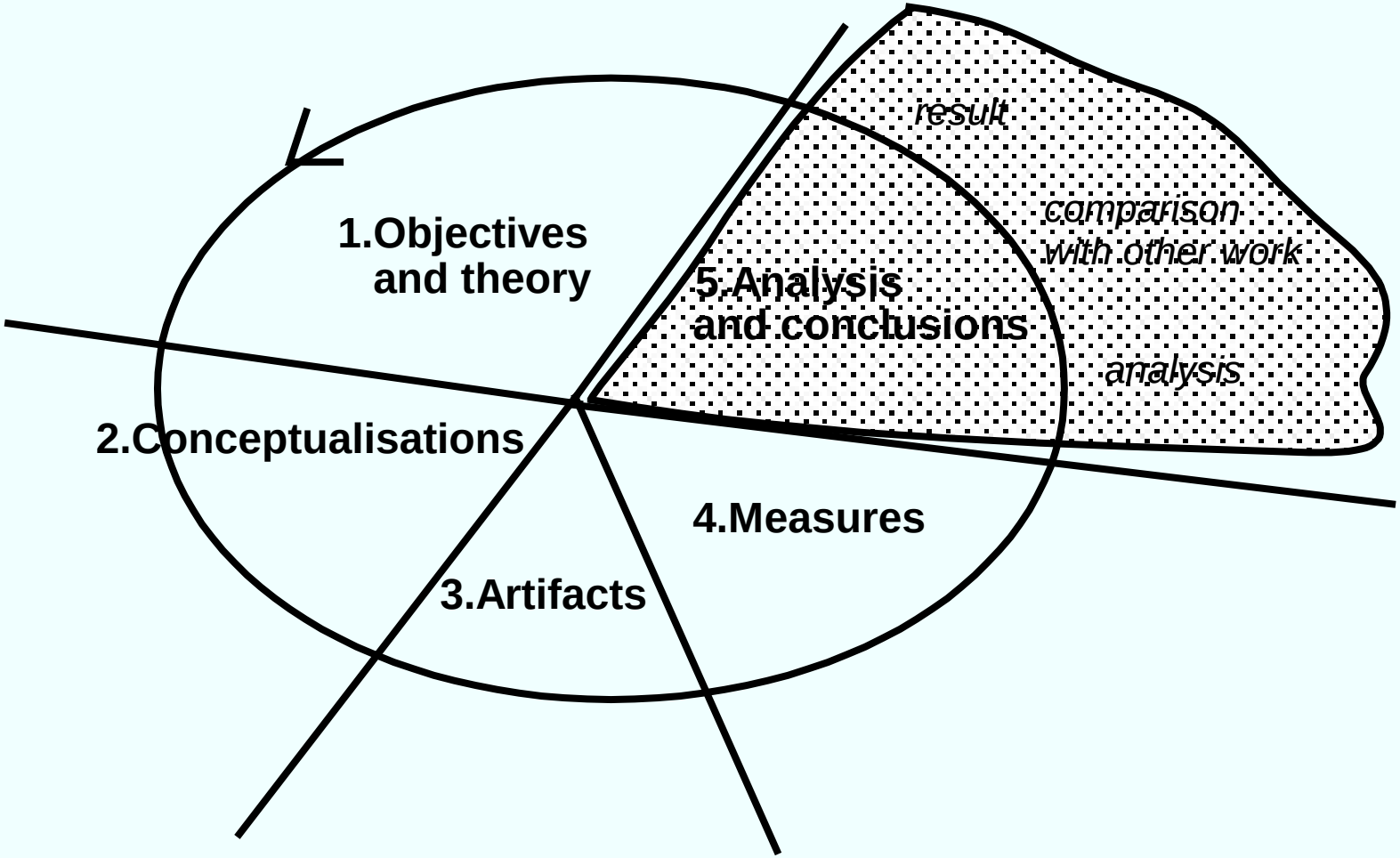
- The reliability of indicators can be bad.
- Example: Software ratings may not mean the same
  - According to cultures (sub-cultures, organizations, countries) people are more or less outspoken.

(3) Are your data comparable ?

- The meaning of certain data is not comparable.
- Examples:
  (a) School budgets don’t mean the same thing in different countries (different living costs)
  (b) Percentage of student activities in the classroom don’t measure "socio-constructive" sensitivity of a teacher (since there is a huge cultural differences between various school systems and since other types of activities may exist)

5. Interpretation: validity (truth) and causality

- Can you really trust your conclusions
- Did you misinterpret statistical evidence for causality ?



5.1. **The role of validity**

- Validity (as well reliability) determines the formal quality of your research
- More specifically, validity of your work (e.g. your theory or model) is determined by the validity of its components.

In other words:

- can you justify your interpretations ??
- are you sure that you are not a victim of your confirmation bias ?
- can you really talk about causality (or should you be more careful) ?

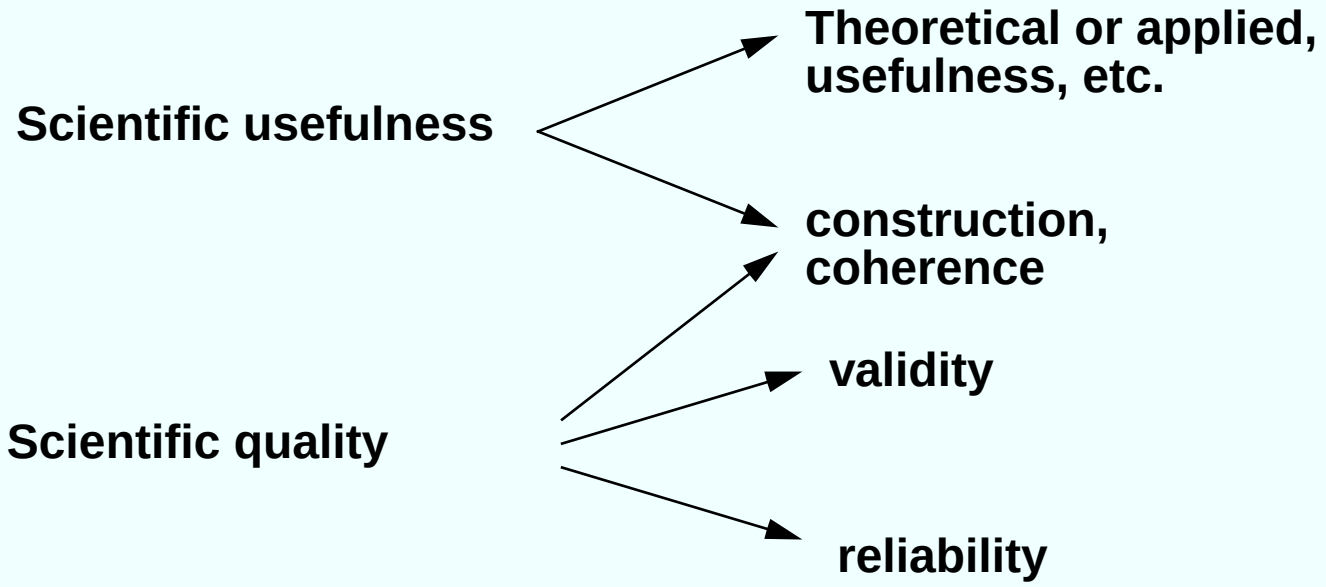
Validity is not the only quality factor

	Judgments
Theories	usefulness (understanding, explanation, prediction)
Models ("frameworks")	usefulness & construction (relation between theory and data, plus coherence)
Hypotheses and models	validity & logic construction (models)
Methodology ("approach")	usefulness (to theory and conduct of empirical research)
methods	good relation with theory, hypothesis, methodology etc.
Data	good relation with hypothesis et models, plus reliability

A good piece of work satisfies first an objective, but it also must be valid

The same message with another picture:

- **The most important usefulness criteria is: "does it increase our knowledge"**
- **The most important formal criteria are validity and reliability**
- **Somewhere in between: "Is your work coherent and well constructed"?**



5.2. Some reflections on causality

A correlation between 2 variables (measures) does not prove causality

Co-occurrence between 2 events does not prove that one leads to the other

- The best protection against such errors is theoretical and practical reasoning !

Example:

- "We introduced ICT in our school and student satisfaction is much higher"
- (It's maybe not ICT, but just a reorganization effect that had impact on various other variables such as teacher-student relationship, teacher investment, etc.)

If you observe correlations in your data and you are not sure, talk about association and not cause !

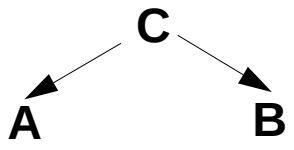
Even if can provide sound theoretical evidence for your conclusion, you have the duty to look a rival explanations !

- There are methods to test rival explanations (see modules on data-analysis)

Some examples of bad inference

- Simple hidden causalities

Situation 1: Badly interpreted correlation (no real link between A and B)

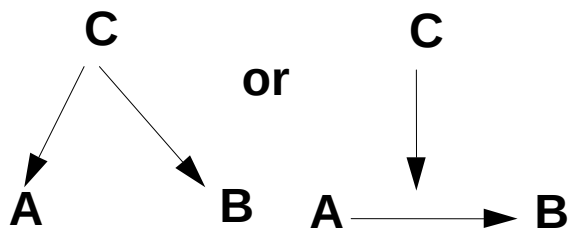


Example from european folklore:

"Observed storks and birth rate.
Birth rate (A) and storks (B) are both negatively
Correlated with urbanization (C)

Situation 2: Double effect

A and B are explained by C and/or
the relation between A and B is function of C



example:
"more parent meetings increase spending for ICT"
School's organizational culture (C) influences
participation (A) and spending (B)

Situation 3: Causality chain

example: "Young teachers hate ICT"
Young teachers (A) use less ICT (C)
because they have less resources (time)
left to spend on it (B)

- Think !

6. Some advice

At every stage of research, you have to think and refer to theory:

- Good analytical frameworks (e.g. instructional design theory or activity theory) will provide structure to your investigation and will allow you to focus on essential things.
- You cannot answer your research questions without a serious operationalization effort.
  - Identify major dimensions of concepts involved, use good analysis grids !

Watch out for validity problems

- You can't prove a hypothesis (you only can test, reinforce, corroborate, etc.).
  - Therefore, also look at anti-hypotheses!
- Good informal knowledge of a domain will also help
  - Don't hesitate to talk about your conclusions with a domain expert
- Purely inductive reasoning approaches are difficult and dangerous.
  - ... unless you master an adapted (costly) methodology, e.g. "grounded theory"

You have a "confirmation bias" !

- humans look for facts that confirm their reasoning and ignore contradictory elements
- It's your duty to test rival hypothesis (or at least to think about them) !

Attempt some (but not too much) generalization

- show the others what they can learn from your piece of work , confront your work to other's !

7. Choice and complementarily of methods

Triangulation of methods

☞ **Different viewpoints methods can consolidate or even refine results**

- E.g. imagine that you (a) led a quantitative study about teacher's motivation to use ICT in school or (b) that you administered an evaluation survey form to measure user satisfaction of a piece of software.
- You then can run a cluster analysis through your data and identify major types of users
  - (e.g. 6 types of teachers or 4 types of users).
- Then you can do in-depth interviews with 2 representatives for each type and "dig" in their attitudes, subjective models, abilities, behaviors, etc. and confront these results with your quantitative study.

Theory creation v.s theory testing

☞ **qualitative methods are better suited to create new theories**

- (exploration / comprehension)

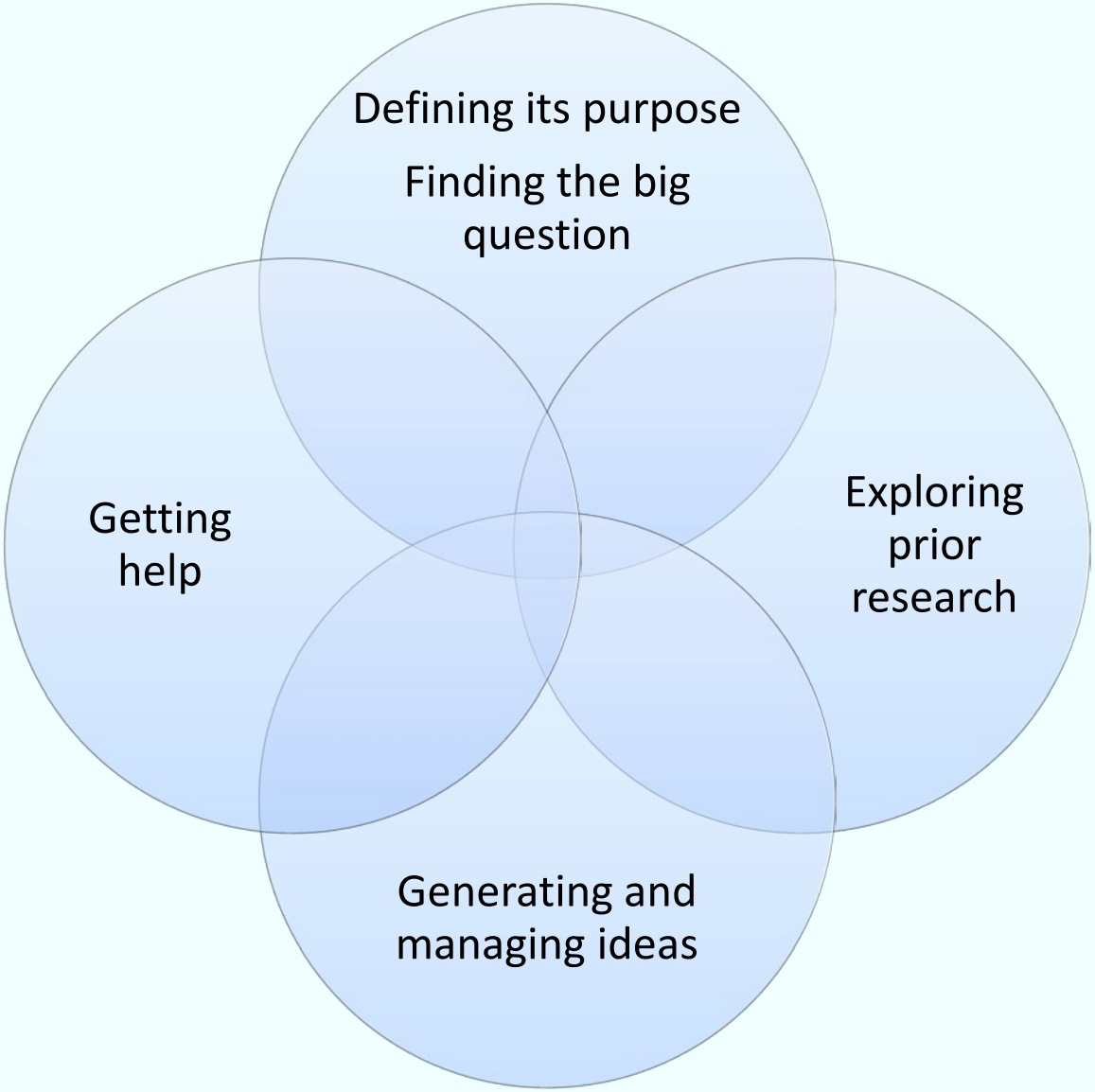
☞ **quantitative methods are better suited to test / refine theories**

- (explication / prediction)

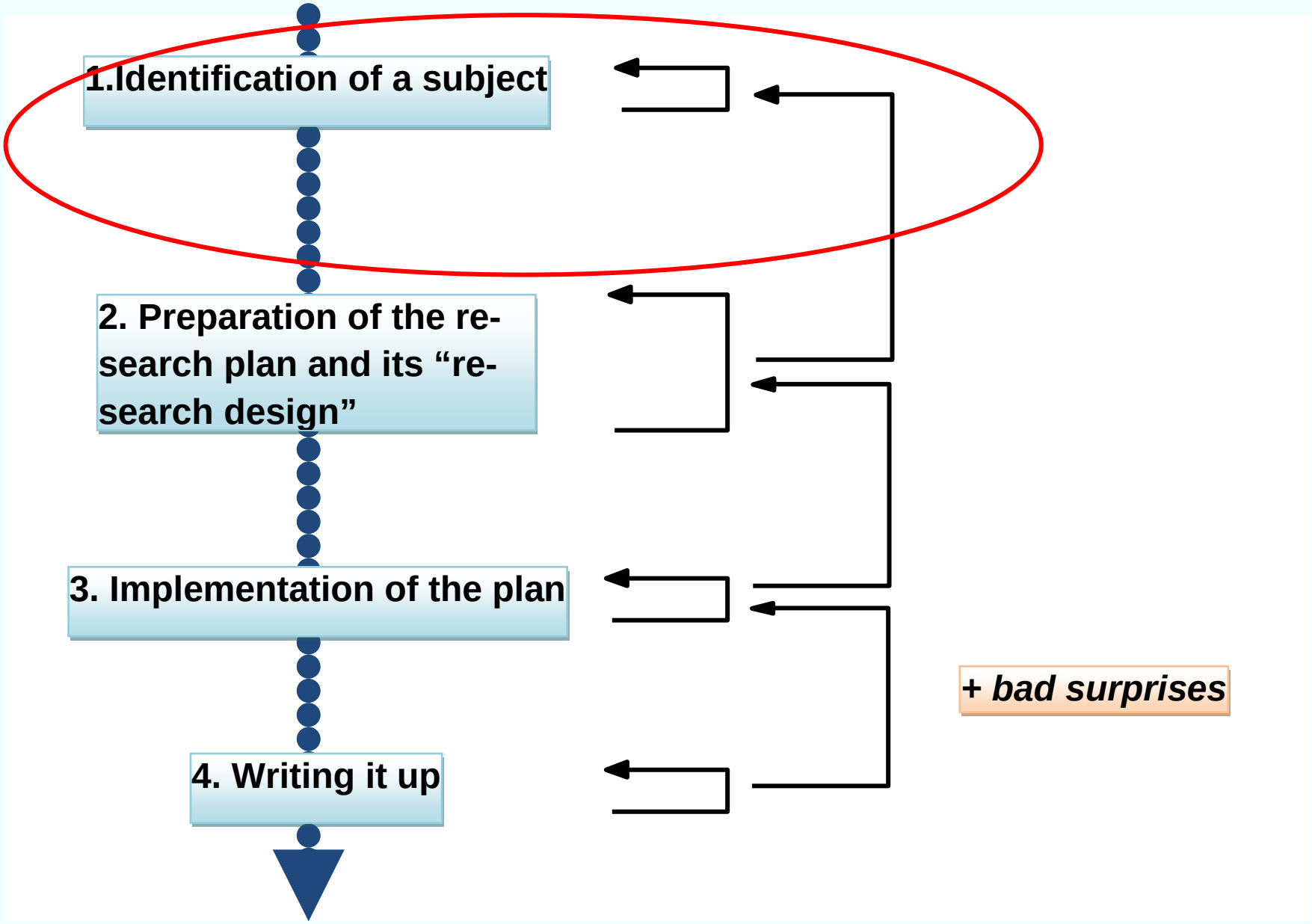
... but:

- validity, causality, reliability issues ought to be addressed in any piece of research
- it is possible to use several methodological approaches in one piece of work

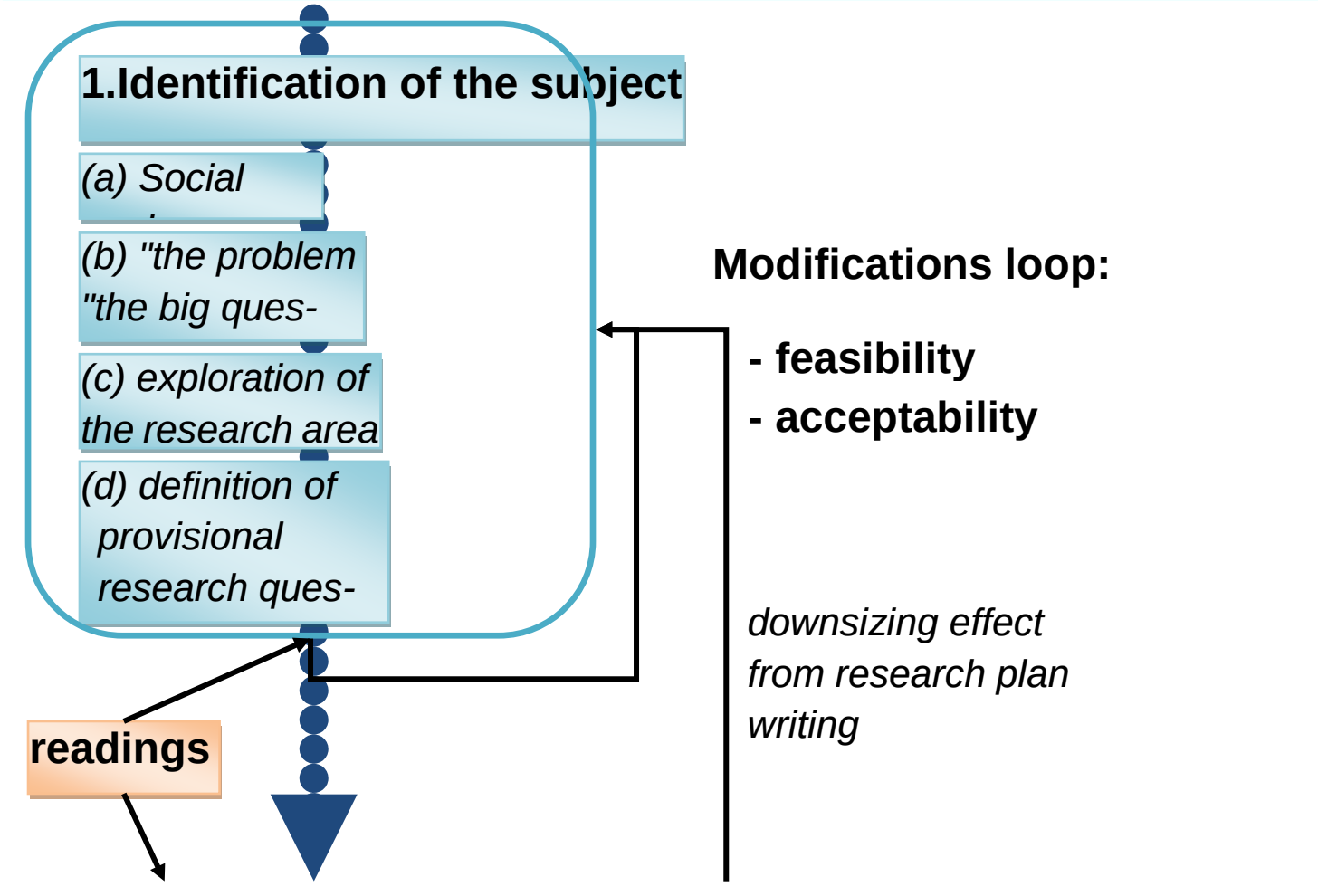
Chapter 4: Finding a research subject in educational technology



Stage one of a research project....



1. Identification of the subject: important elements



- You won't get it right from start
- You need to loop through this several times ....

2. The identification process

The most important phases

1. Identify a few topics / subjects and make a "short list"
2. Make explicit each potential subject
   - see: Identification of the central problem
3. Discuss with your professors
4. Explore the subjects (new short list)
   - see: Readings and ideas
5. Make a draft of the research plan and negotiate
   - see: Anticipation of the research plan
6. Make it official
   - (consult your local procedure)

3. Identification of social goals

Learn something, institutional constraints, fun, ...

1. What should your job be in 3-4 years ?
   - A thesis is part of your "profile", a "visit card"
   - A thesis will teach you a lot, what do you wish to learn ?
2. And your employer ?
   - Is he interested in your master thesis
   - can you marry academic work with the goals of your organization ?
3. What would you consider to be real "fun" ?
   - are you intrinsically motivated ?

4. Identification of the central problem

- A research subject is not just a topic !!
- It must be of some academic interest
  for example: explain a phenomenon, identify processes, provide scientific arguments for an expertise, prove cognitive ergonomics of some software, demonstrate pedagogic effectiveness, invent new design rules, ...

4.1. The "big question"

- does not necessarily match the title of your project (which just can announce a topic)

La “grande question”

- is a summary of your research question
- .... may also imply practical goals

Exemple 3-1: E-learning

Bad: “E-learning” in vocational teacher training

Good (a): ***Efficiency*** of e-learning in ...

Good (b): ***Perception*** of e-learning ....

Maybe: ***Analysis of e-learning*** in ...

(all these variants need further precision)

4.2. Objectives and research questions

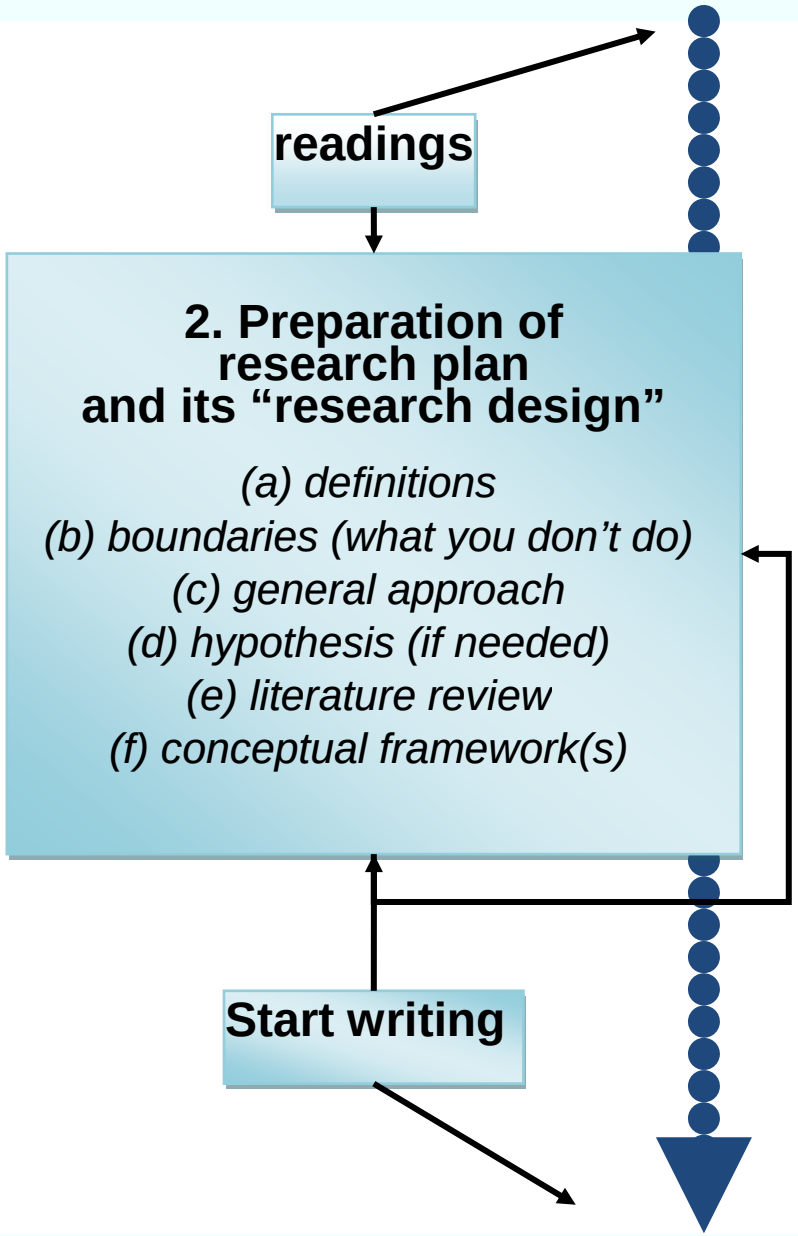
Even if you did manage to phrase a good "big question", your intentions will be too vague

- Therefore you clarify your big question apart in the form of research questions and/or hypothesis

1. You ***absolutely must make all your objectives explicit*** (else you are looking for conflicts and other problems).
2. You then must formulate ***research questions*** that cover your objectives
   - Formulate working hypotheses if you can and if it is appropriate.
   - You also may formulate scientific hypothesis (based on theoretical argumentation)
   - It is much easier to deal with hypothesis than with more open research questions ....
3. Finding the right research questions / hypothesis is an ***iterative*** process.
   - Usually you only get them right after having written a draft of the literature review !!
   - Therefore, don't start field research, development etc. before you have done some theory !

5. Anticipation of the research plan

Here is an idea



At this point you still can change your subject !

modifications due to:

- **your skill**
- **your resources**
- **literature (readings)**
- **accessibility to data**

- **constraints from your school**

The research plan = what + why:

What?	• A good question !	▪ “So what” ? "What knowledge do we gain"
	• A (or more) good conceptual framework(s) that…	▪ links your research to a larger identified issue, ▪ structures your phenomenon ▪ links your project to a body of existing knowledge ▪ … is preferably available as a nice drawing
How?	• Consider that your research plan should be …	▪ systematic: show that you will study your "big question" and related research questions (and nothing else!) ▪ academic: identify your main approache(s) and major techniques you will use. ▪ somewhat flexible (make sure that you identify priorities also) ▪ In some designs it is required that show details regarding how you plan to answer your questions.
	• Be realistic ! • Prove that you have …	▪ the time to do it ? ▪ access to data ? ▪ the ability to do it (or to learn how to do it) ?
A whole !	• Integration !	▪ A coherent whole ! ▪ All your intentions are made explicit. ▪ Your research questions cover your essential planned work.

6. Readings and ideas

6.1. Who / what can help you finding a good subject

1. Examples (other thesis in the same area)
2. Academic articles
3. Interviews with academic experts
4. Interviews with domain experts
5. Your librarian, your library, on-line journals
6. http://scholar.google.com

Remarks

- Your research topic will be vague in the beginning
- Be sure to talk to other persons than just your advisor
- Engage discussion with a written ***list of precise questions***
  - and make sure that all questions have been covered at the end of your meeting
  - don't ask by mail, ask for an appointment (unless the teacher tells you otherwise)
- Don't just think, start producing at some point

6.2. Initial readings

1. Start with 2-3 ***articles/standard works*** and that contain a survey of your topic or a related area.
   - ask experts, use the library, use scholar.google.com, use on-line journals
2. if you can't find anything:
   - Hunt for articles that cover subjects with similar structural properties (e.g. concerning the approach, the "way to look at things", etc.).
   - Start to occupy "islands" (and enlarge with "circles").
3. Look for further publications:
   - follow-up leads from you 2-3 initial articles,
   - go through specialized indexes,
   - systematically browse through specialized journals.
4. Go through the ***Internet pages of well known researchers in your field***
   - do not trust randomly found things (e.g. indirect quotes) on the Internet
   - hunt down the home pages (a lot of researchers publish at least a few papers on their web site)

☞ **Don't read too much ! Stop when:**

1. the same information comes back,
3. you found a good central framework, the analysis grids for your concepts, experimental designs that provide you with a good example,…
4. you can relate all your research questions to published work.

7. Use of literature and draft of the theory part

Do not write “summary memos”, it takes too much time

1. Read texts "diagonally", and mark the most relevant concepts, theories, models, hypothesis, etc.
2. Make a matrix of the most important concepts

	Concepts				
Articles	**A**	**B**	**C**	**D**	**....**
1		x	x		
2	x		x	x	
...					x

3. Sort concepts
   - mark the most important ones and look at relations
   - throw away the ones you won’t need **to answer your research questions**
4. Write a draft
   - Be synthetic and be critical (!)
   - Do not align one mini-summary after each other, order by concepts and not authors !)
   - End up with a conclusion that argues in favor of a central framework, that identifies major dimensions (elements) and corresponding analysis grids
   - Look again at your research questions (revise them or add/remove things)

8. Idea generation

8.1. Brainstorming

☞ **is done in several stages:**

2. Write ***rapidly*** keywords (what you want investigate, know, etc.) on paper
2. Take this list and do it again for each point
3. Sort/clean and go to the next steps

8.2. Organize your ideas

☞ **make drawings, that contain major elements and relationships**

- you may use mind mapping software, but don't not overdo it !
- … mind mapping may generate too much complexity

8.3. The outline

☞ **Outlines are useful for your research plan, difficult chapters like the theory part, to:**

- organize your ideas,
- produce a detailed plan of work to do (e.g. work packages),
- order your ideas in a linear way (your thesis will be linear).

Have something to write on you (always)!

- good ideas sometimes pop out of nothing at odd times, and you should not forget them.

9. Summary of some exploration activities

Discussions

- Talk to field experts, academic experts (in particular potential advisors)
- Also contact your "victims"

Political feasibility

- Make sure that you will find “subjects”, that organizations will cooperate, etc.

Theoretical feasibility

- Have got a good enough overview ?
- E.g. theoretical frameworks, analysis grids, propositions (hypothesis)

Methodological feasibility

- Did you make a list of the concepts found in your research questions ?
- Do you have initial definitions for them ?
- Do you believe that you can measure each empirical concept ?
- Do you have an idea how to analyze relationships (to answer your research questions) ?

Budgetary feasibility

- Time is your enemy
- Keep your subject as small as possible (but make sure that you address an academic question ..)

10. Identify a general thrust for your research

Some possibilities for a master thesis:
• ***Experimental designs*** that study ***how humans behave under certain conditions*** (e.g. "Under what conditions does a multimedia animation have a positive effect on learning ?").
• ***Quasi-experimental*** studies (e.g. ***test*** if one instructional design is better then an other).
• ***Sociological studies*** (e.g. the introduction of ICT to school systems and/or organizations, study of certain population's ***attitudes and behaviors*** towards ICT or an ICT initiative, e.g. teachers).
• Economic studies (e.g. ***Return on investment*** at the organizational or the national level)
• ***Ethnographic*** or clinical studies of human subjects, i.e. ***in-context behavior*** (e.g. usability studies of software, work place analysis to study informal learning, problem-solving behavior related to the use of ICT etc.)
• Development of ***innovative instructional designs*** (either in real world settings or exploratory studies). All kinds of settings: Formal/informal, distance/blended/classroom, workplace e-learning, just-on-the-spot learning, ...
• ***Technical development*** of a system or exploration of new technologies (and that explore/introduce ***new ideas (pre-theories)*** profitable to education and learning)

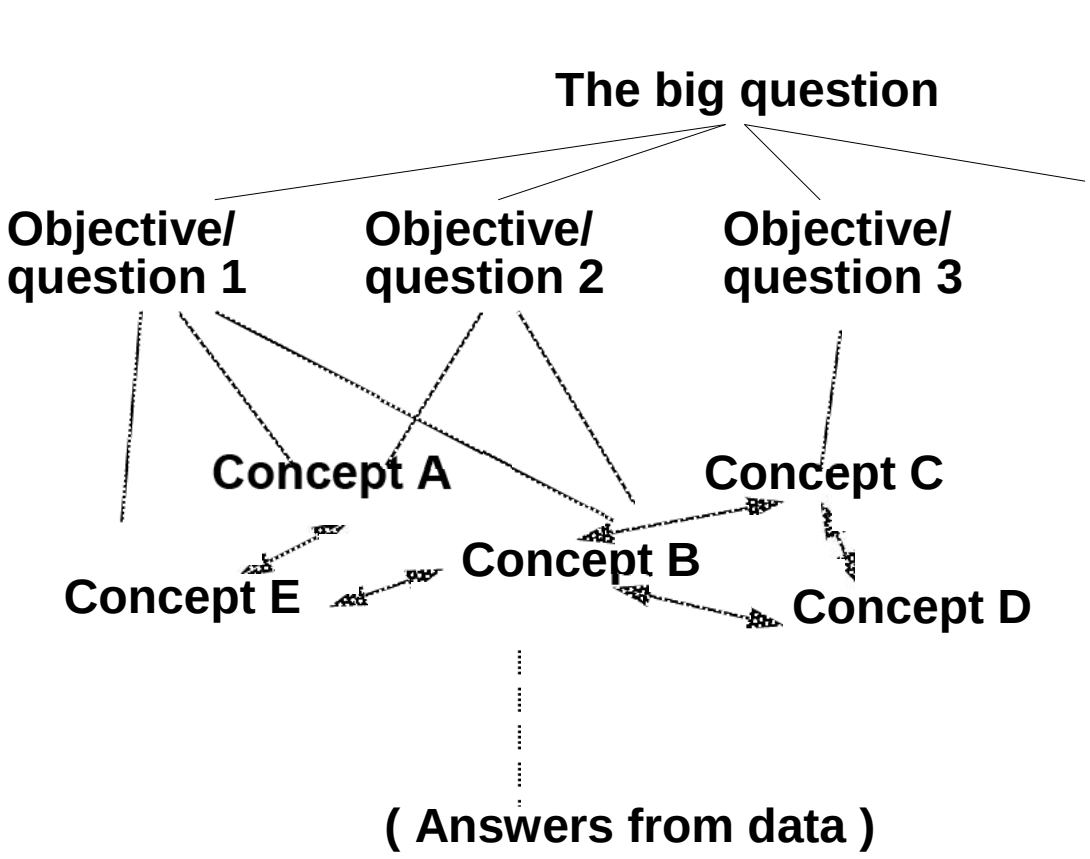
Explanatory (theory-testing)

Comprehensive (theory-creation)

Design

11. Think hard about the concepts you use

The theoretical face



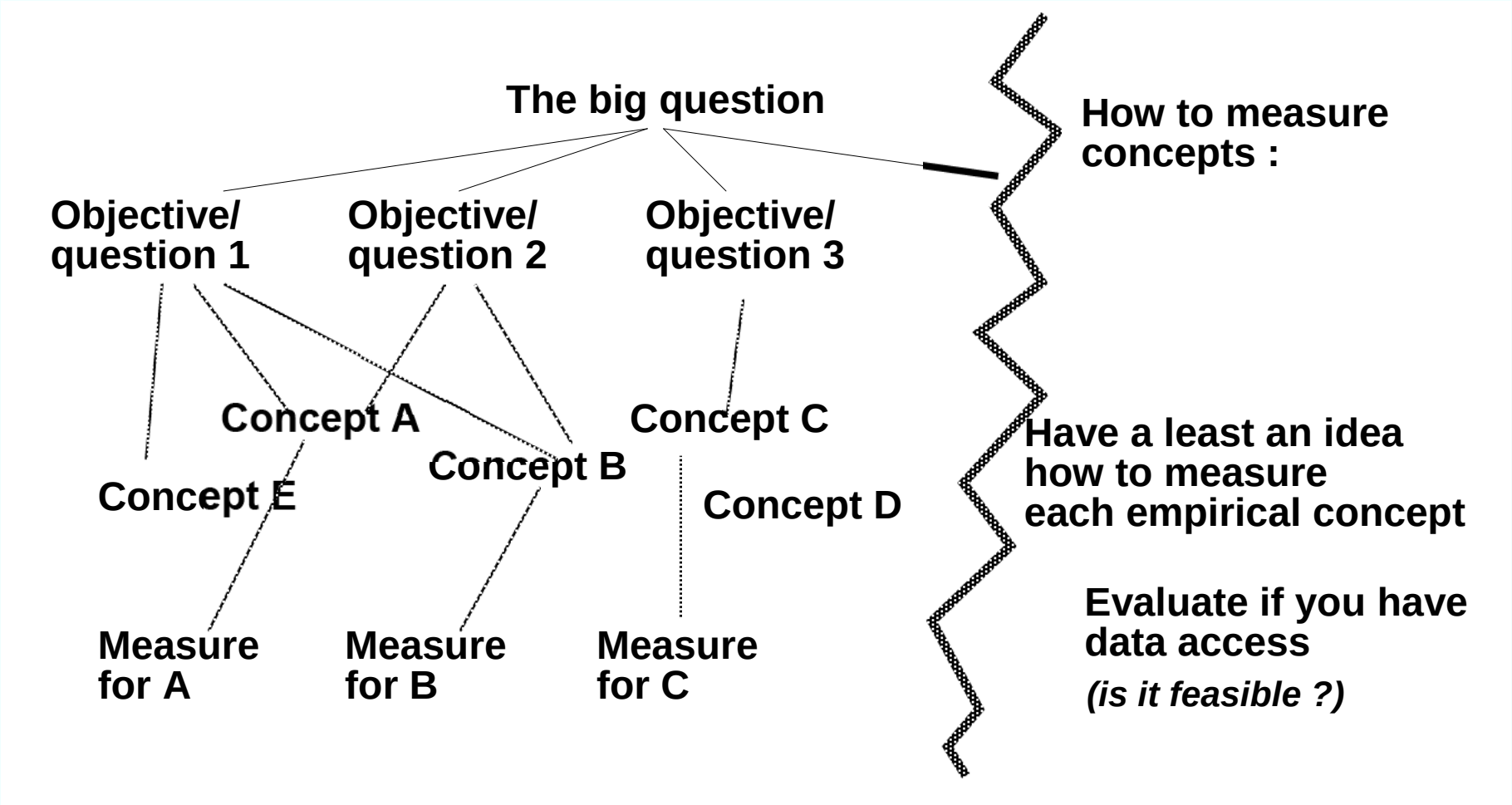
Objectives & preliminary research questions
(don't forget anything don't hide anything !)

Concepts
(be precise)

Hunt (keep some for later):

Theoretical anchors
Approaches
Hypothesis
"Frameworks"
Analysis grids
Analysis methods

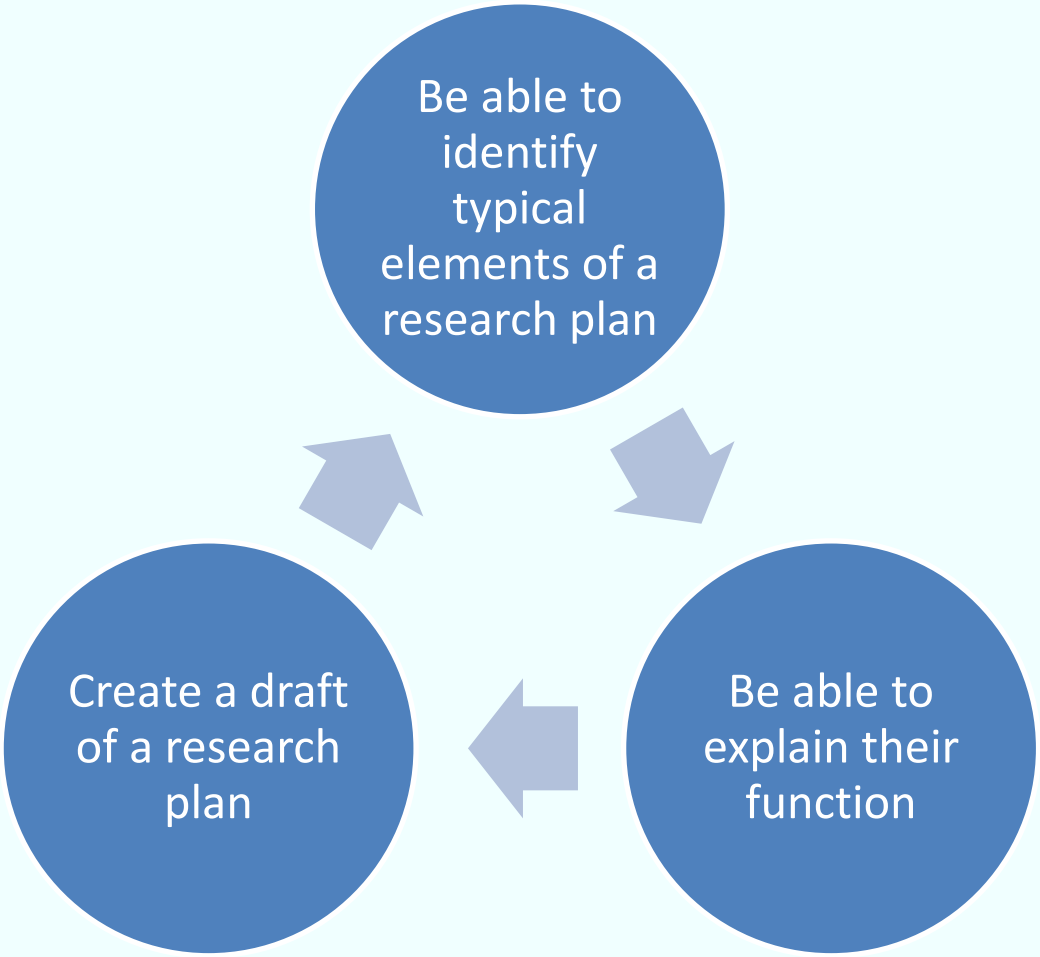
The empirical face



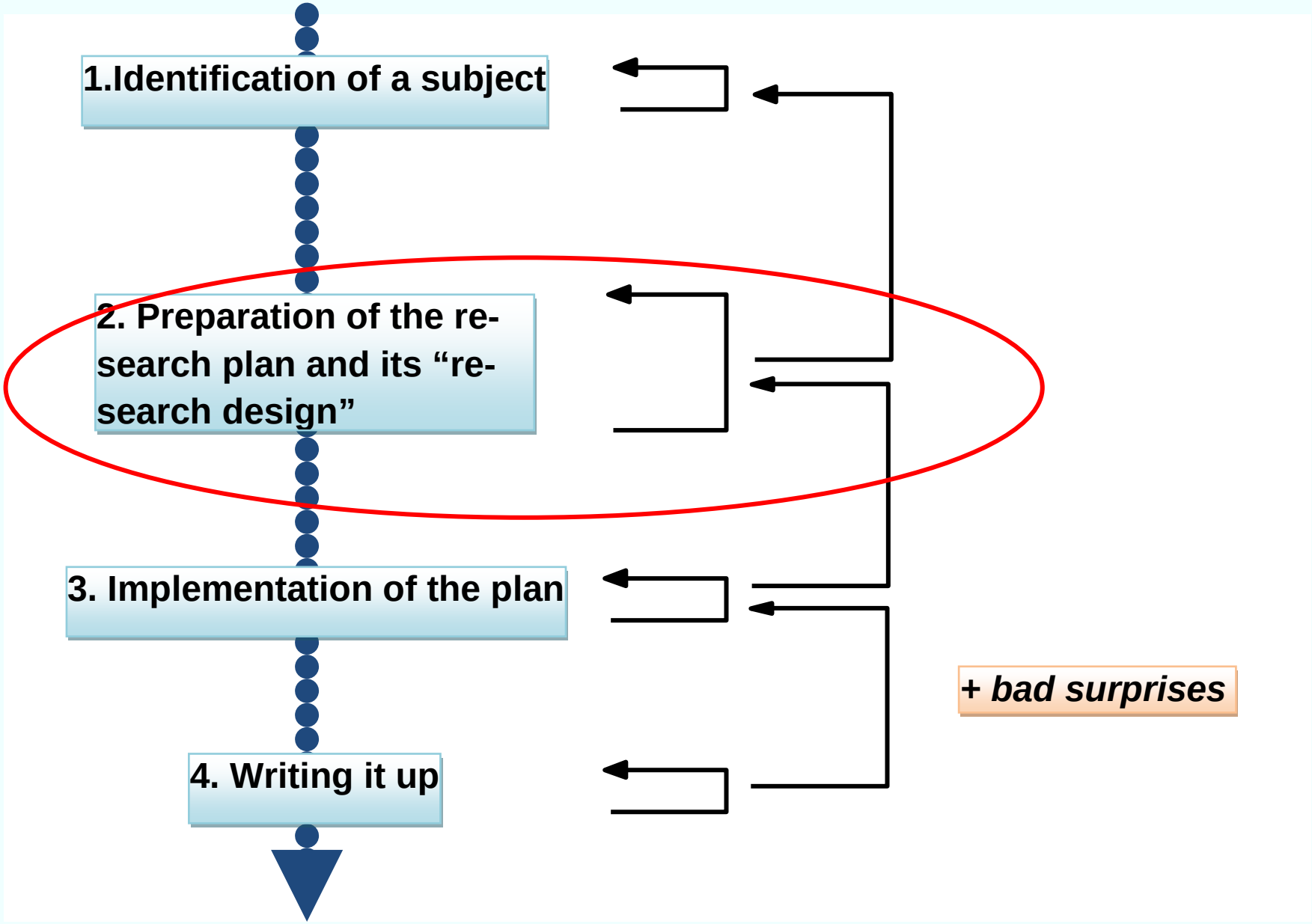
- See modules on research design if you don't understand this (and come back later)

Chapter 5: The research plan

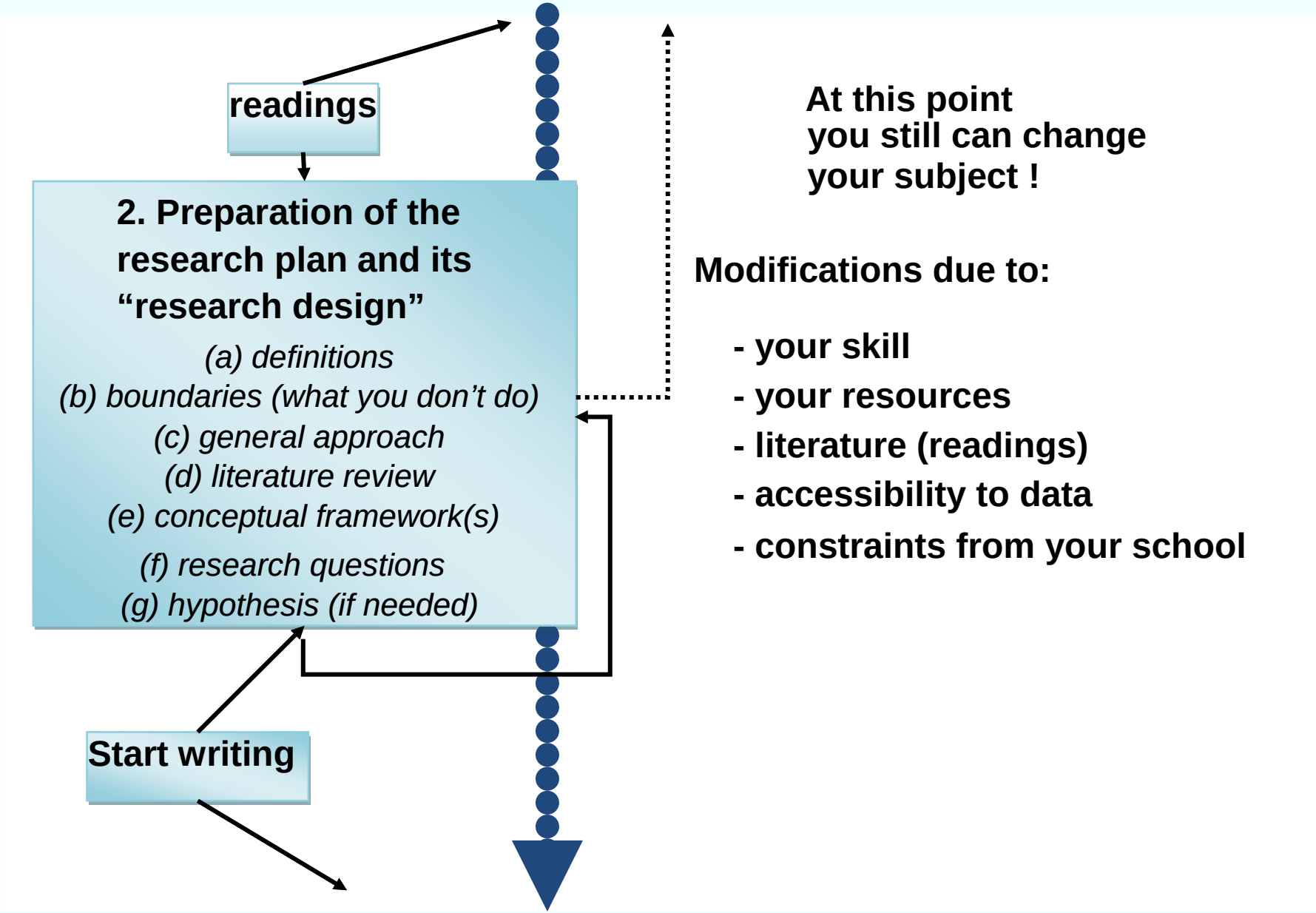
Learning goals



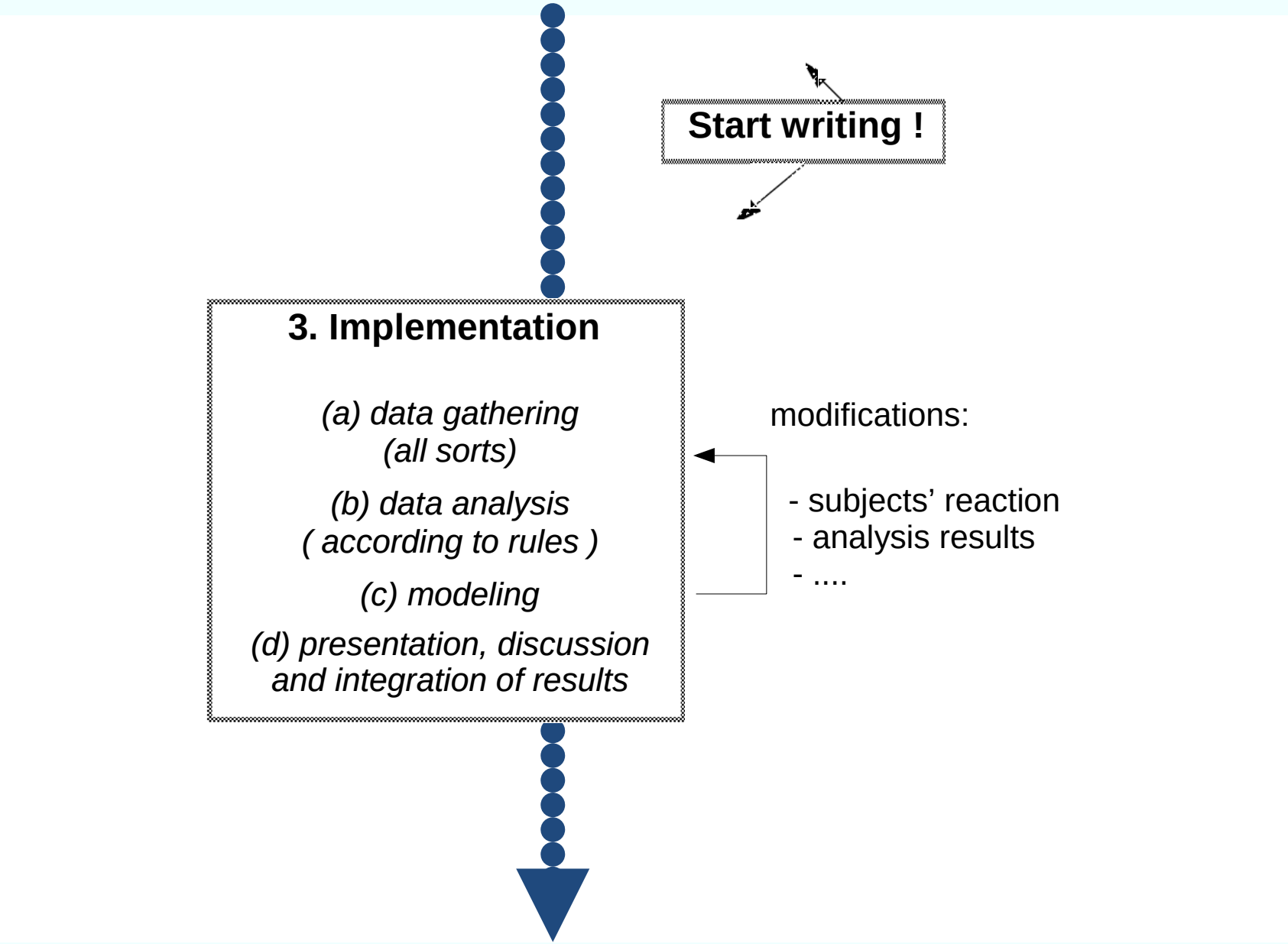
1. Place of the research plan



2. Important elements of the research plan



2.1. Anticipation of main research activity (implementation)



3. Elements of a typical research plan

- Note: You may have to adapt this list to fit formal requirements from your institution or methodology constraints ...

3.1. Element: Your research subject

- the big question (general subject in one sentence)
- make the big question explicit
  - at least a few sentences that demonstrate its practical and theoretical interests.
- motivations and various ends
- delimitations (what you are not going to do)

3.2. Element: Objectives of your research

- Say clearly what you wish to achieve
- Will determine Element: Research questions and/or hypothesis
- Valorization (if appropriate): how can you transfer results in a "real context" ?

3.3. **Element: theory**

- Start with a short and synthetic text describing and discussing the "state of the art" in your subject area.
  - Be sure to mention the major publications. Read the ones you quote from !
- You may point out inconsistencies and gaps (adds additional interest to your project !)
- Identify theories and conceptual models that you will use.
  - Maybe add your modifications and present both at the end
- Make sure that you define all concepts
  - A lot of concepts are controversial, e.g. pedagogical effectiveness, efficiency, ...

3.4. **Element: Research questions and/or hypothesis**

Make explicit your research subject, main goal and objectives

Choose from (or combine):

- Open research questions (but make an effort to be as precise as possible).
- Research questions formulated as working hypothesis.
- Real hypothesis that are based on theory.
- In theory-oriented research, formulate hypothesis that postulate causalities
  - Bad: "I postulate that my e-learning design will work"
  - Good: "Conditions for successful implementation of an e-learning design in the context XXX of are ....."
  - Bad: "ICT doesn't work in schools"
  - Good: "Critical variables A, B, C for successful implementation of e-learning are ...". Then, make explicit A, B, C as causal rules.

3.5. **Element: Approach & methodology**

- “Description of your overall approach (for example "experimental design", "survey study", "usability study", "instructional design")
- Description of data gathering and analysis techniques (for example, semi-directive interviews, content analysis ...)

Note: Make sure to explain your methodological designs for all levels of analysis !

- at the organizational level (if you are interested in this question),
- at the individual level (e.g. students, teachers)

Basic principle:

- Show convincingly ***how you are going to answer each research question !***
- Obey guidelines dictated by the general approach
  - in particular: be careful with experimental designs (rules are strict !)
- (more details below)

Approach

- Briefly describe the overall approach you are using
- Discuss analysis grids that will measure important concepts
- You also can discuss conceptual frameworks (if not done before)
- For experimental studies: clearly describe the experimental conditions

Measures and material

- Data gathering techniques: (interviews, observations, surveys, ...)
- Sampling strategies (or justification of singular case selection)
- For qualitative in-depth studies
  - sampling of interviews, events, etc.
- For experimental studies
  - there is a strict way of doing things ! You have to describe in detail experimental conditions, materials used, sampling conditions etc.

Analyses

- Shortly describe analysis techniques (both qualitative and quantitative)
- If necessary: point out which methods need development (e.g. analysis of student-student interaction in a CSCW environment)

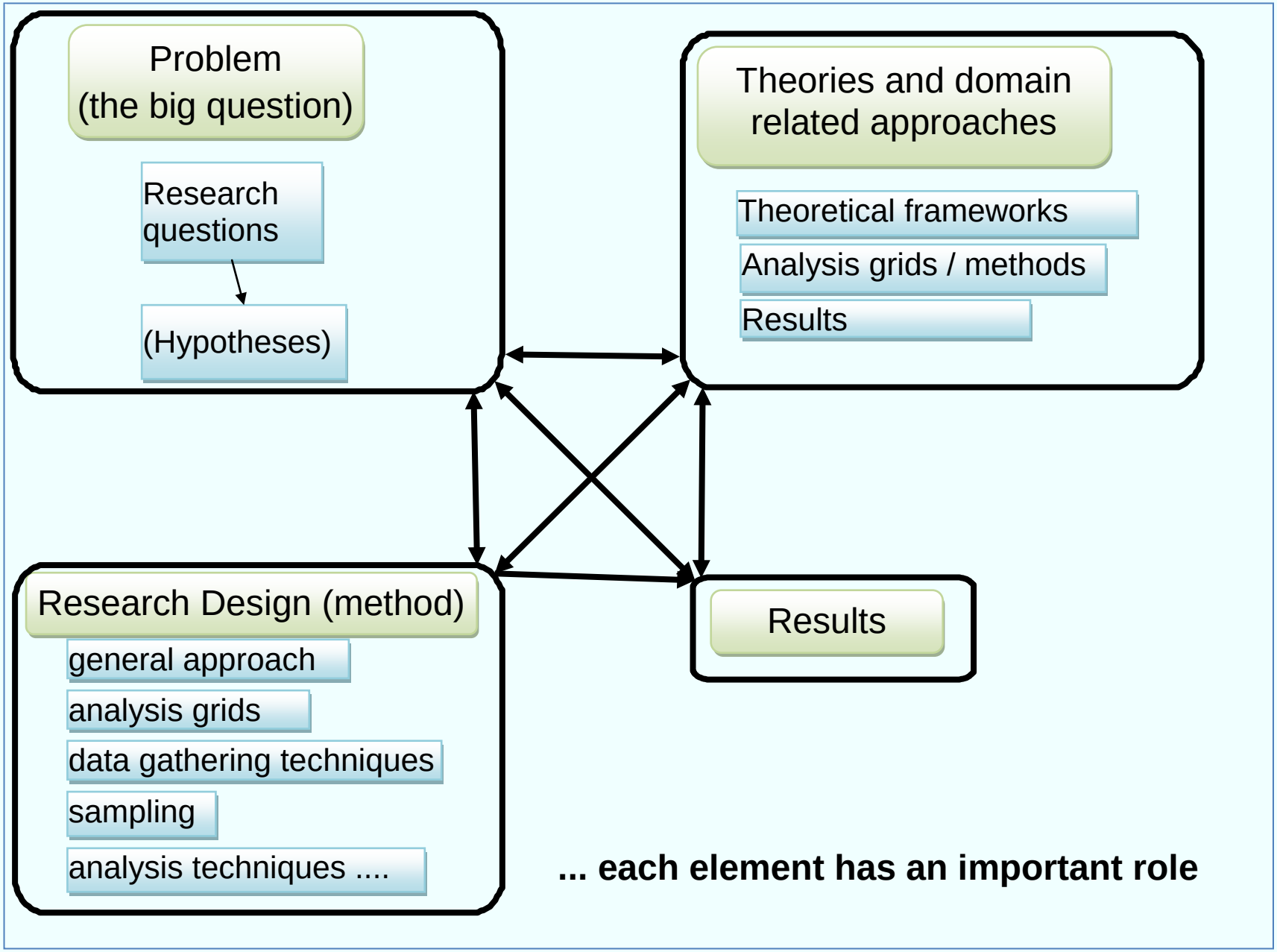
3.6. Element: Information sources

- Bibliography (use a real standard, like APA !)
- Documents to analyze
- Information interviews, etc., ...

3.7. Element: Work Agenda

(see module «xiv Planning techniques»)

4. The research plan is a whole



... each element has an important role

5. Recall: Research plan = what + why:

What?	• A good question !	▪ “So what” ? "What knowledge do we gain"
	• A (or more) good conceptual framework(s) that…	▪ links your research to a larger identified issue, ▪ structures your phenomenon ▪ links your project to a body of existing knowledge ▪ … is preferably available as a nice drawing
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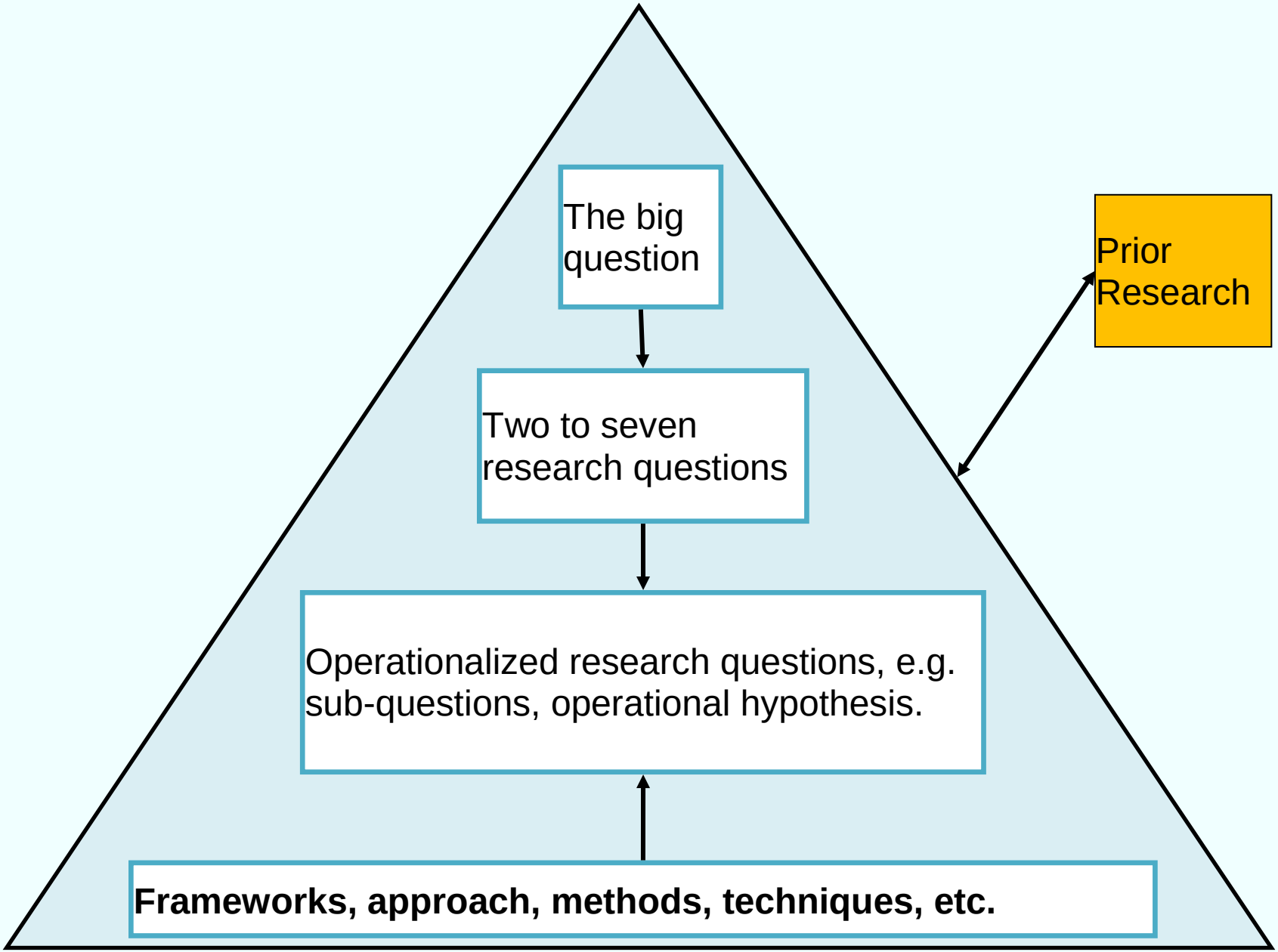
A whole !	• Integration !	▪ A coherent whole ! ▪ All your intentions are made explicit. ▪ Your research questions cover your essential planned work.

An integrated whole !



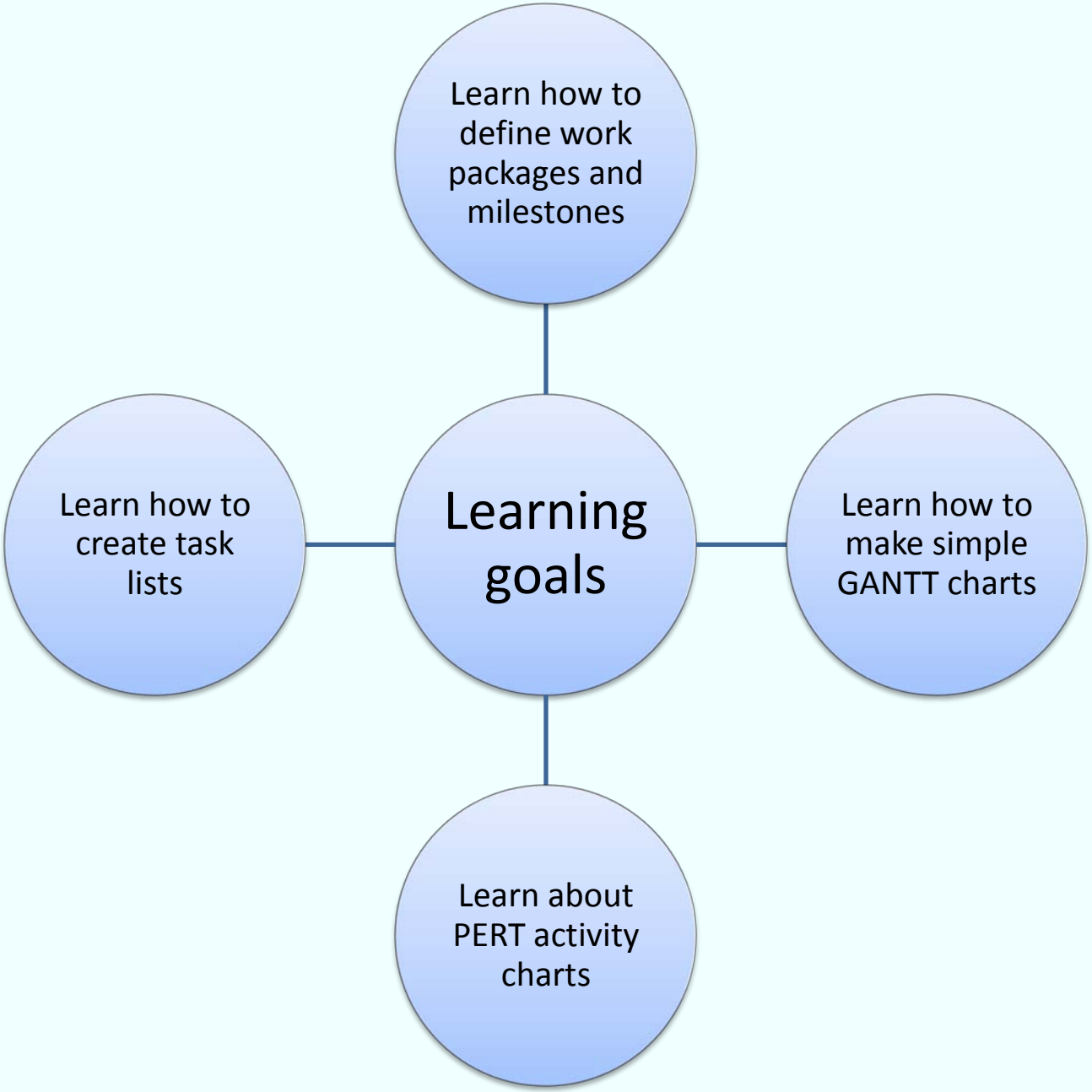
6. Before you believe that your are done

Check again:

1. Theoretical feasibility
   - You can't do it all by yourself, check the literature (if not already done so, find "ground breaking" articles)
   - In particular: theoretical frameworks, analysis grids, theoretical statements.
   - organize an interview with a least an academic and a domain expert
2. Inventory of approaches and methods
   - there are some constraints, you can't study everything in any way (but you do have choice !)
   - finding a good design always is an iterative process (so don't worry if your first version looks bad)
3. Identify your main approach :
   - look at similar research
   - if you want to prove things and make causality claims, you need comparison !
   - use qualitative approaches to explore and to understand, quantitative to confirm, generalize, prove, ...

4. Methodological feasibility
   - Dress a list of all the ***concepts*** that appear in your research questions (and hypothesis if you have)
   - Take each concept apart for its dimensions,
   - Operationalize each empirical dimension (make it is measurable)
5. Does your theory part really relate to your empirical / practical part ?
6. Make sure that you can produce needed data and then analyze them
   - do you know how to gather data (make observations, design questionnaires, make interviews, ...
   - can you handle these data ?

Chapter 6: Planning techniques



1. Why planning

It is not necessary to use project management techniques for a smaller research project, but doing so could help getting your thesis done in time….

The main advantages good planning are:

- Better estimation of resources (time), i.e. a good planning effort will likely tell you to reduce the scope of your research.
- Planning can be a tool for self-control. If at some point, you are a lot behind schedule you can detect this, and have an opportunity to act.

The minimal planning you should do is the following:

1. A list of the major things to do (each item is called a work packages)
2. Specify deadlines for each work package
3. Estimate the time (e.g. in man/days) needed to complete each work package.

Then create a to-do / start / deadline list, e.g. something like:

1. Literature review: start = oct. 2020, end = feb. 2021, volume = 1 man/month
2. Case study 1 field work: start = ____

2. Scheduling

1. Divide a project into ***tasks***, called ***work packages*** (WPs)
2. For each WP, provide an estimation in man/days or man/weeks it takes to finish

- A work package usually is a stage of the research plan, e.g. "the research plan", "field work", "development work".
- If possible, a work package should depend little on parallel work packages
- Each work package can lead to a ***milestone*** (an important stage in your research plan") and/or to deliverables, e.g. tangible products such as the research plan.

To manage the scheduling two kinds of graphics):

1. An ***activity diagram*** shows dependencies of work packages and a critical path.
2. A ***bar diagram*** illustrates activities over time.

2.1. **Activity diagrams**

- Estimate the time it takes to reach an important stage
- Calculate global time needed for the whole project.

Methods

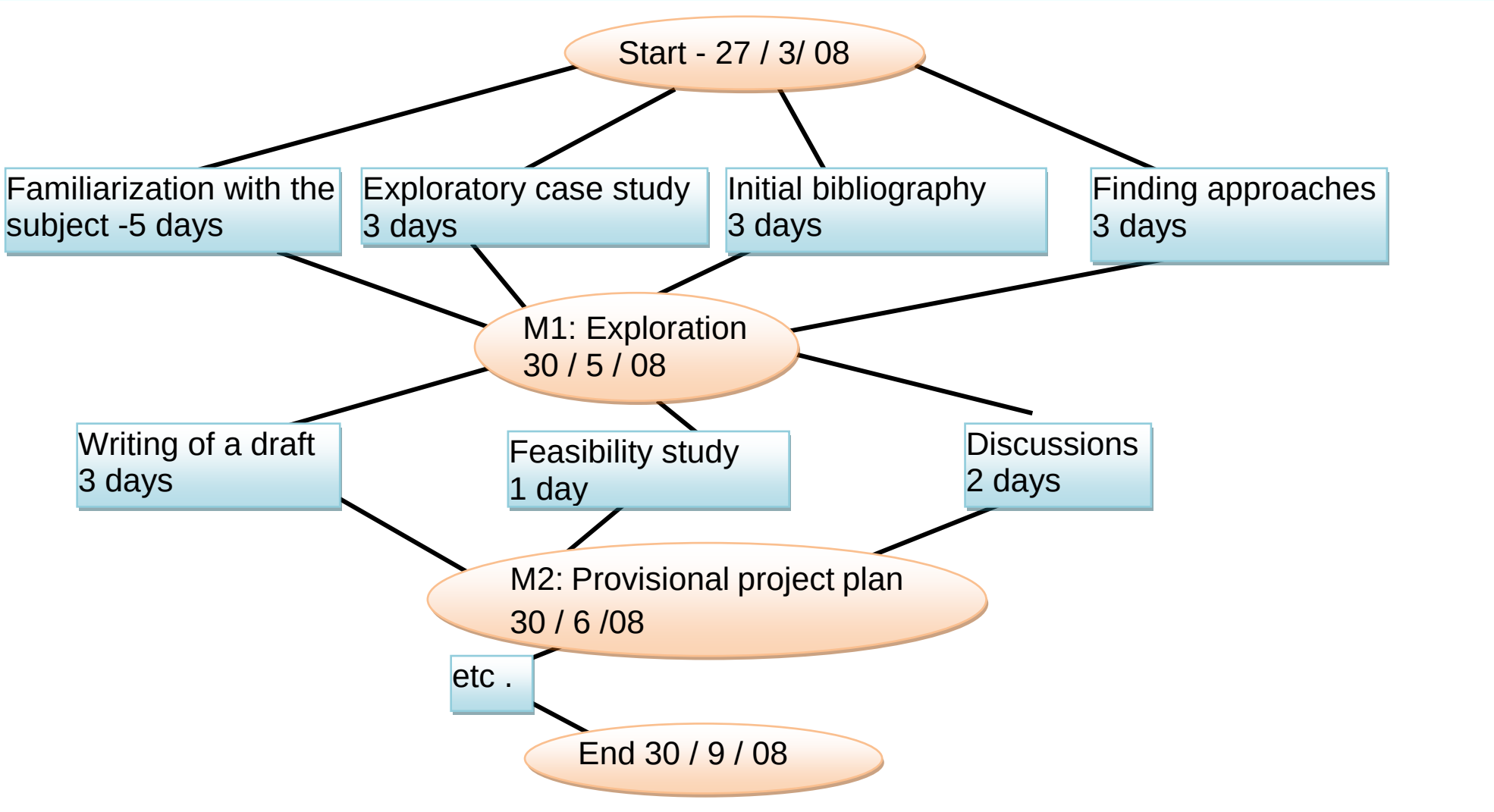
- PERT (Program Evaluation and Review Technique)
- CPM (Critical Path Method)

Activity diagrams contain the following elements:

- Each project is represented as a directed graph of tasks (the rectangles)
- Some tasks depend on other tasks
- For each task, you must estimate its duration.
  - Often you do this with three estimations: expected minimum time, most expected time and expected worst case.
- Then you also add milestones, i.e. the completion of a group of tasks and that represent the end of an important stage.
- Once you defined such a graph, you then can compute “expected duration”,
  - If you added minima and maxima you also can compute “best possible outcome” and “worse case scenario”

Example 1. **A simple PERT example**

- *Milestone M1 – Exploration* is done after you completed “becoming familiar with the domain of study” (5 days), after you studied an example (3 days), you found some references (3 days) and you thought hard about finding an appropriate approach (3 days).
- *Milestone M2 - a project draft*" needs an extra 5 days.



2.2. **Bar Charts (GANTT Charts)**

Represent a sort of calendar that includes time units (e.g. weeks) in one axis and work packages in the other.

- The horizontal axis is organized either by days, or weeks, or month (depending on the size of the project).
- The vertical axis includes a list of work packages (WPs) and milestones.

Fill in the table like this:

- use "XXX" during the weeks you plan to work hard
- use "xxx" during the weeks you plan to work a bit on it

WPs and Milestones	oct 6 08	oct 13 08	oct 20 08	oct 27 08	...	...	...	...	...	...	...	jun 1 09
Exploration of the subject area	xxxxxxxxxx											
.....												
Preliminary case study		XXXxxx										
Research plan			M									
.....												
.....												
Writing it up				x	xxx							XXXXXXXXXX

2.3. **To-do lists**

To-do lists are a simple alternative

- Write down all the work packages you have to do and
- regularly annotate what you did complete in terms of percentages.

For example:

Task	Completion
Exploration of the subject area	20%
.....	
Preliminary case study	50%
Research plan	10%
.....	
.....	
Writing it up	5%

- There exist simple online tools, e.g. in WebTops like Pageflakes.

2.4. **Controlling**

Who should / will control your progress?

- In industry, it's the boss or the project group as a whole that does it.
- Depending on the educational institution, it's you mostly, but you may give it to your advisor or integrate it into the research proposal.

Progress monitoring and crisis management

- Compare reality with planning about once per month
- If there are important deviations from schedule, you should understand why and take corrective action.

Crisis management strategy.

- Asking help from your advisor
- Negotiating to do less, i.e. downsizing you initial plans
- Adapt the approach for another that is less costly

3. Duration of a typical master thesis

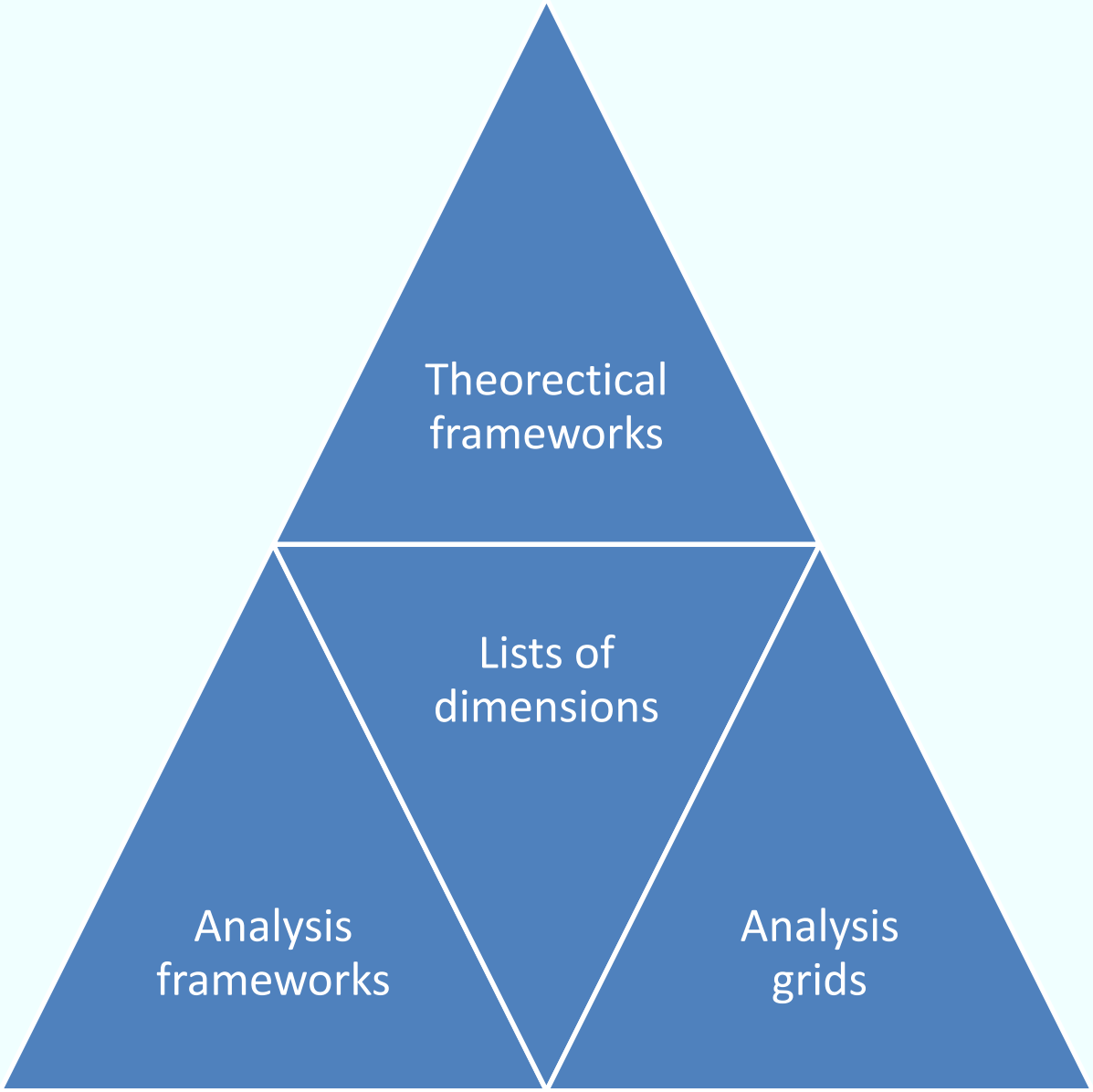
- Below is an example for a qualitative field-study.
- Estimations are in man/month. Divide by the percentage of time you can spend on the thesis.

Tasks (large WPs)	By element	Total
Find a subject and do the research plan		1 month
Literature review and initial writing		1 month
Contact each research site	1/2 day	1 month
Site visits	1 day	
Coding of data	2-3 days	1 month
Analysis (matrices and visualizations)		
Draft thesis		1 month
Revisions		1 month
Total		6 month

- Your planning is likely to be over-optimistic!

Chapter 7: Finding Conceptual frameworks

Learning goals: Get some inspiration from various frameworks



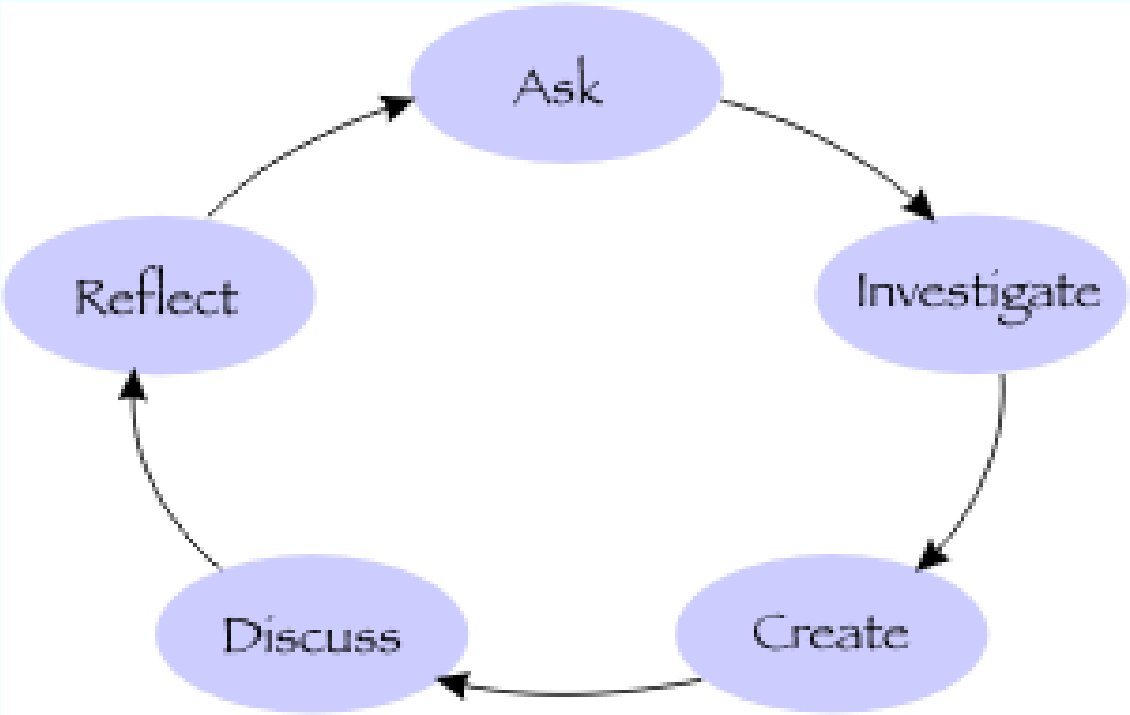
Kinds of conceptual frameworks you could use

1. Theoretical frameworks
   - Provide an overview of the phenomenon (elements and relations)
   - Help to bridge the gap between theory and empirical research
2. Analysis frameworks
   - Help you focus analysis and formulate research questions (e.g. what causalities to look at, what is of interest, etc.)
3. Lists of dimensions
   - Help to focus on all aspects of a concept
   - Help to think about empirical instruments for measuring a concept
4. Analysis and evaluation grids
   - Help to organize data gathering and collection
   - Will bridge the gap between general concepts at theory level (e.g. your research questions) and measurable indicators
5. ….

1. Example frameworks

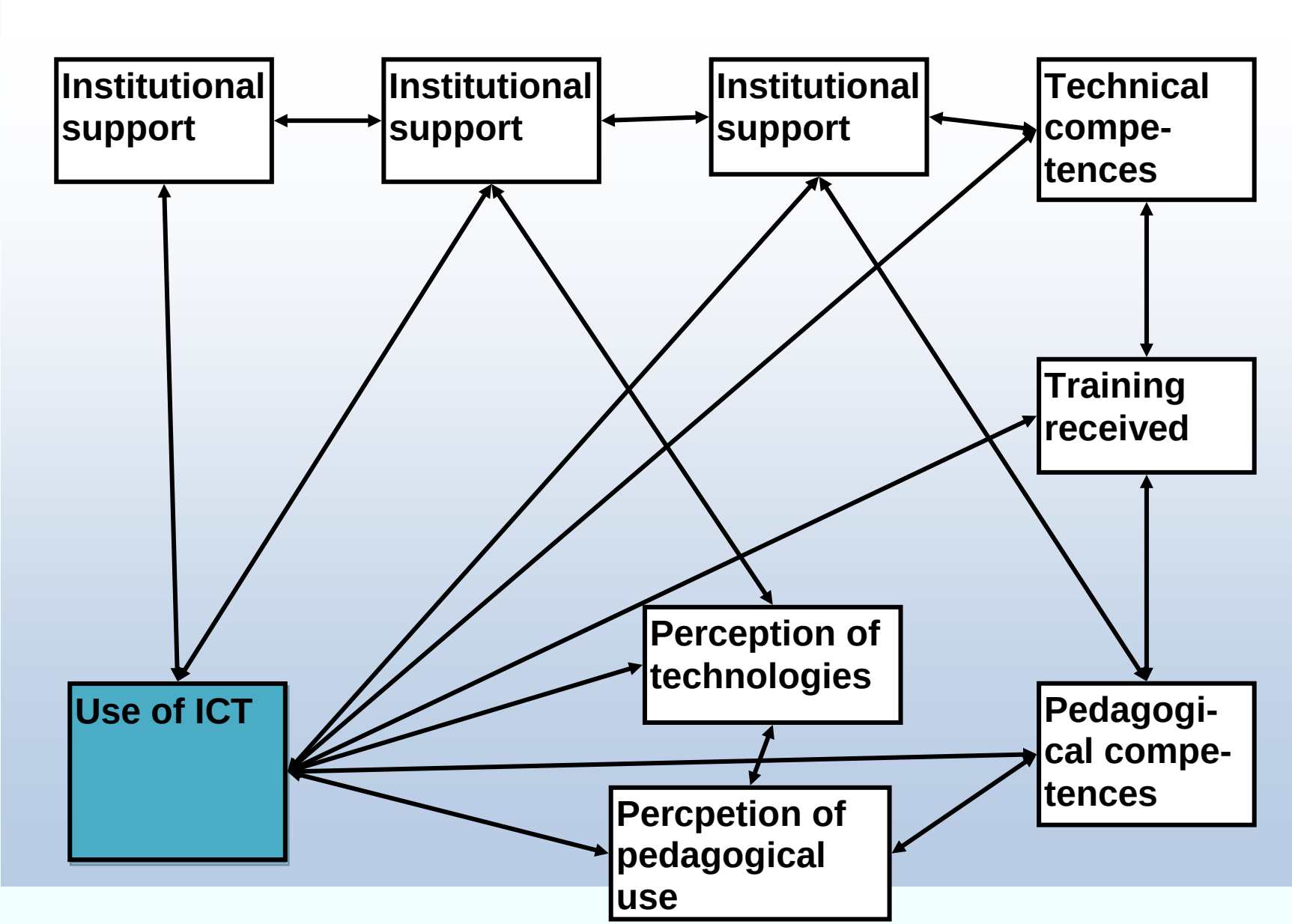
Example 1. **The inquiry circle in inquiry-based learning doctrine**

url: **http://www.inquiry.uiuc.edu/**



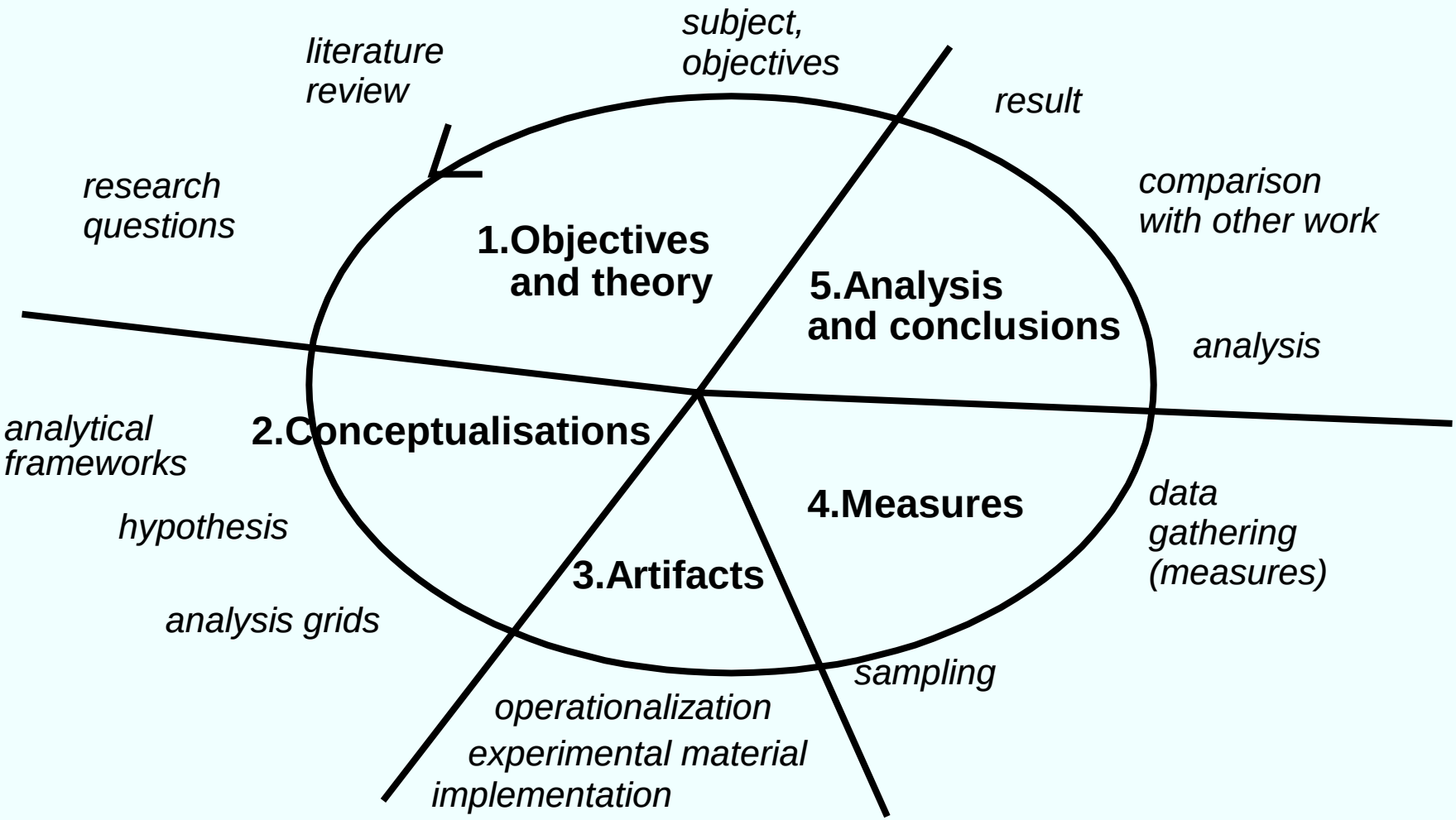
- clearly identifies 5 elements of inquiry
- claims/shows that inquiry is circular

Example 2. **Gonzalez 8-factor model for ICT usage in schools**



Example 3. **A linear model of research**

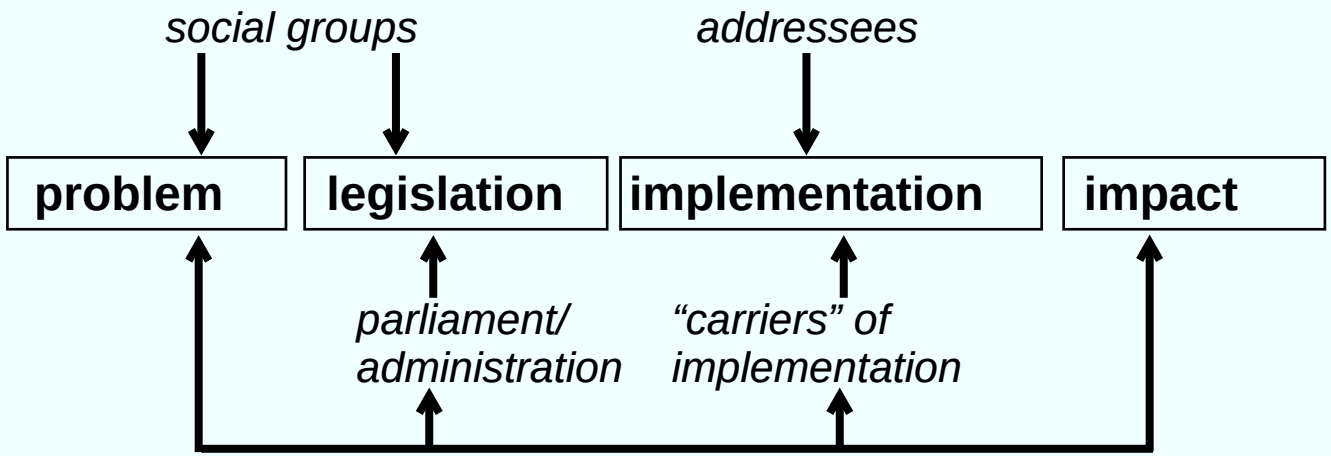
- Note: Even this course has a analytical organizing framework :)



Example 4. **Implementation research model**

Provides a certain "image" of the policy-making process:

- Actors intervene during the whole process (and not just in their "natural" stage"
- Problem perception, goals and other elements can be changed over time !
  - i.e. sometimes the implementors may redefine the set goals !



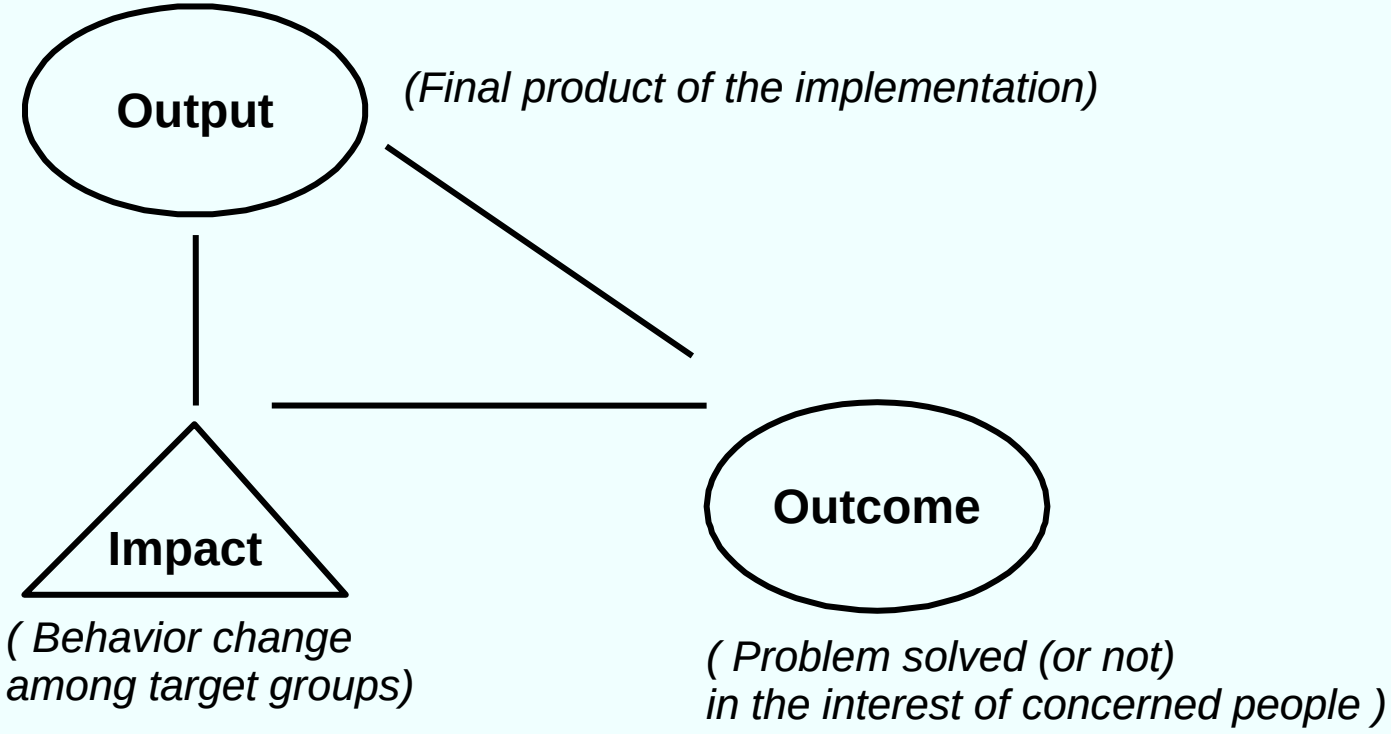
Possible relevance for educational technologies:

The fact that a government agency has been created to sponsor ICT-based pedagogical reform, does not entail that it will happen as they plan. Implementation "carriers" (e.g. schools) and addressees (e.g. teachers) may redefine goals and will have to establish operational practise.

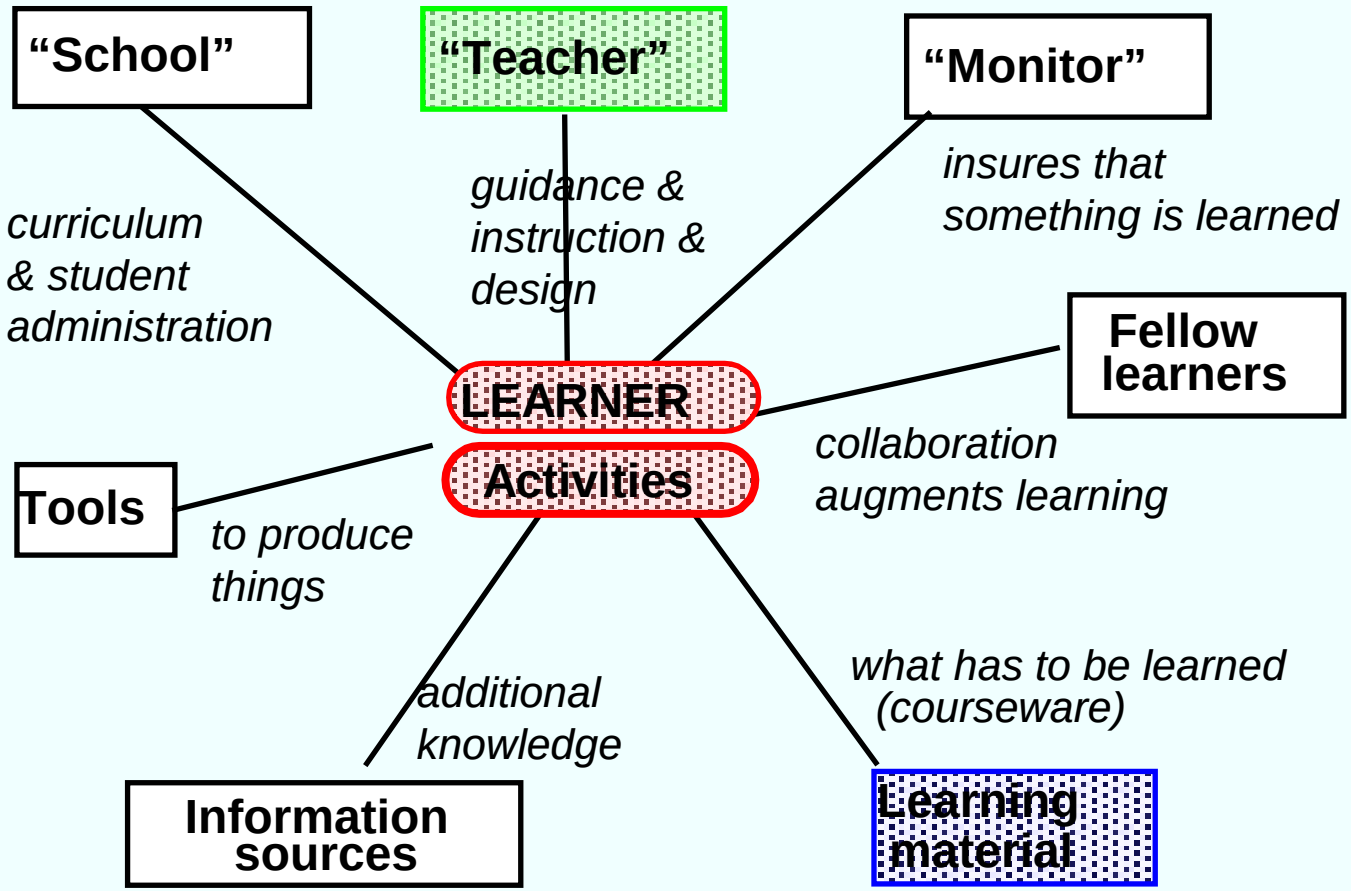
Example 5. **Policy outcomes**

Définition des prestations au sens de produits finaux de mise en oeuvre d'une politique publique [Knoepfel, P. (1996) TQM et fédéralisme, Cahier de l'IDHEAP, 159, p 10]

- E.g. useful to provide a perspective on the analysis of educational reform policies
- There are three major kinds of "results" you can study according to the author



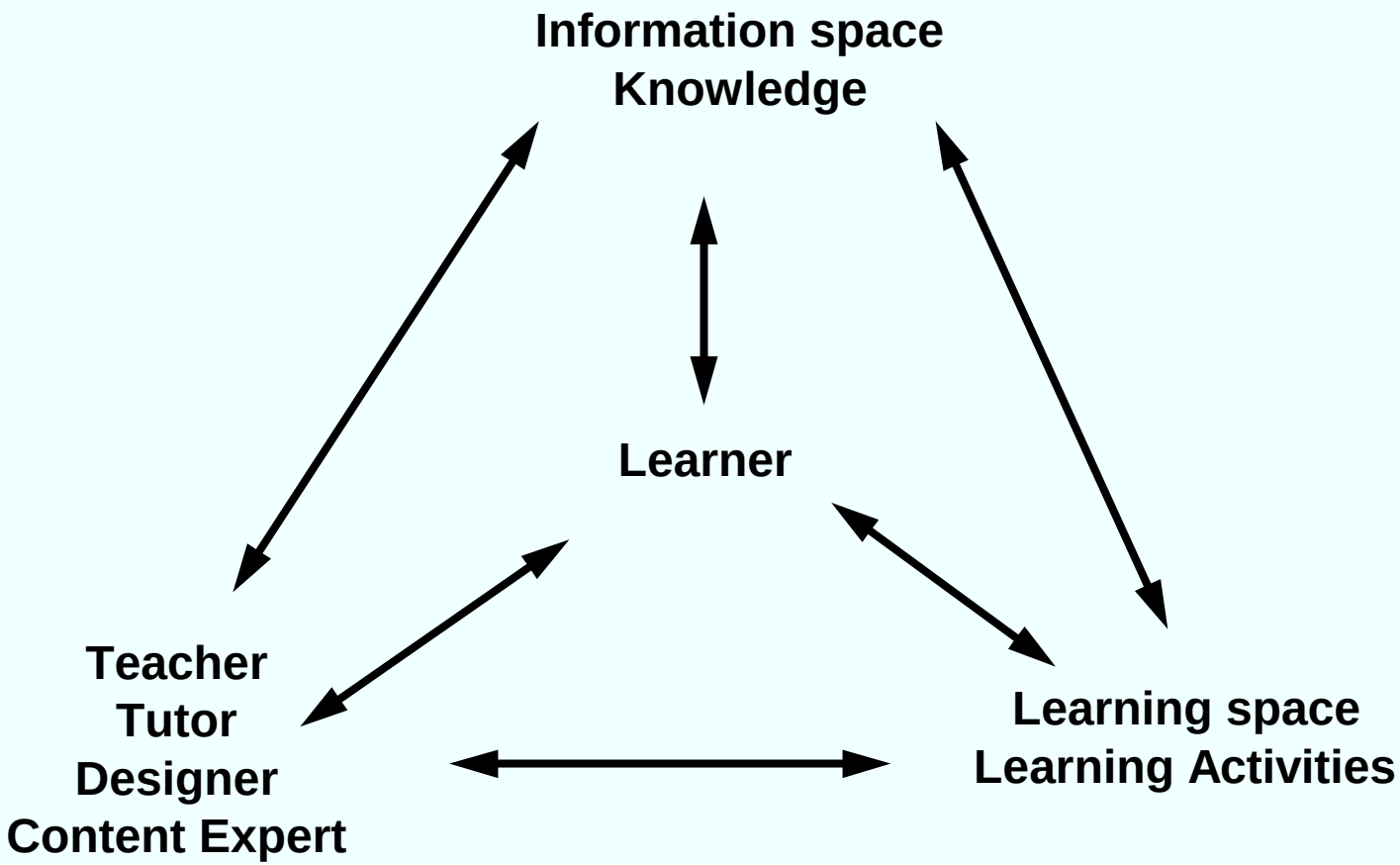
Example 6. **Functions of a learning environment: Where do we focus ?**



modified from Sandberg

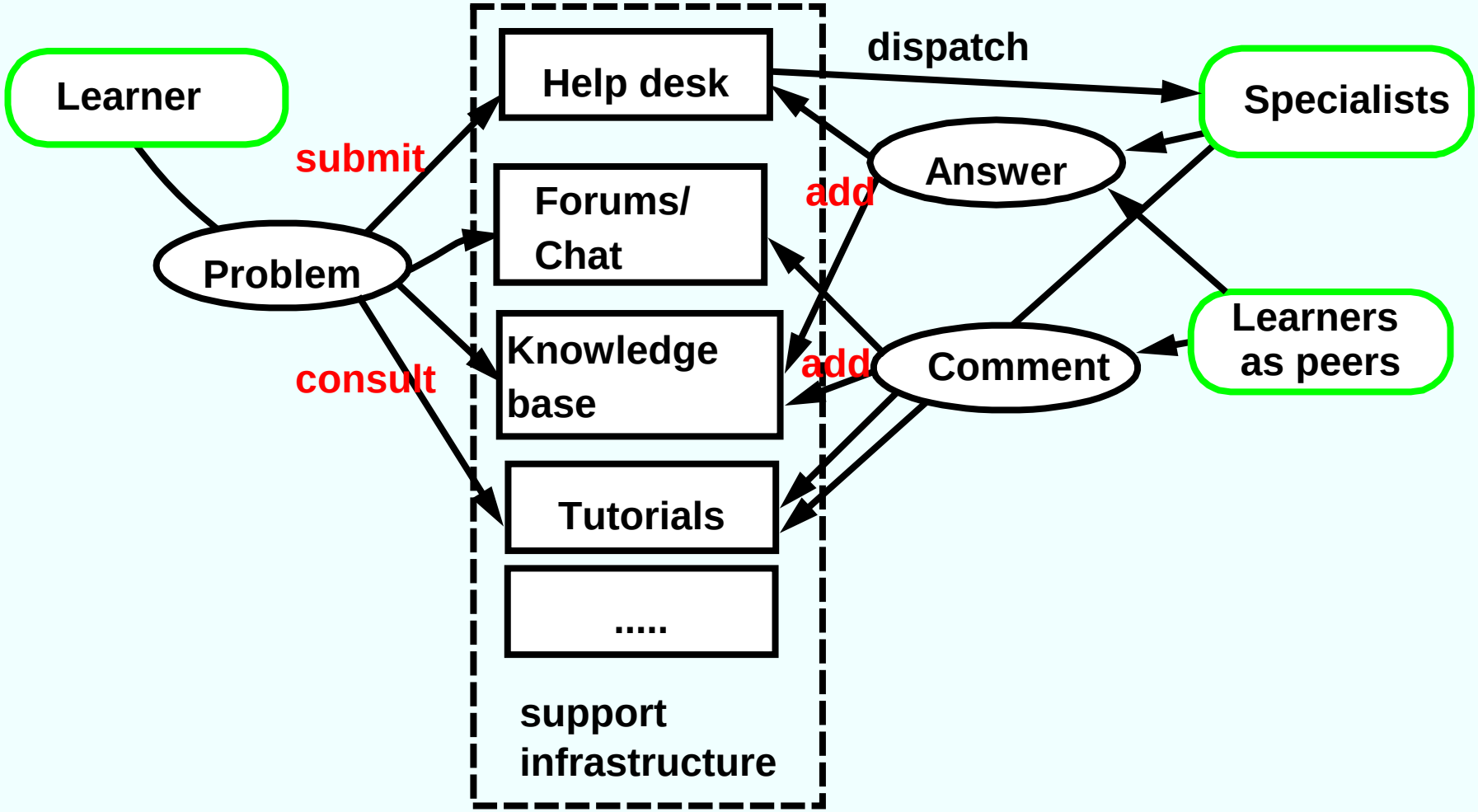
- This model makes you think about functions that a learning environment should provide and therefore about structure that will instantiate function
- It also allows to think about priorities in your design
  - E.g. teacher role is central in activity-based designs
  - E.g. **Learning material** is important in e-learning designs for mass-education

Example 7. **A simple picture defining key elements of an ICT design**



- This is not a great model, but it makes you think about the distinction between pedagogical activities, information (learning material), people involved……
- Roles and relations here can't be filled in without some reference to pedagogical method (so it's not such a good model)

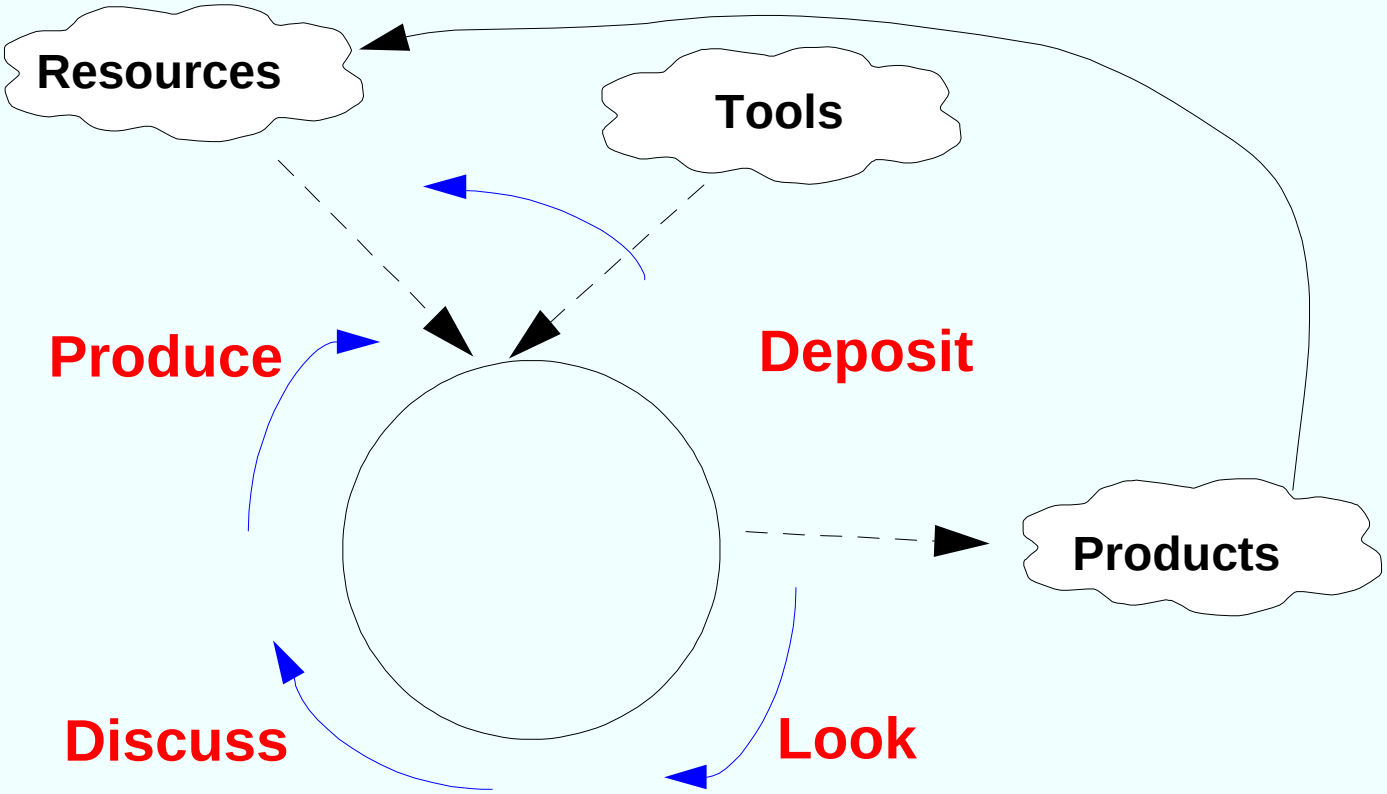
Example 8. **A "help desk model" for "on-the-spot" life-long learning**



- This model allows you to think at the same time about system components and actor's roles
- Technical infrastructure used: either C3MS portals, groupware, specialized help desk, knowledge management software.

Example 9. **Activity-based teaching with portals or web2 software**

- Scenarios are sequences of activity phases within which group members do tasks and play specific roles
- This ***orchestration*** implies organizing workflow loops



... this is just the “ur-loop” ... other variants exist !

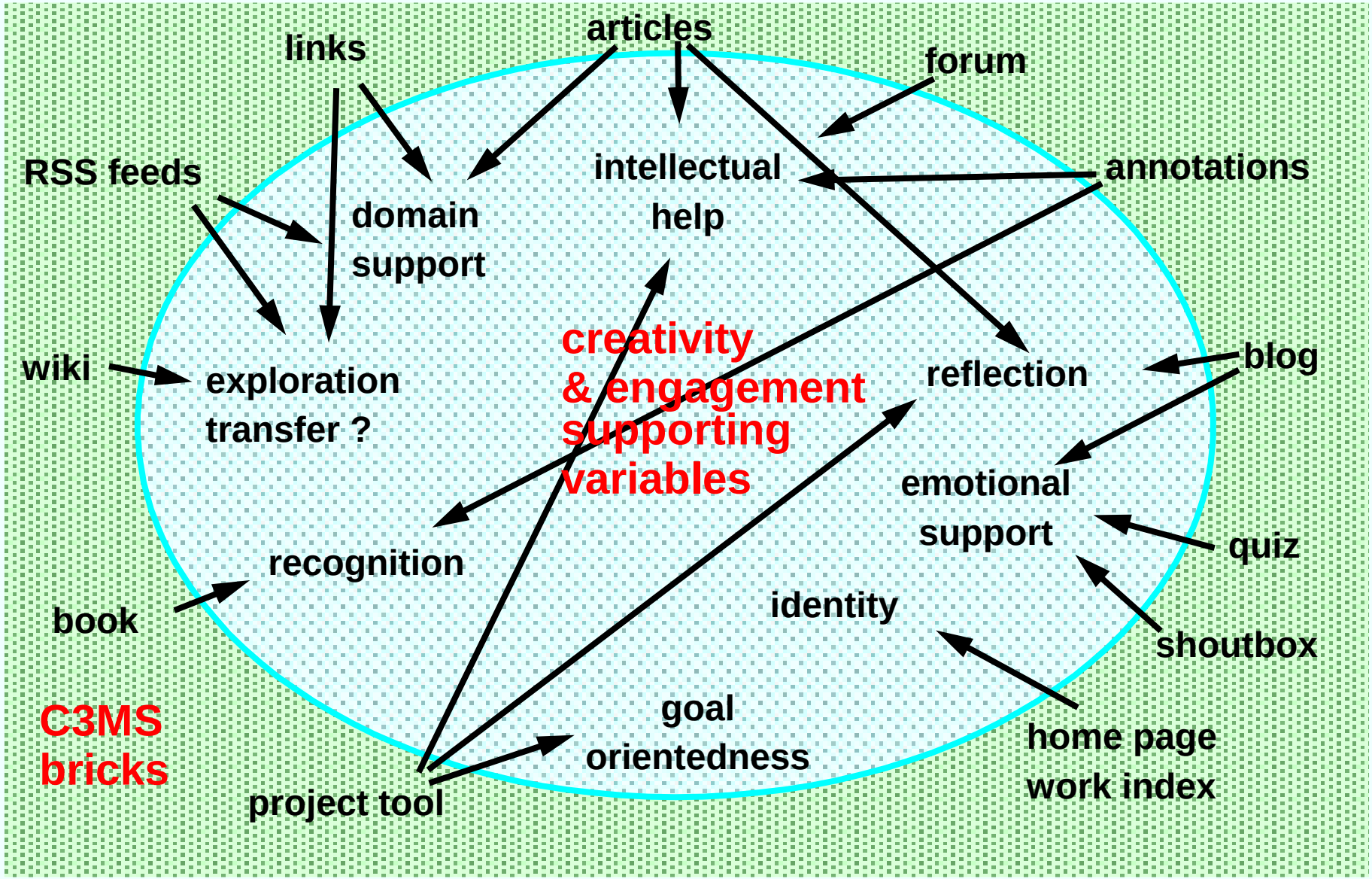
- This framework clearly shows that students have to engage in activities, that activities lead to products that can be discussed and reused.

Example 10. **Definition of a C3MS (community) portal**

Function	C3MS modules (tools of the portal)
Content management	News engine (including a organization by topics and an annotation mechanism) - Content Management Systems (CMS) Collaborative hypertexts (Wikis) - Image albums (photos, drawings, etc.) - Glossary tool or similar - Individual weblogs (diaries)
Knowledge exchange	News syndication (headlines from other portals) File sharing (all CMS tools above)
Exchange of arguments	Forums and/or new engine Chats, ...
Project support	Project management modules, Calendars, ...
Knowledge management	FAQ manager, Links Manager ("Yahoo-like") Search by keywords for all contents, "top 10" box, rating systems for comments "What's new" (forum messages, downloads, etc.), ...
Community management	Presence, profile and identification of members Shoutbox (mini-chat integrated into the portal page) Reputation system, activity tracing for members Event calendar, News engine, ...

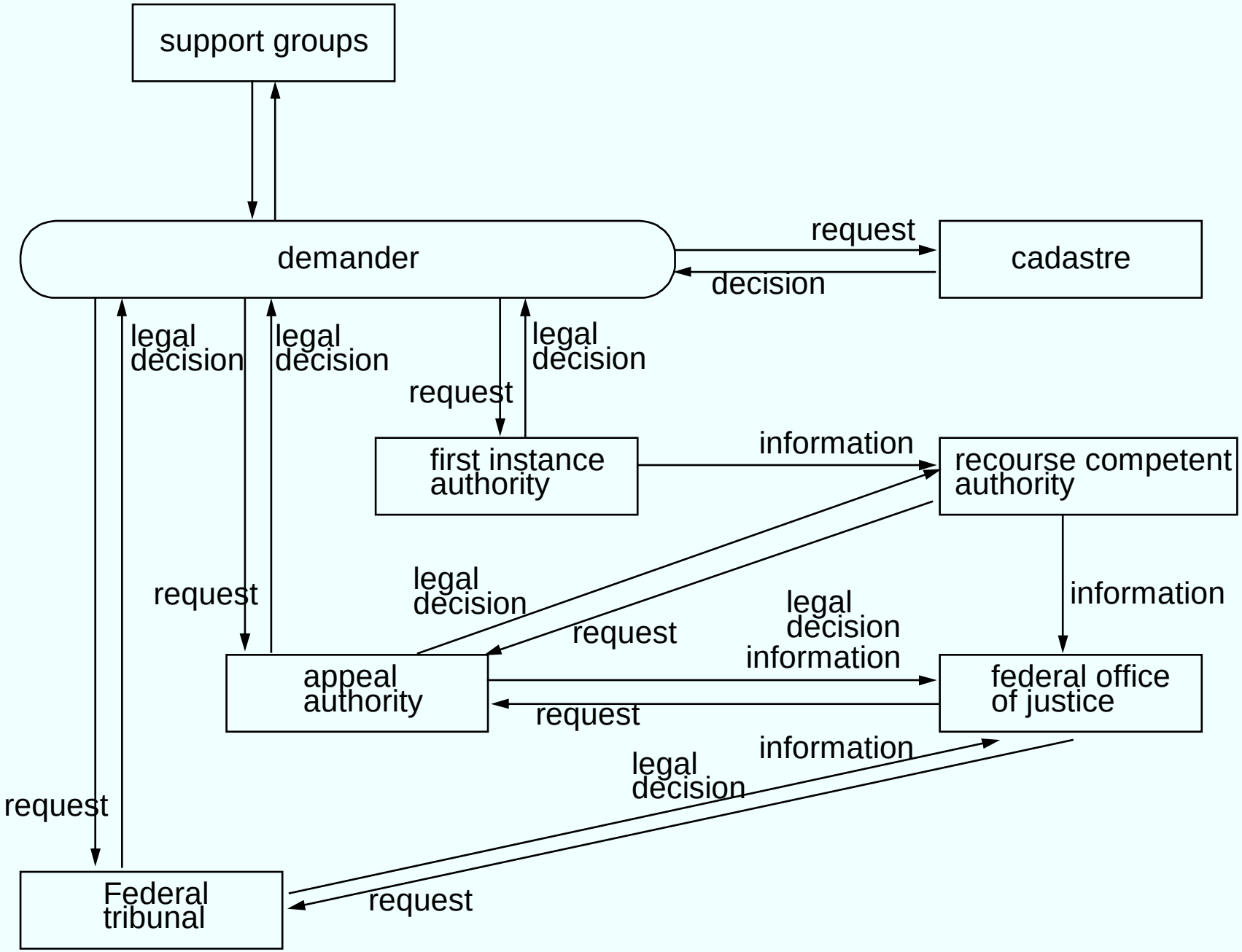
- This table makes association between a list of functions and structure (software modules)

Example 11. **C3MS modules support for creativity and engagement**



- Also links structure (software elements) to functions (creativity and engagement enhancing variables)

Example 12. **Visualization of formal procedures**



2. Lists of dimensions and typologies

Example 13. Types of Learning (Kearsley)

http://tip.psychology.org/

1. Attitudes:
   - Disposition or tendency to respond positively or negatively ....
2. Factual Information (memorization):
   - Processing of factual information and remembering .....
3. Concepts (discrimination):
   - ... how to discriminate and categorize things. Concept mastery is not related to simple recall and must be constructed.
4. Reasoning (inference, deduction):
   - thinking activities that involve making or testing inferences
5. Procedure learning:
   - .... being able to solve a certain task by applying a procedure.
6. Problem solving:
   - identification of subgoals, use of methods to satisfy subgoals.
7. Learning strategies:
   - can hardly be taught and only be learned through appropriate experience and to some extent only !

Example 14. **Major pedagogical approaches (strategies)**

(**Baumgartner & Kalz**, modifications by Schneider)

Transfer	**Tutor**	**Coach**
Factual knowledge, "know-that"	Procedural knowledge, "know-how"	Social practise, "knowing in action"
Transfer of propositional knowledge	Presentation of predetermined problems	Action in (complex and social) situations
to know, to remember	to do, to practise	to cope, to master
Production of correct answers	Selection of correct methods and its use	Realization of adequate action strategies
Verbal knowledge, Memori-zation	Skill, Ability	Social Responsibility
to teach, to explain	to observe, to help, to demonstrate	to cooperate, to support
Teaching I	**Teaching II**	**Teaching III**

- E.g. helps to decide what sort of teaching and learning you want to study or favor with an ICT-based environment

Example 15. Khan's (2000) list of pedagogical methods and strategies

Presentation	**Exhibits**
Demonstration	**Drill and Practice**
Tutorials	**Games**
Story Telling	**Simulations**
Role-playing	**Discussion**
Interaction	**Modeling**
Facilitation	**Collaboration**
Debate	**Field Trips**
Apprenticeship	**Case Studies**
Generative Development	**Motivation**

Makes you worry a bit:

- Which pedagogical strategies work better **for what types** of learning ?

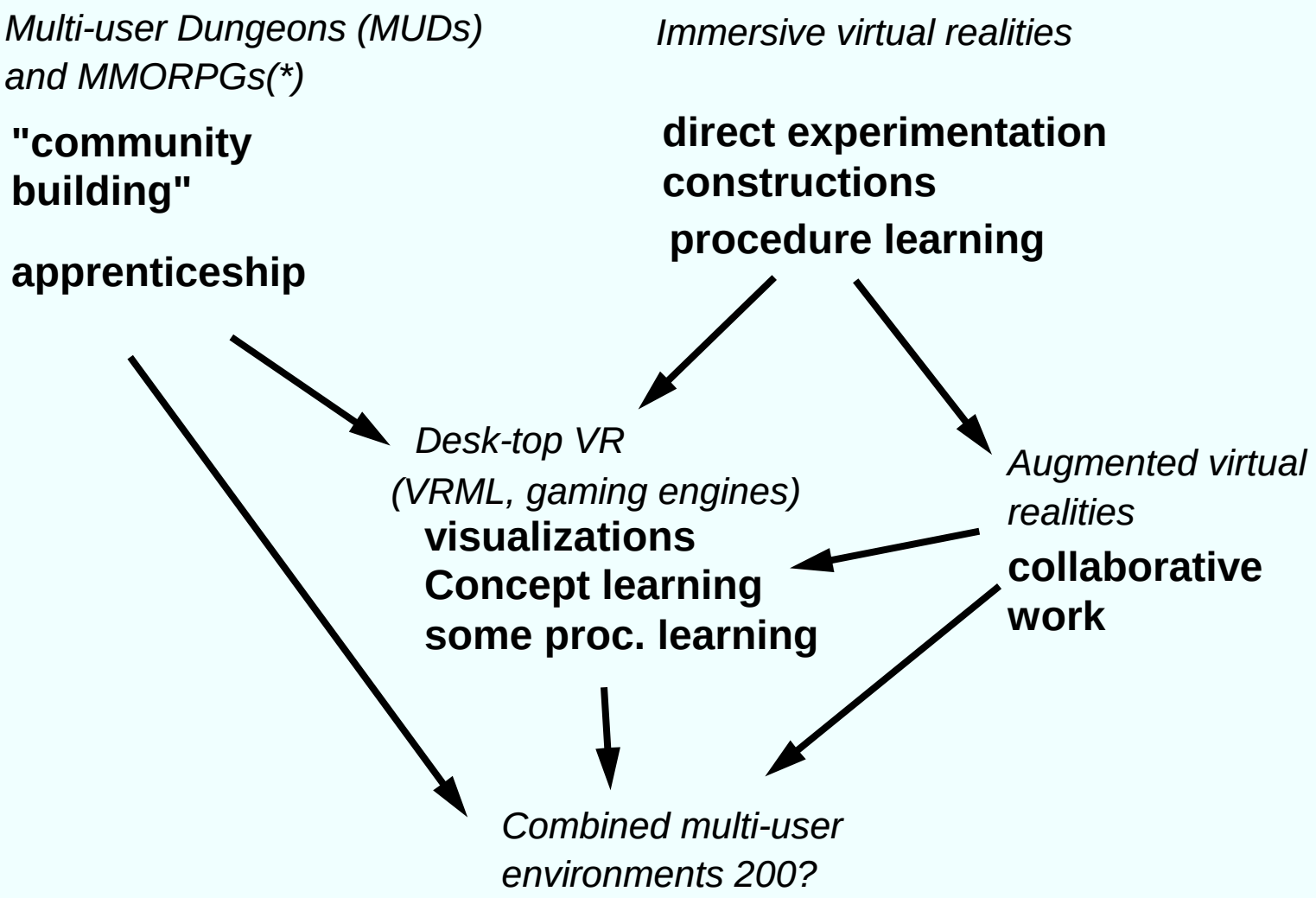
Example 16. **Intrinsically motivating elements of gaming ...**

(Frété 2002, Master thesis TECFA)

Element	
fantasy	• imagination and freedom (make believe + voluntary activity)
challenge & curiosity	• a level of difficulty that triggers curiosity • presence of goals • uncertainty (surprise)
feedback	• immediate • clear
self-esteem	• adapted tasks • encouragement to learn & augment scores
control	• levels to play, user selection of goals, strategies & tactics

- What could we learn from gaming ?
- Why do kids spend many hours playing games without getting bored or tired ?

Example 17. **Typology and typical functions of virtual environments**

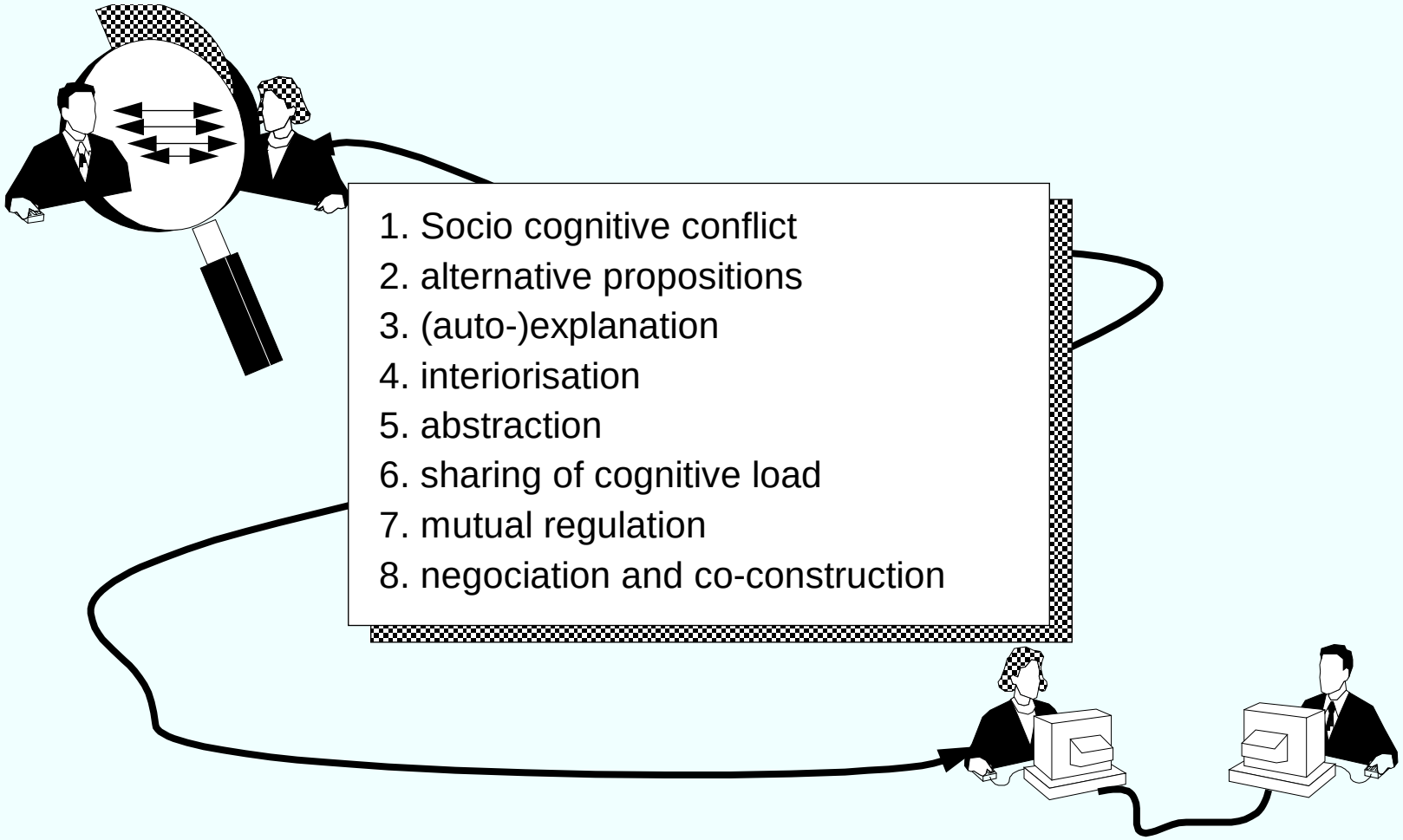


(*)Massively multiplayer online role-playing games

- What do ***you*** mean by a virtual environment ?
- Is it safe to use "virtual environment" when you talk about an e-learning platform ?

2.2. **Effects of CSCL (Computer supported collaborative learning)**

(Pierre Dillenbourg)



- Collaborative learning can be very powerful because its properties engage students in various meta-cognitive activities.
- Note: needs scenario-building (story-boarding)

3. Example analysis grids

- more grids (scales) are shown in quantitative design and analysis modules

Example 18. Ergonomics criteria of Bastien

url: **http://www.lergonome.org/pages/detail_articles.php?indice=22**

1. Guidance	4. Adaptability
1.1 Incitation	4.1 Flexibility
1.2 Grouping/Distinction between items	4.2 Taking into account user experience
1.2.1 … for localization	5.Error management
1.2.2 … for the format	5.1 Protection against errors
1.3 Immediate feed-back	5.2 Quality of error messages
1.4 Readability	5.3 Correction of errors
2. Cognitive load	6. Homogeneity/Coherence
2.1 Briefness	7. Meaning of codes and labels
2.1.1 Concision	8. Compatibility
2.1.2 minimal actions	
2.2 Info density	
3. Explicit control	
3.1 Explicit actions	
3.2 User control	

Example 19. **COLLES Grid**

(Taylor and Maor: socio-constructivist features of on-line teaching

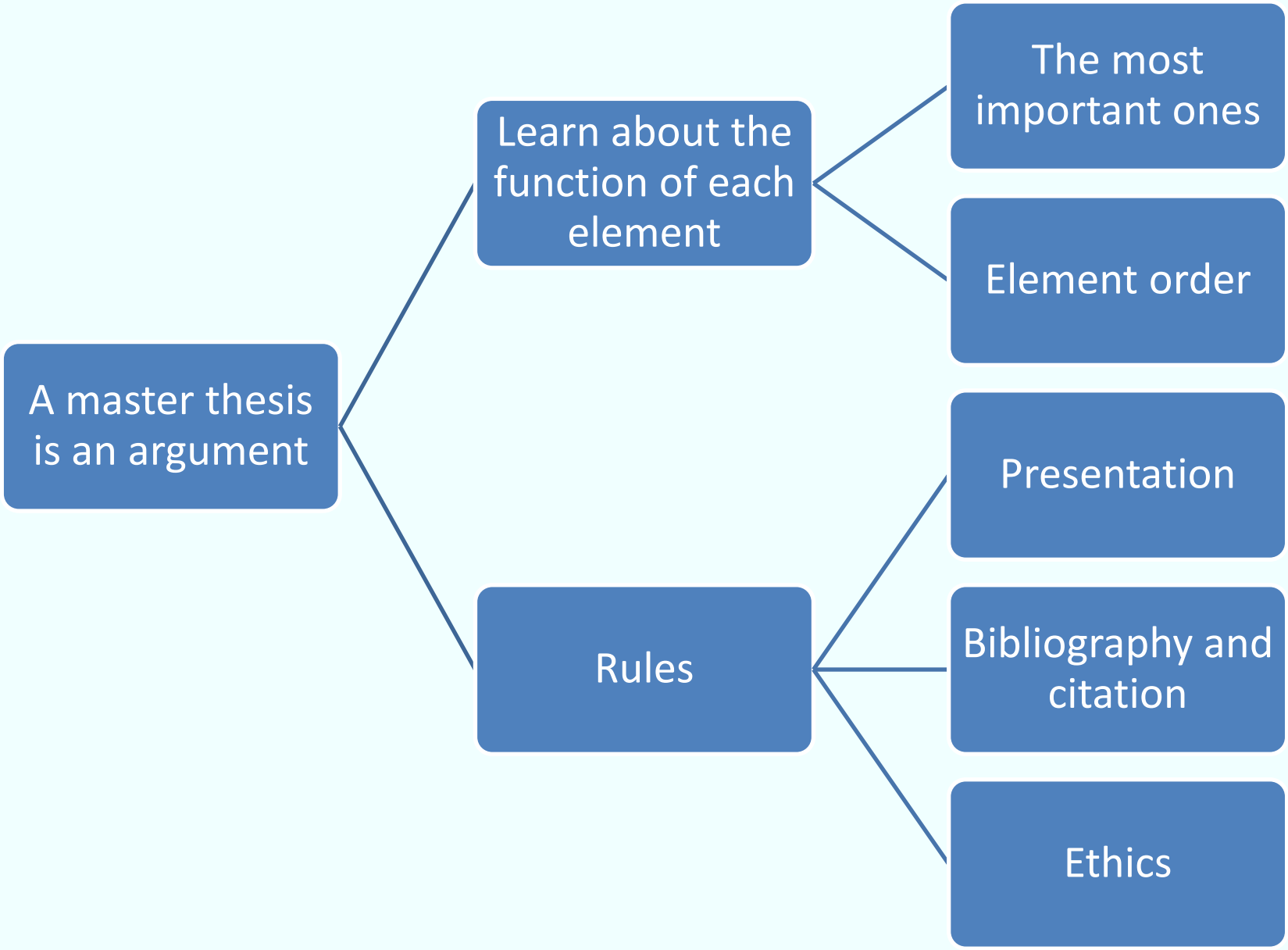
1. Relevance
   - How relevant is on-line learning to students' professional practices?
2. Reflection
   - Does on-line learning stimulate students' critical reflective thinking?
3. Interactivity
   - To what extent do students engage on-line in rich educative dialogue?
4. Tutor Support
   - How well do tutors enable students to participate in on-line learning?
5. Peer Support
   - Is sensitive and encouraging support provided on-line by fellow students?
6. Interpretation
   - Do students and tutors make good sense of each other's on-line communications?

Remarks:

- This grid clearly identifies 6 dimensions of socio-constructivism (there are many other grids)
- We will see in the data gathering and analysis modules how to make it operational

Chapter 8: The master thesis

Learning goals



1. Introduction: A thesis is an “argument”

The Link between writing and research activity

☞ **Research design *not* = research phases *not* = written thesis.**

- A **research plan** (i.e. the research design) defines and organizes your work according to logical criteria.
- The research **planning** organizes your time according to work packages and deliverables.
- Research is just done and not told, i.e. you do not tell people your personal experience with this.
  - The thesis is ***not*** the tale of this research experience.
- The **thesis** or research article therefore presents the results of your research
  - (including a literature review and a methodological explanation on how you did it).

Structure of your thesis is defined by three elements

1. research type, i.e. the focus of thesis.
2. methodological criteria,
3. rhetoric

2. The organization of a thesis

Elements	Importance	Main functions
Foreword	*	Personal Context
Table of contents	* *	Navigation
Abstract	*	Main objective, result and scope
Introduction	* * *	Objectives, global approach
Principal part	* *	(depends on your research type)
Conclusion	* * *	Summary of results, further work and scope
List of sources	*	Data anchoring
Indexes	*	Navigation
Bibliography	* *	Theoretical anchoring
Annexes	*	Presentation of detailed data, materials, etc.

3. Elements of the dissertation

3.1. Foreword

The foreword (also called preface) is **not** part of your thesis. You may use it to:

- thank people (e.g. your parents, your partner, your advisor),
- explain why you have chosen this subject,
- (maybe) excuse yourself for things to didn't do,
- announce some follow-up.

3.2. Table of contents of tables and figures

Tables of contents and figures are mandatory

- Position: At start and after the foreword
- Items in the table of contents match chapter and section titles in the text
- You also should add tables for the figures and the tables.

This will allow people finding synthetic information.

3.3. The Abstract

- An abstract is often mandatory and should summarize all aspects of your work, in particular the big research question, the approach and the results.
- If it is not, you also may summarize your thesis as a paragraph in the introduction

3.4. **The Introduction**

Elements	Details
The big question	.... Summarizes your subject, i.e. what you wanted to find out.
	.... implicitly or explicitly defines a scope
The "language"	.... which major *concepts* you use, word definitions you use, etc.
The general approach	.... research type, global approach, principal *methods* used
	.... the *structure* of your thesis

Usually includes

1. A description of your *research subject* (including the big question).
2. A *short discussion* of the *interest* of your work and its *scope*
3. A synthetic list of research questions and/or working hypothesis
4. A list of some important definitions,
   - You also can do this in the literature review.
5. A presentation/discussion of the global approach,
   - unless you dedicate a special section to this. In the latter case, you should just briefly describe the approach in a single short paragraph.
6. A short guide for the reader.
7. An introduction of the object(s) you study.

3.5. **Main chapters**

No universal solution

- Each research approach has its own rules !!
- Tip: Read real articles or examples of other dissertations !

General rules

- present and discuss **existing work**
- **present** data and results
- **discuss** results
- **link** results with the questions and hypothesis
- **confront** results with **existing** knowledge

The literature review chapters

- Only present theories, frameworks etc. that you will use
- Other chapters (methodology, analysis and results) must link to theory !

3.6. **The Conclusion**

1. Recall the *principal results* of your research
2. Discuss the scope of your results and provide an outlook

- You may discuss the *external validity* (i.e. attempt some generalization)
- Discuss questions for which you don't have answers or things you didn't implement (and why)
- You could *formulate a new theory* that could be refined/tested in further work
- You can formulate new interesting research questions. Often the value of a master thesis is to generate new research ideas that your adviser could pick up or that you could turn into a Ph.D. thesis :)
- You could globally compare your work to other empirical studies (if not already done so)
- You may discuss the practical usefulness of your work (in particular if your thesis does not have a practical aim)
- If you produced an applied and/or design-oriented thesis, you should recall major recommendations (e.g. present a set of design rules for practitioners)

3.7. List of sources

If necessary, this chapter will include a list of all your primary sources, e.g.

- laws and other legal or paralegal documents, or
- historical sources.
- You also may include these in the bibliography.

3.8. Indexes

- Not mandatory, but really helpful for finding concepts and authors

3.9. Annexes

Typically, the annex(es) may include:

- All research artifacts (such experimental materials, survey questions, etc.),
- some raw data (e.g. stories told by individuals), most often just excerpts,
- Intermediate analysis data like descriptive statistics, qualitative summary tables, etc.).

Allows a critical reader to find how you conducted your data analysis.

3.10. The bibliography and citations

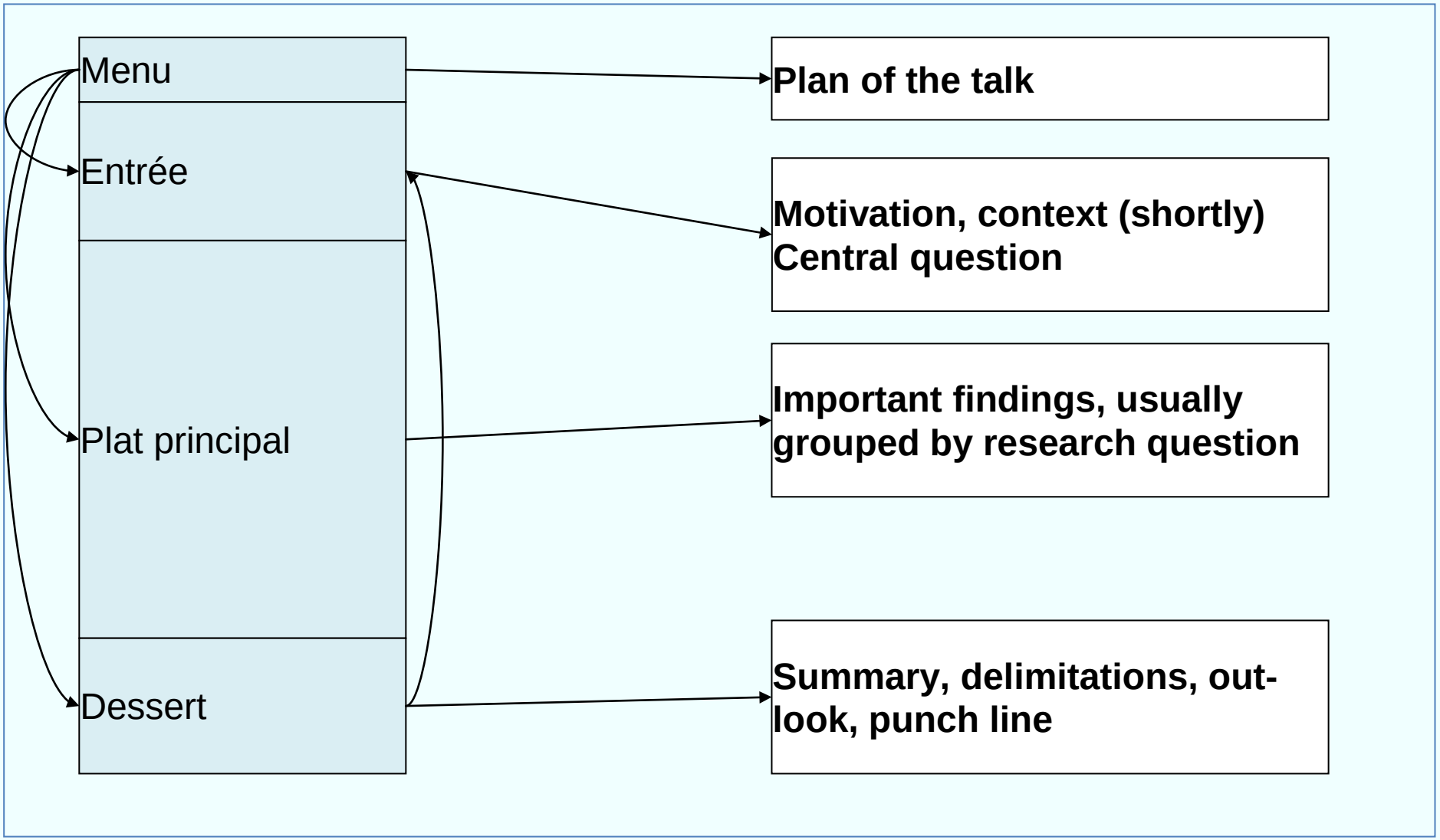
- You must respect a certain standard (and be coherent)
  - It is likely that your institution will provide guidelines !
- Start doing the bibliography right from the start.

3.11. Ethical issues

- When you work with a population (e.g. children in a school or students): Participants must consent
  - There exist considerable policy differences between countries.
- In qualitative studies, you should anonymize names.
  - E.g. instead of quoting student “Monica”, you should use “Student A”.
- In the annex, you should not include data tables that include names

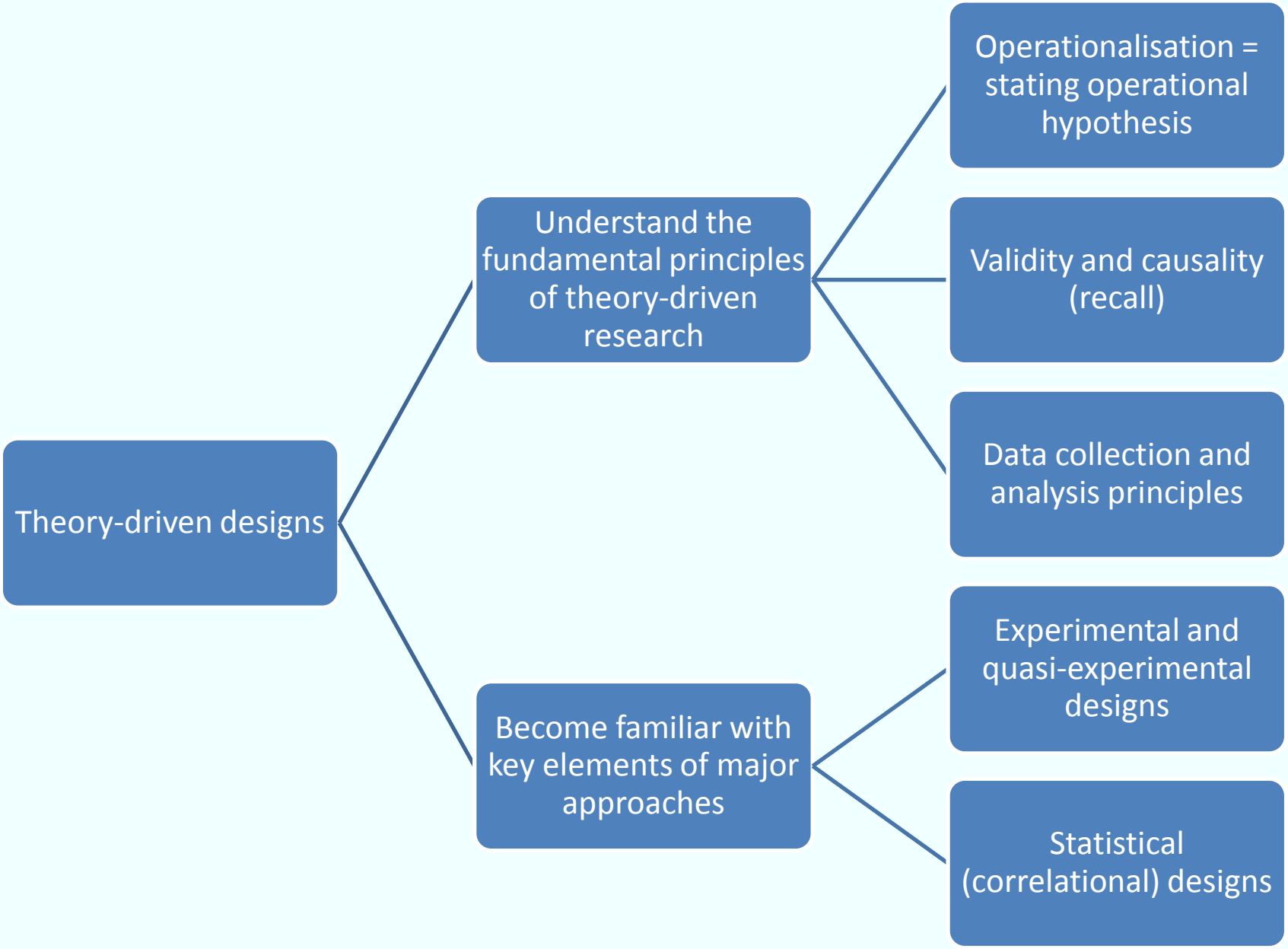
4. The presentation

1. Make sure to present the essential things only
2. Plan a test run with some friends. Ask them to tell you what was not clear.
3. Prepare the delivery. Repeat three times and vocalize!

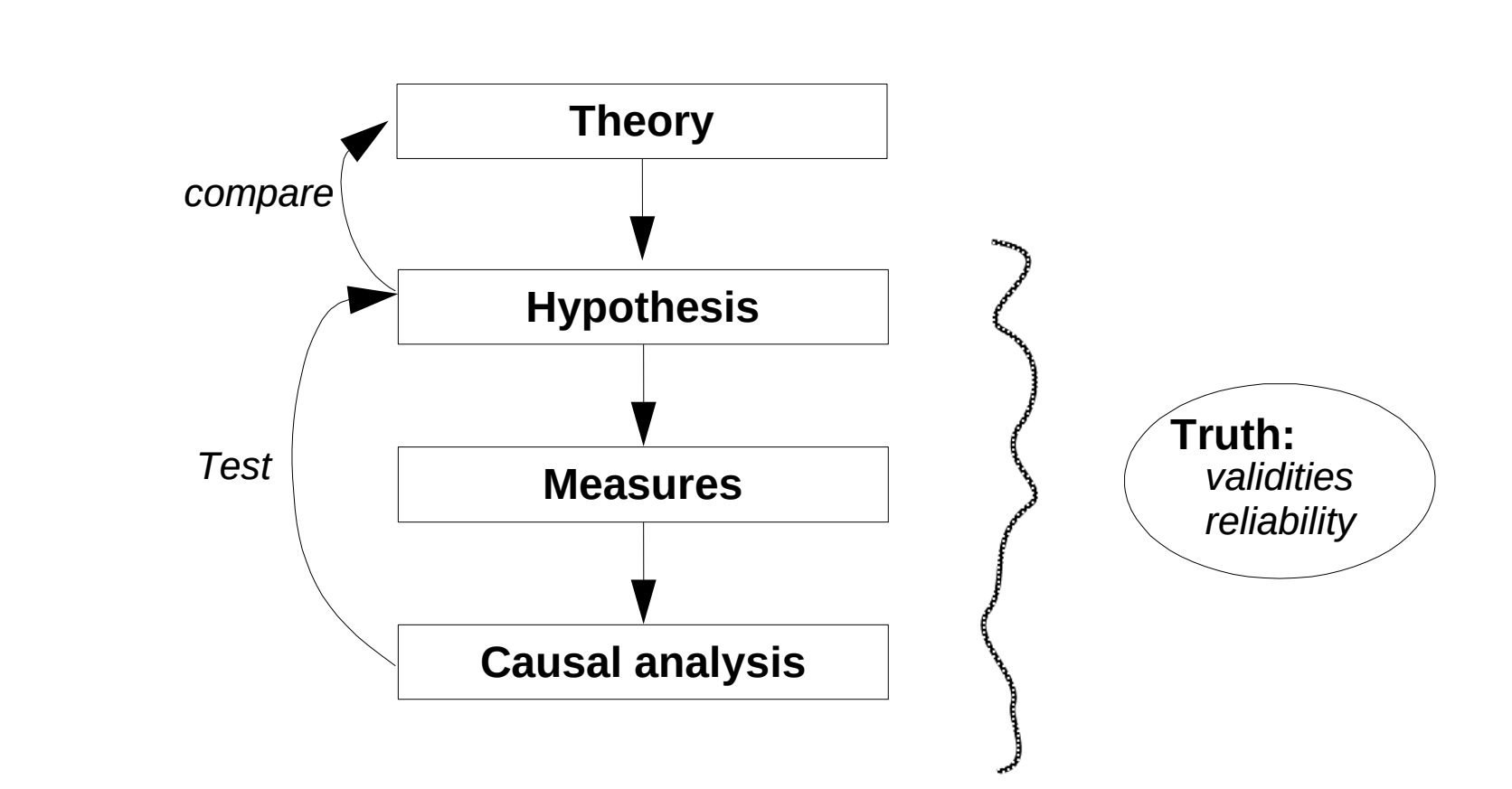


Chapter 9: Theory driven research designs

Learning goals



1. Important elements of an empirical theory-driven design:



- ***Conceptualizations***: Each research question is formulated as one or more hypothesis. Hypotheses are grounded in theory.
- ***Measures***: are usually quantitative (e.g. experimental data, survey data, organizational or public "statistics", etc.) and make use of artifacts like surveys or experimental materials
- ***Analyses & conclusion***: Hypothesis are tested with statistical methods

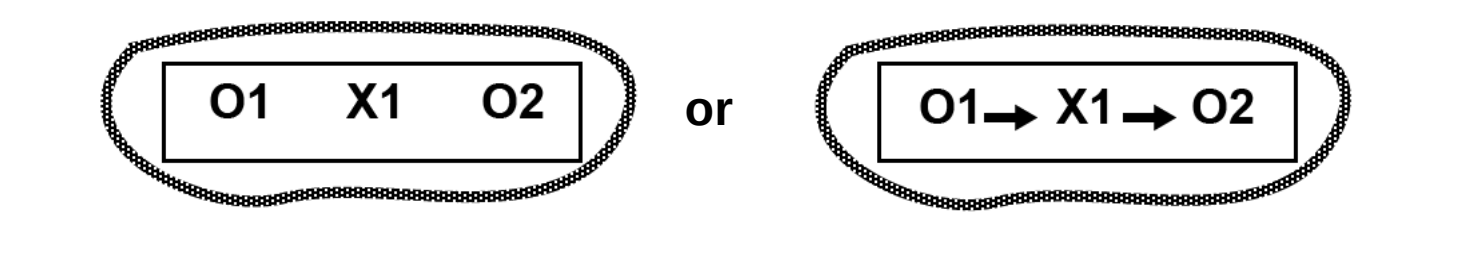
2. Experimental designs

2.1. The scientific ideal

☞ **Control physical interactions between variables**

Experimentation principle in science:

1. The study object is completely isolated from any environmental influence and observed (O1)
2. A stimulus is applied to the object (X)
3. The object's reactions are observed (O2).



- O1 = observation of the non-manipulated object's state"
- X = treatment (stimulus, intervention)
- O2 = observation of the manipulated object's state".

☞ **Effect of the treatment (X): the difference between O1 and O2**

The simple experiment in human sciences

☞ **It is not possible to totally isolate a subject from its environment**

Example 1. **Simple experimentation using a control group**

R	**X**	**O**	**experimental group**
R		**O**	**control group**

X=stimulus,
(independent explanatory variable)
O=mesure
(dependant variable, to explain)

Principle:

1. Two groups of subjects are chosen randomly (R) within a mother population:
   - this ought to eliminate systematic influence of unknown variables on one group
2. Ideally, subjects should not be aware of the research goals
3. The independent variable (X) is manipulated by the researcher (experimental condition)

Analysis of results: effects are compared:

	effect (O)	**non-effect (O)**	
treatment: (group X)	bigger	smaller	100 %
non-treatment: (group non-X)	smaller	bigger	100 %

- What is the probability that treatment X lead to effect O ?
- Answer: Compare values of X and non-X for each effect,
  - e.g. effect is bigger for group X than non-treated group X.

Example 2. **Simple experiment with different treatments:**

R	**X1**	**O1**	**experimental group 1**
R	**X2**	**O2**	**experimental group 2**
R	**X3**	**O3**	**experimental group 3**
R	**X..**	**O..**	

- a slightly different alternative
- Example: First students are assigned randomly to different lab sessions using a different pedagogy (X) and we would like to know if there are different effects at the end (O).

Problems with simple experimentation:

- Selection: Subjects may not be the same in the different groups
  - Since samples are typically very small (15-20 / group) this may have an effect
- Reactivity of subjects: Individuals ask themselves questions about the experiment (compensatory effects) or may otherwise change between observations
- Difficulty to control certain variables in a “real” context
  - Example: A new ICT-supported pedagogy may work better, because it stimulates the teacher, students may increase their attention and work input, groups may be smaller and individuals get more attention.
  - In principle one could test these variables with experimental conditions, but for each new variable, one has to add at least 2 more experimental groups, ...

Example 3. **The simple experiment with pretests:**

R	**O1**	**X**	**O2**	**experimental group**
R	**O3**		**O4**	**control group**

- To control the potential difference between groups: compare O2-O1 (difference) with O4-O3
- Disadvantage: effects of the first measure on the experiment
  Example: (a) If X is supposed to increase pedagogical effect, the O1 and O3 tests could have an effect (students learn by doing the test), so you can’t measure the "pure" effect of X.

Example 4. **The Solomon design**

R	**O1**	**X**	**O2**
R	**O3**		**O4**
R		**X**	**O5**
R			**O6**

- combines the simple experiment design with the pretest design:
- and we can test for example: O2>O1, O2>O4, O5>O6, O5>O3

Note: comparing 2 different situations is NOT an experiment ! The treatment variable X must be simple and uni-dimensional (else you don't know the precise cause of an effect)

- There a more complicated designs to measure interaction effects of 2 or more treatments

Example 5. **A simple two-factor design**

Let us imagine a most simple two-factor design:

“What is the impact of a training length (1 hour vs. 4 hours) and the setting (presential vs. distance) on learner achievement?”

Factor A is the level of training and factor B is the setting (presential vs. distance”).

		Factor A	
		1 hour condition	**4 hours condition**
Factor B	**Presence condition**	Group 1	Group 3
	Distance condition	Group 2	Group 4

R	O X11 O	Group 1 is in condition A=1 and B=1
R	O X12 O	experimental group 2
R	O X21 O	experimental group3
R	O X22 O	experimental group3

3. The non-experiment: what you should not do

Example 6. **The experiment without control group nor pretest:**

X O	**experimental group**

Example: A bad discourse on ICT competence of pupils

"Since we introduced ICT in the curriculum, most of the school's pupils are good at finding things on the Internet"

There is a lack of real comparison !!

- We don't compare: what happens in other schools that offer no ICT training ? (Maybe this is a general trend since more households have computers and Internet access.)
- We don't even know what happened before !

"Most of the students are good" **means that you do not compare to what happens in other settings that do not include ICT in their curriculum**...

The variable to be explained (O)	x= ICT in school	x= no ICT in school	
bad at web search	10 students	???	Horizontal comparison of % can't be done
good at web search	20 students	???	

Example 7. **Experiments without randomization nor pretest**

X	O	**experimental group**
	O	**control group**

There is no control over the conditions and the evolution of the control group

- Example: Computer animations used in school A are the reason of better grade averages (than in school B)
- School A simply may attract pupils from different socio-economic conditions and that usually show better results.

Example 8. **The experiment without control group**

O	X	O	**experimental group**

We don’t know if X is the real cause

- Example: “Since I bought my daughter a lot of video games, she is much better at word processing ”
- You don’t know if this evolution is "natural" (kids always get better at word processing after using it a few times) or if she learnt it somewhere else.

4. Quasi-experimental designs

- are inspired by experimental design (pre- and post tests, and control groups)
- are led in non-experimental situations (e.g. real contexts)
- are used when the treatment is too "heavy", i.e. does not just involve a well defined variable
- address all sorts of threats to internal validity (see next slides)

In quasi-experimental situations, you really lack control

- you don't know all possible stimuli (causes not due to experimental conditions)
- you can't randomize (distribute evenly other intervening unknown stimuli over the groups)
- you may lack enough subjects

Usage examples in social sciences:

- evaluation research
- organizational innovation studies
- questionnaire design (think about control variables to test alternative hypothesis)

4.1. Interrupted time series design

O1	**O2**	**O3**	**O4**	**X**	**O5**	**O6**	**O7**	**O8**

☞ **Advantages:**

- you may control (natural) trends

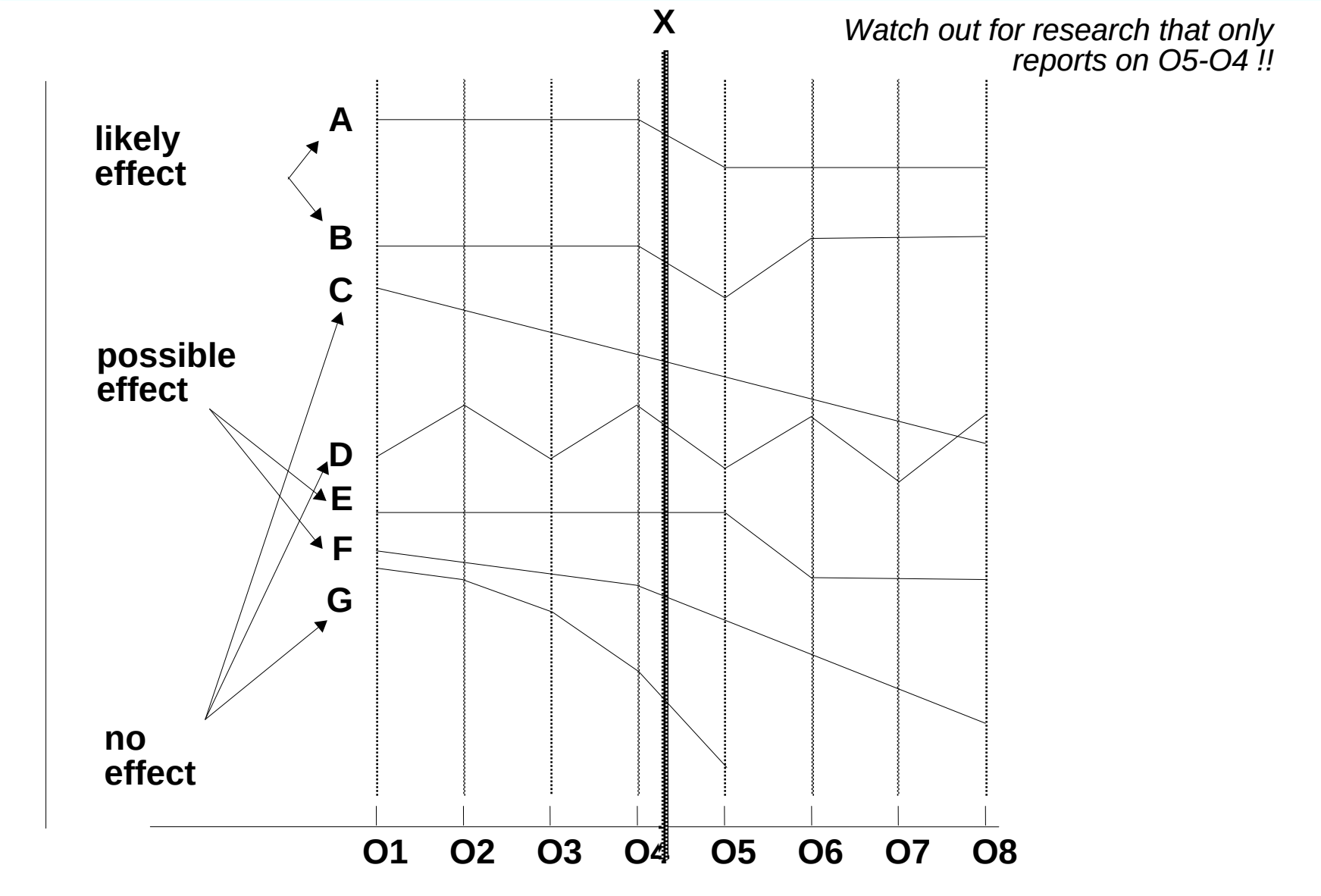
☜ **Problems:**

- Control of external simultaneous events (X2 happens at the same time as X1)
- Example: ICT-based pedagogies are introduced together with other pedagogical innovations. So which one does have an effect on overall performance ?

☞ **Practical difficulties**

- Sometimes it is not possible to obtain data for past years
- Sometimes you don't have the time wait long enough (your research ends too early)
  - Example: ICT-based pedagogies often claim to improve meta-cognitive skills. Do you have tests for year-1, year-2, year-3 ? Can you wait for year+3 ?

Example 9. **Various time series (see next slide also)**



- O1, O2, etc. are observation data (e.g. yearly), X is the treatment (intervention)

A. a statistical effect is likely

- Example "Student's drop-out rates are lower since we added forums to the e-learning content server "
- but attention: you don't know if there was an ***other intervention*** at the same time.

B. Likely "Straw fire" effect:

- Teaching has improved after we introduced X. But then, things ***went back to normal***
- So there is an effect, but after a while the cause "wears out"
  - e.g. the typical motivation boost from ICT introduction in the curriculum may not last

C. Natural trend (unlikely effect),

- You can control this error by looking beyond O4 and O5 !

D. "Confusion between cycle effects and intervention"

- Example: government introduced measures to fight unemployment, but you don't know if they only "surf" on a natural business cycle. Control this by looking at the whole time series.

E. Delay effect:

- Example: high investments in education (take decades to take effect)

F. Trend acceleration effect,

- difficult to discriminate with G

G. Natural exponential evolution: same as (C).

4.2. Threats to internal validity

☞ **What other variables could influence our experiments ? (Campbell and Stanley, 1963)**

Type	Definition:
history	An other event than X happens between measures example: ICT introduction happened at the same time as introduction of project-based teaching.
maturation	The object changed “naturally” between measures example: Did this course change your awareness of methodology or was it simply the fact that you started working on your master thesis.
testing	The measure had an effect on the object example: Your pre-intervention interviews had an effect on people (e.g. teachers changed behavior before you invited them to training sessions)
instrumenta-tion	Method use to measure has changed example: Reading skills are defined differently. E.g. newer tests favor text under-standing.
statistical regression	Differences would have evened out naturally example: School introduces new disciplinary measures after kids beat up a teacher. Maybe next year such events wouldn’t have happened without any intervention.
(auto) selection	Subjects auto-select for treatment example: You introduce ICT-based new pedagogies and results are really good (Maybe only good teachers did participate in these experiments).

mortality	Subjects are not the same- example: A school introduces special measures to motivate "difficult kids". After 2-3 years drop-out rates improve. Maybe the school is situated in a area that show rapid socio-demographic change (different people).
interaction with selection	Combinatory effects example: the control group shows a different maturation
directional ambiguity	example: Do workers show better output in "flat-hierarchy" / participatory / ICT-supported organization or do such organizations attract more active and efficient people ?
Diffusion or treatment im-itation	example: An academic unit promotes modern blended learning and attracts good students from a wide geographic area. A control unit also may profit from this effect.
Compensatory egalization	example: Subjects who don’t receive treatment, react negatively.

4.3. Non-equivalent control group design

O_1	X	O_2	**experimental group**
O_3		O_4	**control group**

Advantages: Good at detecting other causes

- If O2-O1 is similar to O4-O3, we can reject the hypothesis that O2-O1 is due to X.

Inconvenients and possible problems:

- Bad control of natural tendencies
- Finding equivalent groups and control interaction effects between groups may not be easy.

Example 10. **Experimentation and imitation effects**

- Let us image that management of a school wants to know if introducing "Technology-enhanced training" (TEET) has an effect on student satisfaction, respect of deadlines for assignments and cost.
- Two parallel courses taught by the same teacher participate in this experiment. One uses TEET, the other does not.

Results

	Course A introduces TEET	**Course B doesn't**
Effect 1:costs	augment	stable
E 2: student satisfaction	augments	augments
E 3: deadlines respected	better	stable

Questions:

- E2: Why does student satisfaction improve at the same time for B ?

4.4. Validity in quasi-experimental design

Types of validity according to Stanley et al.

Internal validity* concerns *your research design

- You have to show that postulated causes are "real" (as discussed before), that alternative explanations are wrong.
- This is the most important validity type

***External validity* .... can you make generalizations ?**

- not easy ! because you may not be aware of "helpful" variables, e.g. the "good teacher" you worked with or the fact that things were much easier in your private school ....
- How can you provide evidence that your successful ICT experiment will be successful in other similar situations, or situations not that similar ?

***Statistical validity* .... are your statistical relations significant ?**

- not too difficult for simple analysis
- just make sure that you use the right statistics and believe them
  - (see module on data analysis)

***Construction validity ...* are your operationalizations sound ?**

- Did you get your dimensions right ?
- Do your indicators really measure what you want to know ?

4.5. Use comparative time series if you can

O	O	O	O	X	O	O	O	O
O	O	O	O		O	O	O	O

1. Compare between groups (situations)
3. Make series of pre- and post observations (tests)

☞ **Difficulties:**

1. Find comparable groups
4. Find groups with more than just one or a few cases (!)
5. Find data (in time in particular)
6. Watch out for simultaneous interventions at point X.

5. Statistical designs

Statistical designs are related to experimental designs:

☞ **Statistical designs formulate laws**

- there is no interest in individual cases (unless something goes wrong)
- You can test quite a lot of laws (hypothesis) with statistical data (your computer will calculate)

☞ **Designs are based on prior theoretical reasoning, because:**

- measures are not all that reliable,
  - what people tell may not be what they do,
  - what you ask may not measure what you want to observe ...
- there is a statistical over-determination,
  - you can find correlations between a lot of things !
- you can not get an "inductive picture" by asking a few dozen closed questions.

☞ **Design à la Popper:**

1. You start by formulating hypothesis
   (models that contain measurable variables and relations)
2. You test relations with statistical tools

- Most popular variant in educational technology: Survey research

5.1. Introduction to survey research

A typical research plan looks like this:

1. Literature review leading to general research questions and/or analysis frameworks
2. You may use qualitative methodology to investigate new areas of study
3. Definition of hypothesis
4. Operationalization of hypothesis, e.g. definition of scales and related questionnaire items
5. Definition of the mother population
6. Sampling strategies
7. Identification of analysis methods

Implementation (mise en oeuvre)

1. Questionnaire building (preferably with input from published scales)
2. Test of the questionnaire with 2-3 subjects
3. Survey (interviews, on-line or written)
4. Coding and data verification + scale construction
5. Analysis

Writing it up

- Compare results to theory
- Marry good practise of results presentation and discussion, but also make it readable

5.2. Typology of internal validity errors

Error of type 1: you believe that a statistical relation is meaningful

... but "in reality" it doesn't exist

- In complicated words : You wrongly reject the null hypothesis (no link between variables)

Error of type 2: you believe that a relation does not exist

... but "in reality" it does

- E.g. you compute a correlation coefficient, results show that is very weak. Maybe because the relation was non-linear, or because an other variable causes an interaction effect ...
- In complicated words: Your wrongly accept the null hypothesis

The are useful statistical methods to diminish the risks

- See statistical data analysis techniques
- Think !

6. Similar comparative systems design

Principle

- **Make sure to have good variance within "*operative variables*" (dependant + independent)**

- **Make sure that no other variable shows variance (i.e. that there are no hidden control variables that may produce effects)**

$$\frac{\text{variance of operative variables}}{\text{variance of control variables}} = \text{maximum}$$

In more simple words: Select cases that are different in respect to the variables that are of interest to your research, but otherwise similar in all other respects.

E.g. don't select an prestige school that does ICT and a normal school that doesn't do ICT if you want to measure the effect of ICT. Either stick to prestige schools or "normal" schools, otherwise, you can't tell if it was ICT that made the difference ...

Advantages and inconvenient of this method

- less reliability and construction validity problems
- better control of "unknown" variables
- worse external validity (possibility to generalize)

7. Summary of theory-driven designs discussed

approach	some usages
Experimental designs	• Psycho-pedagogical investigations • User-interface design
Quasi-experimental designs	• Instructional designs (as a whole) • Social psychology • Public policy analysis • Educational reform • Organizational reform
Statistical designs	• Teaching practise • Usage patterns
Similar comparative systems design	• Public policy analysis • Comparative education

☞ Of course, you can combine these approaches within a research project. You even can use combinations to triangulate answers for a single research question.

Chapter 10: Theory-finding Research Designs

Learning goals

- Familiarize with names of different kinds of qualitative methodology
- Understand the typical research process (which is very different from a theory-testing approach)
- Be able to differentiate use of qualitative methods within a rather quantitative design and within a fully qualitative design

1. The concept of qualitative methodology

What is qualitative methodology ?

- 2 frequent stereotypes: synonym of “simple description” or “interview analysis”
- In reality there is a huge pool of design approaches and methods.

Qualitative approaches (there are more !)

Families of approaches	Names of particular approaches	Description
investigative journalism	case description	explanatory story
collaborative research	action research	practical experimentation with a social goal
	participatory observation	analytic immersion
	collaborative research	participatory design of something
Design sciences	See the chapter on design-oriented research designs	
language	text analysis	analysis of relations between elements (grammars)
	dialogue analysis	organization and structure of dialogue

observation in context	anthropology	structured and non-structured observation
	«field research»	(same, but less in depth, more formal)
interpretism	hermeneutics	human activity as "text"
	phenomenology	empathy of «Lebenswelt»
	symbolic interactionism	symbolic interactions between actors

2. The qualitative research process

Qualitative research works in cycles (see later)

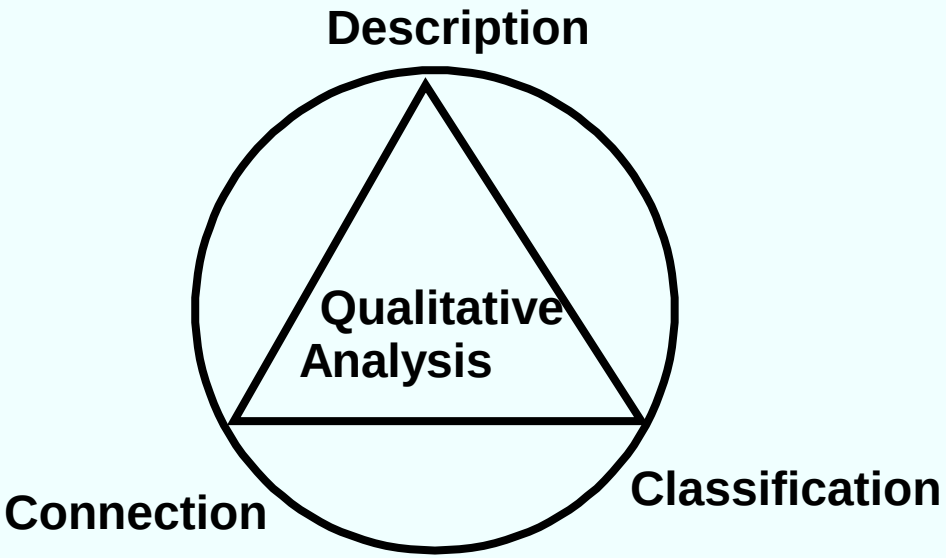
Most common features:

- Research must be ***anchored*** in “rich” descriptions
- Each theoretical ***proposition*** must be anchored in ***observations***
- The researcher play a ***delicate role***. He always is visible and even can play an active role.
- Most modern designs also insist on reliability and validity issues.

Regarding the role of theory: 2 very different doctrines:

Little theory (no theoretical grounding of research questions and analysis grids)		**A lot of theory (theoretical grounding of research questions and concepts)**	
👍	openness of mind	👍	linking to other research
		👎	closeness of mind
👍	allows to tackle new subjects	👍	integration of your results with other knowledge
👎	tendency to collect too much data	👎	tendency to ignore phenomena
👎	difficult comparison with other work	👍	easier generalization
👎	non-explicit preconceptions	👍	explicit preconceptions (therefore controllable

3. The description - classification - connection triangle

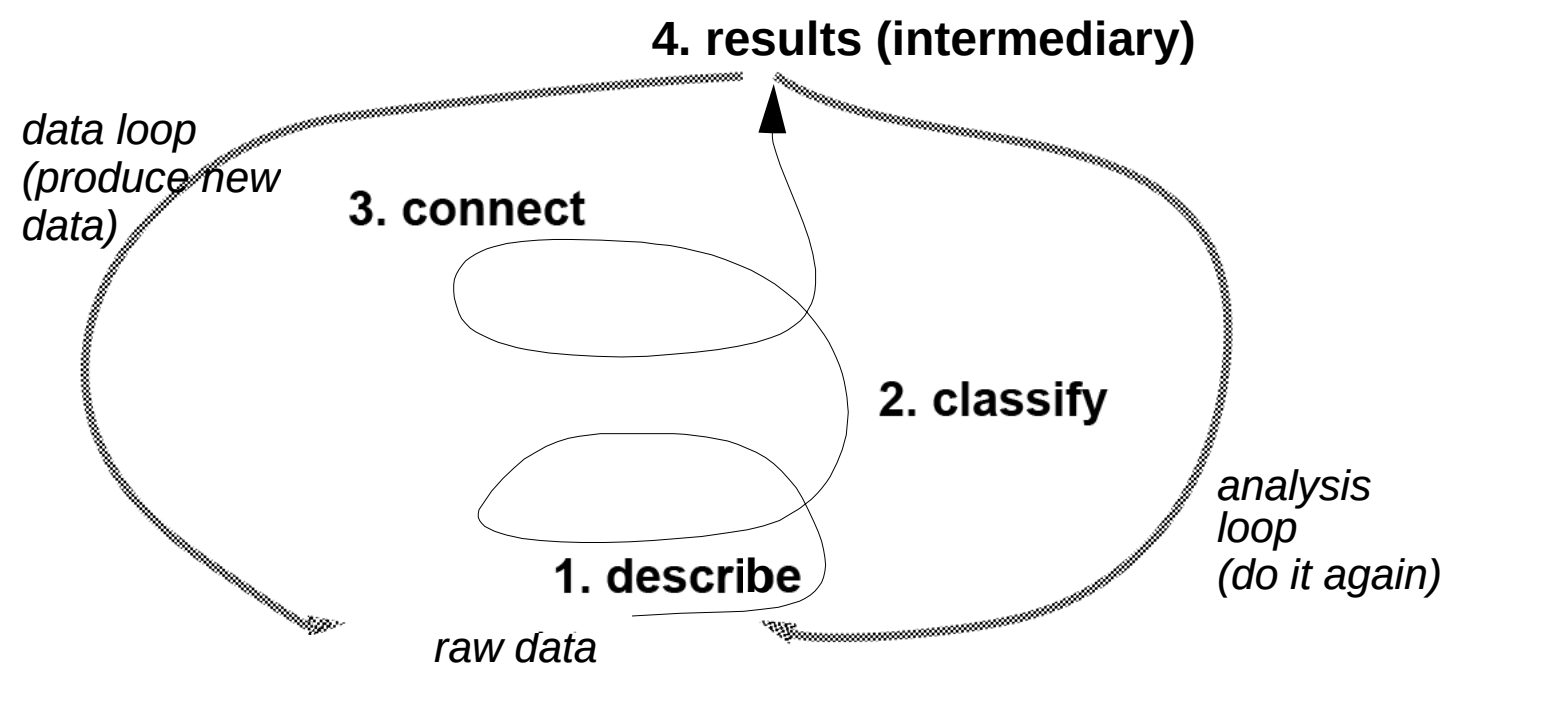


Dey (1993:31):

- **description: each qualitative analysis relies on "rich" data**
  - otherwise you can't interpret the full meaning of an observation !
- **classification: data structuring and reduction according to coding principles**
  - the mass of data can be staggering !
- **connection: Identification of relationships between concepts**
  - to make relations (and other structure) appear !

3.1. **A dynamic vision**

also Dey (1993:53)



This figure shows the circularity of a qualitative approach:

- classify and connect data
- The need to look at data again or to produce new data

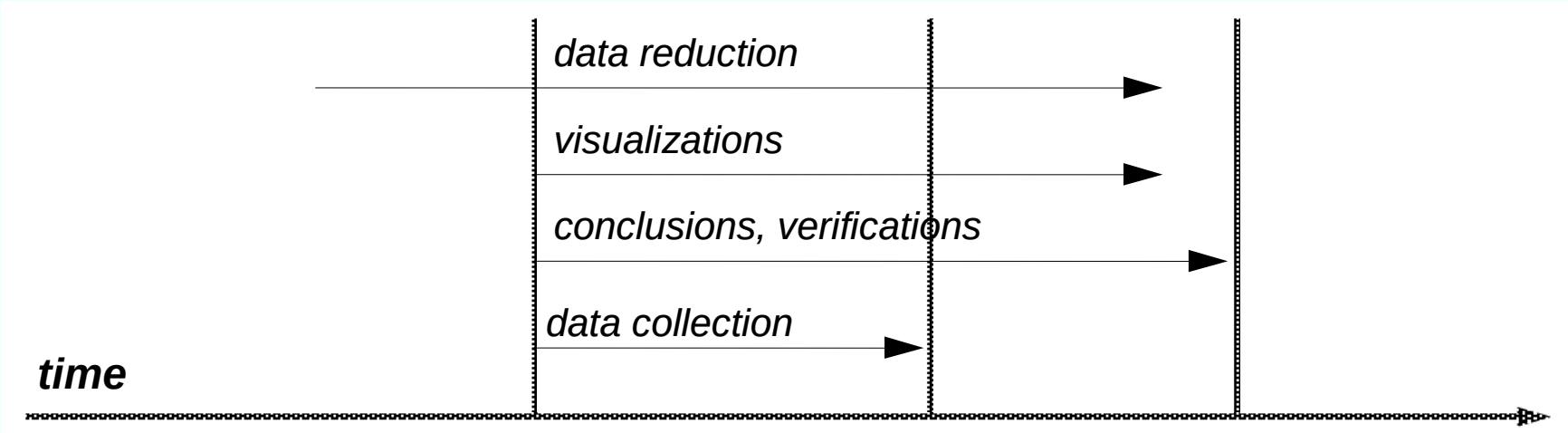
"Modern" qualitative researchers:

- ***produce a lot of drawings***
- use ***matrices***
- use (sometimes) ***quantitative data exploration techniques***

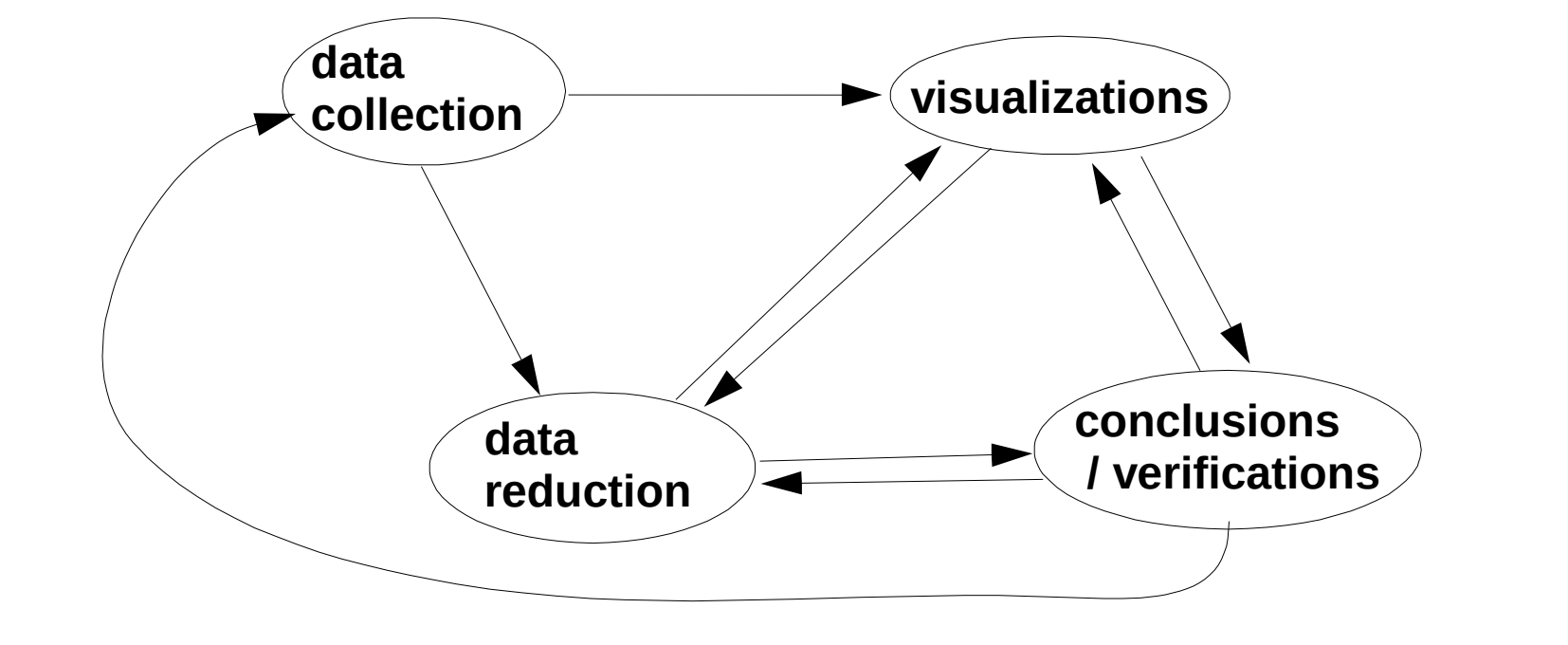
☞ **Difficulty = Do something with the huge mass of data**

3.2. The circularity principle again over time

Miles & Hubermann (1994:10)



dynamic version of the same schema



4. The role of data

- Qualitative data are most frequently generated by the researcher (same as in quantitative designs)
- However, qualitative approaches prefer "***natural***" data and refers to the concepts of ***meaning*** and ***process*** (the last issue is shared with systems analysis).

Elements that distinguish typical quantitative from qualitative research:

Types of approach	
Quantitative approaches search:	**Qualitative approaches search:**
social or individual structures: laws	social construction: rules and languages" as they are perceived and created by subjects
observable facts	units de meaning, interpretations by people e.g. subjective meaning and goal of an action
abstract behavior and attitudes or experi-mental situations	actions and thoughts in context
standardized macro-observations (applied to a population)	"thick" micro-observations (few "settings", small groups, etc.)

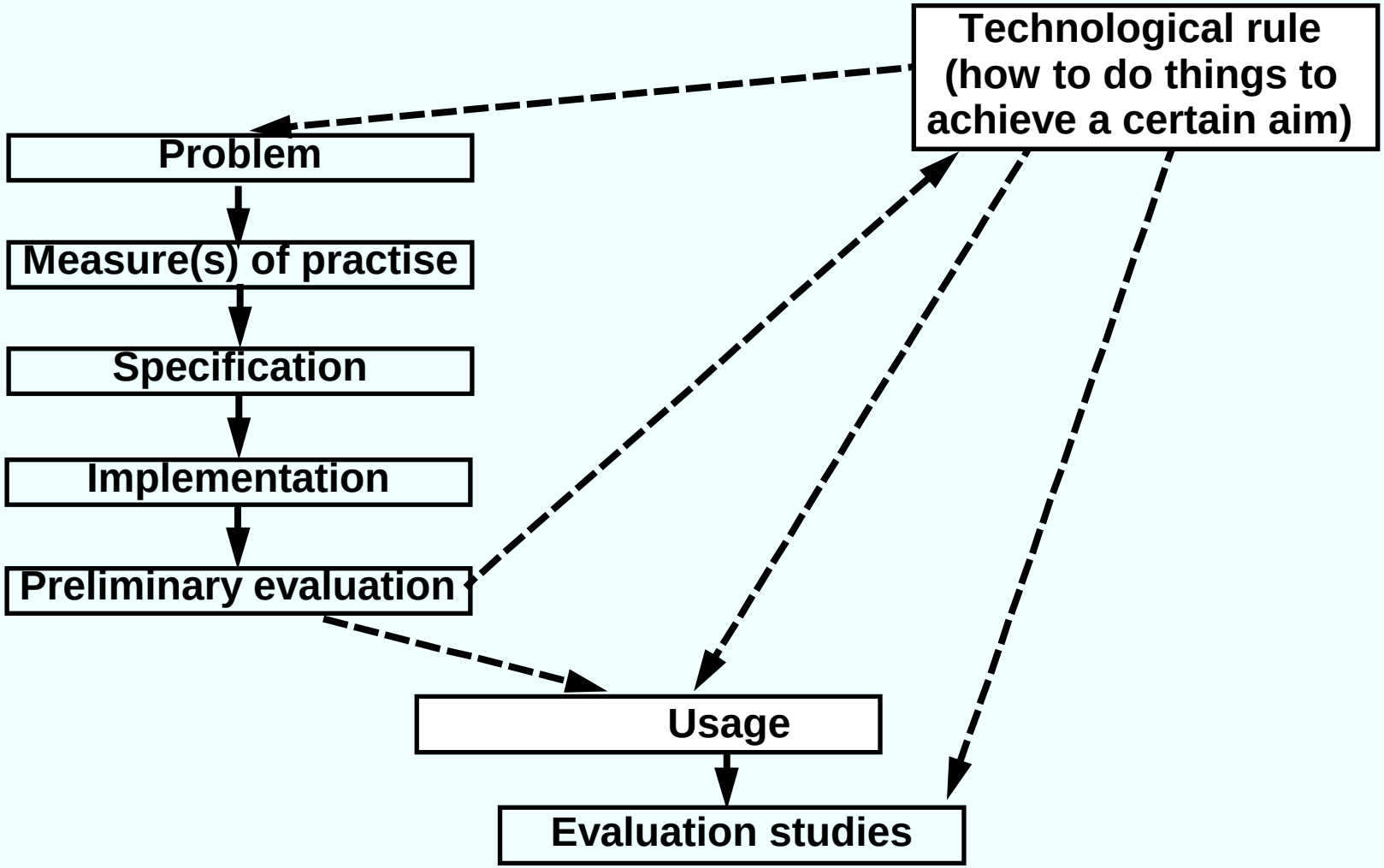
Chapter 11: Design-oriented Approaches

Learning goals

- Understand the aims of design research
- Understand the nature of the design process and the principle of traditional vs. agile participatory design
- Understand the aims of so-called design-based research in educational technology
- Be able to conduct a simple evaluation study

1. Key elements of a design-oriented approach:

1.1. The global picture



- investigate at least one of the dotted lines
- Technological rule as (theory on how to things) can be input, output, or both

1.2. **Ingredients of design research**

(Pertti Järvinen, 2004)

Technological rules

- tell you how to do things and are dependant on other theories (and beliefs)
- Bunge (quoted by Järvinen:99): "A technological rule: an instruction is defined as a chunk of general knowledge, linking an intervention or artifact with a desired outcome or performance in a certain field of application".

Types of outcomes (artifacts, interventions):

- Constructs (or concept) form the "***language***" of a domain
- Models are sets of propositions expressing ***relationships*** among constructs
- Methods are a ***set of steps*** to perform a task (guidelines, algorithms)
- Instantiations are ***realizations*** of an artifact in its environment

Types of research:

- Build: Demonstrate feasibility of an artifact or intervention
- Evaluate: Development of criteria, and assessment of both artifact building and artifact usage

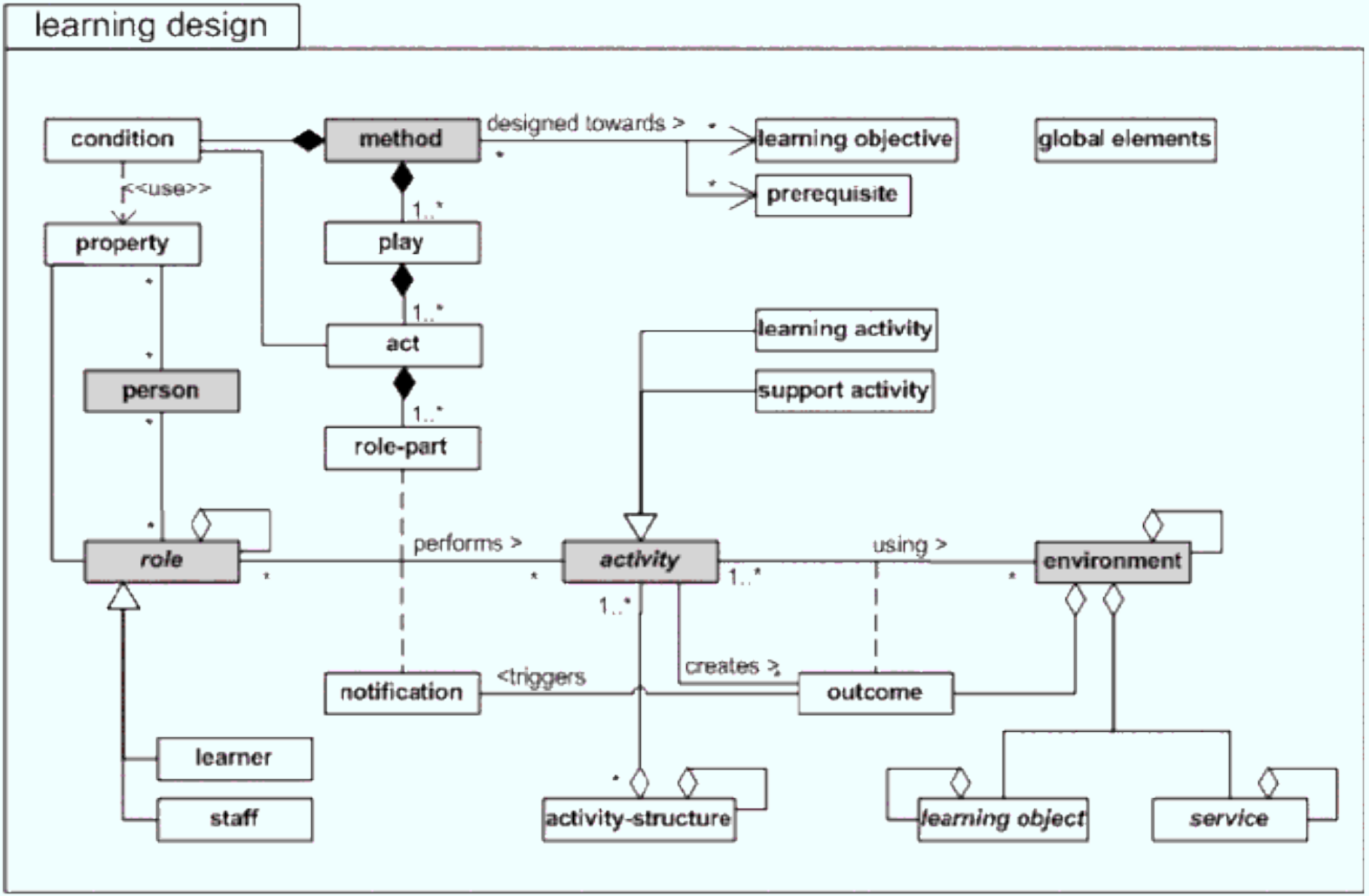
What does this mean ?

- There are 4*2 ways to lead interesting design research.
- Usually, it's the not the program you build that is interesting, but something behind (constructs, models, methods) or around (usage).

2. Instructional design models

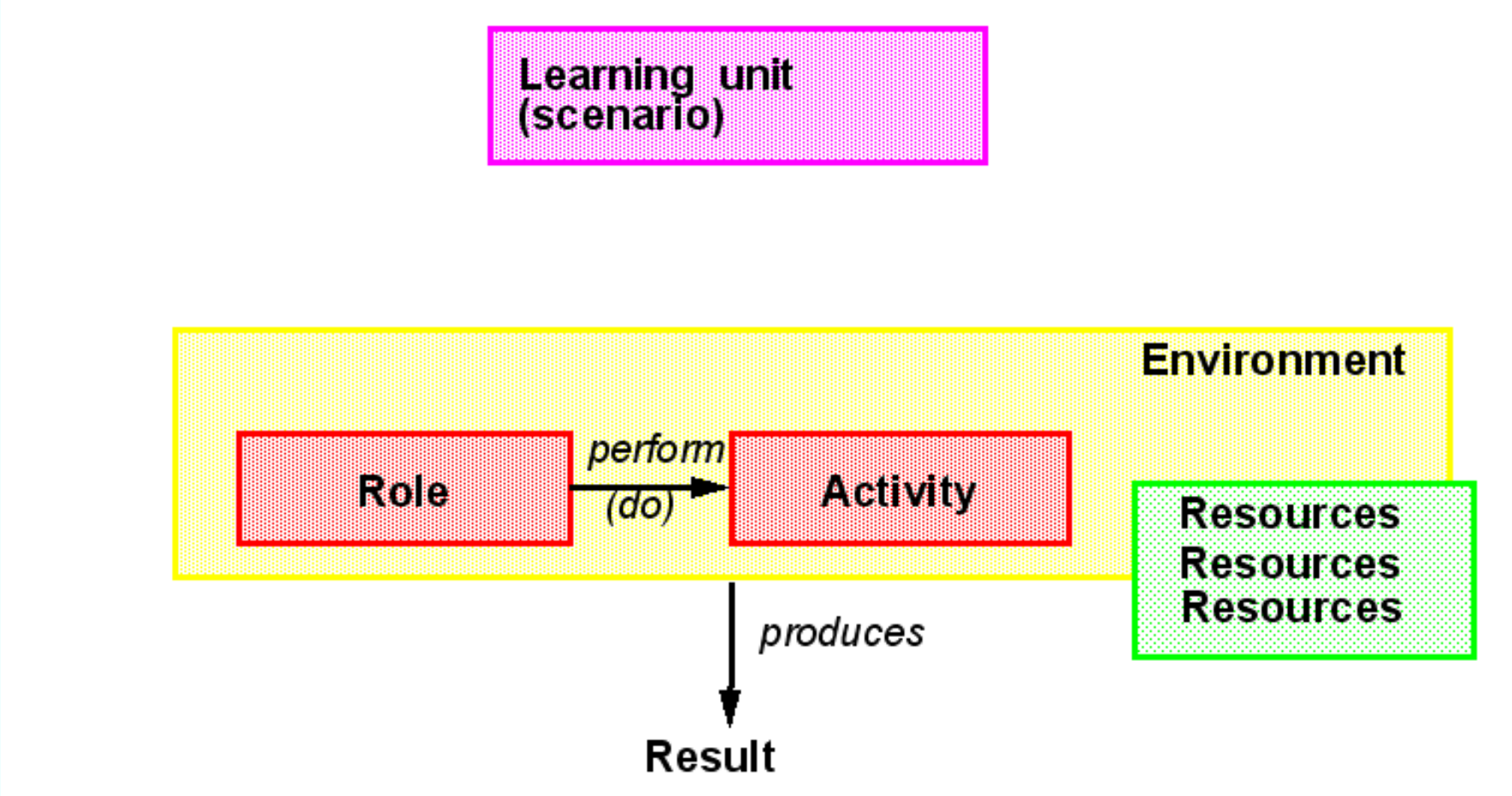
Example 1. **IMS learning design**

- Modeled with a UML class diagram



Most important elements of IMS LD

- ***Roles*** that are performed by learners, teachers, tutors, etc.
- ***activities***
- ***environments*** including ***services*** (e.g. a forum) and ***learning resources***
- The scenario is called ***method*** and contains in turn ***play***, ***act*** and ***role-parts***.



Example 2. **The MISA/MOT/ADISA technical rule**

E.g. MISA/MOT/ADISA: Course designer works on "4 models"

1. Knowledge and Skill Representation
   DC: Design of Content (know-that and know-how)
2. Application of Teaching Methods and Approaches
   DP: Design of Pedagogical specifications
3. Specification of Learning Materials
   DM: Design of Materials
4. Delivery Planning
   DD: Design of Delivery
4.

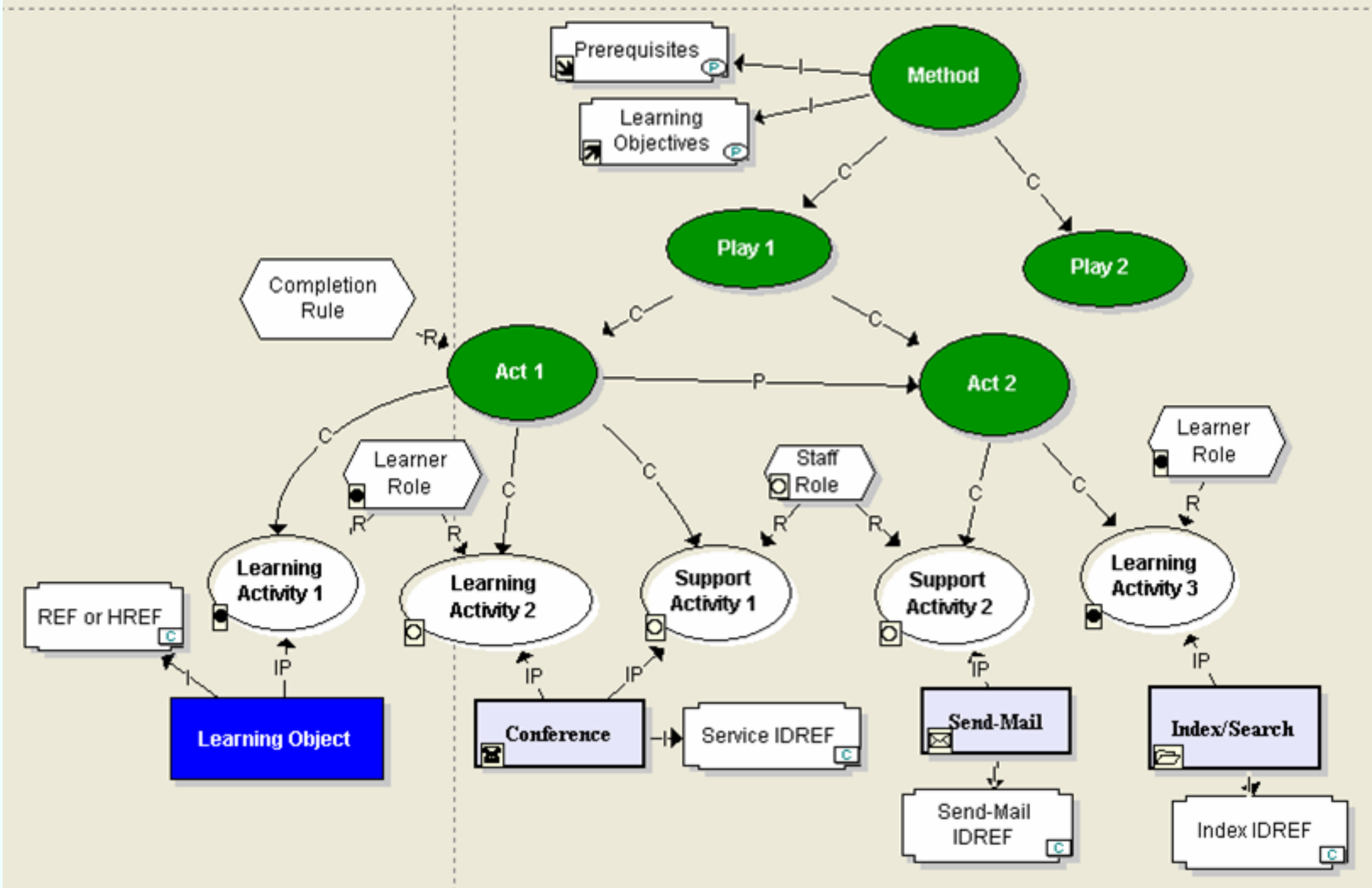
- MISA supports 35 main tasks or processes and around 150 subtasks

Using such a method (see next slide) is worth the effort:

- if you plan do it right (e.g. you learn how to use the MOT editor)
- if you focus on a whole course instead of difficult problems
- if you plan to train yourself in instructional design

url: http://www.cogigraph.com

Screenshot of the MOT editor



Example 3. **Gagné's 9 steps of instruction for learning**

a) Gain attention e.g. present a good problem, a new situation, use a multimedia advertisement.

b) Describe the goal: e.g. state what students will be able to accomplish and how they will be able to use the knowledge, give a demonstration if appropriate.

c) Stimulate recall of prior knowledge e.g. remind the student of prior knowledge relevant to the current lesson (facts, rules, procedures or skills). Show how knowledge is connected, provide the student with a framework that helps learning and remembering. Tests can be included.

d) Present the material to be learned e.g. text, graphics, simulations, figures, pictures, sound, etc. Chunk information (avoid memory overload, recall information).

e) Provide guidance for learning e.g. presentation of content is different from instructions on how to learn. Use of different channel (e.g. side-boxes)

f) Elicit performance "practice", let the learner do something with the newly acquired behavior, practice skills or apply knowledge. At least use MCQ's.

g) Provide informative feedback, show correctness of the trainee's response, analyze learner's behavior, maybe present a good (step-by-step) solution of the problem

h) Assess performance test, if the lesson has been learned. Also give sometimes general progress information

i) Enhance retention and transfer: inform the learner about similar problem situations, provide additional practice. Put the learner in a transfer situation. Maybe let the learner review the lesson.

2.2. Design rules from computer science

In applied computer science, visual design languages are very popular, in particular UML – the Unified modeling language. UML includes a collection of models and graphs to describe the structural and behavioral semantics of any complex information system.

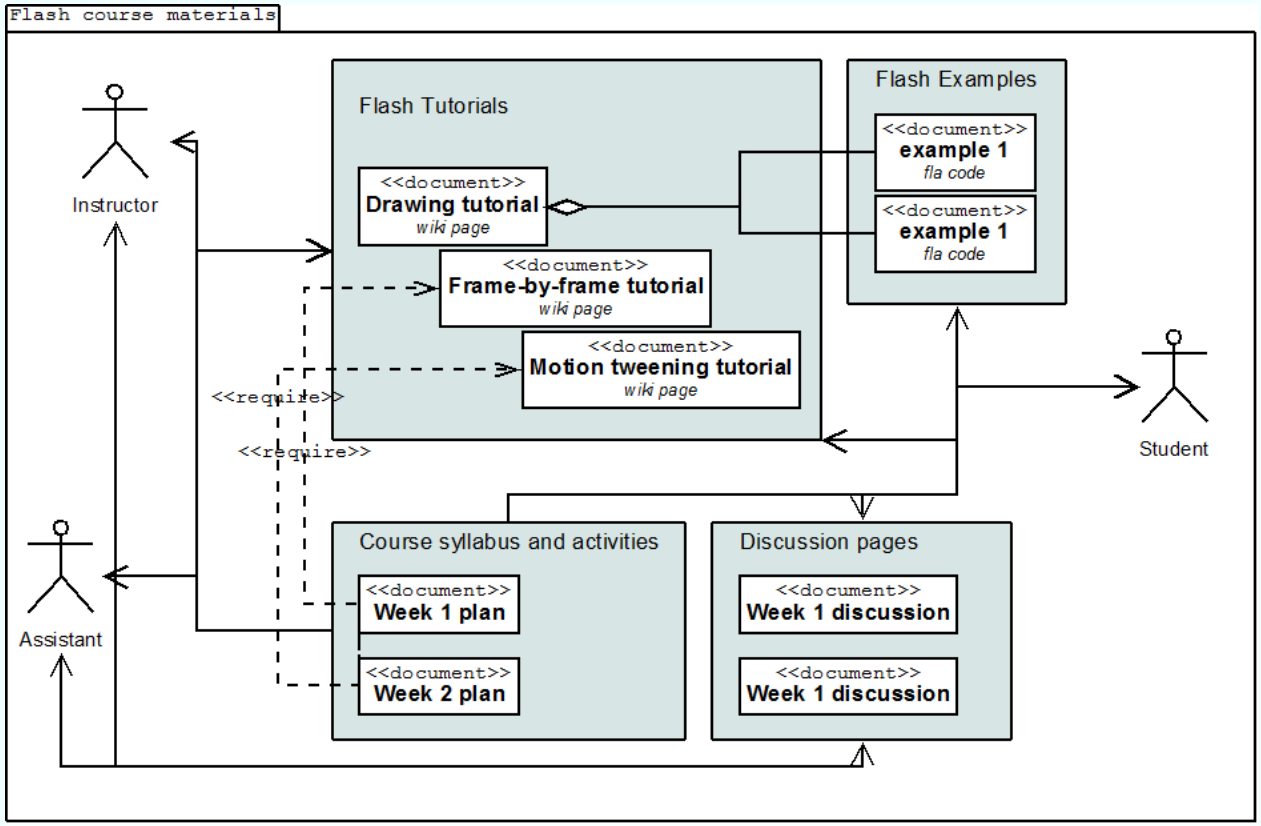
For example:

- UML use case models and scenarios to capture the user requirements and functionality of the system. Scenarios are instances of use cases.
- Class and object diagrams to specify the semantic information structure of a system (see the IMS LD example presented before)
- UML activity diagrams to specify workflows. UML State diagrams to describe the dynamic behavior of an object in a system.

In educational technology, UML is used for three purposes:

1. Description of pedagogical scenarios
2. Definition of pedagogical modeling languages
3. Specification of educational software

Example 4. **Modelling of documents and course activity in coUML**



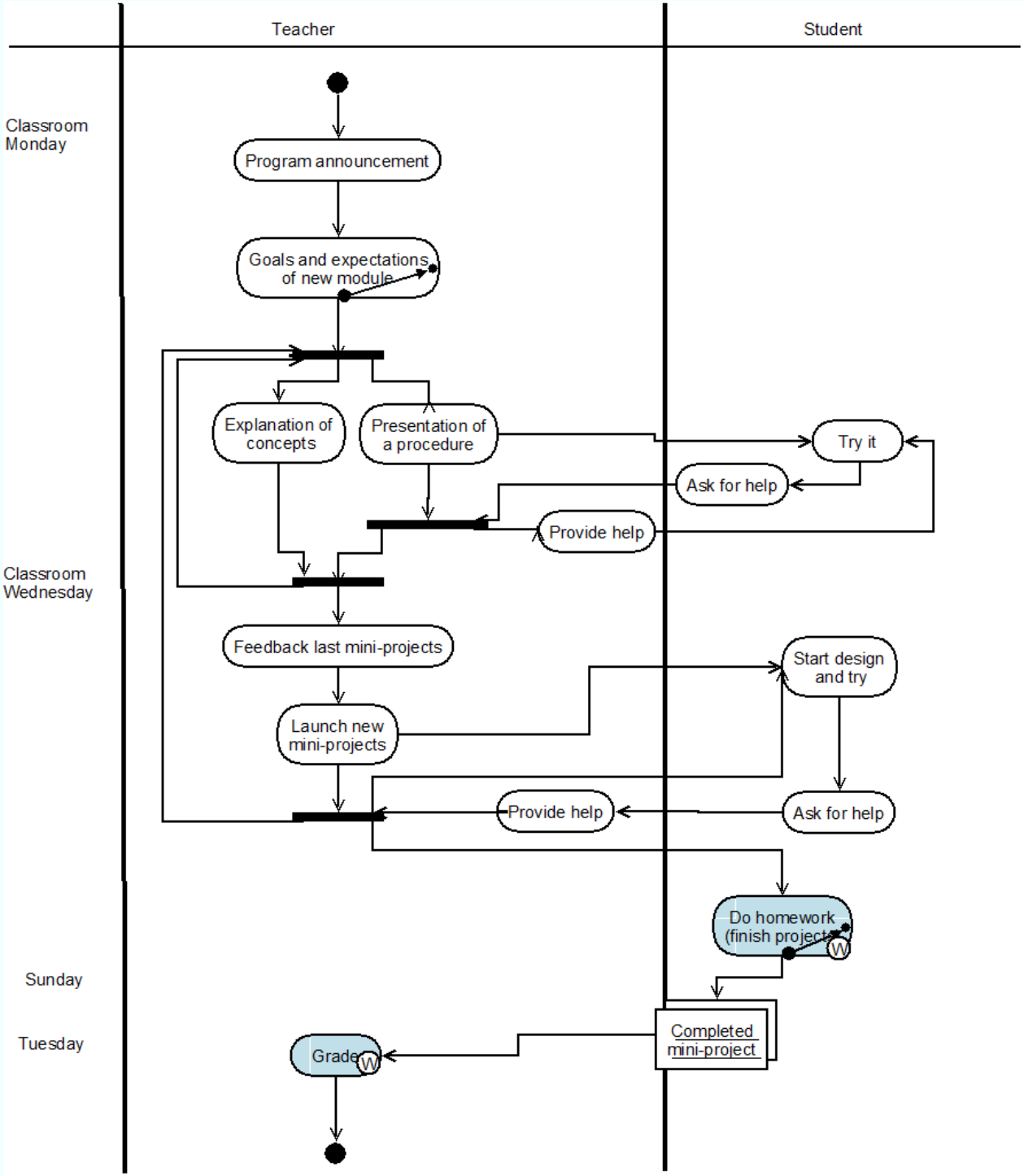
Shows a package for a Flash course. It includes four kinds of documents:

- Flash tutorials, *.fla code examples, Syllabus pages and Discussion pages. For each syllabus page there is a discussion page. This relationship is not shown here.

We also model three types of users:

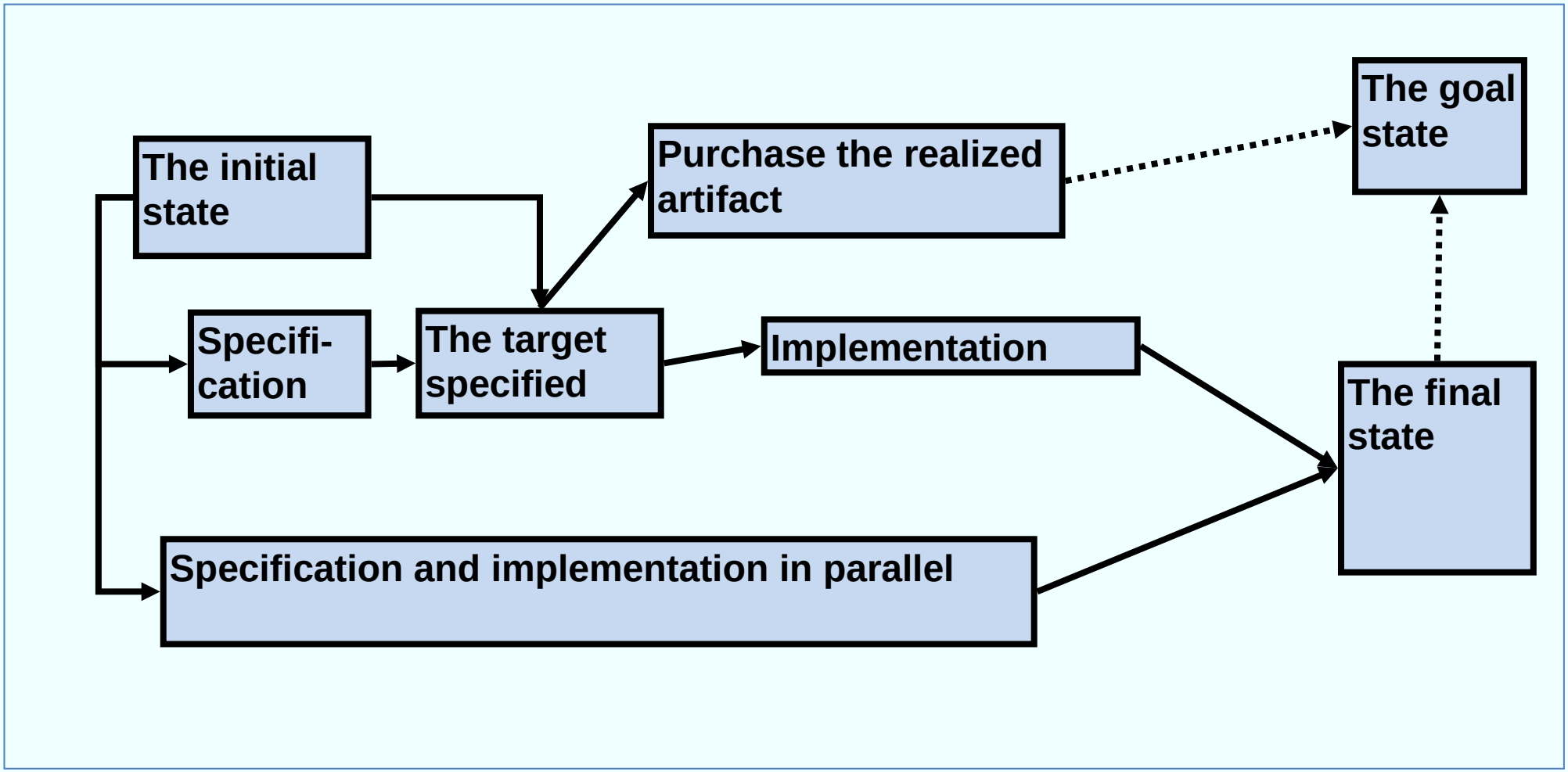
- The instructor writes flash tutorials and creates fla code examples.
- The teacher creates the course program, but the assistant only should read it.
- Students can read, but also modify flash tutorials, but not the examples

The next slide is a model of the typical pattern of a Flash course module


Teacher
Student
Classroom Monday
Program announcement
Goals and expectations of new module
Explanation of concepts
Presentation of a procedure
Try it
Ask for help
Provide help
Classroom Wednesday
Feedback last mini-projects
Start design and try
Launch new mini-projects
Provide help
Ask for help
Do homework (finish project)
W
Sunday
Tuesday
Completed mini-project
Grade
W

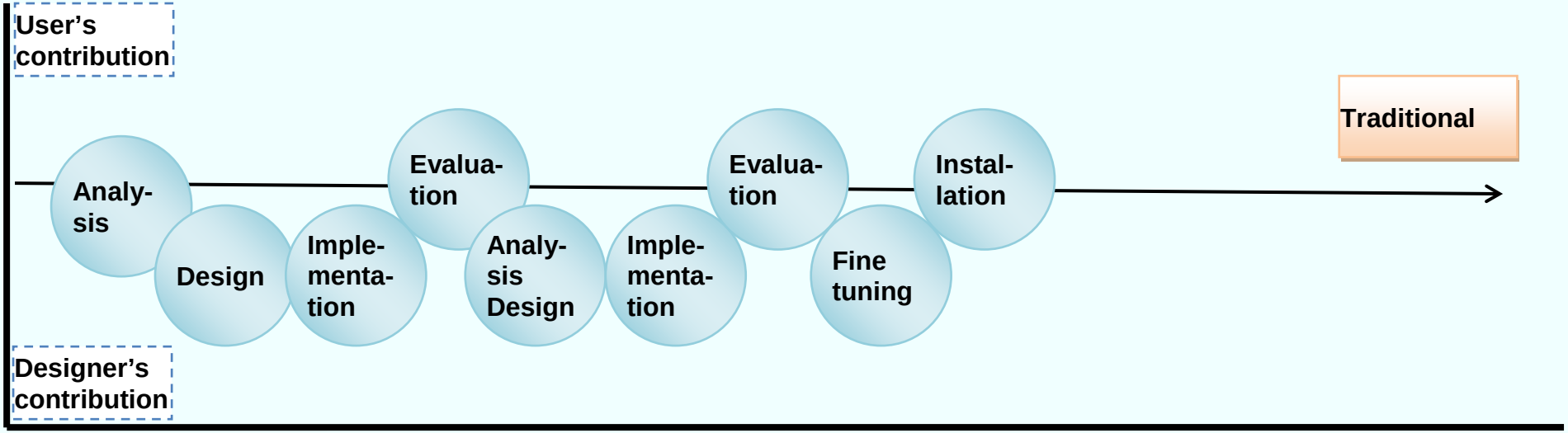
3. The design process

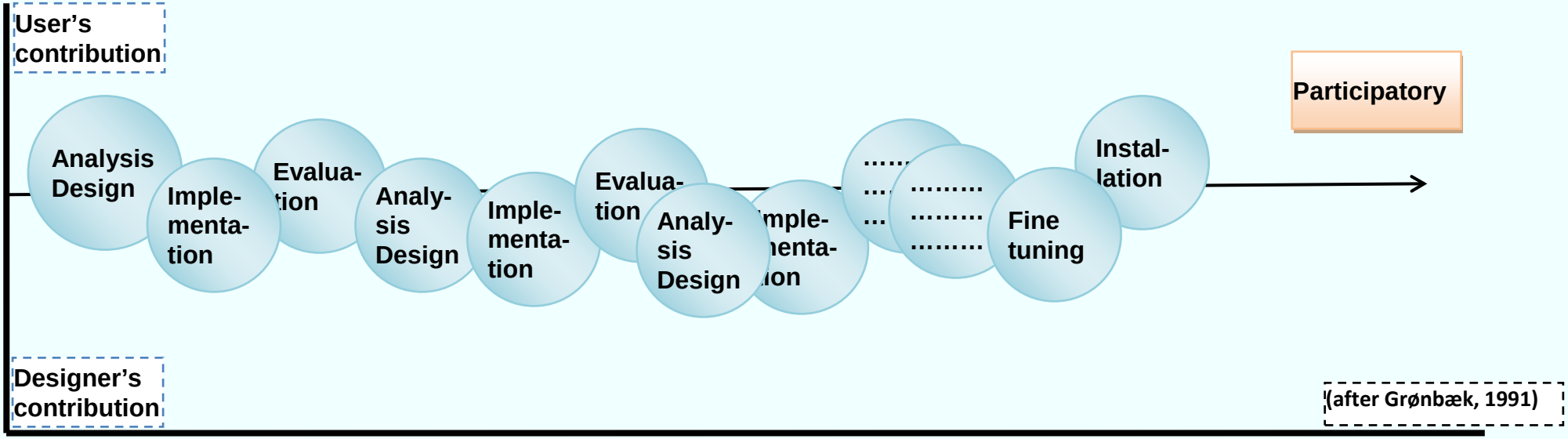
Alternatives: (Pertti Järvinen, 2004: 103)



- Either a top-down “waterfall” approach
- Or agile, participatory design

3.1. Traditional vs. participatory



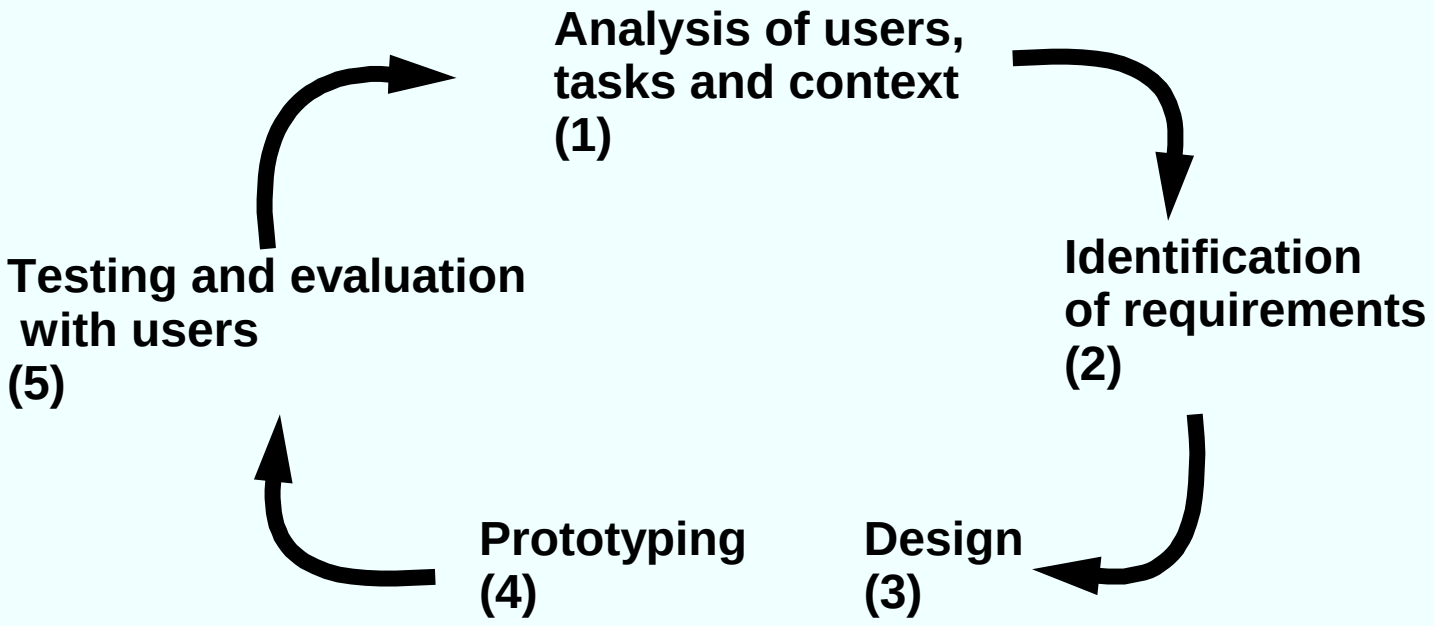


3.2. The participatory design model

Source: Maria Håkansson, slides 2003

User-centred design:

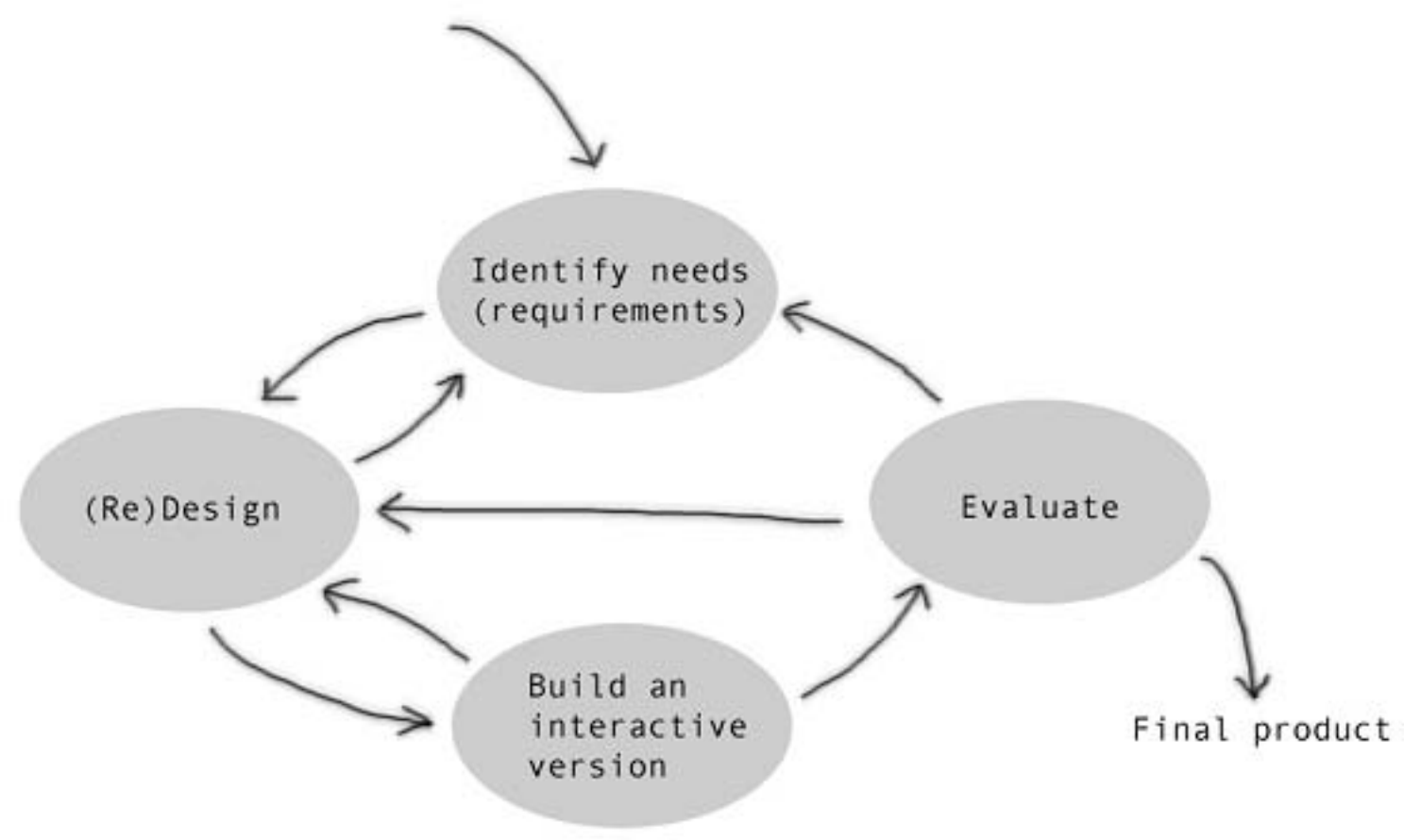
- involves users as much as possible so that they can influence it
- integrates knowledge and expertise from other disciplines than just IT
- is highly iterative so that testing can insure that design meets users' requirements



adapted from Håkansson

A similar model from Preece, Rogers and Sharp (2002)

figure also from Hakansson



3.3. **Typical user analysis techniques**

(Adapted from Håkansson, See the modules on qualitative data gathering and analysis)

- Questionnaires
  - if user number is high
  - if you know precisely what to ask (e.g. to identify user profiles, to test hypothesis gained from in-depth studies, etc.
- Semi-structured Interviews
  - to explore new issues
  - to let participants develop argumentation (subjective causalities)
- Focus groups
  - group interview", collecting multiple viewpoints
- Observations/Ethnography
  - To observe work as it happens in its natural setting (observe task related workflow, interactions)
  - to understanding context (other interactions, conditions)
- Scenarios (for task description)
  - An "informal narrative description", e.g. write ***real*** stories that describe in detail how someone will use your software (do not try to present specifications here !)
- Cultural probes
  - Alternative approach to understanding users and their needs, developed by Gaver (1999) ?

2.3 Definition of requirements

Different types

- Functional requirements
- Environmental requirements
- Physical, social, organizational, technical
- User requirements
- Usability requirements

2.4 Building prototypes

- Prototypes can be anything !!
- Quote: "From paper-based storyboards to complex pieces of software: 3D paper models, cardboard mock-ups, hyperlinked screen shots, video simulations of a task, metal or plastic versions of the final product" (Håkansson).
- Prototypes are of different nature according to the stage and the evolution of the design process:
  - Useful aid when discussing ideas (e.g. you only need a story-board here)
  - Useful for clarifying vague requirements (e.g. you only need some UI interface mockup)
  - Useful for testing with users (e.g. you only need partial functionality of the implementation)

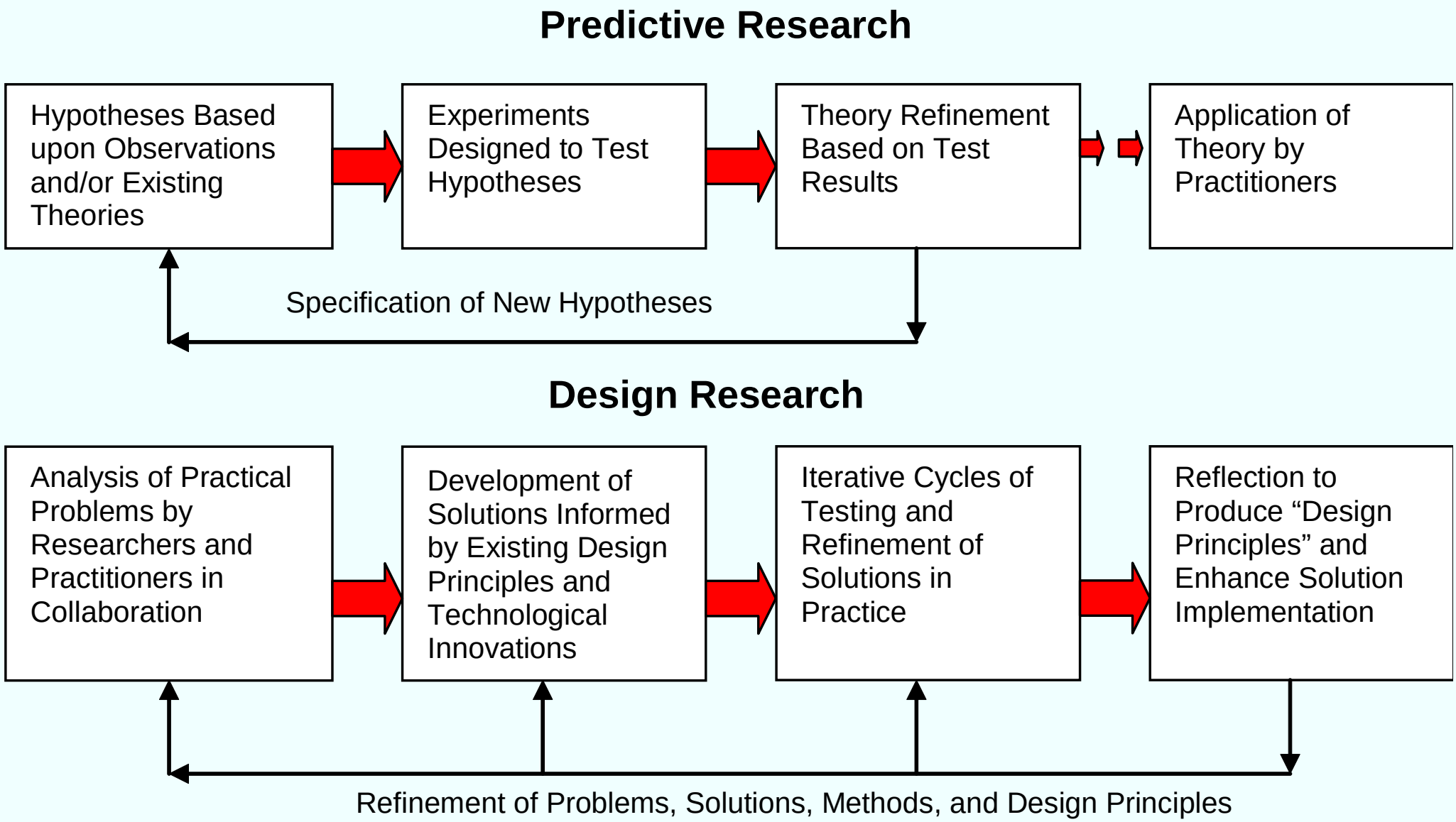
4. Design-based research

Design-based research, also known as "design experiment" is an approach that has been specifically developed by educational technologists.

Purpose according to Collins:

- The need to address theoretical questions about the nature of learning in context.
- The need for approaches to the study of learning phenomena in the real world rather than in the laboratory.
- The need to go beyond narrow measures of learning.
- The need to derive research findings from formative evaluation.

4.1. Reeves contrast between theory-testing and design-based research



4.2. Conjecture maps as tool to organize DBR

1. A conjecture map links theory to design elements to intermediary variables to desired outcomes. Each link is a kind of hypothesis for which various kinds of data could provide some support.
4. An embodied conjecture defines how theoretical propositions might be reified within designed environments to support learning.
   - Designed environments include tools, materials, and activity structures (defined as the combination of task structure, how a task is organized, and social participation structures).
5. Embodied conjectures should predict outcomes at two levels:
   - intermediate outcomes are observable patterns of behavior predicted by a model of how an embodied conjecture functions should support learning.
   - intervention outcomes, refer to the sort of outcome that psychologists look for, e.g. whether students learn what they are intended to learn.

Conjecture maps may include between 3 and 7 columns

Theoretical conjectures	Embodied conjectures	Intermediate outcomes	Objective outcomes
General theory, not embodied, not operational	Design elements: Rather features than just "names"	What's happening ? What students and teachers do	What students will learn

Example 5. **Conjecture map example – Original by Sandoval**

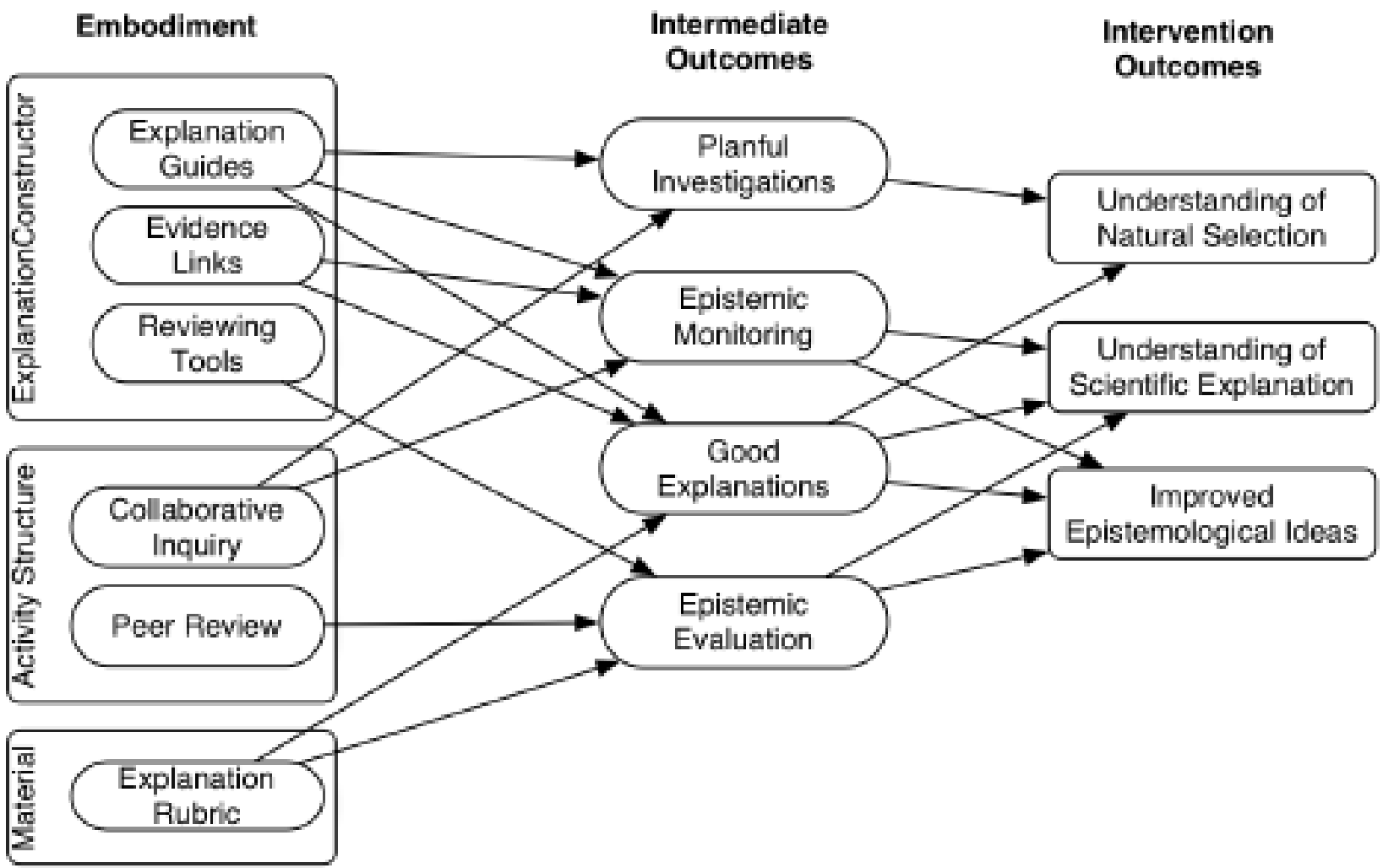
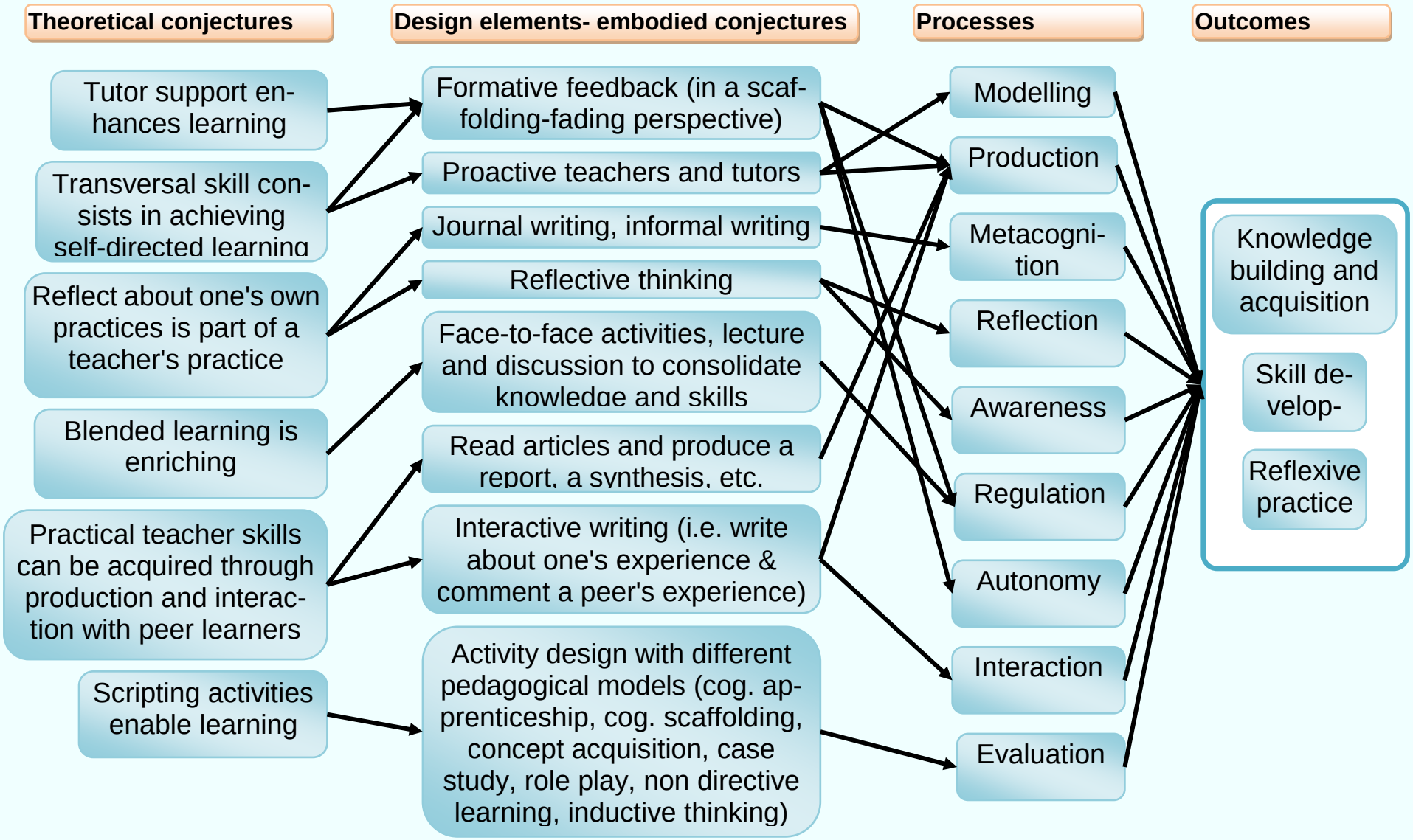


Figure 1: Map of embodied conjecture and predicted outcomes.

Sandoval, William A. (2004). Developing Learning Theory by Refining Conjectures Embodied in Educational Designs. PREPRINT (published later in Educational Psychologist, Vol. 39, No. 4)

Example 6. **Conjecture map by B.Class (interpreter training)**

Research question: To what extent did the Tutoring Support Structure framework help in designing an effective socio-constructivist learning design?



5. Evaluation

5.1. Evaluation of designs

There are many general models for evaluation, this is simple one suggested by Frechtling

1. Develop a conceptual model of the program and identify key evaluation points,
2. Develop evaluation questions and define measurable outcomes,
3. Develop an evaluation design,
4. Collect data,
5. Analyze data, and
6. Provide information to interested audiences.

5.2. **Evaluation criteria**

- Evaluation usually happens according to some "technological rule"

Example 7. **Example: Merril's criteria for 5 Star Instructional Design's**

Not applicable to transmissive ("spray-and-pray" / or exploratory designs ("sink-or swim").

1. Does the courseware relate to real world problems?
   a) show learners the task or the problem they will be able to do/solve ?
   b) are students engaged at problem or task level not just operation or action levels?
   c) involve a progression of problems rather than a single problem?
2. Does the courseware activate prior knowledge or experience?
   a) do learners have to recall, relate, describe, or apply knowledge from past experience (as a foundation for new knowledge) ?
   b) does the same apply to the present courseware ?
   c) is there an opportunity to demonstrate previously acquired knowledge or skill ?
3. Does the courseware demonstrate what is to be learned ?
   a) Are examples consistent with the content being taught? E.g. examples and non-examples for concepts, demonstrations for procedures, visualizations for processes, modeling for behavior?
   b) Are learner guidance techniques employed? (1) Learners are directed to relevant information?, (2) Multiple representations are used for the demonstrations?, (3) Multiple demonstrations are explicitly compared?
   c) Is media relevant to the content and used to enhance learning?
4. Can learners practice and apply acquired knowledge or skill?

a) Are the application (practice) and the post test consistent with the stated or implied objectives? (1) Information-about practice requires learners to recall or recognize information. (2) Parts-of practice requires the learners to locate, name, and/or describe each part. (3) Kinds-of practice requires learners to identify new examples of each kind. (4) How-to practice requires learners to do the procedure. (5) What-happens practice requires learners to predict a consequence of a process given conditions, or to find faulted conditions given an unexpected consequence.

b) Does the courseware require learners to use new knowledge or skill to solve a varied sequence of problems and do learners receive corrective feedback on their performance?

c) In most application or practice activities, are learners able to access context sensitive help or guidance when having difficulty with the instructional materials? Is this coaching gradually diminished as the instruction progresses?

5. Are learners encouraged to integrate (transfer) the new knowledge or skill into their everyday life?

a) Is there an opportunity to publicly demonstrate their new knowledge or skill?

b) Is there an opportunity to reflect-on, discuss, and defend new knowledge or skill?

c) Is there an opportunity to create, invent, or explore new and personal ways to use new knowledge or skill?

Example 8. **The Learning Object Review Instrument (LORI)**

1. Content Quality
   - Veracity, accuracy, balanced presentation of ideas, and appropriate level of detail
2. Learning Goal Alignment
   - Alignment among learning goals, activities, assessments, and learner characteristics
3. Feedback and Adaptation
   - Adaptive content or feedback driven by differential learner input or learner modeling
4. Motivation
   - Ability to motivate, and stimulate the interest or curiosity of, an identified population of learners
5. Presentation Design
   - Design of visual and auditory information for enhanced learning and efficient mental processing
6. Interaction Usability
   - Ease of navigation, predictability of the user interface, and the quality of UI help features
7. Accessibility
   - Support for learners with disabilities
8. Reusability
   - Ability to port between different courses or learning contexts without modification
9. Standards Compliance
   - Adherence to international standards and specification

5.3. **Evaluation methodology**

Design evaluation methodology draws all major social science approaches,

- Heuristics
- Experiments
- Questionnaires
- Interviews
- Observations
- Think-aloud
- ….

We shall introduce some of these in the chapter about qualitative data collection

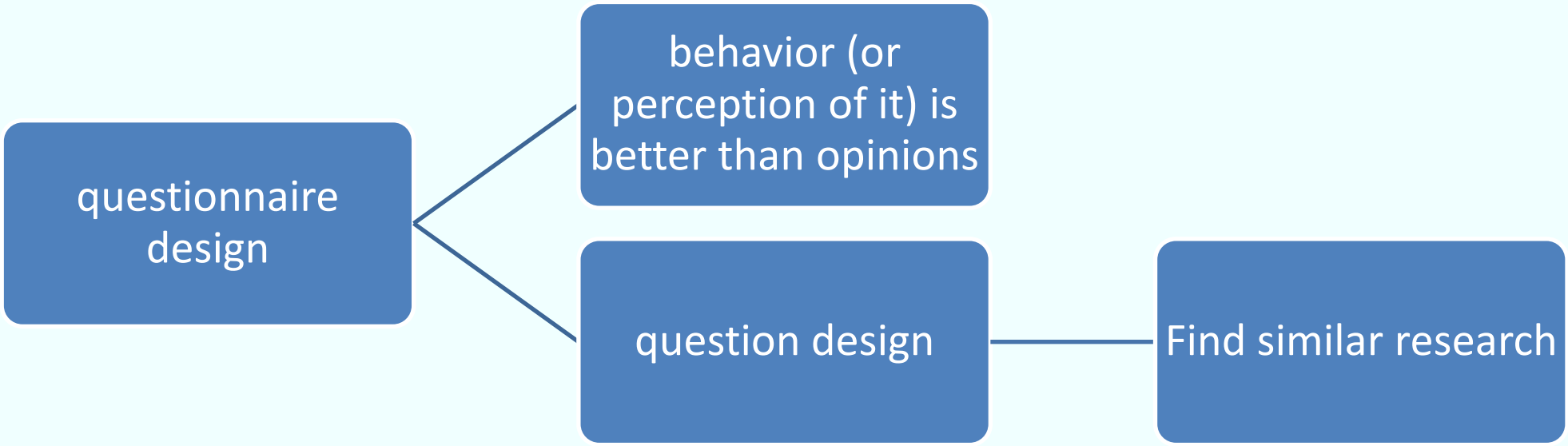
Example 9. **Nielsons (1993) usability methods**

url: **http://fdlwww.kub.nl/~krahmer/evaluation-introduction.ppt**

Table 10 *Summary of the usability methods covered in Chapters 5–7.*

Method Name	*Lifecycle Stage*	*Users Needed*	*Main Advantage*	*Main Disadvantage*
Heuristic evaluation	Early design, "inner cycle" of iterative design	None	Finds individual usability problems. Can address expert user issues.	Does not involve real users, so does not find "surprises" relating to their needs.
Performance measures	Competitive analysis, final testing	At least 10	Hard numbers. Results easy to compare.	Does not find individual usability problems.
Thinking aloud	Iterative design, formative evaluation	3–5	Pinpoints user misconceptions. Cheap test.	Unnatural for users. Hard for expert users to verbalize.
Observation	Task analysis, follow-up studies	3 or more	Ecological validity; reveals users' real tasks. Suggests functions and features.	Appointments hard to set up. No experimenter control.
Question-naires	Task analysis, follow-up studies	At least 30	Finds subjective user preferences. Easy to repeat.	Pilot work needed (to prevent misunderstandings).
Interviews	Task analysis	5	Flexible, in-depth attitude and experience probing.	Time consuming. Hard to analyze and compare.
Focus groups	Task analysis, user involvement	6–9 per group	Spontaneous reactions and group dynamics.	Hard to analyze. Low validity
Logging actual use	Final testing, follow-up studies	At least 20	Finds highly used (or unused) features. Can run continuously.	Analysis programs needed for huge mass of data. Violation of users' privacy.
User feedback	Follow-up studies	Hundreds	Tracks changes in user requirements and views.	Special organization needed to handle replies.

Chapter 12: Quantitative data acquisition methods



1. Basics

1. Make a list of concepts (theoretical variables) in your research questions for which you need data.
2. For each of these concepts make sure that you identify its dimensions (or make sure that they are not multi-dimensional)
   - Consult the literature
   - Discuss with domain experts
   - Make a list of all conceptual variables
3. For each conceptual variable think about how you plan to measure it
   - First, go through the literature and find out if and how other people went about it
   - It is much better to use a suitable published instrument than to build your own. You can compare your results and will have less explanations and justifications to produce !
4. Think about redundancy and triangulation
   - Do not measure a conceptual variable with just one question or observation
   - E.g. combine surveys with objective data and observations
5. Rather ask people how they behave instead of how they think they behave
   - E.g. don't ask: "Do you use socio-constructivist pedagogies ?"
   - Ask several questions about typical tasks assigned to students.
6. Do not ask people to confirm your research questions
   - E.g. don't ask: "Did you manage to make your teaching more socio-constructivist with this new tech"
   - (Again) Ask what the person really does

2. Survey design

2.1. The basics of question and response item design

- Only ask questions that your target population understands (test your questionnaire with at least 2 people)
- Questions should avoid addressing 2 issues in 1 question!
- Make questions short
- Ask several questions that measure the same concept
  - Try be all means to find sets of published items (questions) in the literature that you can reuse
- Avoid open-ended answers (these will give a lot of coding work)
- Use scales that have at least a range of 5 response options
  - otherwise people will have a tendency to drift to the "middle" and you will have no variance.
  - e.g. avoid:

  agree () neither/or () disagree ()

- Response options should ideally be consistent across items measuring a same concept
- If you feel that most people will check a "middle" value, use a large "paired" scale without a middle point

  e.g. 1=totally disagree, 10=totally agree

  1 2 3 4 5 6 7 8 9 10

2.2. **Examples**

Example 1. **Social presence**

Gunawerda, C.N., & Zittle, F.J. (1997). Social presence as a predictor of satisfaction within a computer-mediated conferencing environment. The American journal of distance education, 11(3), 8-26.

The GlobalEd questionnaire was developed to evaluate a virtual conference. Participants (n=50) of the conference filled out the questionnaire. Internal consistency of the social presence scale was a=0.88. Social presence was found to be a strong predictor of user satisfaction.

url: http://www.presence-research.org/Overview.html **(Compendium of Presence Measures)**

- Messages in GlobalEd were impersonal
- CMC is an excellent medium for social interaction
- I felt comfortable conversing through this text-based medium
- I felt comfortable introducing myself on GlobalEd
- The introduction enabled me to form a sense of online community
- I felt comfortable participating in GlobalEd discussions
- The moderators created a feeling of online community
- The moderators facilitated discussions in the GlobalEd conference
- Discussions using the medium of CMC tend to be more impersonal than f2f discussion
- CMC discussions are more impersonal than audio conference discussions
- CMC discussions are more impersonal than video teleconference discussions
- I felt comfortable interacting with other participants in the conference
- I felt that my point of view was acknowledged by other participants in GlobalEd
- I was able to form distinct individual impressions of some GlobalEd participants even though we communicated only via a text-based medium.

A 5-point rating scale was used for each question

Example 2. **Socio-constructivist teachers**

Class (and Schneider) 2005, PhD thesis project (scale based on Dolmans 2004)

The problem was how to identify socio-constructivist elements in a distance teaching course for interpreter trainers.

Decomposition of "socio-constructivist design" in (1) active or constructive learning, (2) self-directed learning, (3) contextual learning and (4) collaborative learning, (5) teacher's interpersonal behavior (according to Dolmans et al., 1993)

Note that headers regarding these dimensions (e.g. "Constructive/active learning" are not shown to the subjects. We do not want them to reflect about theory, but just to answer the questions ... So they are just shown below to help your understanding

	Statements: Teachers stimulated us …	Totally disagree	Disagree	Somewhat agree	Agree	Totally agree
		1	2	3	4	5
(Constructive / active learning)						
4	… to search for explanations during discussion	O	O	O	O	O
5	… to summarize what we had learnt in our own words	O	O	O	O	O
6	… to search for links between issues discussed in the tutorial group	O	O	O	O	O
7	… to understand underlying mechanisms/theories	O	O	O	O	O
8	… to pay attention to contradictory explanations	O	O	O	O	O

(Self-directed learning)						
9	… to generate clear learning issues by ourselves unclear	O	O	O	O	O
10	… to evaluate our understanding of the subject matter by ourselves	O	O	O	O	O
(Contextual learning)						
11	… to apply knowledge to the problem discussed	O	O	O	O	O
12	… to apply knowledge to other situations/problems	O	O	O	O	O
13	… to ask sophisticated questions	O	O	O	O	O
14	… to reconsider earlier explanations	O	O	O	O	O
(Collaborative learning)						
15	… to think about our strengths and weaknesses concerning our functioning in the tutorial group	O	O	O	O	O
16	… to give constructive feedback about our group work	O	O	O	O	O
17	… to evaluate our group cooperation regularly	O	O	O	O	O
18	… to arrange meetings with him/her to discuss how to improve our functioning as a group	O	O	O	O	O

3. The questionnaire

The Introduction in written questionnaires (on paper or on-line)

- Write a short introduction that states the purpose of this questionnaire
  - Example (in french): The purpose of this questionnaire is to help us understand how well you liked the on-line delivery of the first blended edition of the Certificate for Interpreter Trainers. Each one of the 117 statements below asks about your experience in the on-line part of the Certificate. Data will be processed and published only statistically. The following questions will be dealt with: personal information, teachers' behavior, learning environment, tutoring support structure, tools and skills. Filling in this questionnaire will take you about 20 minutes. Please be assured that your responses will be treated confidentially, and that they will not affect your assessment. Thank you very much for your cooperation.
- Guarantee that you only will publish statistical data (no names !).
- Specify how long it will take to fill it in.

Coding information for the researcher

- Assign a code (e.g. number) to each question item (variable) and assign a number (code) to each response item (see next slide)
- This will help you when you transcribe data or analyze data
- Use "small fonts" (this information is for you)

Ergonomics

- Do not include anything else than questions and response items (besides the introduction)
- Make sure that people understand where to "tick".

Example 3. **A question set (one question with several sub questions):**

Teachers' behavior

Below you will find general statements about teachers' behavior. Please indicate to what extent you agree or disagree with them? Please tick the appropriate circle on the scale (totally disagree - totally agree) for each statement.

	Statements: Teachers stimulated us …	**Totally disag-ree**	**Disag-ree**	**Some-what agree**	**Agree**	**Totally agree**
		1	2	3	4	5
4	… to search for explanations during discussion	O	O	O	O	O
5	… to summarize what we had learnt in our own words	O	O	O	O	O
14	… to reconsider earlier explanations	O	O	O	O	O

4. Experiments

- Designing a true experiment needs advice from some expert. Typically, a beginner makes the mistake to differentiate 2 experimental conditions by more than one variable !!

There are many kinds of experimental measures

- observations (e.g. Video, or recordings of computer input)
- tests (similar to surveys)
- tests (similar to examination questions)
- tests (performance in seconds)
- tests (similar to IQ tests)

Consider all the variables you want to measure

- most times the dependant variables (to explain) are measured with tests
- usually the independent (explanatory) variables are defined by the experimental conditions (so you don't need to measure anything, just remember to which experimental group the subject belonged)

See the literature !!

- First of all, read articles about similar research !
- Consult test psychologists if you need to measure intellectual performance, personality traits, etc.
- Use typical school tests if you want to measure typical learning achievement

5. Sampling

5.1. The ground rules

The number of cases you have to take into account is rather an absolute number

- therefore not dependent on the size of the total "population" you study

The best sampling is random, because:

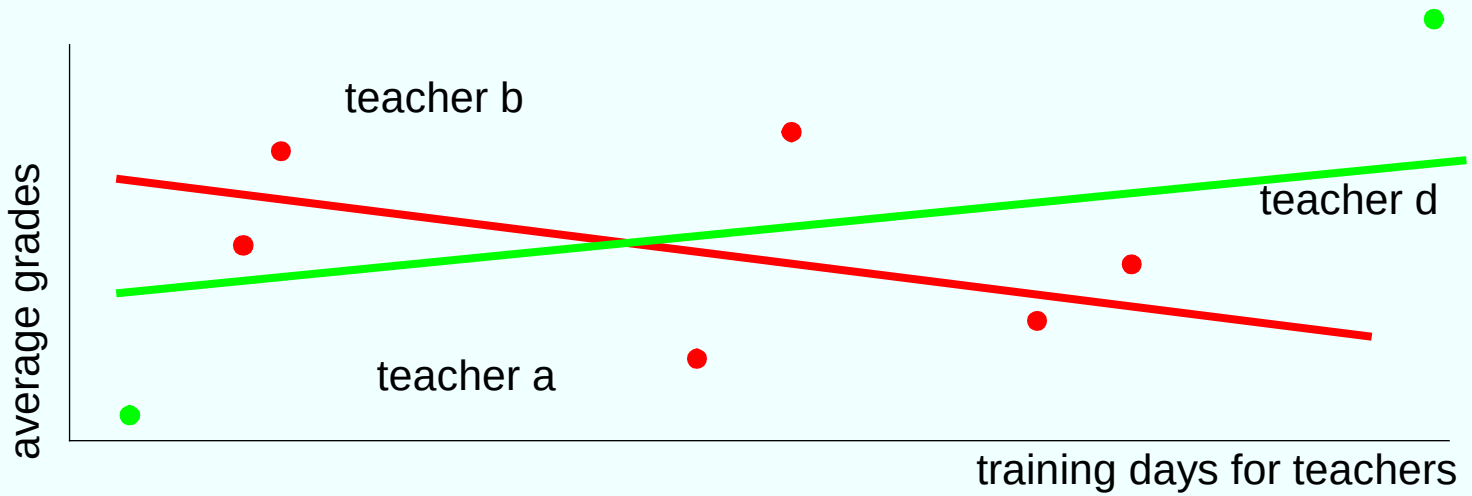
- you have a likely chance to find representatives of each "kind" in your sample
- you avoid auto-selection (i.e. that only "interested" persons will answer your survey or submit to experiments

When you work with small samples, you may use a quota system

- e.g. make sure that you have both "experts" and "novices" in a usability study of some software
- e.g. make sure that you (a) both interview teachers who are enthusiastic users and the contrary, (b) schools that are well equipped and the contrary in a study on classroom use of new technologies.

6. A first look at significance

- Significance of results depend both on strength of correlations and size of samples
  - therefore: the more cases you have got, the more likely your results will be interpretable !



- Let's assume you have data from only 6 teachers (the red dots):
  - your data suggest a negative correlation: more training days lead to worse averages
- By only adding 2 teachers (the 2 green dots) this relation will switch from negative to positive
  - data suggests a (weak) positive correlation.
  - So: doing a statistical analysis on very small data sets is like gambling. If your data set included 20 teachers, adding these 2 more wouldn't have changed the relationship

6.1. **Typical sampling for experiments**

- ***preferably*** 20 subjects / experimental condition
- ***at least*** 10 / experimental condition (but expect most relations to be non-significant)

Example 4. **Study the effect of multimedia on retention**

Explanatory (independent) variable X: ***Static diagrams*** vs. ***animation*** vs. ***interactive animation***

Dependant (to be explained) variable Y1: Short term recall

Dependant (to be explained) variable Y2: Long-term recall

- Both dependant variables (Y1 and Y2) can be measured by recall tests
- For variable X we have three conditions
- Therefore we need 3 * 20 = 60 subjects
  - If you expect very strong relations (don't for this type of research !) you can get away with 3 * 15
  - Note: we can not administer the three different conditions to each individual (because by moving from one experiment to another they will learn). You may consider building 3 * 3 = 9 different kinds of experimental materials however and have each individual do each experiment in a different condition. However, they may get tired or show other experimentation effects ... and producing good material is more expensive than finding subjects.

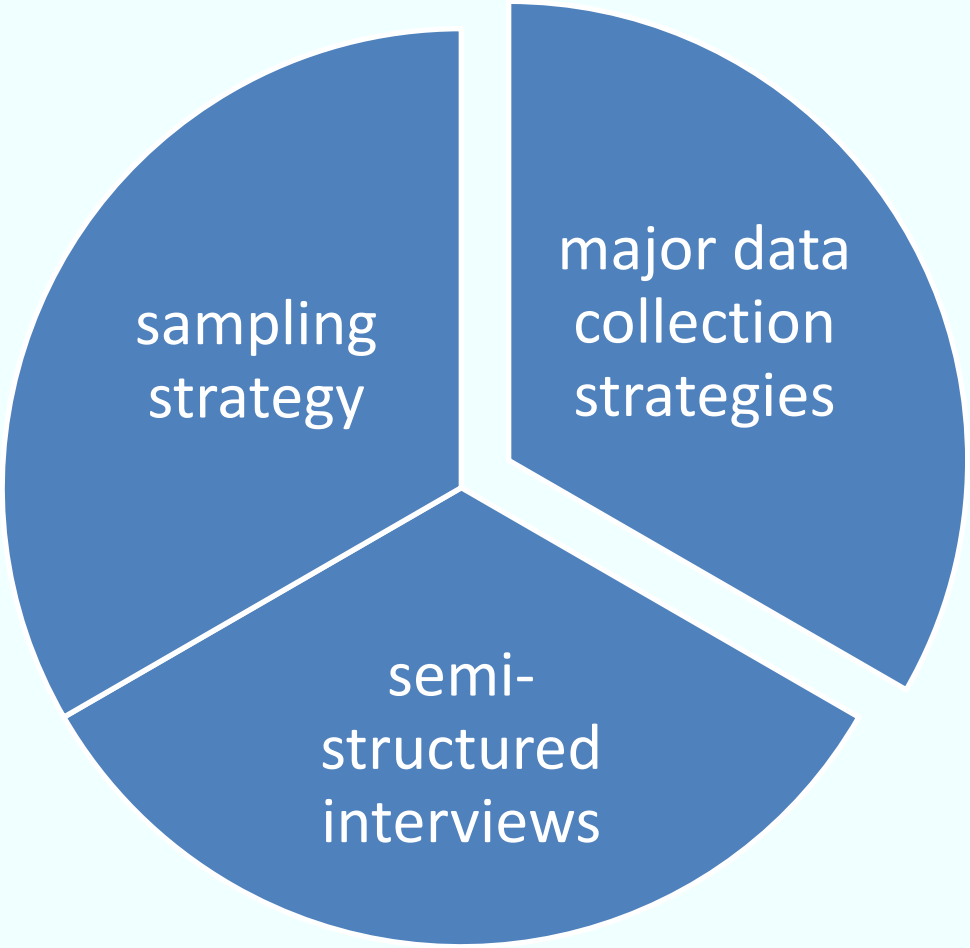
6.2. Typical samples for survey research

- As much as you can if you use written or on-line surveys
- 50 or more, 40 is a minimum, 100 is good and 200 is excellent for a MSc thesis.
  - otherwise you can’t do any sort of interesting data analysis, because your significance levels will be too high (i.e. bad) when you analyze detailed or complex relationships.

6.3. Typical samples for aggregate data

- e.g. schools, districts, countries etc.
- Since these data reflect real "realities" you can do with less (however talk to an expert, a lot depends on the kinds of analysis you plan to do).

Chapter 13: Qualitative data acquisition methods



1. Sampling strategies in qualitative research

☞ **Often you only work with 1-2 big cases (i.e. classes, organizations)**

- Qualitative analysis is highly labor intensive

☞ **But within each case you also have to think about sampling !**

Example: organizational study (innovation research)

- informants within the organization
- external experts (domain/subject experts/practitioners)
- clients and other interacting organizations
- observed processes (e.g. workflow analysis)
- texts (e.g. written decisions, files, ...)

Example: impact of an initiative on a public area (e.g. publicly accessible computer rooms)

- external decision makers and interest groups
- organized local groups (e.g. parent's associations)
- population of the area
- events and behaviors associated with this initiative

☞ **Sampling is often multi-stage (by waves)**

- Research in progress can show new phenomena that need investigation and therefore sampling

1.1. General sampling strategies

Miles & Huberman (1994:28)

Type of case	Usage	
maximal variation	will give better scope to your result s (but needs more complex models !!)	major strategies
homogeneous	provides better focus and conclusions will be "safer" since it will be easier to identify explaining variables and to test relations	
critical	exemplify a theory with a "natural" example	
according to theory, i.e. your research questions	will give you better guarantees that you will be able to answer your questions	
confirming / infirming	test the limits of an explanation	validation
extremes and deviant cases	test the boundaries of your explanations, seek new adventures	
typical	Show what is “normal” or “mean” or "typical"	
intense	complete a quantitative study with an in-depth study	specialization
according to dimen-	Study of particular phenomena	

sion		
“snow ball”	According to information received during study	inductive approach
“opportune”	Follow new “leads”	
all	(rarely possible)	representativeness
quota	selection of subgroups	
according to repu-tation	recommendations of experts	
comparative method	according to operative variables	
according to criteria	according to criteria you want to study	
convenient	those who are willing ...	bad
polititical	Exclusion/inclusion for political reasons	

Use this big list to think about your own strategy

- There are no general rules !
  - Use this table to think the kind of sampling you need for ***your*** research.
- Choose well your cases = avoid trouble later …
- … avoid adopting a sampling-by-induction strategy (more difficult)
- Look at your research questions !!
  - can you answer all of them (measure concepts, find causalities, etc.)
- Understand the scope of the sampling task (see next slide)
  - roles (functions organization),
  - groups, organizations, institutions, ….
  - “programs”,
  - processes,
  - ….

Advice for intra-case sampling:

- identify ***types of informations*** you need.
- sample ***all categories*** (activities, processes, events, dates, locations, agents, ...)
- again: think about your the theory you want to produce and its scope
- reduce your ambitions (research questions) when your sampling lists get to large
- you always can add cases (snow-ball strategy)

Advice for inter-case sampling:

- It's a good strategy to adopt a kind of similar systems design:
  - select similar cases that have a nice variance within your operative variables (dependant and independent)
  - E.g. to test an e-learning design, select relatively similar domains, or relatively similar target population
- You then can add contrasted (extreme) cases to test the external validity (generalization potential) of your analysis
-

Remember: qualitative research is very expensive

- 2-3 big cases (e.g. courses, schools, designs) are enough for a master thesis
- 12-30 cases within all cases (e.g. people, processes) are enough for a master thesis
- else complete qualitative strategies with quantitative

2. Data gathering techniques (empirical measures)

Overview:

activity	medium	principal objective
look	observation	Global observation of an organization, culture, activity, etc. see: Observation, transcription and text analysis
examine activities	transcriptions of natural activities	In-depth study of activities and interactions in context see: Observation, transcription and text analysis
provoked activities	transcriptions of provoked activities	In-depth study of formal activities you engage somebody in see: Observation, transcription and text analysis
study	texts	Written traces of activities (e.g. decision protocols, guidelines) See: Observation, transcription and text analysis
ask	interviews	Extraction of information in peoples head see: Interviews.
participate	share	Participatory observation shares research and work

Different roles for qualitative technology

☞ Don’t confuse method as technique with method as approach

	Some different objectives and preferred techniques for different kinds methodologies (approaches)	
method	**quantitative**	**qualitative**
look	• preliminary work for questionnaire design	• "Deep understanding of an institution’s or culture’s working
examine activities	• quick studies of work activities and interactions to prepare initial design specifications • systematic usability studies	• dialogue analysis
provoked activities		• understanding of reasoning processes
study	• formal content analysis • most often work counting or more sophisticated like LSA	• categorization and understanding of concepts
ask	• fixed questions to systematically gather relatively complex attitudes, opinions and descriptions of behaviors	• open interviews or semi-structured interviews to engage subjects in

- This table is not very complete, but it shows that qualitative designs are more geared towards going in depth whereas mostly quantitative designs put more emphasis on scale or preparation of quantitative studies, ...

3. Observation, transcription and text analysis

3.1. Observation of behaviors in natural contexts

☞ **Essential instrument for** *in-depth studies* **of cultures and / or organizations**

- Takes ***time*** and requires ***skills*** (see below)
- Needs assessment:
  - of the researcher's role in the organization, group, culture, ...
  - on investigation methods, research goals (in order to focus observations), etc.
- Needs a good "field notes" technique:
  - notational conventions for sessions
  - notational conventions after session notes
  - a journaling technique
- Example:

Marks	Usage
"..."	verbatim quotations
' ... '	paraphrases
(...)	contextual data (or researchers interpretations)
< ... >	Analytical categories) derived from the subject's conceptual frameworks
/ ...	Analytical categories) derived from the researcher's conceptual frameworks
_____	time elapsed

3.2. **Computer mediated transcriptions**

- ... are very popular in educational technology
- Media: experimental artifacts, portals, CSCL, CSCW
- Tools are sometimes rigged to register detailed user acts for research purposes
- Types of activities observed:
  - user-machine interactions
  - mediated user-user interactions
- In addition, screen activities can be filmed or electronically registered
  - give extra informations, also allows to register non CMC-mediated user-user communication

Data

- can be enormous amounts
- Analysis of transcriptions take an enormous amount of time
  - either you have to spend days/weeks for manual coding (preferably using specialized software adapted to the media type)
  - or you need high technical skills to write scripts to reduce and "massage" data
- Likely you also have to invent your own data analysis and visualization techniques
- Be sure to search the literature for coding and analysis techniques !

Advice

- think very hard about the concepts you need to measure !

3.3. **Elicitation of cognitive processes**

- The "***thinking aloud***" method combined with protocol analysis (Ericsson & Simon, 1983) is a popular method in cognitive science and expert system design
- Used to collect relatively "objective" data about thinking processes, problem solving in particular.
- There can be important experimentation effects:
  - ex-post rationalization of behavior,
  - analytical thinking instead of case-based/pattern matching
  - influence of experimenter
  - subject may become silent and confused ...
- Basic principle: Users are given tasks and are asked to think aloud what they do.

The Ecrisson & Simon procedure for elicitation cognitive processes

- Experimenter is completely silent...
- ...except when subject is ± 15s silent
- "Keep talking"

Boren & Ramey: Usability testing practice is different:

- Subjects asks for help,
- Testers ask questions (clarification, opinion, ...),
- 'Push' subjects in certain directions.

3.4. Transcriptions of user activities in semi-formal situations

☞ **Usually audio or video recordings**

- Take time to analyze (like above) !
- Ask permission to use a tape-recorder or a camera if you do this in a work context
- Can also modify user's behaviors

(more details to follow in a next version, sorry ...)

3.5. Texts

- Text analysis (other than "texts" mentioned above) concerns artifacts like official documents, student/teacher paper productions, etc.
- Don't ask for everything when you start your research
  - People don't always like to give away written traces of their activities, and therefore you need to establish a confidence relation first.
- There are a large amount of analysis techniques
  - will not be covered in this short "crash course".

4. Interviews

Type	composition	function / advantages
Information interviews	check-list	**Initial studies** • See The information interview
Semi-structured interviews	list of questions and “probes”	**Main interview type in qualitative research** • subjects are allowed to "talk" and therefore to think • difficult to analyze • See The semi-structured interview
Structured (directive) interviews	list of fixed questions	**Semi-quantitative studies:** • easier analysis • better comparison • faster than semi-structured • See The structured interview
Interviews with a fixed list of questions and closed questions (see quantitative modules)	list of questions with response items	**Quantitative studies** • fast interview • reliable • easy to analyze • needs good understanding of the studied phenomenon

4.1. General advice for interviews

☞ **Interviewing is a well documented technique (in most textbooks)**

Interviewees (in natural settings) don't have time to loose

- focus on the ***essential***
- check if some information is available in other forms (e.g. written memos, rules, etc.)
- learn the ***"jargon"***
- consult all other available information before the interview

4.2. The information interview

- Possible Objectives:
  - determine your research goals, e.g. you need to find out if your potential research subject is of any interest, etc. ;
  - prepare your research questions ;
  - prepare field research, e.g. you need information about the workings of an organization, process, procedure, about people and their roles, etc.
- Find ***the*** person:
  - often you may first interview ***a domain specialist ;***
  - sometimes any person that has knowledge on your subject area will also do.
- In "natural contexts" avoid to "over-tax" key actors:
  - You must make sure that key actors will agree to in-depth semi-structured interviews in later stages, interviewing twice may not please some of them.

4.3. **The structured interview**

- Definition: A list of questions and open responses (usually a few sentences)
  - Useful to systematically gather comparable informations about relatively complex variables (beliefs, behaviors, etc.)
- The questionnaire needs a ***lot of preparation !***
  - make sure that each concept can reliably be measured and lead to valid indicators.
- To prepare the questionnaire you ought to do 2-3 semi-structured interviews (or at least some information interviews)
- In addition, make ***pre-tests*** with 2-3 subjects in order to be sure that your questions are understandable
- You have to think about analysis methods beforehand
  - manual or machine coding?
  - code books
  - cost estimations, remember that any sort of text analysis is very costly (!)
  - etc.
- .... Consider surveys with closed response items as cheaper alternative !

4.4. **The semi-structured interview**

- This is preferred type of interview in typical qualitative research.
- You will get answers for your questions.
- Concurrently, this interview type allows the interviewee to ***reason.***

☞ General remarks

- (again): ***preparation*** !
- (again): ***read your research questions*** and identify the ones that need interviewing

☞ Usual structure of the interview: 2 layers

- prepare a ***list of general question***
- for each of these questions you make a "secret" list of points (***"probes"***) that need to be covered
  - during the interview you must "probe" the interviewee for all those points

☞ Interviewer's behavior

- ***Let the person talk !!!***
  .... and cover your questions and probes later !
- it is important that the interviewee is allowed to develop chains of reasoning (e.g. perceptions of causality, associations between concepts, etc.).
- The goal is to extract "meaning", i.e. so called "deep" or "think" structures.

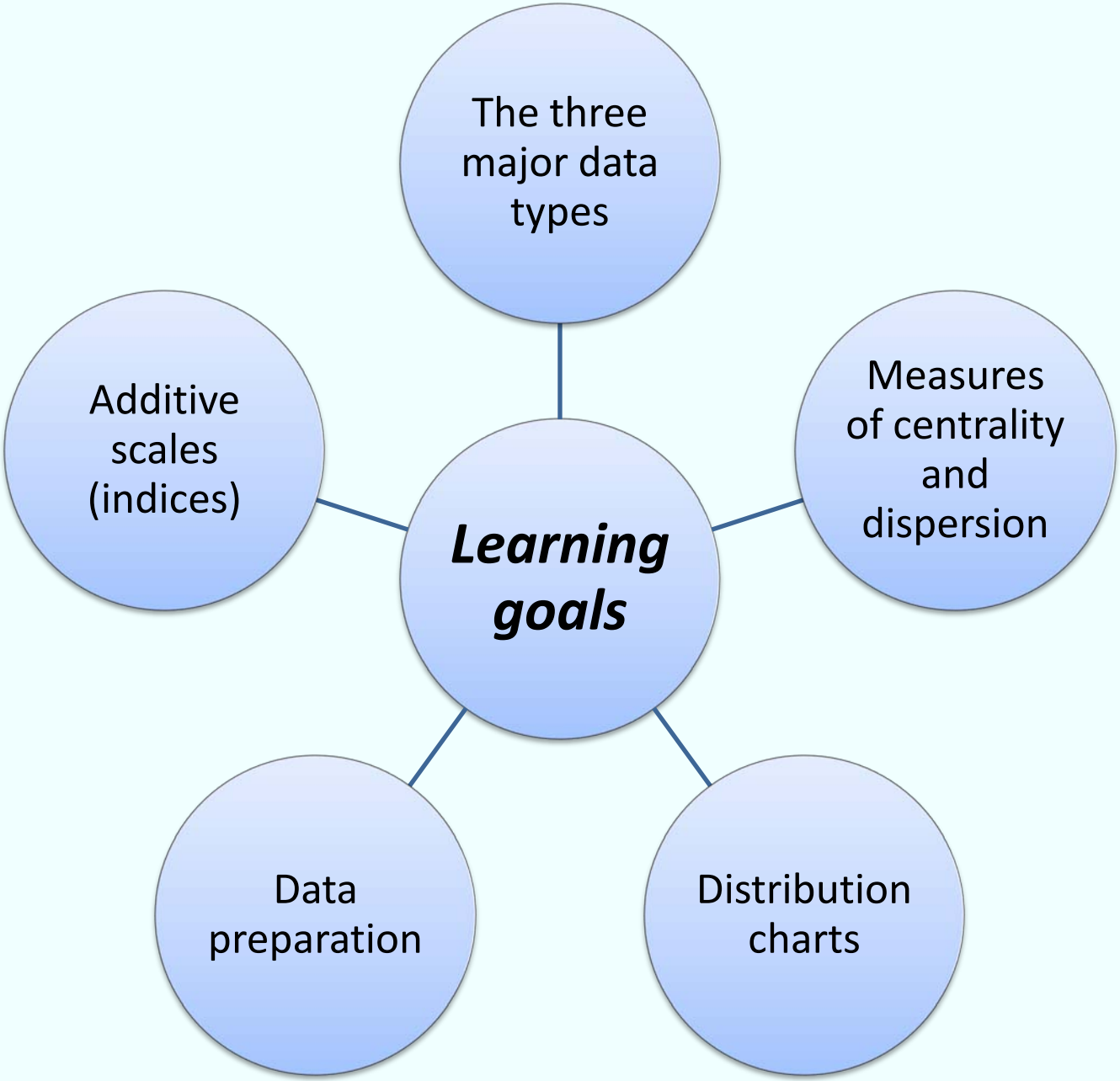
☞ Carefully word your questions

- Watch out for sensitive questions
  - put them at the end
  - if you are lucky the subject will mention them anyhow.
- Use indirect questions that project the interviewee into a situation
- Example:
  - don't ask: "do you work well with person A ?"
  - but: "do you have frequent contacts with A", "how do you coordinate", etc.
  - don't ask: "do you know how to use this software" ?
  - but: "how frequently do you use this software", etc. ?
- When appropriate, ask about concrete cases
  - e.g. present a hypothetical case and ask how they solve it.
  - e.g. (in usability testing) give them tasks to solve

En résumé:

- rather ask what people ***do*** than what they feel
- in many situations, it is useful to present the interviewee with a scenario and use it also to let people reflect on more general issues

Chapter 14: Descriptive statistics and scales



1. Use of descriptive statistics

Two main purposes

- To summarize a set of variables to compare them across systems, e.g. compare performance in science literacy of a country with an OECD average.
- To summarize a set of data in order to select appropriate techniques for analyzing relations between variables (inferential statistics)

In addition

- coefficients of descriptive statistics are the basis for more advanced statistics, e.g. models of causal relationships or multivariate data reduction techniques.

2. Scales and "data assumptions"

2.1. Types of quantitative measures (scales)

Types of measures	Description	Examples
nominal or category	enumeration of categories	male, female district A, district B, software widget A, widget B
ordinal	ordered scales	1st, 2nd, 3rd
interval or quantitative or "scale" (in SPSS)	measure with an interval	1, 10, 5, 6 (on a scale from 1-10) 180cm, 160cm, 170cm

- For each type of measure use different analysis techniques.
- For interval variables, there is a bigger choice of statistical techniques.
  - Therefore scales like (1) strongly agree, (2) agree, (3) somewhat agree, etc. usually are treated as interval variables.

3. Overview of descriptive statistics

3.1. Measures of centrality

- ***Mean*** also called ***average*** is the most popular measure for interval variables.
- ***Median*** is the data point that in the middle of "low" and "high" values,
  - 50% of the sample has higher values and another near 50% has lower values.
  - It can be used with both interval and ordinal variables
- ***Mode*** is the most frequent value encountered
  - i.e. the highest point in a histogram or the biggest slice in a pie.
  - To be used with ordinal or nominal variables.

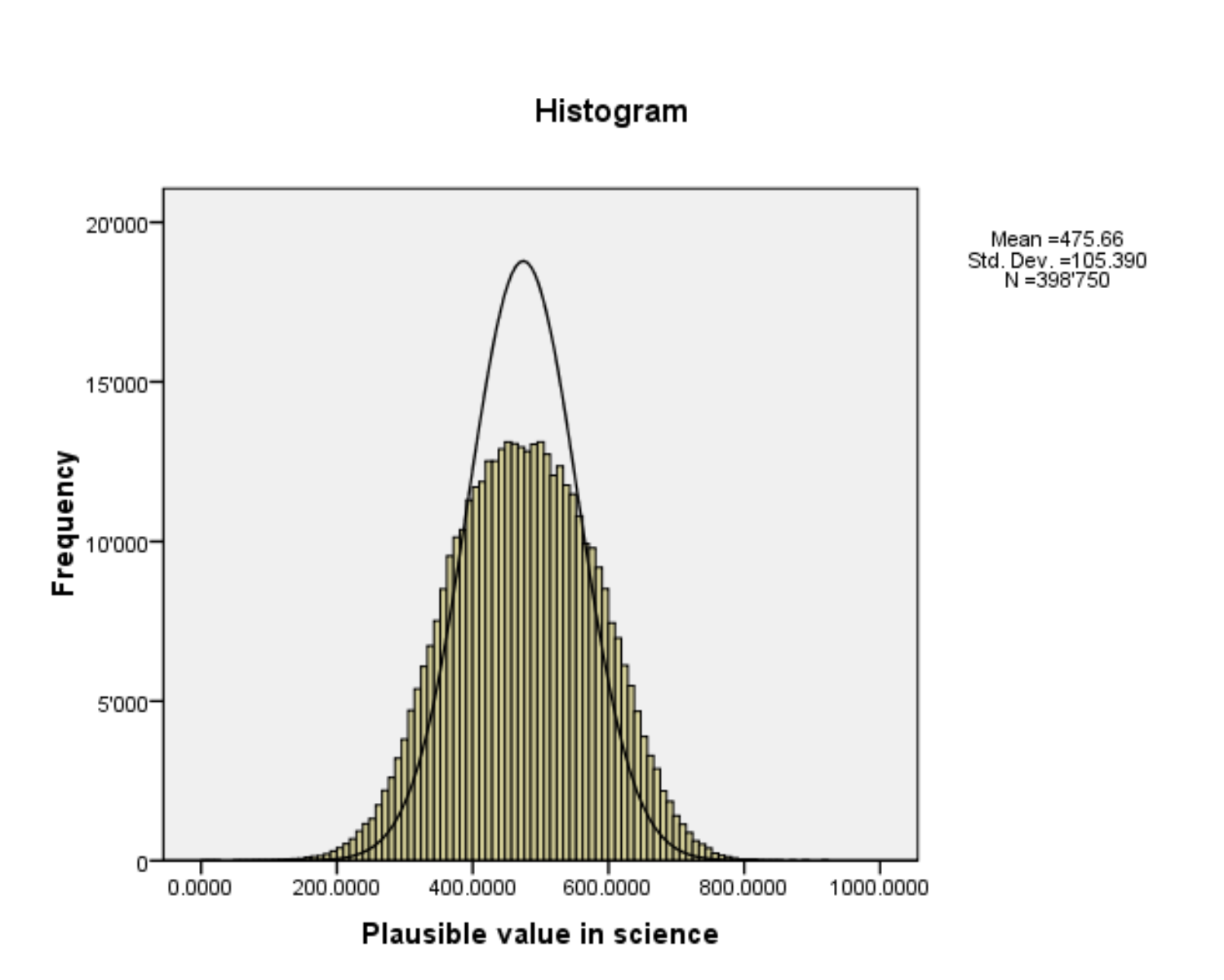
3.2. Measures of dispersion

- The ***Standard deviation*** (SD) is the mean deviation from the mean, i.e. the average of all differences from the mean.
- The variance is the mean of squared distances (used to compute advanced statistics). The SD is just its square root.
- ***High*** and **low** values are the extremes at both ends of an interval or ordinal scale
- ***Quartiles*** are based on the same principles as the median. They define points for 1/4 intervals (25%, 50% and 75% of the population)

3.3. **Measures of normality**

- Many statistical procedures require a so-called normal distribution of data

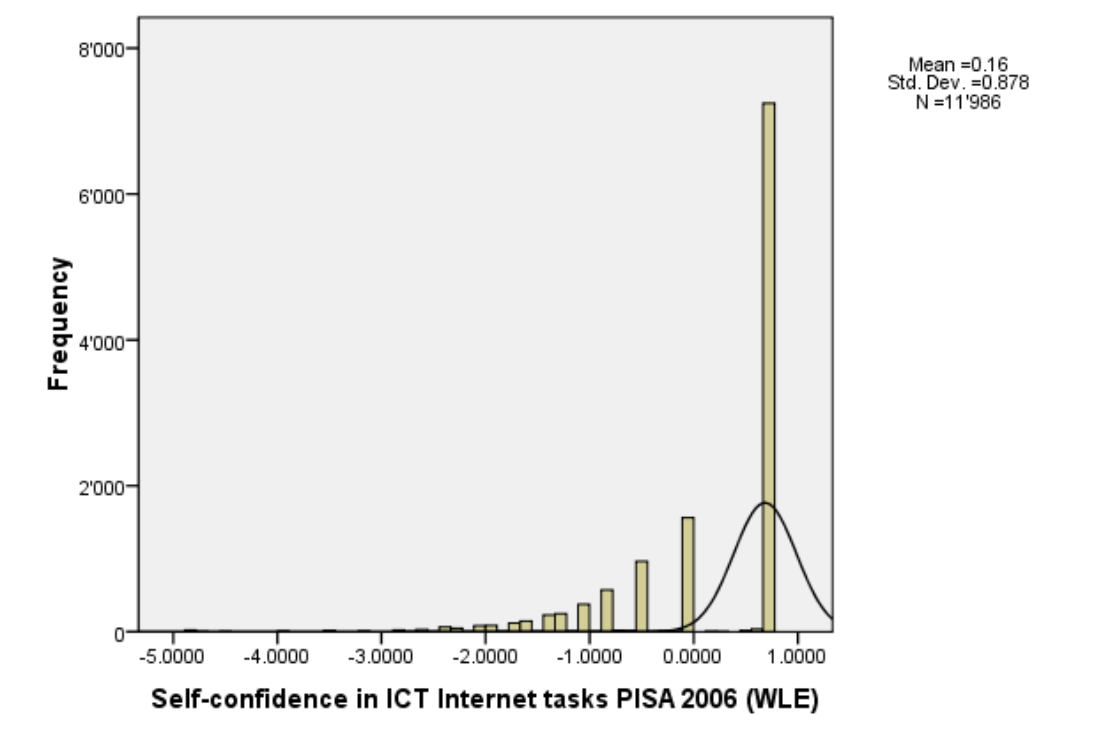
Example of a fairly normal distribution:



3.4. **Measures of normality**

- **Skew** or **skewness** is a tilt to the left or to the right. The skewed part is also called **tail**.
  - Skew should be within the +2 to -2 range when the data are normally distributed.
- **Kurtosis** measures how "peaked" a distribution is.
  - *Kurtosis should be within the +2 to -2 range*
- **Outliers** are cases further away from the mean than 3 standard deviations
  - Also called **extreme cases** (but usually extreme case refers to lowest and highest values)

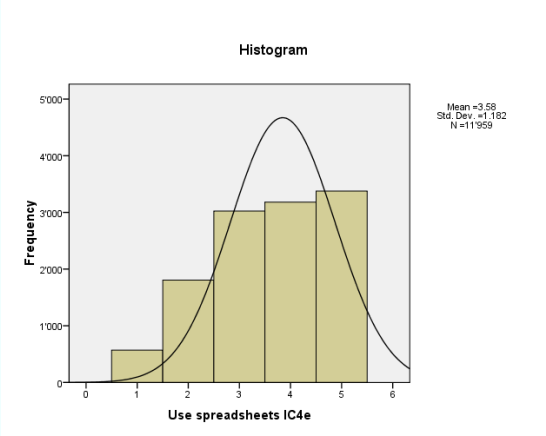
Example of a skewed (not normal distribution):



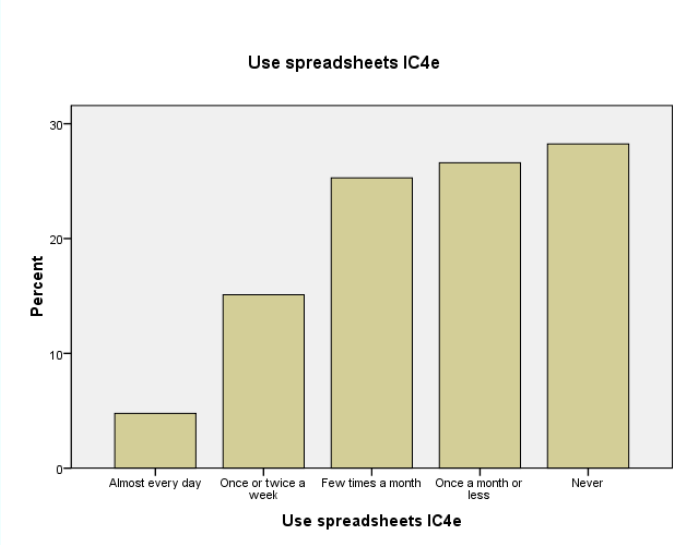
3.5. **Charts**

- The most popular charts for presentation in academic papers are histograms of various sorts. PIE charts are also popular. Avoid using too many of these, your research should not just be descriptive, but explain things ….

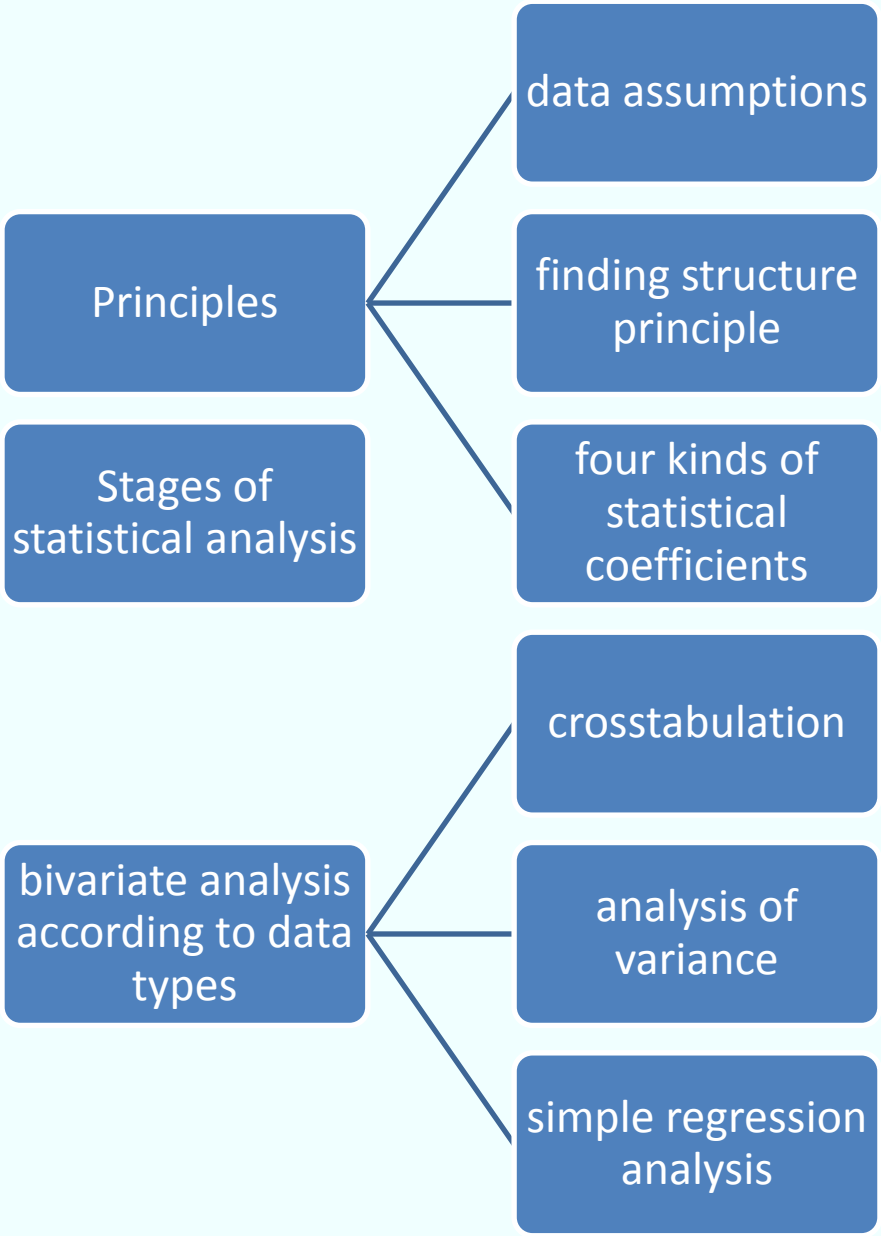
Histogram



Histogram chart



Chapter 15: Quantitative Data Analysis

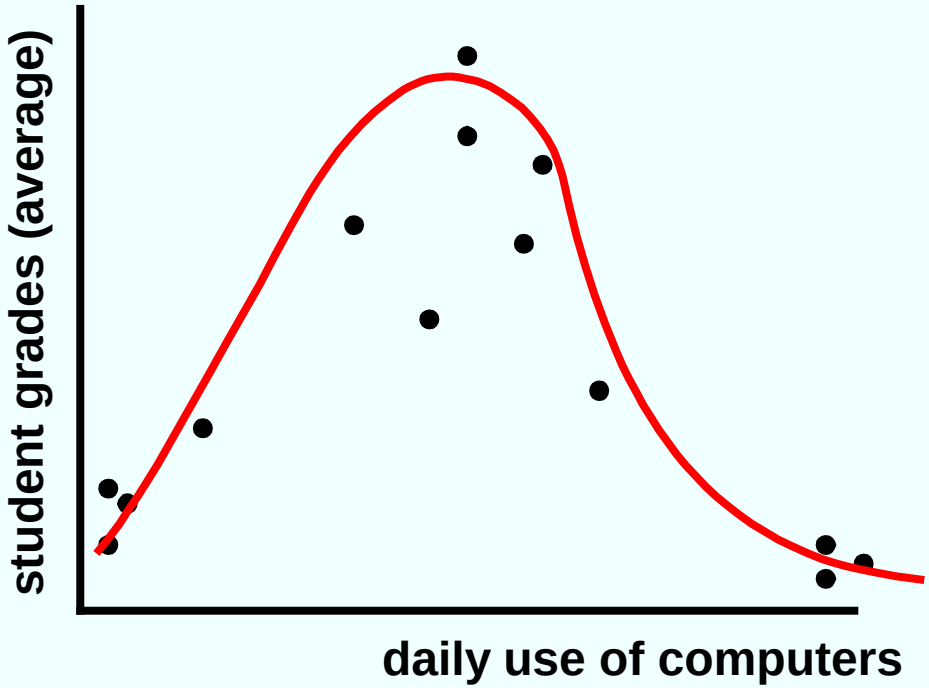


1. Data assumptions

- You have to adapt your analysis techniques to types of measures
- You should respect data assumptions.

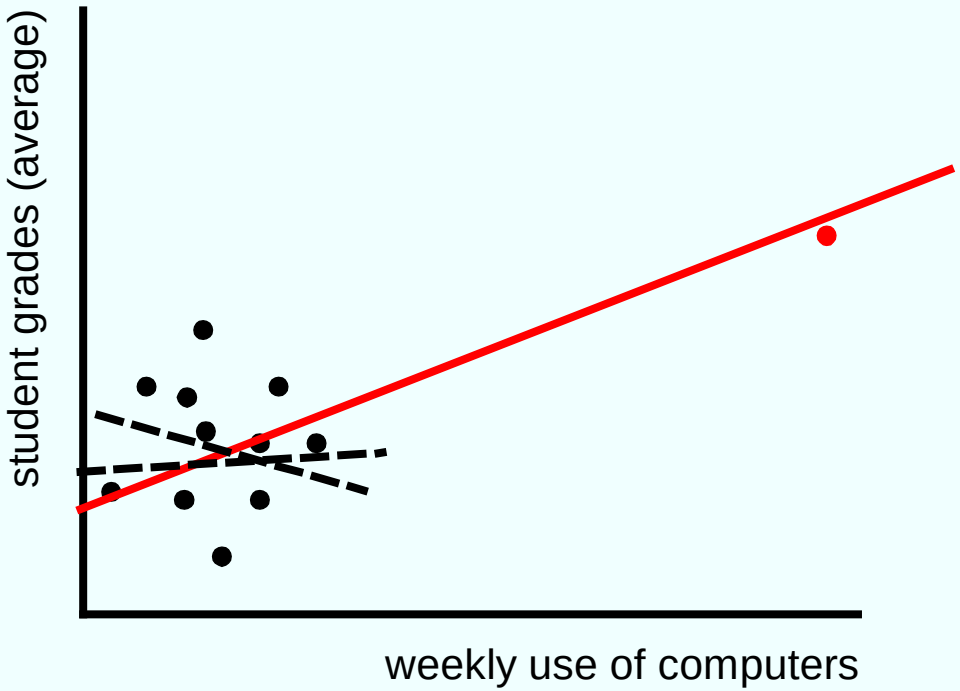
1.1. Linearity

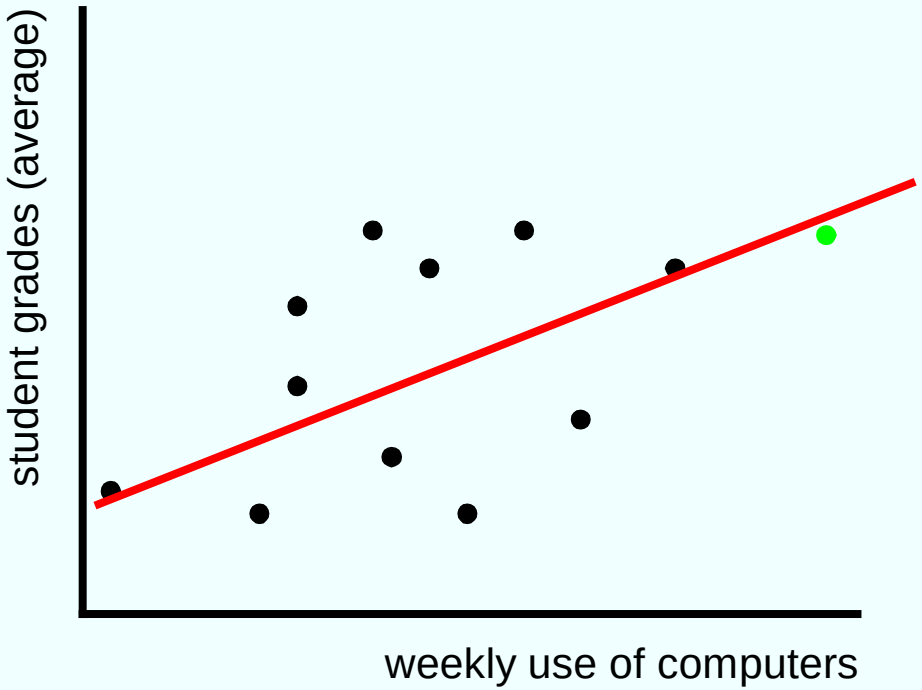
- Example: Most popular statistical methods for interval data assume ***linear relationships***:
  - In the following example, the relationship is non-linear: students that show weak daily computer use have bad grades, but so do the ones that show very strong use.
  - Popular measures like the Pearson's r will "not work", i.e. you will have a very weak correlation and therefore miss this non-linear relationship



1.2. **Normal distribution**

- Most methods for interval data also require "***normal distribution***"
- If you have extreme outliers and/or skewed data, some individuals will have much more "weight" than the others.
- Hypothetical example:
  - The "red" student who uses the computer for very long hours will determine a positive correlation and positive regression rate, whereas the "black" ones suggest an inexistent correlation. Mean use of computers does not represent "typical" usage.
  - The "green" student however, will not have a major impact on the result, since the other data are well distributed along the 2 axis. In this second case, the "mean" represents a "typical" student.





2. The principle of statistical analysis

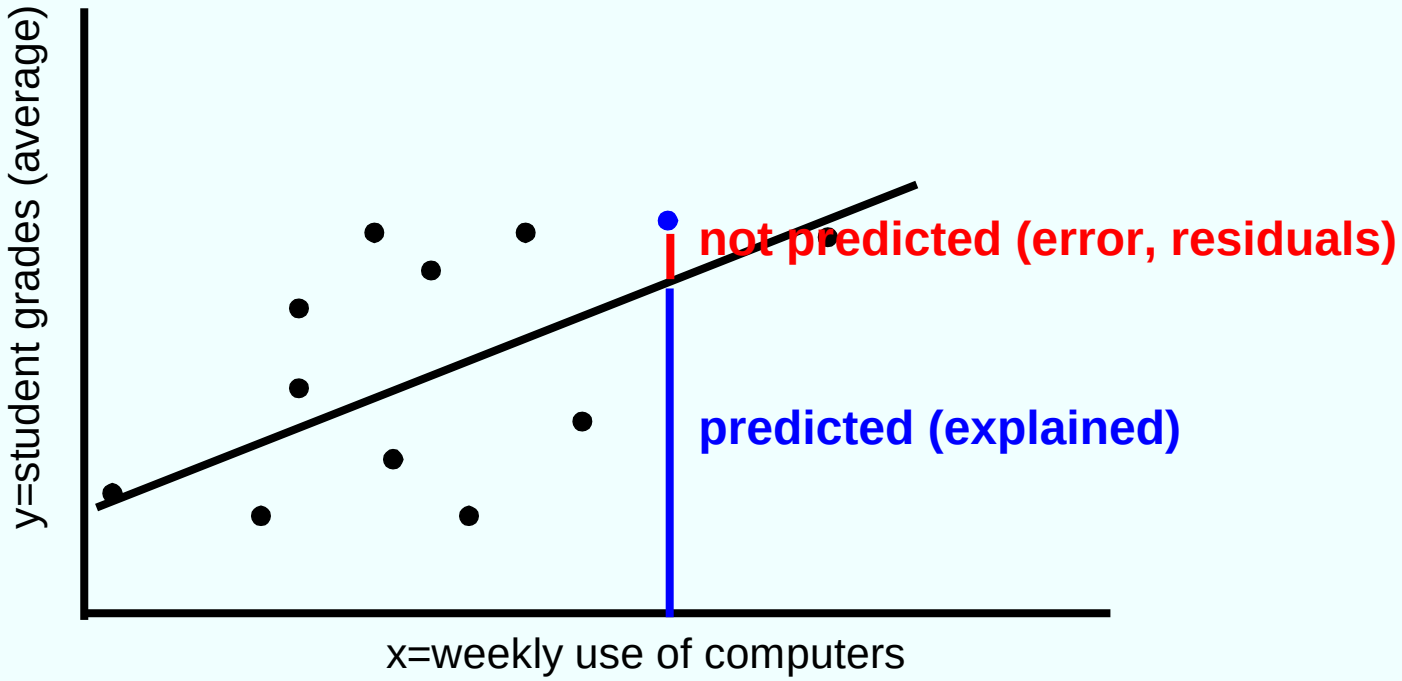
- The goal of statistical analysis is quite simple: find structure in the data

  DATA = STRUCTURE + NON-STRUCTURE

  DATA = EXPLAINED VARIANCE + NOT EXPLAINED VARIANCE

Example: Simple regression analysis

- DATA = **predicted** regression line + **residuals**
- in other words: regression analysis tries to find a line that will maximize prediction and minimize residuals



3. Stages of statistical analysis

1. Clean your data
   - Make very sure that your data are correct (e.g. check data transcription)
   - Make very sure that missing values (e.g. not answered questions in a survey) are clearly identified as missing data
2. Gain knowledge about your data
   - Make lists of data (for small data sets only !)
   - Produce descriptive statistics, e.g. means, standard-deviations, minima, maxima for each variable
   - Produce graphics, e.g. histograms or box plot that show the distribution
3. Produce composed scales
   - E.g. create a single variable from a set of questions
4. Make graphics or tables that show relationships
   - E.g. Scatter plots for interval data (as in our previous examples) or crosstabulations
5. Calculate coefficients that measure the strength and the structure of a relation
   - Strength examples: Cramer's V for crosstabulations, or Pearson's R for interval data
   - Structure examples: regression coefficient, tables of means in analysis of variance
6. Calculate coefficients that describe the percentage of variance explained
   - E.g. R2 in a regression analysis
7. Compute significance level, i.e. find out if you have to right to interpret the relation
   - E.g. Chi-2 for crosstabs, Fisher's F in regression analysis

4. Data preparation and composite scale making

4.1. Statistics programs and data preparation

Statistics programs

- If available, plan to use a real statistics program like SPSS or Statistica
- Good freeware: WinIDAMS (statistical analysis require the use of a command language)
- Freeware for advanced statistics and data visualization: R (needs good IT skills !)
- Using programs like Excel will make you lose time
  - only use such programs for simple descriptive statistics
  - ok if the main thrust of your thesis does not involve any kind of serious data analysis

Data preparation

- Enter the data
  - Assign a number to each response item (planned when you design the questionnaire)
  - Enter a clear code for missing values (no response), e.g. -1
- Make sure that your data set is complete and free of errors
  - Some simple descriptive statistics (minima, maxima, missing values, etc.) can help
- Learn how to document the data in your statistics program
  - Enter labels for variables, labels for responses items, display instructions (e.g. decimal points to show)
  - Define data-types (interval, ordinal or nominal)

4.2. **Composite scales (indicators)**

Basics:

- Most scales are made with the mean of different items ("Lickert scales")
- Eliminate items that have a high number of non responses
- Make sure to take into account missing values (non responses) when you add up the responses from the different items
  - A real statistics program (SPSS) does that for you
- Make sure when you create your questionnaire that all items use the same range of response item, else you will need to standardize !!

Quality of a scale:

- Again: use a published set of items to measure a variable (if available)
  - if you do, you can avoid making long justifications !
- Sensitivity: questionnaire scores discriminate
  - e.g. if exploratory research has shown higher degree of presence in one kind of learning environment than in an other one, results of presence questionnaire should demonstrate this.
- Reliability: internal consistency is high
  - Intercorrelation between items (alpha) is high
- Validity: results obtained with the questionnaire can be tied to other measures
  - e.g. were similar to results obtained by other tools (e.g. in depth interviews),
  - e.g. results are correlated with similar variables.

Example 1. **The COLLES surveys**

url: **http://surveylearning.moodle.com/colles/**

- The Constructivist On-Line Learning Environment Surveys include one to measure preferred (or ideal) experience in a teaching unit. It includes 24 statements measuring 6 dimensions.
- We only show the first two (4 questions concerning relevance and 4 questions concerning reflection).
- Note that in the real questionnaire you do not show labels like "Items concerning relevance" or "response codes".

Statements	**Almost Never**	**Seldom**	**Some-times**	**Often**	**Almost Always**
response codes	**1**	**2**	**3**	**4**	**5**
Items concerning relevance					
a. my learning focuses on issues that interest me.	O	O	O	O	O
b. what I learn is important for my prof. practice as a trainer.	O	O	O	O	O
c. I learn how to improve my professional practice as a trainer.	O	O	O	O	O
d. what I learn connects well with my prof. practice as a trainer.	O	O	O	O	O
Items concerning Reflection					
… I think critically about how I learn.	O	O	O	O	O
… I think critically about my own ideas.	O	O	O	O	O

Algorithm to compute each scale:

- for each individual add response codes and divide by number of items
- or use a "means" function in your software package:

```
relevance = mean (a, b, c, d)
```

Examples using the first four questions above

- Individual A who answered a=sometimes, b=often, c=almost always, d= often gives:

```
(3 + 4 + 5 + 4) / 4 = 4
```

Missing values (again)

- Make sure that you do not add "missing values", example
- Individual B who answered a=sometimes, b=often, c=almost always, d=missing gives:

```
(3 + 4 + 5) / 3 = 4
```

- and certainly NOT:

```
(3 + 4 + 5 + 0) / 4 or (3 + 4 + 5 -1) / 4 !!
```

5. Overview on statistical methods and coefficients

5.1. Which data analysis for which data types?

Popular bi-variate analysis models

		Dependant variable Y	
		Quantitative (interval)	Qualitative (nominal or ordinal)
Independent (explaining) variable X	Quantitative	Correlation and Regression	Logistic regression or transform X into a qualitative variable and see below
	Qualitative	Analysis of variance	Crosstabulations

Popular multi-variate anaylsis

		Dependant variables Y	
		Quantitative (interval)	Qualitative (nominal or ordinal)
Independent (explaining) variables X	Quantitative	Factor Analysis, Multiple regresstion, SEM, Cluster Analysis,	Logit, or transform X into a qualitative variable and see below or dichotomize variables and see to the left
	Qualitative	Anova, Manova, etc.	Multidimensional scaling etc.

5.2. **Types of statistical coefficients:**

- Make sure that the coefficient you use is more or less appropriate for you data

The big four:

1. Strength of a relation
   - Coefficients usually range from -1 (total negative relationship) to +1 (total positive relationship). 0 means no relationship.
2. Structure (tendency) of a relation
3. Percentage of variance explained
4. Signification level of your model
   - Computes that chance that you are in fact gambling (your data has random distribution)
   - Typically in the social sciences a sig. level lower than 5% (0.05) is acceptable
   - Do not interpret data that is above this 0.05 level !!!

These four are mathematically connected:

- E.g. Signification is not just dependent on the size of your sample, but also on the strength of a relation.

6. Crosstabulation

- Crosstabulation is a popular technique to study relationships between normal (categorical) or ordinal variables

6.1. Computing the percentages (probabilities)

- See the example on the next slides

1. For each value of the explaining (independent) variable compute the percentages
   - Usually the X variable is put on top (i.e. its values show in columns).
   - If X is to the left, you have to compute percentages across lines !
   - Remember this: you want to know the probability (percentage) that a value of X leads to a value of Y
2. Compare (interpret) percentages across the dependant (to be explained) variable

Example 2. **Teachers beliefs and classroom practice**

Question: Will teachers' agreement about the belief *that students will gain autonomy when using Internet resource* will have an influence on classroom practice ?

			X= Learners will gain autonomy through using Internet resources (teacher agreement)				
			0 Fully disagree	1 Rather disagree	2 Rather agree	3 Fully agree	Total
Y= Search information on the Internet (teacher practice)	0 Regularly	Count	0	2	9	11	22
		% within X	**.0%**	**18.2%**	**19.6%**	**42.3%**	**25.6%**
	1 Occasionally	Count	1	7	23	11	42
		% within X	**33.3%**	**63.6%**	**50.0%**	**42.3%**	**48.8%**
	2 Never	Count	2	2	14	4	22
		% within X	**66.7%**	**18.2%**	**30.4%**	**15.4%**	**25.6%**
	Total	Count	3	11	46	26	86
		% within X	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

- What do these data tell ?
- Tip: compare columns

6.2. Statistical association coefficients for crosstabs

Some popular ones

- Phi is a chi-square based measure of association and is usually used for 2x2 tables
- The Contingency Coefficient (Pearson's C). The contingency coefficient is an adjustment to phi, intended to adapt it to tables larger than 2-by-2.
- Somers' d is a popular coefficient for ordinal measures (both X and Y).
  - Two variants: symmetric and Y dependant on X (but less the other way round).

Statistical significance tests

- Pearson's chi-square is by far the most common.
  - If simply "chi-square" is mentioned, it is probably Pearson's chi-square.
  - This statistic is used to test the hypothesis of no association of columns and rows in tabular data. It can be used with nominal data.

Coefficients for the data above

Values	Somer's D	Significance
Symmetric	-.210	.025
Y = Search information on the Internet - Dependent	-.215	.025

7. Simple analysis of variance

Analysis of variance (and its multivariate variants Anova and Manova) are the favorite tools of the experimentalists.

- X is an experimental condition (therefore a nominal variable)
- Y usually is an interval variable.
  - E.g. Does presence or absence of ICT usage influence grades ?
- You can show that X has an influence on Y if the means of different groups (e.g. ICT vs. non-ICT users) are significantly different.

Significance improves when:

- means of the X groups are different (the further apart the better)
- variance inside X groups is low (certainly lower than the overall variance)

Coefficients

- Standard deviations for each group and for the global sample.
  - As explained above, the standard deviation tells how far from the mean point is the "average" individual.
- Eta is a correlation coefficient
- Eta square measures the explained variance

Example 3. **Analysis of variance**

We want to know if teacher trainees are different from real teachers regarding classroom activities. We look at three kinds of variables:

- The frequency of different kinds of learner activities (COP1)
- The frequency of exploratory activities outside the classroom (COP2)
- The frequency of individual student work (COP3)

Population		COP1 Frequency of different kinds of learner activities	COP2 Frequency of exploratory activities outside the classroom	COP3 Frequency of individual student work
1 Teacher trainee	Mean	1.528	1.042	.885
	N	48	48	48
	Std. Deviation	.6258	.6260	.5765
2 Regular teacher	Mean	1.816	1.224	1.224
	N	38	38	38
	Std. Deviation	.3440	.4302	.5893
Total	Mean	1.655	1.122	1.035
	N	86	86	86
	Std. Deviation	.5374	.5527	.6029

- Differences between means are weak !

... See next slides for coefficients

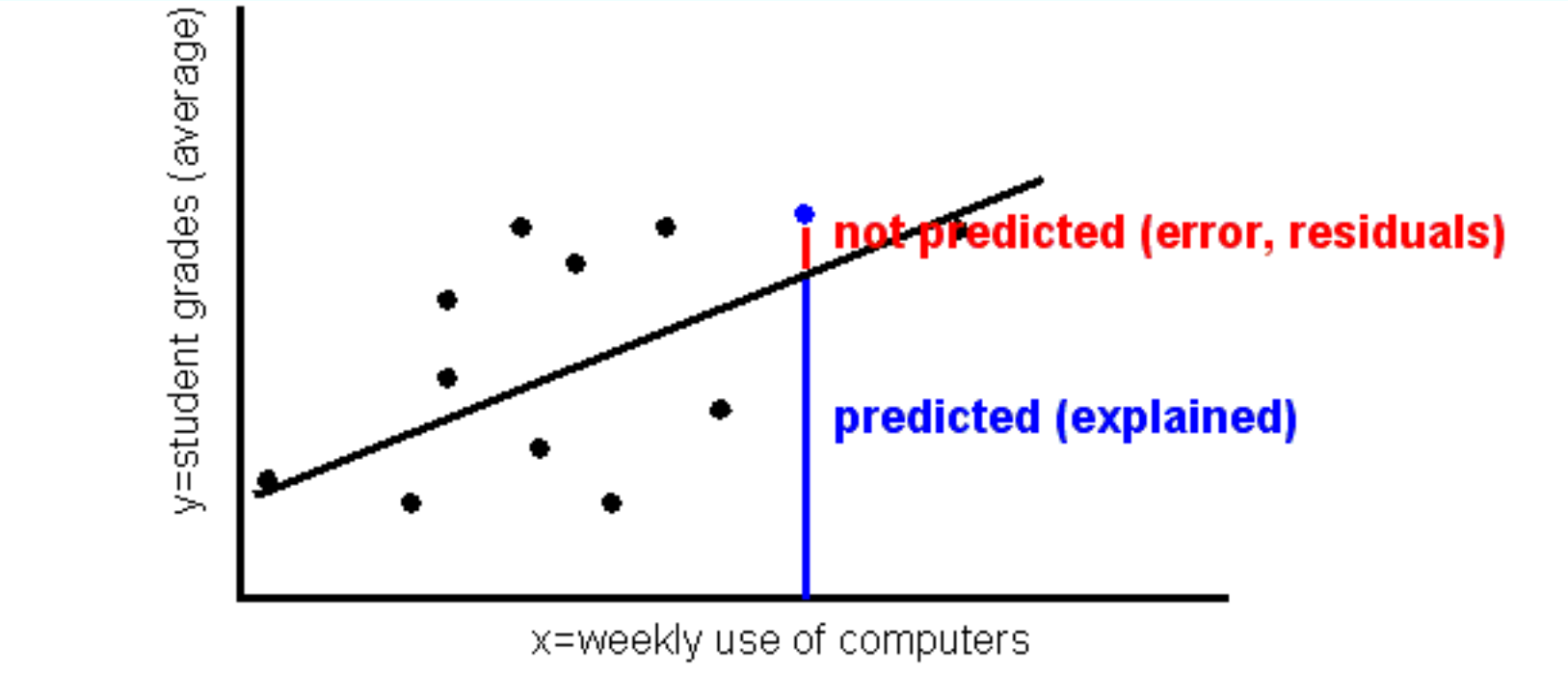
Coefficients

- Coefficients tell the same story:
  - All relationships are weak
  - Population X COP2 is not significant

Variables (Y) explained by population (X)		Sum of Squares	df	Mean Square	F	Sig.
COP1 Frequency of different kinds of learner activities * Population	Between Groups	1.759	1	1.759	6.486	.013
	Within Groups	22.785	84	.271		
	Total	24.544	85			
COP2 Frequency of exploratory activities outside the classroom * Population	Between Groups	.703	1	.703	2.336	.130
	Within Groups	25.265	84	.301		
	Total	25.968	85			
COP3 Frequency of individual student work * Population	Between Groups	2.427	1	2.427	7.161	.009
	Within Groups	28.468	84	339		
	Total	30.895	85			

	Eta	Eta Squared
Var_COP1 Frequency of different kinds of learner activities * Population	.268	.072
Var_COP2 Frequency of exploratory activities outside the classroom * Population	.164	.027
Var_COP3 Frequency of individual student work * Population	.280	.079

8. Regression Analysis and Pearson Correlations



DATA = *predicted* regression line + *residuals* (unexplained noise)

- The two *regression coefficients* summarize the model, i.e. describe the line.

Y = A + X * B

  - B represents the slope of the line
  - A is a constant and represents the offset from 0
- The *Pearson correlation (r)* summarizes the strength of the relation
- *R square* (R^2) represents the variance explained.

Example 4. **Does teacher age explain outside classroom activities ?**

- Independant variable X: Age of teacher
- Dependent variable Y: Frequency of exploratory activities organized outside the classroom

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate	Pearson Correlation	Sig. (1-tailed)	N
.316	.100	.075	.4138	.316	.027	38

Model Coefficients

	Coefficients		Stand. coeff.	t	Sig.	Correlations
	B	Std. Error	Beta			Zero-order
(Constant)	.706	.268		2.639	.012	
AGE Age	.013	.006	.316	1.999	.053	.316

Dependent Variable: Var_COP2 Frequency of exploratory activities organized outside the classroom

(see next slide)

All this means:

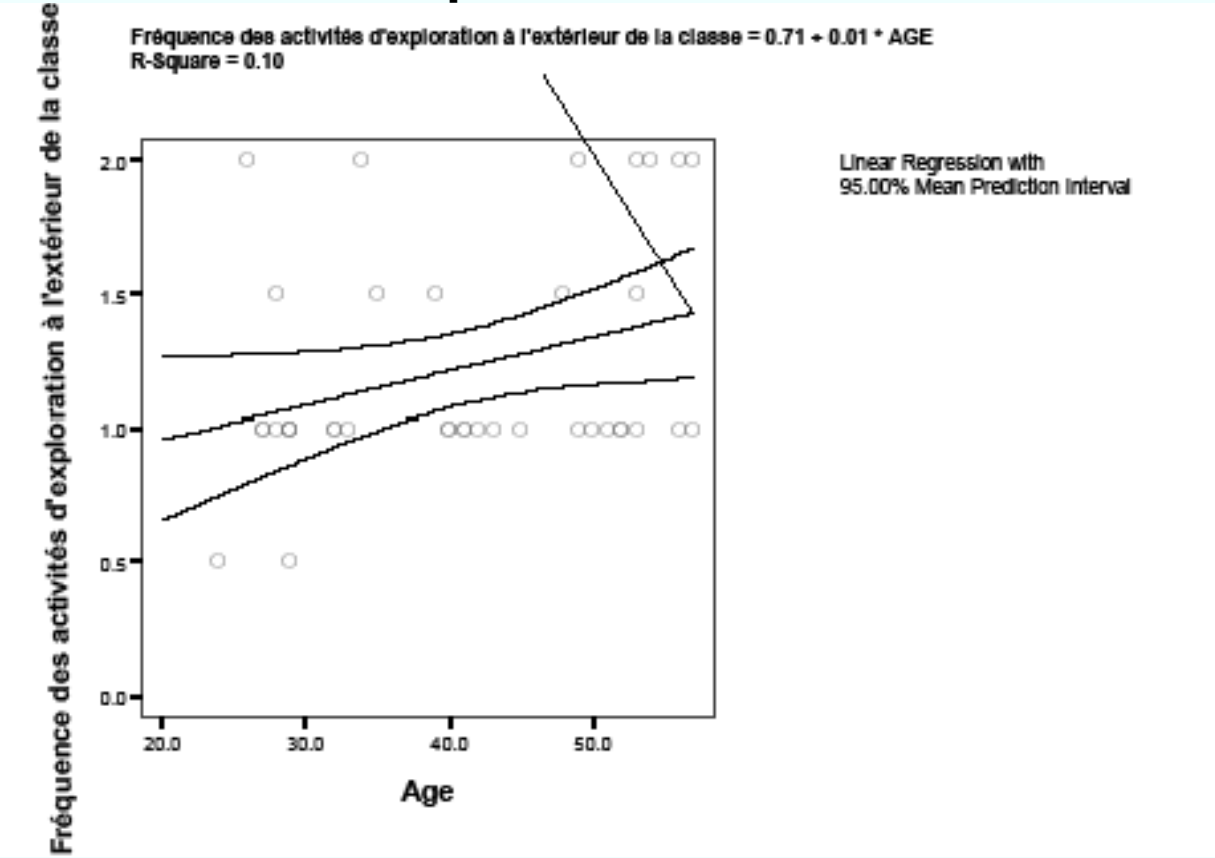
- We have a week relation (.316) between age and exploratory activities.
- It is significant (.027)

Formally the relation is:

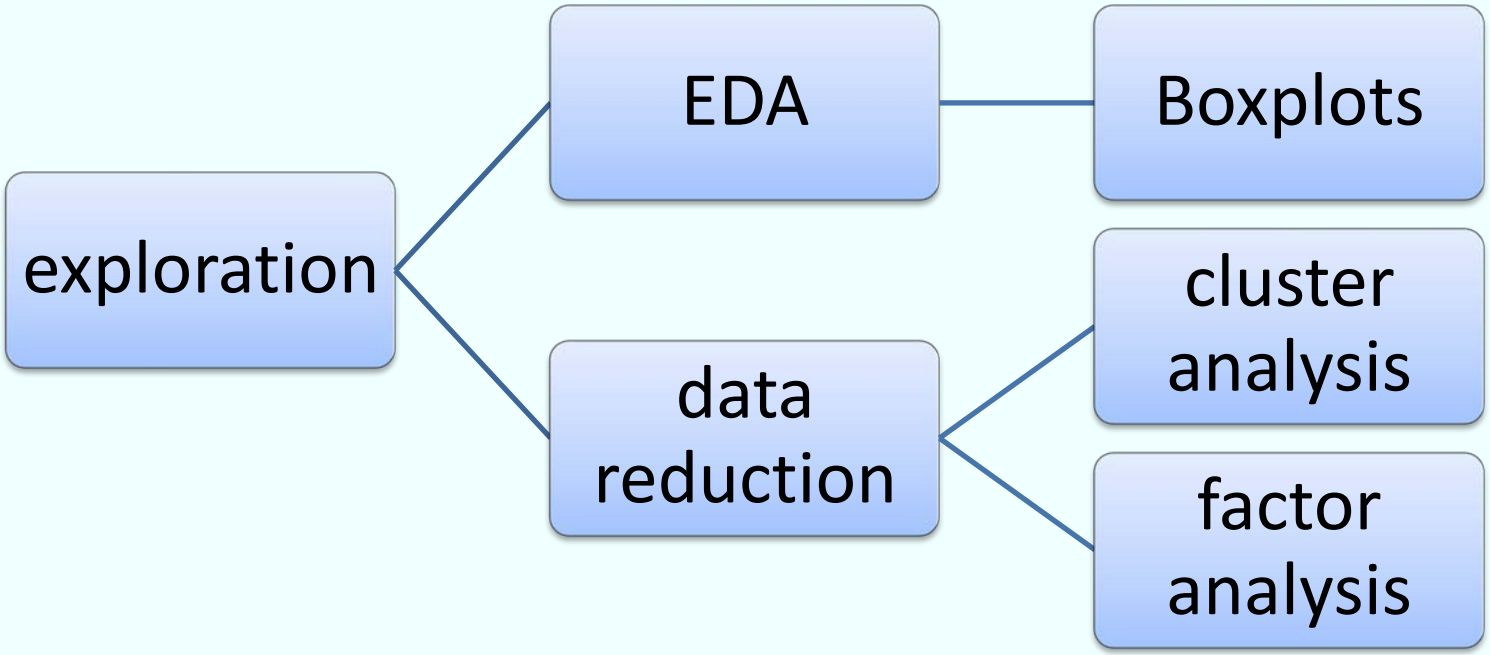
Exploratory outside classroom activities = .705 + 0.013 * AGE

(only people over 99 are predicted a top score of 2)

Here is a scatter plot of this relation



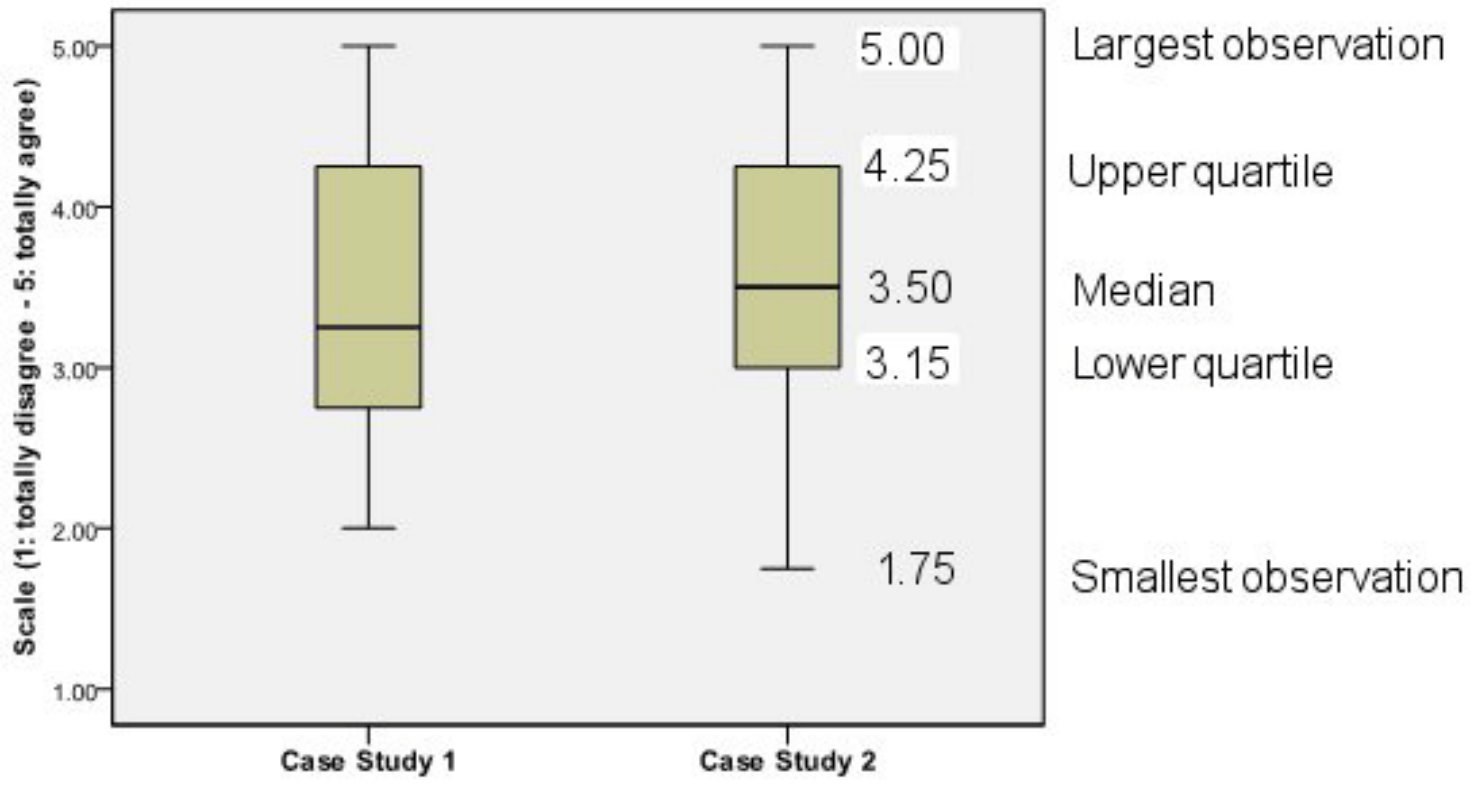
Chapter 16: Exploratory data analysis and data reduction



1. Purpose of exploratory data analysis

- Suggest hypotheses about the causes of observed phenomena
- Assess assumptions on which statistical inference will be based
- Support the selection of appropriate statistical tools and techniques
- Provide a basis for further data collection through surveys or experiments

A popular tool are Boxplots

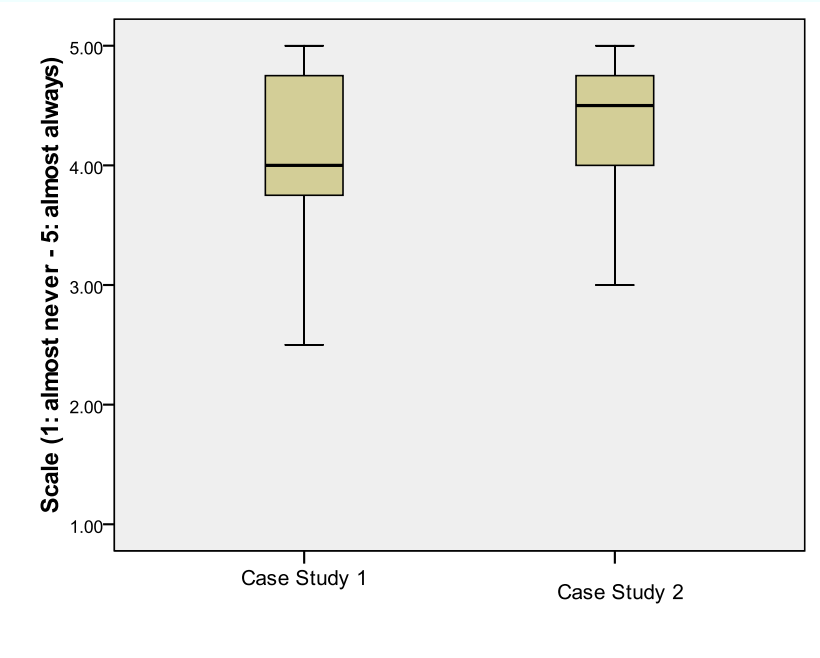


- Tip: Rather use boxplots than pie charts and such in case and design studies

Example 1. **Boxplot about tutoring support**

Source: Study of a blended socio-constructivist conference interpreters trainers training course empowered by an activity based, collaborative learning.

The boxplot shows distribution of a tutoring support index variable for two different case studies.



- In case study 1, the distribution is high, varying between 2.50 (halfway between disagree and somewhat agree) and 5 (totally agree). The typical learner agrees (median=4) that teaching staff stimulated and encouraged learning enterprise.
- In Case Study 2, distribution is smaller.
- Whiskers are dissymmetrical in both, the lower whisker being much longer than the upper one, observations are negatively skewed.

2. Cluster Analysis

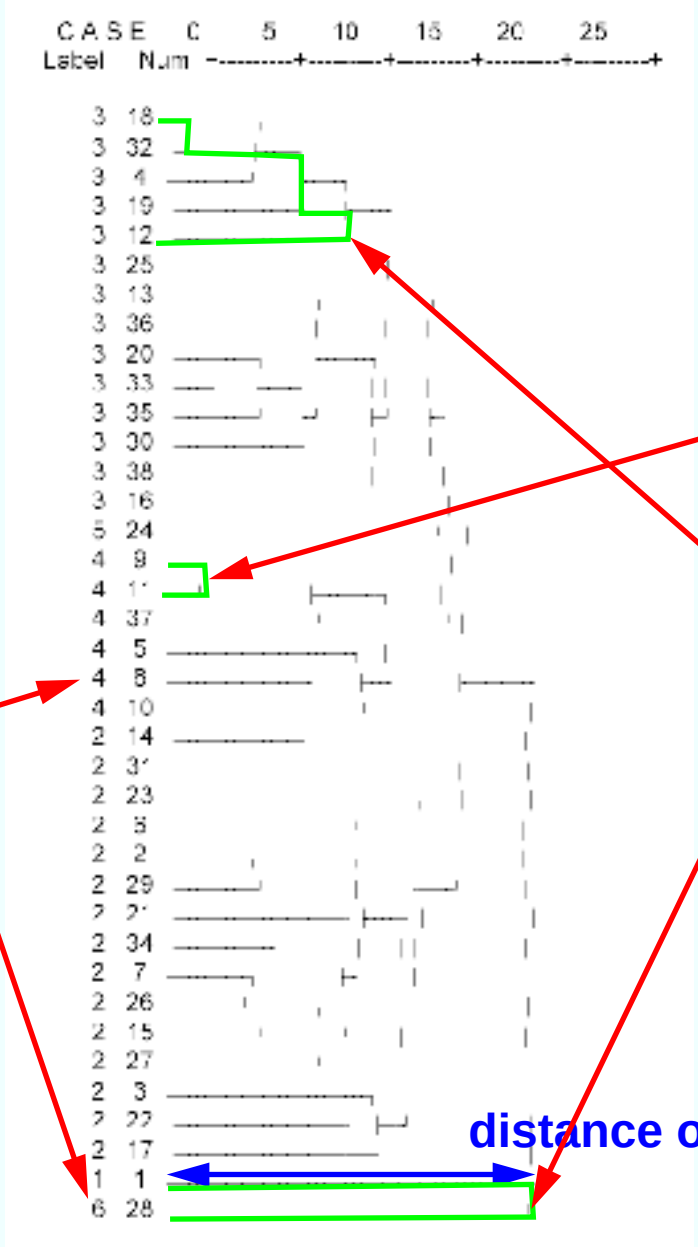
- Cluster analysis or classification refers to a set of multivariate methods for grouping elements (subjects or variables) from some finite set into clusters of similar elements (subjects or variables).
- There are 2 different kinds: hierarchical cluster analysis and K-means cluster.
- Typical examples: Classify teachers into 4 to 6 different groups regarding ICT usage

Example 2. **Teacher types computed from 36 survey questions**

- Type 1 : The "convinced teacher"
- Type 2 : The "active teacher"
- Type 3 : The "motivated teacher working within a bad environment"
- Type 4 : The "willing but not ICT-compentent teacher"
- Type 5 : The "ICT-competent teacher unwilling to use ICT in the class"
- Type 6 : The "Willing and relatively weak in ICT teacher"

(see next two slides)

Dendogram (tree diagram of the population)



vertical ordering
is of no importance

case 9 and case 11 are
very close

case 18 and case 12 are
quite close

cluster
number

case 1 and case 6
are very different

distance of cases (horizonal)

The table below shows some variables and means for cluster types

	Means for type [number of teachers]					
	1 [1]	2 [15]	3 [14]	4 [6]	5 [1]	6 [1]
Importance attributed to student collaboration and help tools	4.7	2.1	1.5	2.9	.0	5.0
Importance attributed to student communication tools	4.0	2.4	1.7	2.7	1.0	4.3
Effects of computer use to prepare and manage teaching	3.0	2.9	2.2	2.8	2.3	2.3
Importance of ICT use in the classroom	.0	2.7	1.9	2.3	1.0	3.0
Advanced computer hardware that teachers own at home.	.5	.8	.4	.3	1.0	.0
Level of ICT competence in documentation and communication tools	2.3	2.6	2.3	1.7	3.0	1.8
Variety of learner activities	1.3	1.8	1.9	1.7	2.0	1.0
Satisfaction with the ICT environment in the school	2.0	.8	.6	.0	.5	.0
Consultation et production de documents	.4	.9	.6	1.0	.6	1.2
Use of learning software in the classroom	2.0	1.7	.9	1.5	1.0	2.0

3. Factor analysis

- Factor analysis and principal component analysis (PCA) transform a number of possibly correlated variables into a smaller number of factors, called principal components. Like cluster analysis, factor analysis reduces dimensions.
- The first component explains as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible.

Example 3. **PISA ICT capabilities of Swiss youngsters**

- 16 survey questions “How well can you do each of these tasks on a computer?”
- With a principal component analysis we extracted four factors
- They explain about 62% of the total variance as the following table shows:

Total Variance Explained

Component	Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	2.777	17.357	17.357
2	2.634	16.462	33.820
3	2.311	14.444	48.263
4	2.223	13.896	62.159

Extraction Method: Principal Component Analysis.

The component matrix shows how each variable is related to each factor

Rotated Component Matrix

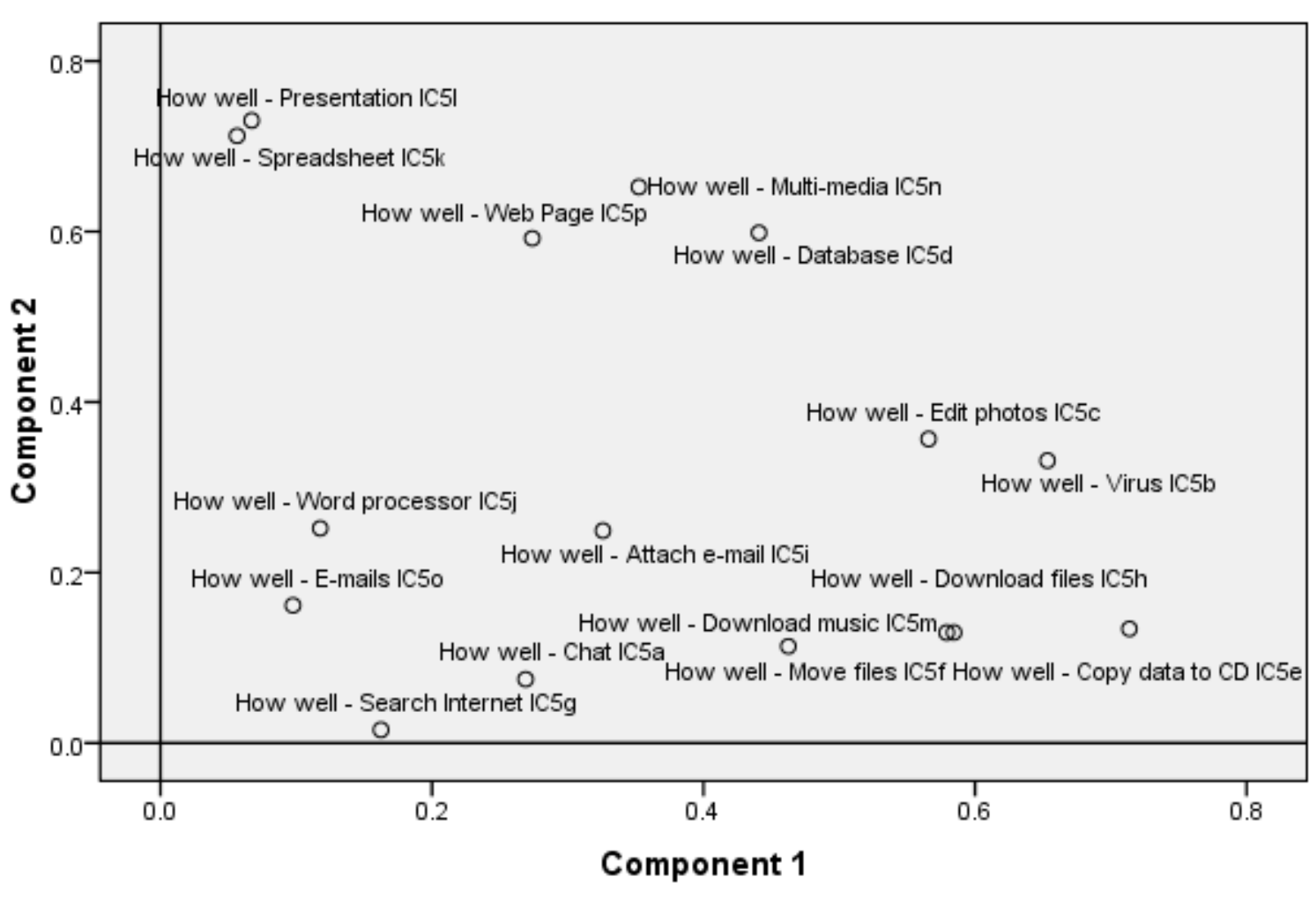
	Component 1	2	3	4
IC05Q01 How well - Chat IC5a	.269	.075	.727	.231
IC05Q02 How well - Virus IC5b	.653	.331	.173	.063
IC05Q03 How well - Edit photos IC5c	.566	.357	.159	.287
IC05Q04 How well - Database IC5d	.441	.599	-.095	.027
IC05Q05 How well - Copy data to CD IC5e	.714	.134	.194	.297
IC05Q06 How well - Move files IC5f	.463	.113	.163	.644
IC05Q07 How well - Search Internet IC5g	.162	.015	.390	.664
IC05Q08 How well - Download files IC5h	.584	.130	.359	.304
IC05Q09 How well - Attach e-mail IC5i	.326	.249	.523	.381
IC05Q10 How well - Word processor IC5j	.118	.252	.187	.734
IC05Q11 How well - Spreadsheet IC5k	.056	.712	.029	.350
IC05Q12 How well - Presentation IC5l	.067	.730	.117	.279
IC05Q13 How well - Download music IC5m	.579	.129	.535	.036
IC05Q14 How well - Multi-media IC5n	.352	.652	.258	-.009
IC05Q15 How well - E-mails IC5o	.098	.161	.753	.379
IC05Q16 How well - Web Page IC5p	.274	.592	.360	-.131

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Interpretation

- Component one could be labeled: Subjective competence in downloading
- Component two could be labeled: Subjective competence in use of production tools
- Component three could be labeled : Subjective competence in Internet use

Component plots for factors show relationships of variables with respect to factors (components)



4. Repertory grid analysis

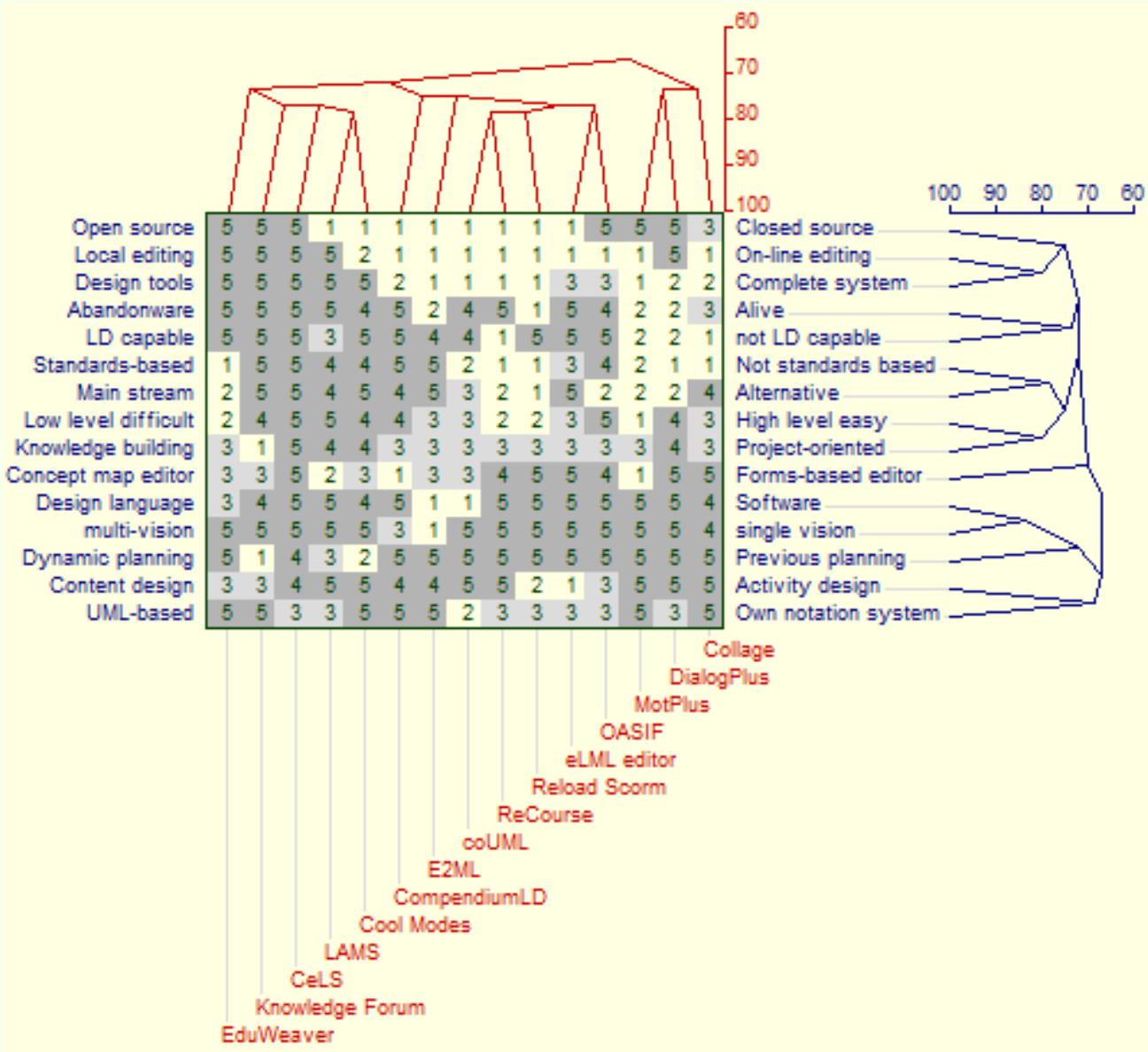
- Repertory grid analysis is a mostly qualitative research method
- It is used to analyze subjective constructs for individuals.

Principle

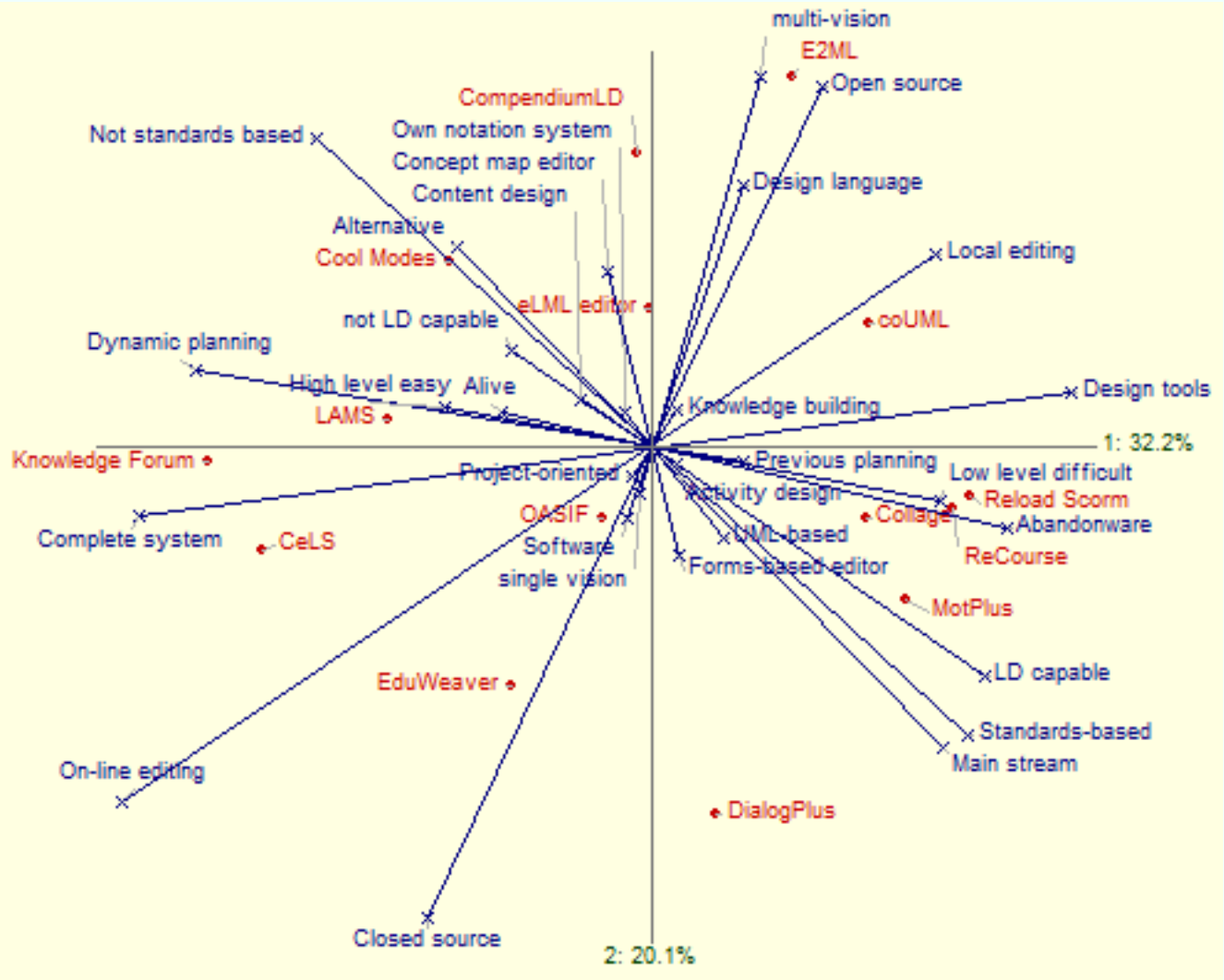
- Elements of a topic (e.g. a set of design languages) are rated according to certain criteria termed constructs.
- Elements and constructs are elicited from the subject by a so-called triadic method.
  - Participants will first name a few elements with which they are familiar, e.g. names of design systems.
  - They have to compare triads of elements, for instance design A with designs B and C, and then state in what aspect two are similar and the third is different.
  - This procedure is repeated with other combinations of elements until no more new constructs are elicited from the user and until all elements can be discriminated in the construct's space.
- The output is a grid, which records a subject's ratings, usually on a 5- or 7-point scale, of *m* elements in terms of *n* constructs.
- This resulting grid can then be analyzed with various data analysis techniques, such as visual inspection, factor and cluster analysis.

Example 4. **A repertory grid about educational design systems**

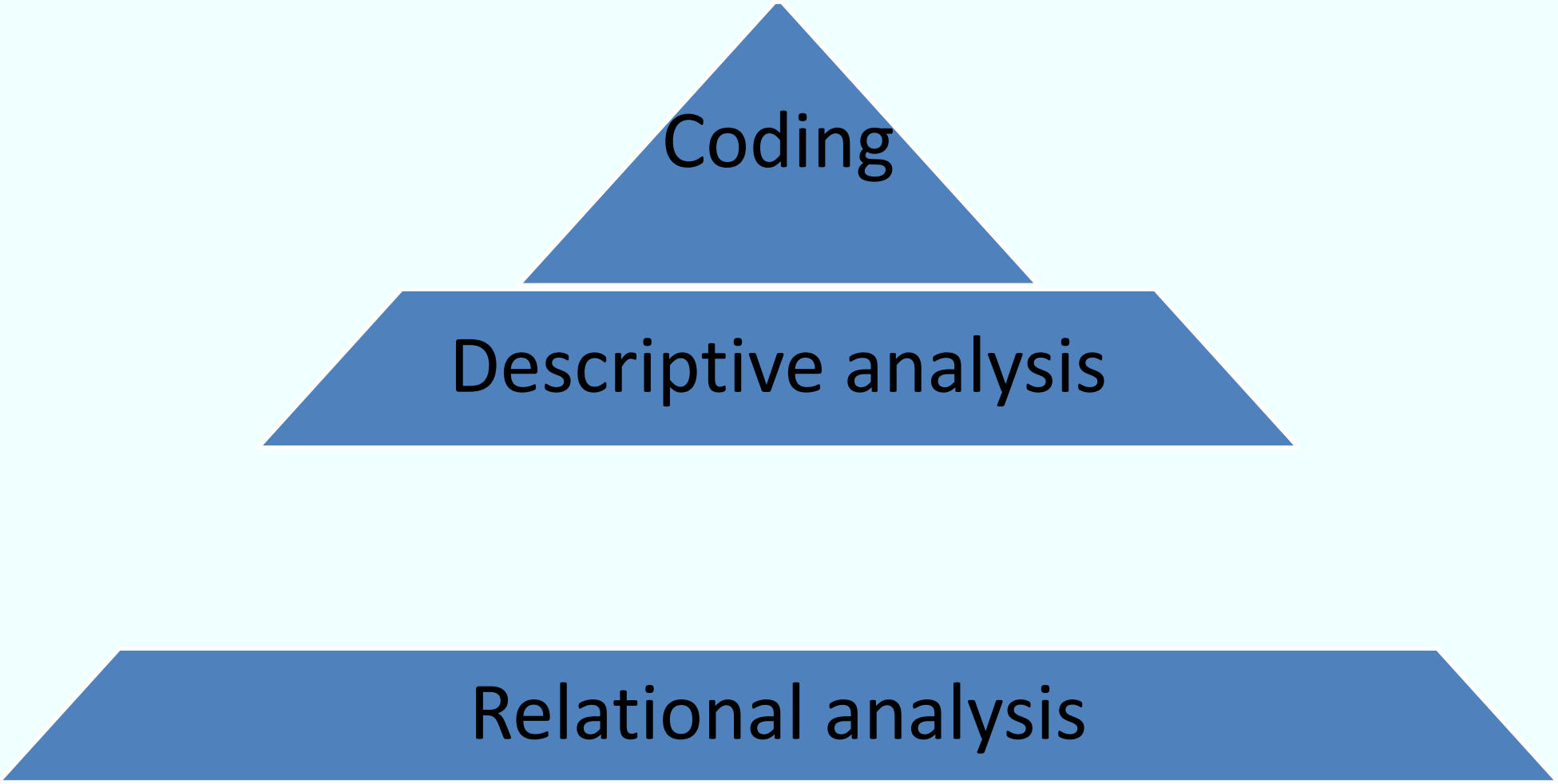
- This plot shows both the repertory grid data for an individual and a two-way (individuals and variables) cluster analysis



Principal component analysis of the same grid



- This 2 components plot also shows cases (in red)


Coding
Descriptive analysis
Relational analysis

1. Introduction: classify, code and index

☞ **Coding and indexing is necessary for systematic data analysis.**

☞ **Information coding allows to identify variables and values, therefore**

- allows for systematic analysis of data (and therefore reliability)
- ensures enhanced construction validity, i.e. that you look at things allowing to measure your concepts

1.1. Keep your documents and ideas safe !

Write memos (conservation of your thoughts)

- if is useful to write short memos (vignettes) when an interesting idea pops up, when you looked at something and want to remember your thoughts

Write contact sheets to allow remembering and finding things

After each contact (telephone, interviews, observations, etc.), make a short data sheet

- Indexed by a clear filename or tag on paper, e.g. CONTACT_senteni_2005_3_25.doc
- type of contact, date, place, and a link to the interview notes, transcripts.
- principal topics discussed and research variables addressed (or pointer to the interview sheet)
- initial interpretative remarks, new speculations, things to discuss next time

Index your interview notes

- Put your transcription (or tapes) in a safe place
- Assign a code to each "text", e.g. INT-1 or INTERVIEW_senteni_3_28-1
- You also may insert the contact sheet (see above)
- number pages !

2. Codes and categories

☞ **A code is a “label” to tag a variable (concept) and/or a value**
Anything can be code, but mostly it will be text.

Basics:

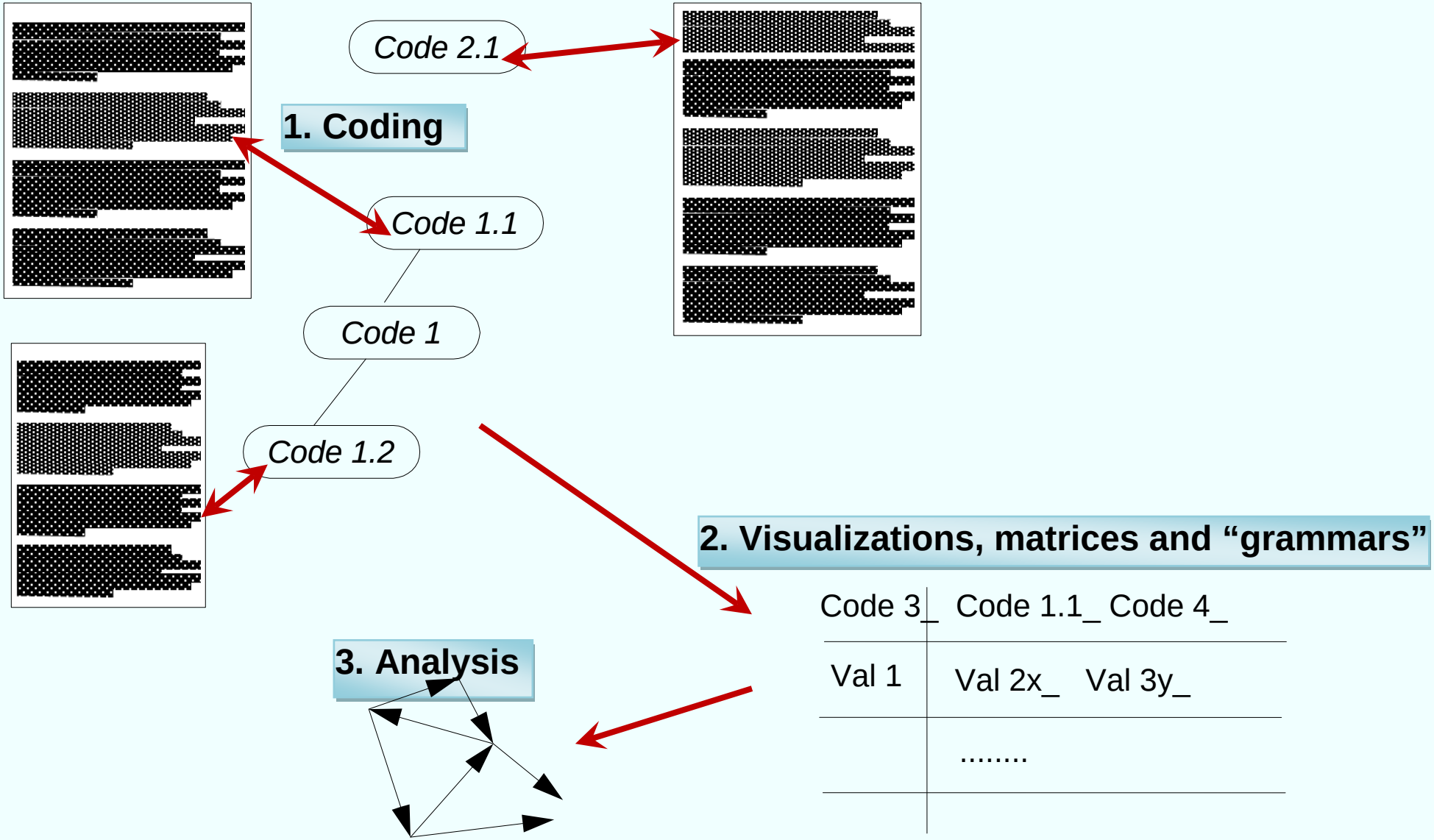
2. A code is assigned to each (sub)category you work on
   - In other words: you must identify ***variable names***
2. In addition, you can for each code assign a set of possible values (e.g.: “positive”/”neutral/”negative)
3. You then will systematically scan all your texts (documents, interview transcripts, dialogue captures, etc.) and tag all occurrences of variables.

- Three very different coding strategies exist
  - Code-book creation according to theory
  - Coding by induction (according to “grounded theory”)
  - Coding by ontological categories
-

Benefit

- Coding will allow you to find all informations regarding variables of interest to your research
- Reliability will be improved

2.1 The procedure with a picture



2.1. **Technical Aspects**

- The safest way to code is to use specialized software
  - e.g. Atlas or Nvivo (NuDist),
  - however, this takes a lot of time !
- For a smaller piece (of type master), we suggest to simply tag the text on paper
  - you can make a reduced ***photocopy*** of the texts to gain some space in the margins
  - overline or circle the text elements you can match to a variable
  - make sure to distinguish between codes and other marks you may leave.
- Don't use "flat" and long code-books, introduce hierarchy (according to dimensions identified)
- Each code should be short but also mnemonic (optimize)
  - e.g. to code according to a schema "principal category" - "sub-category" ("value"):

CE-CLIM(+)

instead of: external_context -climate (positive)

- Don't start coding before you have good idea on your coding strategy !
  - either your code book is determined by you research questions and associated theories, frameworks, analysis grids
  - or you really learn how to use an inductive strategy like "grounded theory".

3. Code-book creation and management

3.1. Code-book creation according to theory

☞ **The list of variables (and their codes), is defined by theoretical reasoning, e.g.**

- analytical frameworks, analysis grids
- concepts found in the list of research questions and/or hypothesis

Example from an innovation study (about 100 codes):

	categories	codes	theoretical references
properties of the innovation		PI	.... (fill for your own code book) .....
external context		CE	
	demography	CE-D	
	support for the reform	CE-S	
internal context		CI	
adoption processes		PA	
	official chronology	PA-CO	
dynamics of the studied site		DS	
external and internal assistance		AEI	
causal links		LC	

3.2. Coding by induction (according to “grounded theory”)

☞ **Principle:**

- The researcher starts by coding a small data set and then increases the sample in function of emerging theoretical questions
- Categories (codes) can be revised at any time

Starting point = 4 big abstract observation categories:

- conditions (causes of a perceived phenomenon)
- interactions between actors
- strategies and tactics used by actors
- consequences of actions

(... many more details: to use this approach you ***really*** must document yourself)

3.3. Coding by ontological categories

Example:

Types	
Context/Situation	information on the context
Definition of the situation	interpretation of the analyzed situation by people
Perspectives	global views of the situation
Ways to look at people and objects	detailed perceptions of certain elements
Processes	sequences of events, flow, transitions, turning points, etc.
Activities	structures of regular behaviors
Events	specific activities (non regular ones)
Strategies	ways of tackling a problem (strategies, methods, techniques)
Relations and social structure	informal links
Methods	comments (annotations) of the researcher

- This is a compromise between “grounded theory” and “theory driven” approaches

3.4. **Pattern codes**

- Some researchers also code patterns (relationships)

☞ *Simple* **encoding (above) breaks data down to atoms, categories)**
"*pattern coding***" identifies relationships between atoms.**

The ultimate goal is to detect (and code) regularities, but also variations and singularities.

Some suggested operations:

1. Detection of ***co-presence*** between two values of two variables
   - E.g. people in favor of a new technology (e.g. ICT in the classroom) have a tendency to use it.
2. Detection of ***exceptions***
   - e.g. technology-friendly teachers who don't use it in the classroom
   - In this case you may introduce new variable to explain the exception, e.g. the attitude of the superior., of the group culture, the administration, etc.
   - Exceptions also may provoke a change of analysis level (e.g. from individual to organization)

Attention: a co-presence does not prove causality

4. Descriptive matrices and graphics

Qualitative analysis attempts to detect structure in data

(as in exploratory quantitative techniques)

In short: *Analysis* **=** *visualization*

☞ **2 types of analyses:**

1. A ***matrix*** is a tabulation engaging at least one variable, e.g.
   - Tabulations of central variables by case
     (equivalent to simple descriptive statistics like histograms)
   - Crosstabulations allowing to analyze how 2 variables interact
2. Graphs (***networks***) allow to visualize links:
   - temporal links between events
   - causal links between several variables
   - etc.

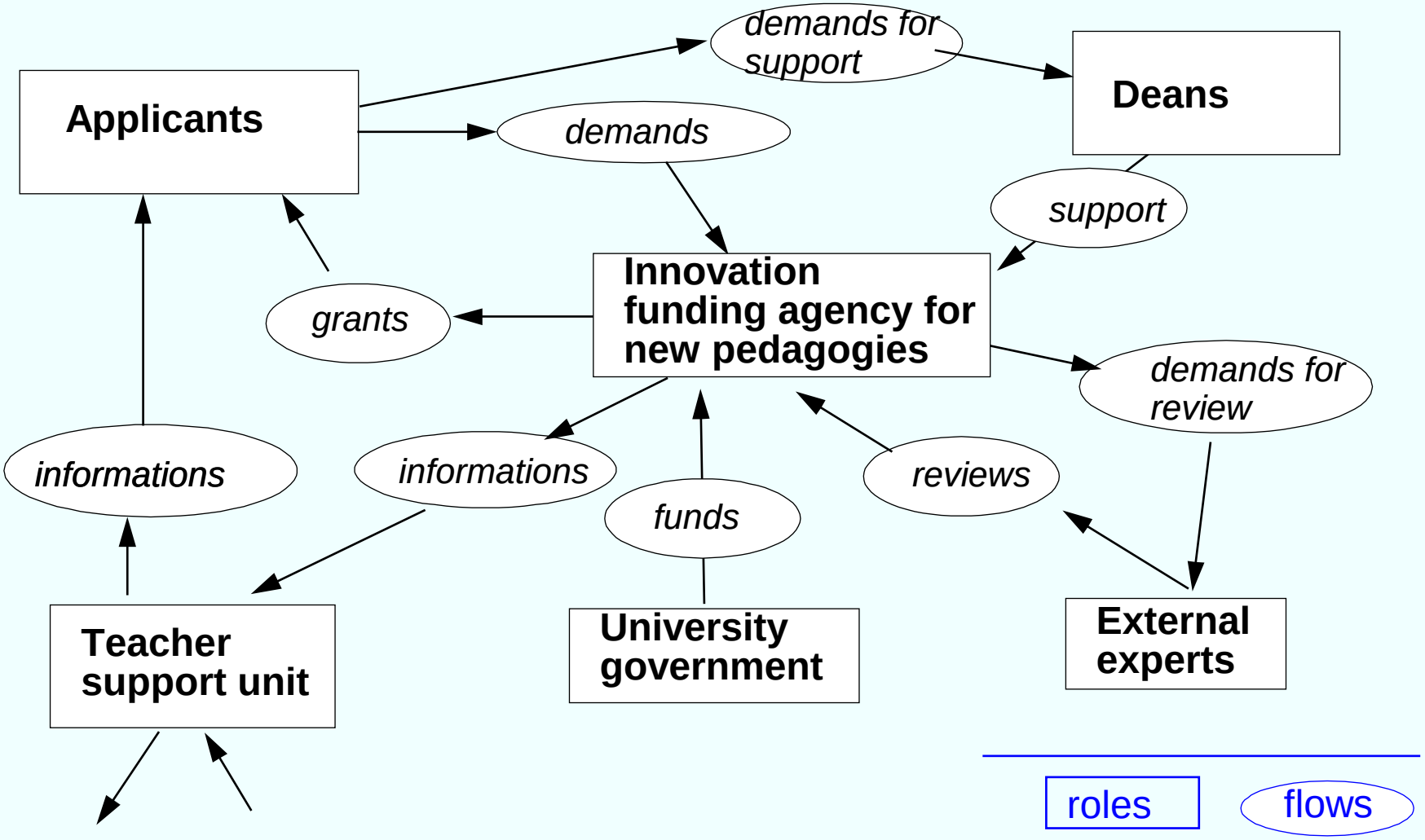
☞ **Some advice:**

- when use these techniques always keep a link to the source (coded data)
- try to fit each matrix or graph on a ***single page*** (or make sure that you can print things made by computer on a A3 pages)
- you have to favor synthetic vision, but still preserve enough detail to make your artifact interpretable
- Consult specialized manuals e.g. Miles & Huberman, 1994 for recipes or get inspirations from qualitative research in the same domain

4.1. The “context chart”,Miles & Huberman (1994:102)

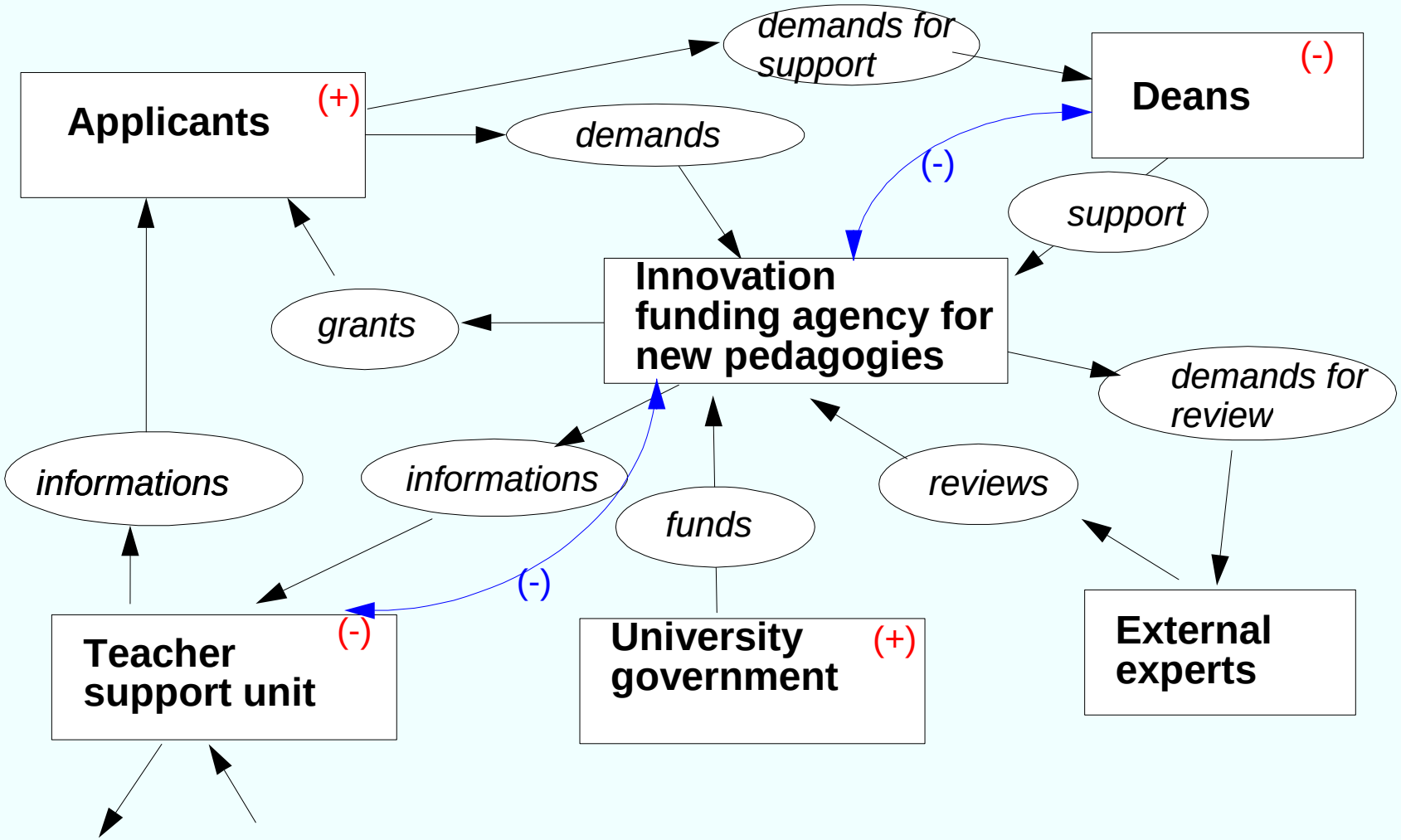
☞ **Allows to visualize relations and information flows between rôles and groups**

Example 1. **A new pedagogies program at some university**



- There exist codified "languages" for this type of analysis, e.g. UML or OSSAD

Once you have clearly identifed and clarified formal relations, you can use the graph to make annotations (like below)



(+) (-) () positive or negative attitudes towards a legal program

+ / _ good or bad relations between authorities (or people)

4.2. Check-lists, Miles & Huberman (1994:105)

☞ **Usage: Detailed summary for an analysis of an important variable**

Example: "external support is important for succeeding a reform project

Examples for external support	At counselor level	At teacher level
Analysis of deficiencies	**Fill in each cell as below**	
Teaching training		
Change monitoring		
Incentives		
Group dynamics	adequate: "we have met an organizer 3 times and it has helped us" (ENT-12:10)	not adequate: "we just have informed" (ENT-13:20)
etc. ..		

- such a table displays various dimensions of and important variable (external support), e.g. in the example = left column
- in the other columns we insert summarized ***facts*** as reported by different roles.
- Question: Imagine how you would build such a grid to summarize teacher's, student's and assistant's opinion about technical support for an e-learning platform

4.3. Chronological tables Miles & Huberman (1994:110)

- Can summarize a studied object's most important events in time

Exemple 4-2: Task assignments for a blended project-oriented class

	Activity	Date	imposed tools (products)
1	Get familiar with the subject	21-NOV-2002	links, wiki, blog
2	project ideas, Q&R	29-NOV-2002	classroom
3	Students formulate project ideas	02-DEC-2002	news engine, blog
4	Start project definition	05-DEC-2002	ePBL, blog
5	Finish provisional research plan	06-DEC-2002	ePBL, blog
6	Finish research plan	11-DEC-2002	ePBL, blog
7	Sharing	17-DEC-2002	links, blog, annotation
8	audit	20-DEC-2002	ePBL, blog
9	audit	10-JAN-2003	ePBL, blog
10	Finish paper and product	16-JAN-2003	ePBL, blog
11	Presentation of work	16-JAN-2003	classroom

- This type of table is useful to identify important events.
- You can add other information, e.g. tools used in this example

4.4. Matrices for roles (function in an organization or program)

Miles & Huberman (1994:124)

Crossing social roles with one or more variables, abstract example

(also see next page)

roles	persons	variable 1	variable 2	variable 3
role 1	person 1	cells are filled in with values (pointing to the source)		
	person 2			
	.....			
role 2	person 9			
	person 10			
.....	.....			
role n	person n			
	.....			

Crossing roles with roles

	rôle 1	...	rôle 3
rôle 1	fill in all sorts of informations about interactions		
...			
rôle 3			

Example 2. **Evaluation of the implementation of a help desk software**

Actor	*Evalu-ation*	*assistance given*	*Assistance received*	*Immediate effects*	*Long term effects*	*Explanation of the researcher*
Manager	-	-	-	demotivating	threatened the program	Felt threatened by new procedures
Consultant	+	help choosing the right soft. involved himself	-	contributed to the start of the experiment	-	....
"Help-desk worker"	+/-	debugging of machines, little help with software		better job satisfaction because of the tool	slight improvement of throughput	is still overloaded with work
Users	+/-	A few users provided help to peers with the tool	debugging of machines, little help with software	Were made aware of the high amount of unanswered questions	slight improvement of work performance	....

Crossing between roles to visualize relations:

	role 1	role 1	role 3
role 1			
trainers		“don’t coordinate very much” (1)	Trainer doesn’t receive all the information from role 3(2)
role 3			

5. Techniques to hunt correlations

5.1. Clusters (co-variances of variables, case typologies)

- An idea that certain values should "go together": Hunt co-occurrences in cells
- E.g.: “Can we observe a correlation between expressed ***needs for support*** and expressed ***needs for training*** for a new collaborative platform (data from teachers’s interviews)?

case	var 1	need for support	need for training	need for directives
case 1		important	important	important
case 2		not important	not important	not important
case 3		important	important	important
case 4	yyy	not important	not important	not important
case 5	.....	important	important	important
case 6....		important	not important	not important

- This table shows e.g. that nedd for support and need for training seem to go together, e.g. cases 1,3,5 have association of "important", cases 2 and 4 have association of "not important".
- See next page how we can summarize this sort of information in a crosstab

5.2. Co-variance expressed in a corresponding crosstab:

training needs * support needs		need for support	
		yes	no
need for training	yes	3	1
	no	1	2

- A correlation here: "blue cells" (symmetry) is stronger than "magenta"!
- check with the data on previous slide

5.3. Example typology with the same data:

	Type 1: "anxious"	Type 2: "dependent"	Type 3: "bureaucrats"	Type 4: "autonomists"
case 1	X			
case 2				X
case 3	X			
case 4				X
case 5	X			
case 6		X		
Total	3	1	0	2

- we can observe emergence of 3 types to which we assign "labels"

Example 3. **Qualitative crosstabulation**

- The table shows co-occurrence between values of 2 variables.
- The idea is to find out what effect different types of pressure have on ICT strategies adopted by a school.

	Strategies of a school				
Type of pressure	strategy 1: no reaction	strategy 2: a task force is created	strategy 3: internal training programs are created	strategy 4: resources are reallocated	strat 5: .....
Letters written by parents	(N=4) (p=0.8)	(N=1) (p=0.2)			
Letters written by supervisory boards		(N=2) (p=0.4)	(N=3) (p=0.6)		
newspaper articles				(N=1) (p=100%)	
type ...	.....	....			

5.4. Recall: Interpretation of crosstabulation

Procedure

- calculate the % for each value of the independent variable
  - Note: this can be either the line or the column depending on how you orient your table
- compute the % in the other direction
- We would like to estimate the probability that a given value of the independent (explaining) variable entails a given value of the dependent (explained) variable

	Variable y to explain = Strategies of action			
Explaining variable x	do nothing	send a mail	write a short tutorial	Total
Students making indirect suggestion	4 (80%)	1 (20%)		5 (100 %)
Students explicitly complaining		2 (40%)	3 (60%)	5 (100%)

Interpretation: "... if students explicitly complain, the tutor will react more strongly and engage in more helpful acitities."

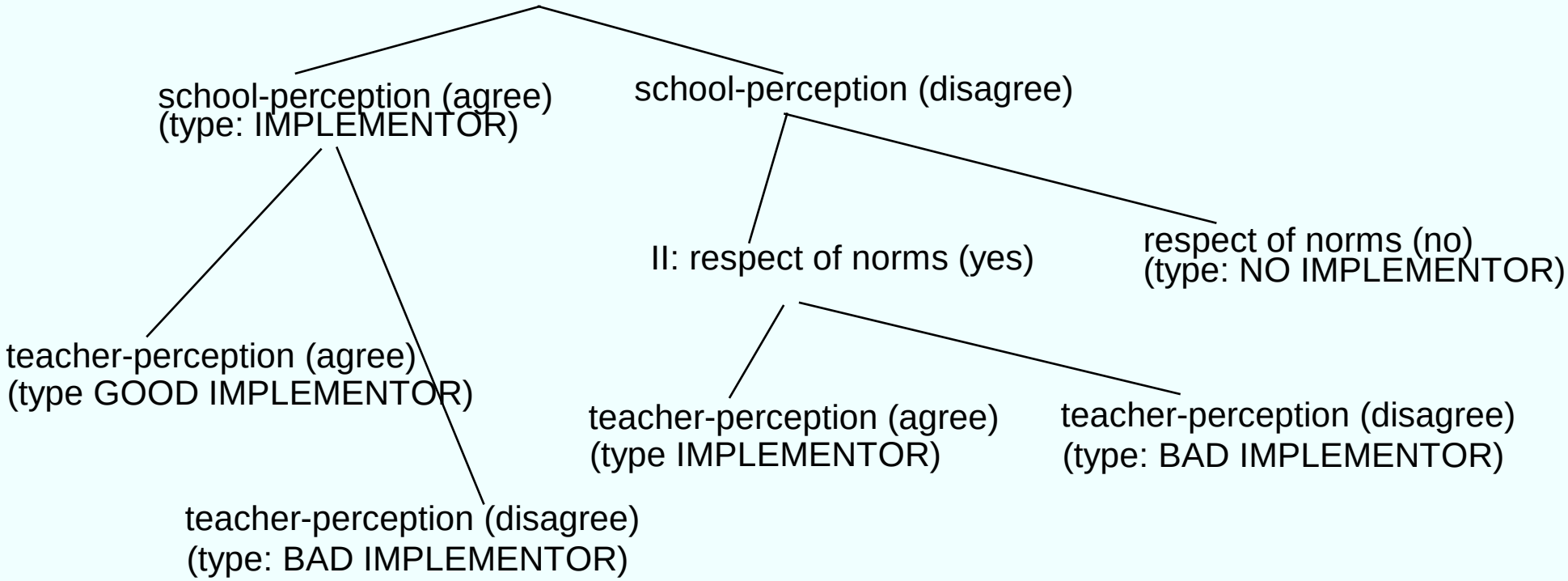
- See also: quantitative data analysis chapter

6. Typology and causality graphs

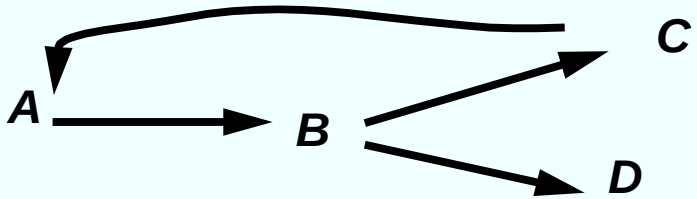
6.1. Typology graphs

- Display attributes of types in a tree-based manner

Exemple 6-1: Perception of a new program by different implementation agencies (e.g. schools) and its actors (e.g. teachers)

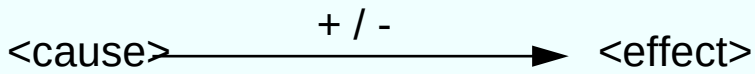


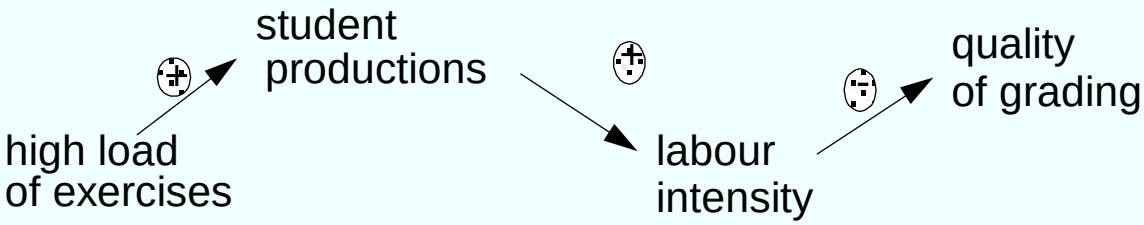
6.2. **Subjective causality graphs**



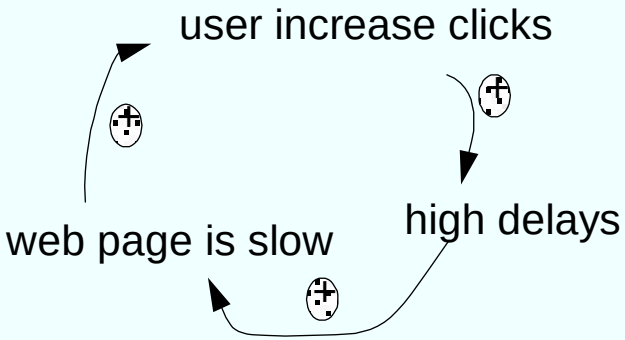
- Cognitive maps à la “operational coding”, AXELROD, 1976
- Allow to compute outcomes of reasoning chains
- Example: Teacher talking about active pedagogies, ICT connections, Forums

About active pedagogies:

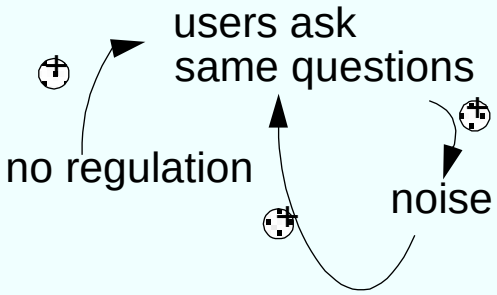




About slow ICT connections:



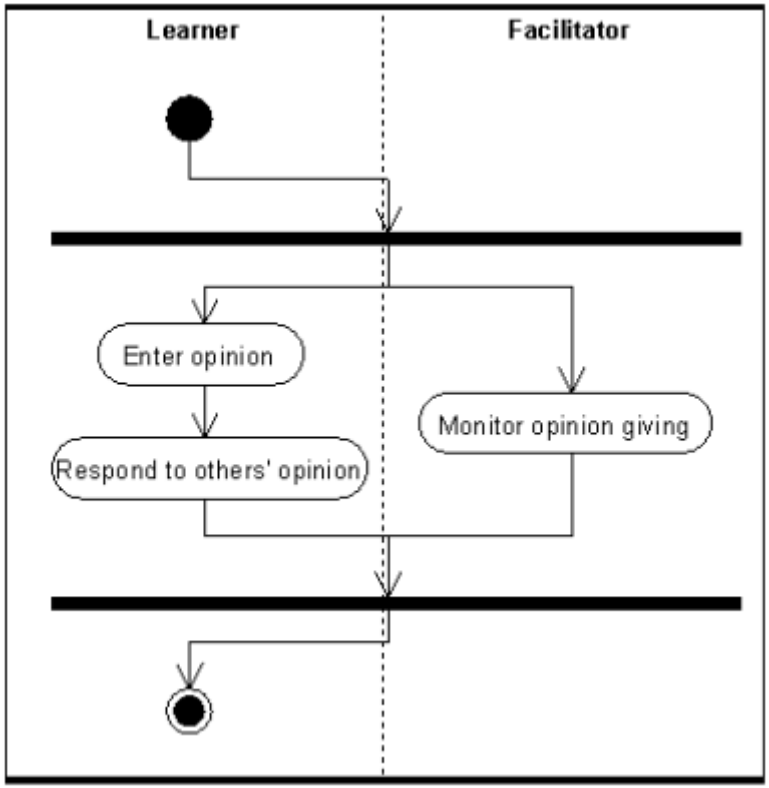
About forum management:



6.3. **UML diagrams**

The Unified Modeling Language (UML) is a object modeling and specification language used in software engineering. UML includes a standardized graphical notation that may be used to create an abstract model of a system.

UML activity diagrams are a popular tool in learning design research to describe learning scenarios. They are used both as analysis and design exchange language.



(see also the chapter on design research …)

Chapter 18: Conclusion

1. You should engage in authentic exercises in order to learn research methodology, e.g. a master thesis or a serious empirical term paper.
2. Introductory research methodology is well documented. There are many good books.
3. However, educational technology is an inter-disciplinary field and you may get very contrasted advice.
4. Read research papers to find out how similar problems are solved. In addition, you should identify a research journal that publishes papers in your area of interest and then browse through its contents.
5. Become a member of a scientific society, e.g. AECT. You will get a free journal and access to online resources.
6. You likely will need additional resources for learning specific research methods and techniques. If so, you may first try to find online tutorials, but do not neglect your local library. Finally, you may have to buy a book or consider taking a summer school course in research methodology, for example at Essex or Michigan.
7. The author's wiki also may help you finding extra information:

http://edutechwiki.unige.ch/en/

http://edutechwiki.unige.ch/en/Research_methodology_resources