Designing a research methodology based on a theory
of learning: A practical case in teacher training

Pedro Gómez
Universidad de Granada

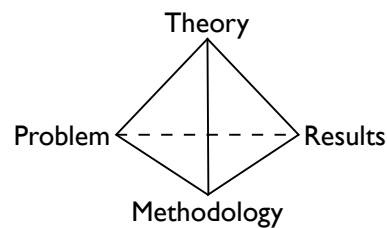Aalborg, September 4, 2004

1

Purpose

- To show and discuss an example of:
  - choosing a theory of learning and
  - designing a methodology, based on that theory, for exploring a phenomenon
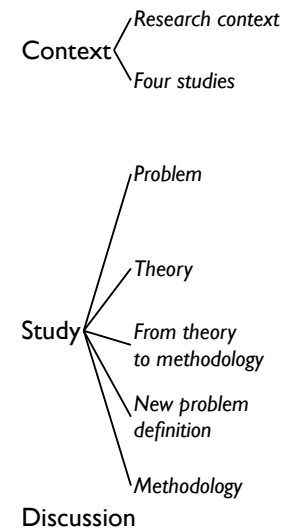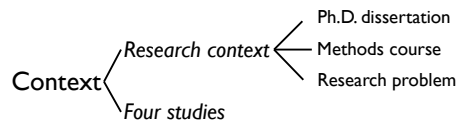
2

Some of the problems of research

- Finding and defining a problem
- Choosing a theory
- Making the theory operational
- Constructing coding and analyzing instruments
- Using and refining the instruments
- Producing results
- Interpreting results

Theory

Problem ← – – – – – → Results

Methodology

3

Context
- Research context
- Four studies

Study
- Problem
- Theory
- From theory to methodology
- New problem definition
- Methodology

Discussion

4

Slide 5

Context — *Research context* — Ph.D. dissertation
               — Methods course
               — Research problem
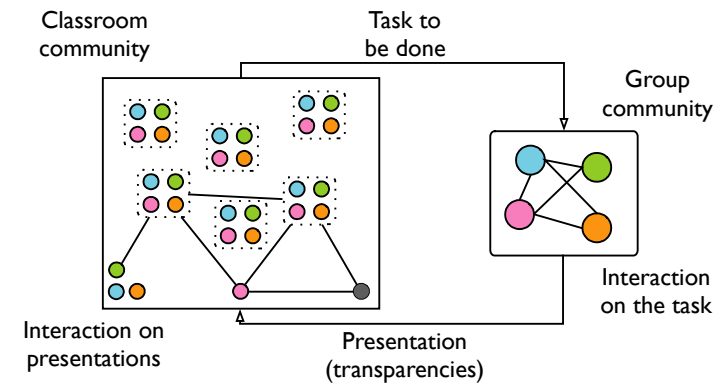   — *Four studies*

Study

Discussion

Slide 6

Research context

- Ph.D. dissertation
- Didactical knowledge development in a pre-service teacher training program

- Methods course

  - Last year mathematics students with no teaching experience

  - Centered on curriculum design

  - History of mathematics education, curriculum, foundations of school mathematics and curriculum organizers

Slide 7

Working methodology

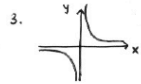- Pre-service teachers organized in groups
- Each group choses a topic

Slide 8

Classroom community

Task to be done

Group community

Interaction on the task

Interaction on presentations

Presentation (transparencies)

HIPÉRBOLA

$L\,^{14}_{2}$

1. Lugar geométrico de los puntos del plano cuya diferencia de distancias a 2 puntos fijos es constante.

2.

← EJE FOCAL
← FOCO

3.

4. $\dfrac{x^2}{a^2} - \dfrac{y^2}{b^2} = 1$

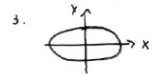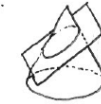5. $f(x,y) = \dfrac{x^2}{a^2} - \dfrac{y^2}{b^2} - 1$
   $f(x,y) = 0$

6.

ELIPSE

1. Lugar geométrico de los puntos del plano cuya suma de distancias a 2 puntos fijos llamados focos es constante.

2.

→ FOCOS

3.

4. $\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} = 1$

5. $f(x,y) = \dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} - 1$
   $f(x,y) = 0$

6.

FUNCIONES DE SEGUNDO GRADO

SIMBÓLICO — GRÁFICA — FENOMENOLOGÍA

FORMAS DE EXPRESIÓN
- FORMA GRAL: $f(x) = ax^2 + bx + c$
- FORMA MULTIPLICATIVA: $f(x) = (x - c_0)(x - c_1)$ (c_0, c_1 ceros de f).
- CORTES CON UN CONO: (CÓNICAS)

CEROS DE LA FUNCIÓN
- CORTES CON EL EJE OX
- $c_0, c_1 = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

VÉRTICE: $v = \left(-\dfrac{b}{2a}, \dfrac{4ac - b^2}{4a} \right)$
- MÁXIMOS
- MÍNIMOS

CONCAVIDAD: $a > 0$
CONVEXIDAD: $a < 0$

EJE DE SIMETRÍA: $x = \dfrac{-b}{2a}$

DOMINIO: $\mathbb{R}$

RECORRIDO:
- $a > 0 \rightarrow \left[\dfrac{4ac - b^2}{4a}, \infty \right)$
- $a < 0 \rightarrow \left(-\infty, \dfrac{4ac - b^2}{4a} \right]$

CONTINUIDAD EN $\mathbb{R}$

CÓNICAS: func. de 2º GRADO EN 2 VARIABLES → Circunf., Elipse...

CUÁDRICAS: func. de 2º GRADO EN 3 VARIABLES → Cono, Cilindro...

ÁREAS, VOLÚMENES, TRIÁNGULOS RECTÁNGULOS Y LA RELAC. ENTRE SUS LADOS...

$\rightarrow h^2 = x^2 + y^2$

$\rightarrow A = \sqrt{3} \cdot \ell^2$ ÁREA DE UN TETRAED.

ANÁLISIS DE CÓNICAS EN FÍSICA PARA RELACIONAR ESPACIO Y TIEMPO

MODELAJE Y SOLUCIÓN DE FENÓMENOS EN BIOLOGÍA, CIENCIAS SOCIALES (ECONOMÍA).

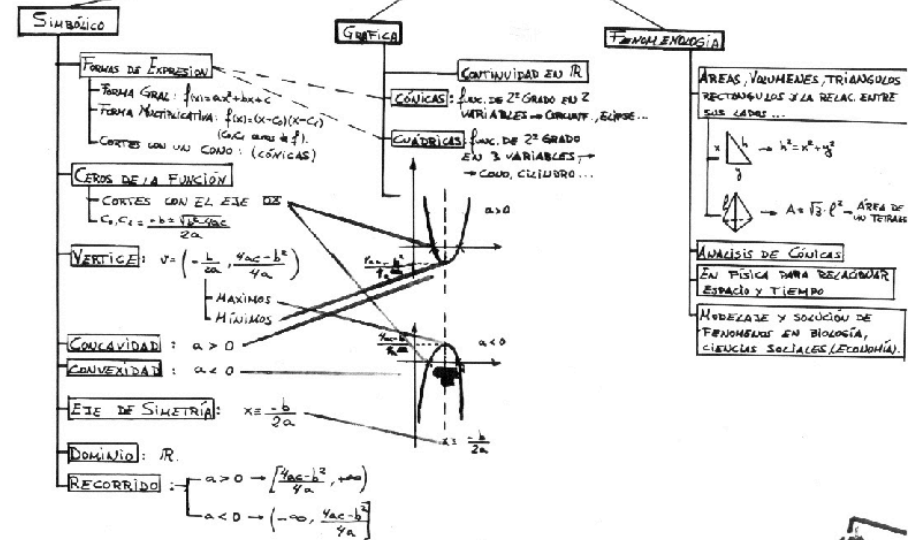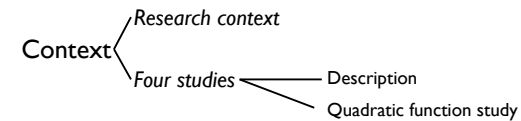
Research problem

- To explore, describe and characterize the evolution in the didactical knowledge of the groups of pre-service teachers on content analysis along the method course

---

Context
- *Research context*
- *Four studies* — Description — Quadratic function study

Study

Discussion

Slide 13

Four studies

Qualitative
Audio recording of group working at home
Process of negotiation of meaning

Presentations

Quantitative
Information in transparencies
Comparing groups
Characterization of stages
Development

One group interaction

Quantitative and qualitative
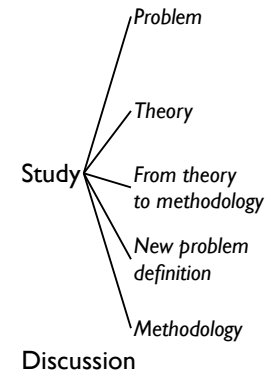Use of content analysis notions
Stage and variables meanings

Didactical unit design

Productions and performance

Qualitative
Specificity of subjects
Transparencies, class
Interactions and interviews
Stages and variables meanings
Social meanings

Slide 14
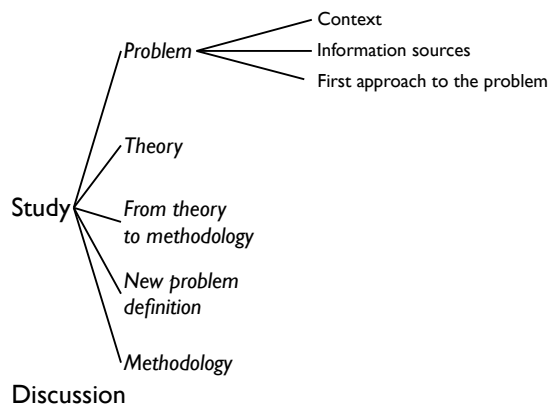
Context

Study — *Problem*
— *Theory*
— *From theory to methodology*
— *New problem definition*
— *Methodology*

Discussion

Slide 15

Context

Study — *Problem* — Context
— Information sources
— First approach to the problem

— *Theory*
— *From theory to methodology*
— *New problem definition*
— *Methodology*

Discussion

Slide 16

Context and information sources

- Selection of a group of pre-service teachers
- Group composition
- Audio recording of group interaction preparing their work
- 950.5 minutes recorded

Example of a transcription

- In the following episode, the group establishes the formula of the aceleration, finding it in a textbook [053,21646,22094]:
  - P3: ( ). Ey, look! The representation of the position.
  - PX: The position.
  - P3: You see? The representation of the position has the form of a parabola.
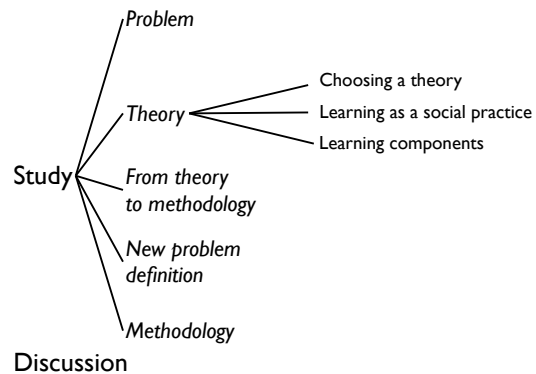 - P2: Yes, look, path of particles in space ( ).

First approach to the problem

- Two purposes
  - Describe the evolution of this group's didactical knowledge
  - Use this information to explain some of the results of the other studies
- Process versus results
  - The other studies explore and characterize the result of the work of the groups
  - This study looks into the details of the process producing those results
- Focus on the group's didactical knowledge
  - Construction and development of social meanings
  - Based on individual meanings

Context

Problem

Theory — Choosing a theory

Learning as a social practice

Learning components

Study — From theory to methodology

New problem definition

Methodology
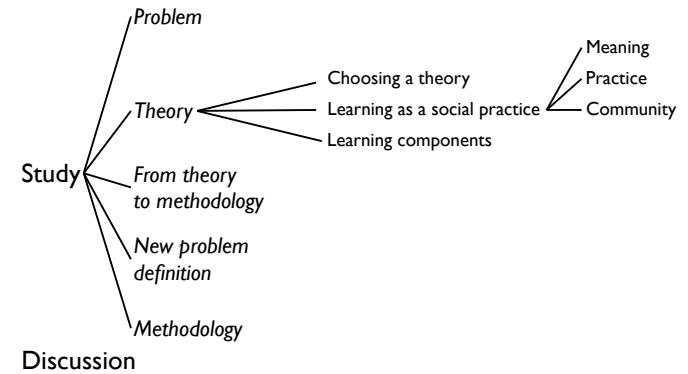
Discussion

Choosing a learning theory

- How to describe the learning of a group?
  - The appearance, development, negotiation, materialization, and use of the group's social meanings
- We found that learning theories focusing on the learning of the individual were not relevant
- From the social theories of learning we chose Wenger's
  - It takes into account most of the other theories ideas that are relevant for our problem

Social theory of learning

- Social theory and other theories of learning
  - It is one of several complementary theories of learning
  - It is not necessarily contradictory with other views about learning
  - Each theory focuses on different aspects
  - Learning is multidimensional problem
- Learning as a social phenomenon
  - Wenger, E. (1998). *Communities of practices. Learning, meaning, and identity*. Cambridge: Cambridge University.

Context

Problem

Theory — Choosing a theory
Theory — Learning as a social practice — Meaning / Practice / Community
Theory — Learning components

Study

From theory to methodology

New problem definition

Methodology

Discussion

Learning as a social practice

Meaning (negotiation)   Practice   Community   Identity

Our (changing) ability –individually and collectively– to experience our life and the world as meaningful

Shared historical and social resources, frameworks, and perspectives that can sustain mutual engagement in action

Social configurations in which our enterprises are defined as worth pursuing and our participation is recognizable as competence

How learning changes who we are and creates personal histories of becoming in the context of our communities

---

Learning as a social practice

Meaning (negotiation)   Practice   Community   Identity

- The negotiation of meaning emerges from the interaction of two processes:
- Participation
  - We establish relationships with other people
  - We define our way to belong to the communities in which we engage on some enterprises
  - We develop our identity
- Reification
  - process of giving form to our experience by producing objects that congeal this experience into "thingness". Every community produces its abstractions, tools, symbols, stories, terms and concepts that reifies some of that practice in congealed form

Slide 25

Learning as a social practice

Meaning (negotiation) Practice Community Identity

- Process through which we experience the world meaningfully
- Source of coherence of the communities
- Does not exist in abstract
- Exists because people engage in actions whose meanings are negotiated

Slide 26

Learning as a social practice

Meaning (negotiation) Practice Community Identity

- Represents the history of a practice in tis process of negotiation of meaning
- It is configured on three notions
- Mutual engagement
  - The engagement with actions whose meaning is negotiated and that generates relationships among people
- Joint enterprise
  - It is negotiated collectively and permanently, generates mutual responsibility, and determines what is valued, what is discussed and what is shown
- Shared repertoire
  - Includes the resources for the negotiation of meaning, the discourse that allows the making of meaningful statements about the world, and the styles for expressing membership forms and member identities

Slide 27

Learning as a social practice

Meaning (negotiation) Practice Community Identity

Learning emerges in practice
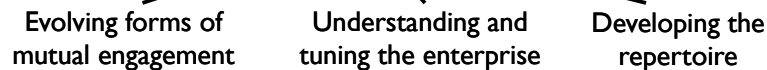
Evolving forms of mutual engagement

How to engage
What helps and what bothers
Developing mutual relations
Defining identities
Establishing who is who, who
is good at what, who knows what

Understanding and tuning the enterprise

Aligning the engagement
Accountability and responsibilities
Defining and interpreting the enterprise

Developing the repertoire

Renegotiating meanings, producing and adopting tools, artifacts and representations, recording and recalling events, inventing and redefining terms, telling stories, creating and breaking routines

Slide 28

Relations

- A community represents the history of a practice in its process of negotiation of meaning
- Communities can be seen as histories of shared learning, learning as the engine of practice, and the practices as shared histories of learning
- The combination of participation and reification determine and affect the conformation of practice, and define the direction in the negotiation of meaning
- In this way, different types of participants are established. Among them, the beginner, whose incorporation to the community implies a a process of legitimate peripheral participation
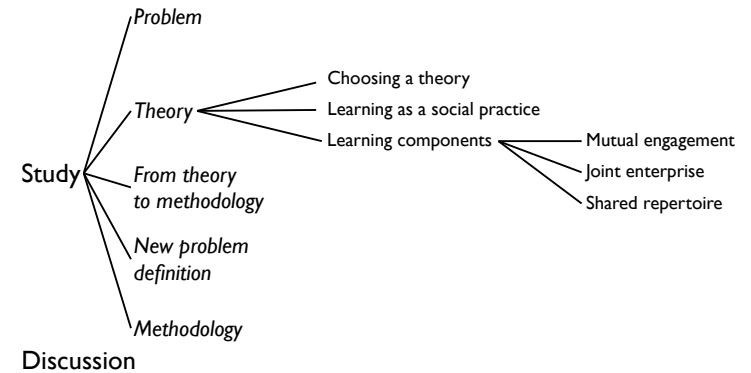
Learning

- Practice is an unstable, emerging structure
- Learning in practice implies a mutual engagement in the search of joint enterprise with a shared repertoire
- Learning in practice involves three processes:
  - Evolving forms of mutual engagement
  - Understanding and tuning the enterprise
  - Developing the repertoire

Context

Problem

Theory — Choosing a theory
Theory — Learning as a social practice
Theory — Learning components — Mutual engagement
Learning components — Joint enterprise
Learning components — Shared repertoire

Study

From theory to methodology

New problem definition

Methodology

Discussion

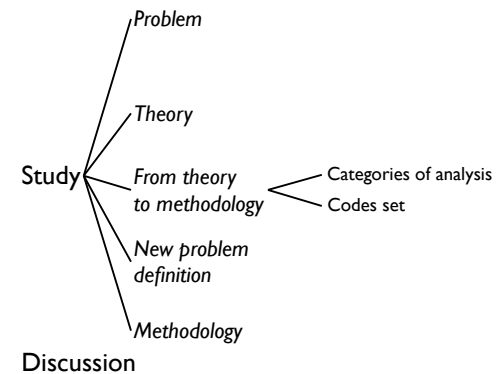
Learning components

- Evolving forms of mutual engagement
  - How to engage
  - What helps and what bothers
  - Developing mutual relations
  - Defining identities
  - Establishing who is who, who is good at what, who knows what
- Understanding and tuning the enterprise
  - Aligning the engagement
  - Accountability and responsibilities
  - Defining and interpreting the enterprise
- Developing the repertoire
  - Renegotiating meanings
  - Producing and adopting tools, artifacts and representations
  - Recording and recalling events, inventing and redefining terms
  - Telling stories
  - Creating and breaking routines

Context

Problem

Theory

Study

From theory to methodology — Categories of analysis
From theory to methodology — Codes set

New problem definition

Methodology

Discussion

Categories of analysis and aspects

- Mutual engagement
  - Environment
  - Indentities
  - Relationships
  - Meaning
- Joint enterprise
  - External conditions
  - Content
  - Enterprise and responsibilities
- Shared repertoire
  - Resources for the negotiation of meaning
  - Other

Producing a set of codes

- Detailing the meaning of the categories of analysis
- Adapting those categories to the research problem
- Defining and revising the codes

Mutual engagement

- Mutual engagement
  - Environment
  - Indentities
  - Relationships
  - Meaning
- Joint enterprise
- Shared repertoire

Mutual engagement

- Mutual engagement
  - Environment
    - What helps? What bothers?
      - Other courses
      - Literature
      - Classmates
      - Teaching experience
      - Textbooks
      - Other groups
      - Technology
      - Career training
  - Indentities
  - Relationships
  - Meaning
- Joint enterprise
- Shared repertoire

Mutual engagement

- Mutual engagement
  - Environment
  - Indentities
    - How are they defined?
    - Who is good at what?
    - Who does what?
    - Who knows what?
  - Relationships
  - Meaning
- Joint enterprise
- Shared repertoire

Mutual engagement

- Mutual engagement
  - Environment
  - Indentities
  - Relationships
    - Which access to reification?
    - What kind of participation
      - Mistakes correction
      - Discussion direction
      - Giving instructions
      - Role of the leader
      - Complementary participation
    - What kind of engagement?
    - What kind of relationships?
  - Meaning
- Joint enterprise
- Shared repertoire

Mutual engagement

- Mutual engagement
  - Environment
  - Indentities
  - Relationships
  - Meaning
    - Discovery of meanings
      - Which, how
    - Difficulties with meanings
      - Search of meanings, confusion of meaning, appearance of conflicts, search for names, conflict resolution
    - Reification
      - Events
    - Making of meaning proposals
      - Which, how, asking questions
    - Adoption of meaning proposals
      - Which, how
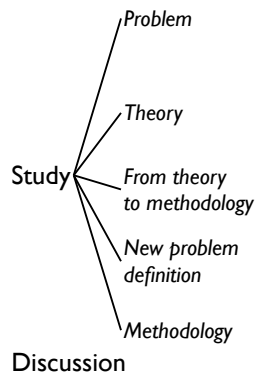- Joint enterprise
- Shared repertoire

Examples of codes

- Relating to an episode
- Teaching experience
  - At least one participant refers to his experience as teacher
- Who is good at what
  - The group identifies a participant as competent for a task or a participant proposes himself as such
- Confusion on meaning
  - Evidence of confusion of one or more participants concerning the meaning of a given issue
- Commentaries to the transparencies
  - A reference is made to the commentaries to the transparencies
- What is valued
  - Evidence of aspects of the work that are valued by the group
- Working routines
  - A working routine is established by the participants
- Connections
  - A reference is made to connections among systems of representation

Slide 41

Context

Study
- *Problem*
- *Theory*
- *From theory to methodology*
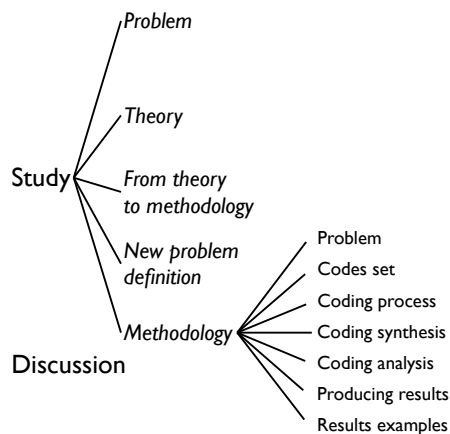- *New problem definition*
- *Methodology*

Discussion

New definition of research problem

- We have used the theory for:
  - identifying the categories of analysis
  - choosing those aspects of the categories that interest us
- Taking into account our research interests
  - We have formulated questions that give meaning to those aspects
- The research problem
  - How do the different forms of mutual engagement evolve?
  - How is the enterprise defined and tuned?
  - How do the shared repertoire, the style and the discourse develop?

Slide 43

Context

Study
- *Problem*
- *Theory*
- *From theory to methodology*
- *New problem definition*
- *Methodology*
  - Problem
  - Codes set
  - Coding process
  - Coding synthesis
  - Coding analysis
  - Producing results
  - Results examples
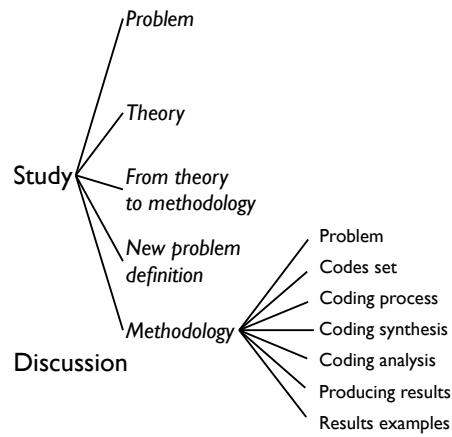
Discussion

The methodological problem

- Information available
  - Audio recordings of the group working to solve the course tasks
  - Transcription of those recordings
- Design of instruments for
  - Coding the transcriptions
  - Analyzing the results of coding

Slide 45

Context

Problem

Theory

Study — From theory to methodology

New problem definition

Methodology — Problem / Codes set / Coding process / Coding synthesis / Coding analysis / Producing results / Results examples

Discussion

Codes set

- Producing a first set of codes based on
  - Categories, aspects and questions
- Checking the codes in practice
  - Refining, creating and eliminating codes while coding
- Final set of 94 codes
- An episode
  - A fragment of the transcriptions containing statements or interaction about an idea or message
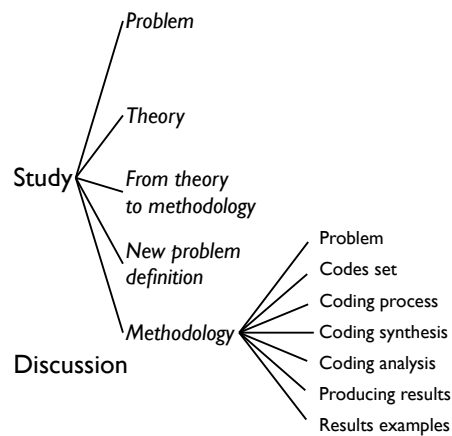

Slide 47

Context

Problem

Theory

Study — From theory to methodology

New problem definition

Methodology — Problem / Codes set / Coding process / Coding synthesis / Coding analysis / Producing results / Results examples
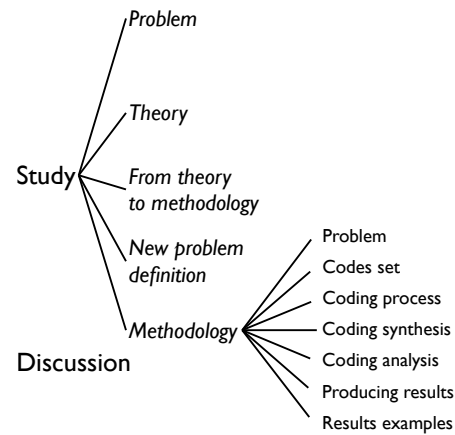
Discussion

Coding process

- Identifying, recording and characterizing episodes
  - Episodes of different lengths
  - Episodes within episodes
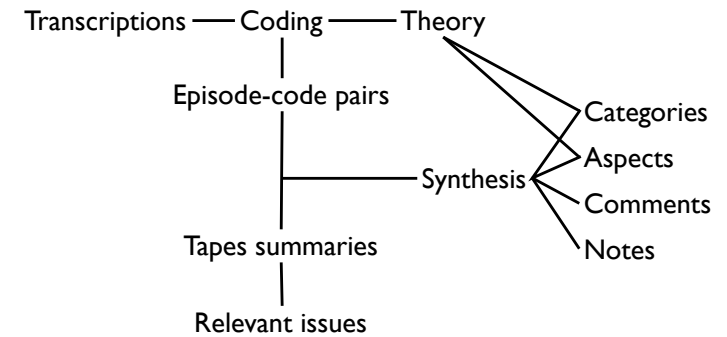 - Different codes for one episode
- Episodes comments

Example of a coded transcription

Coding a tape transcription

- Identifying transcription episodes
- Assigning codes and comment to each episode
- Cyclic revision of the above
- Recording coding notes
- Recording episodes, codes and comments in the database

Coding an episode (example)

- In this episode, a participant whose behavior corresponds to complementary participation, complains about the behavior of the leader
- "I see, now he is the specialist. Since he has been teaching, he is the only one who knows everything"
- Codes
  - Personal relationships, leader, complementary participation
- Comment
  - There is tension again, they complain about the leader: he is the one who knows everything

Recordings — Transcriptions

Theory — Categories and aspects — Codes set

Coding

Identifying episodes — Assigning — Notes

Codes — Comments

7412 episode-code pairs

Slide 53

Context

Study
- *Problem*
- *Theory*
- *From theory to methodology*
- *New problem definition*
- *Methodology*
  - Problem
  - Codes set
  - Coding process
  - Coding synthesis
  - Coding analysis
  - Producing results
  - Results examples

Discussion

Slide 54

Transcriptions — Coding — Theory

Episode-code pairs

Synthesis

Tapes summaries

Relevant issues

- Categories
- Aspects
- Comments
- Notes

Coding synthesis 1

- 7412 records in the database
- Producing tapes' transcription summaries
  - Working on codes, comments and notes
  - Producing listings of comments associated with codes and notes' issues
- Summaries' database
  - Tape number
  - Title
  - General description of the tape's transcription
  - Topics included
  - Most relevant issues

Mutual engagement issues (example) 1

- First hour of preparation of the final document
- 1) Environment
- 2) Definition of identities
  - a) The leader's role continues to be central in the planning of activities and the proposal of ideas
- 3) Relationships
  - a) There is less tension, they are tired and the leader seeks consensus
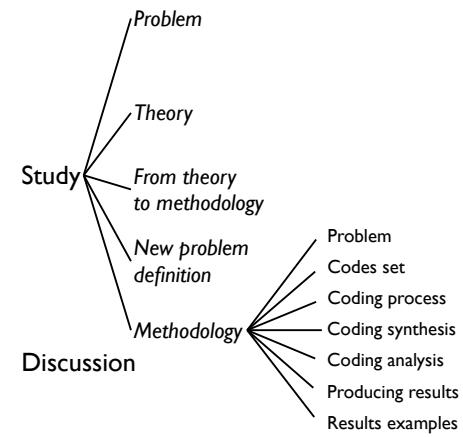 - b) Intense participation

Coding synthesis 2

- The identification of issues
- Listing of issues summarizing the 950.5 minutes of recordings
- For example,
  - There is a leader and his behavior was crucial in the group's performance
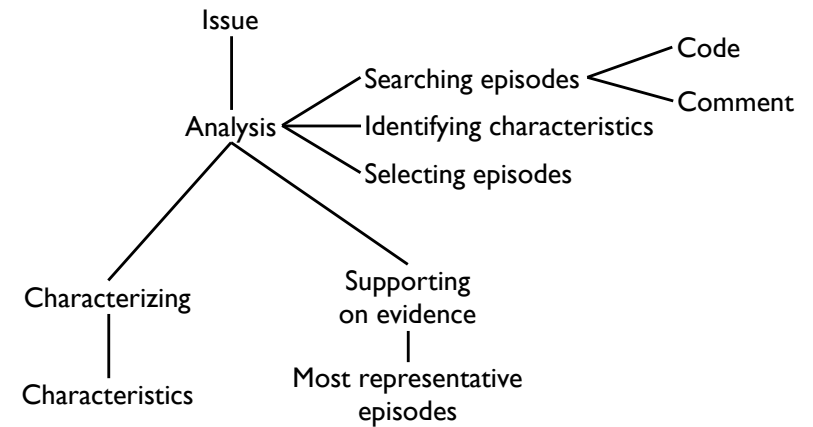- Need for coding analysis

Context

Problem

Theory

Study

From theory to methodology

New problem definition

Methodology
- Problem
- Codes set
- Coding process
- Coding synthesis
- Coding analysis
- Producing results
- Results examples

Discussion

Coding analysis 1

- Three purposes
  - Describe each issue, identifying its main characteristics
  - Identify the episodes better representing those characteristics
  - Support the characterization of the issue with the episodes' evidence
- New methodological problem
  - Each issue might involve more than one code
  - High number of episodes for each code
  - For example, 475 episodes for the code "Search of meaning"
- Issues' database
  - Issue
  - Codes
  - Categories and aspects

Issue

Analysis
- Searching episodes
  - Code
  - Comment
- Identifying characteristics
- Selecting episodes

Characterizing

Characteristics

Supporting on evidence

Most representative episodes

Context

Problem

Theory

Study

From theory
to methodology

New problem
definition

Methodology

Discussion

Problem
Codes set
Coding process
Coding synthesis
Coding analysis
Producing results
Results examples

Producing results 1

- Describing, characterizing and supporting an issue
  - General description of the issue
  - Description of its characteristics
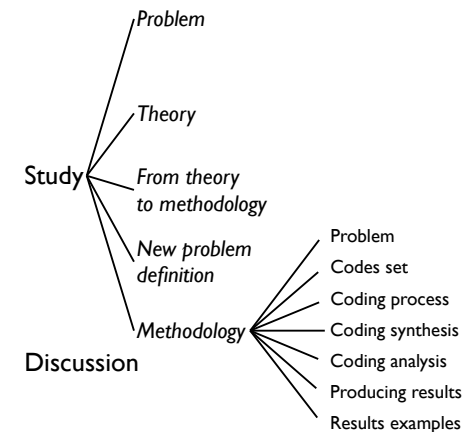 - Presentation, description and analysis of episodes supporting each characteristic

---
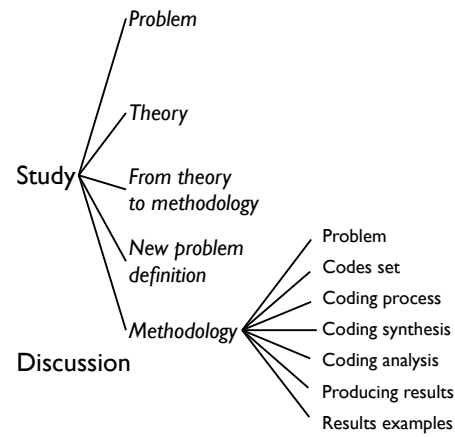
Producing results 2

- Producing a summary of the characterization of issues and the results related to each aspect
- Producing a summary of the results related to each category of analysis
- Going back to the theory in order to talk about the group's learning

---

Context

Problem

Theory

Study

From theory
to methodology

New problem
definition

Methodology

Discussion

Problem
Codes set
Coding process
Coding synthesis
Coding analysis
Producing results
Results examples

Example. Identities: leader's role

- Results
  - There is a leader
  - The other members behave in complementary participation manner
- Leader characterization
  - Plans the work outside the meetings
  - Organizes the tasks the other members are expected to do
  - Plans the work during the sessions
  - Directs the discussion, not allowing it to diverge
  - Encourages the other members to do their tasks
  - Suggests ideas and defines the discussions contents
 - Gives instructions
  - Verifies the work of the other members

Example: leader's role

- The leader takes the responsibility of planning the long term work and of organizing the tasks of the other participants
- For example, in a session preparing a presentation on the history of their subject matter, he defines the tasks the other participants should do before the next meeting
  - "I say: why don't each of us brings its part summarized and structured for coming saturday?" [044,49182,49425]
- The following is an example of two episodes in which the leader manages and steers the discussion in the search of the group's efficiency [052,29180,29373] and [065,55604,55685]:
  - P1: OK, I agree, but we have to talk about the groups, stop kidding... OK, besides those two large groups. The area calculation... Then, what?
  - (…)
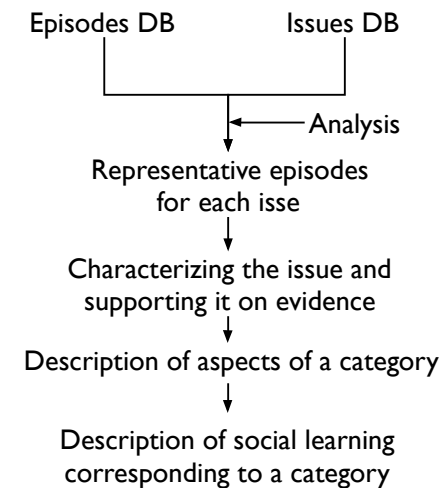 - P1: ( ). OK, let's do it. What else? Problems... What else?

Scheme summarizing the procedure 1
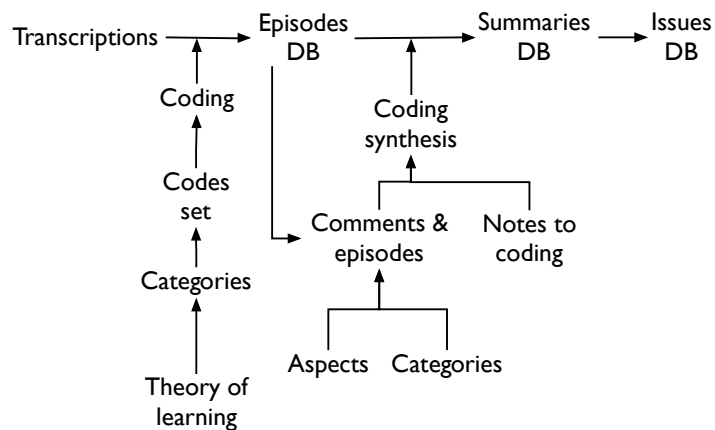
Scheme summarizing the procedure 2

Results example: mutual engagement

- Four aspects:
  - environment, identities, relationships and meaning
- Environment:
  - teaching experience, practice course and textbooks as main elements
- Identities:
  - leader's role and complementary participation
- Relationships:
  - relaxed working atmosphere with moments of tension
- Meaning:
  - permanent effort of meaning search, many occasions of meaning confusion and meaning conflict. Different mechanisms for resolving confusion and conflict, giving rise to meaning proposals involving some times meaning discovery that can become reified

Context

Study

Discussion

Discussion

- One vision on learning
  - Emphasizes some aspects
  - Allows us to "see" phenomena that can be relevant and are obscure to other perspectives
- Complexity of the conceptual and methodological procedures
- Relationship with the study's research problem
- Relationship with the research project goals

Designing a research methodology based on a theory of learning: a practical case in teacher training

Pedro Gómez
Universidad de Granada

Aalborg, September 4, 2004