Mixed Methods in Computing Education Research

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What is Computing Education (CS)?

- Dual emphasis on Computing and Education.
- Particular emphasis on ***Research***.
  - What we cannot research about learning of CS, we do not know.
- A discussion about the nature of insights that can be gained from different research perspectives.
  - What can a computer scientist learn from these ways of thinking?

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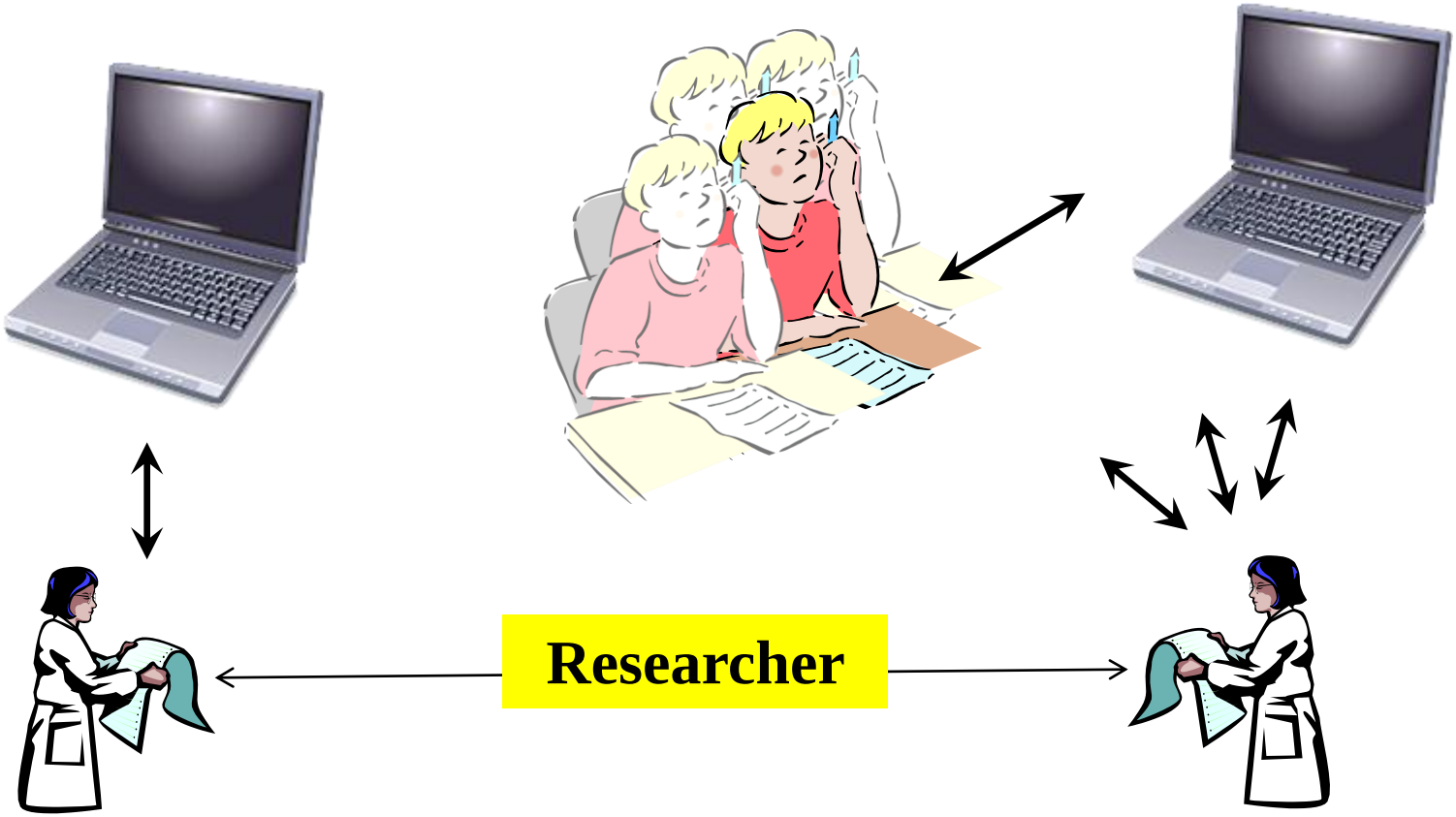
What is Computer Science Education Research (CER)?

- Aim: Study the learning, development, and improvement of education in computing through the use of rigorous research methods.

- The goals are pragmatic:
  - Learning of CS should become enhanced
  - Interest in CS encouraged
  - The recruitment and the retention increased
  - The universities becoming better at teaching and composing educational programs.

Computing Education Research



*A researcher in **Computing** studies/constructs technical artifacts/ processes*

*A researcher in **Computing education** studies how students understand/learn about technical artifacts/processes*

Talk Overview

- Methodological focus in CER
- Value of
  - mixing paradigms
  - mixed methods
  - role of pragmatic knowledge claims
- Framework to guide research design presented
- Design of an introductory (OOP) course
- Contribution to increased awareness of theoretically anchored research in computer science

Research Terminology

Paradigms (researcher's worldview)

Methodology (type of research design)

Assumptions

Methods (procedures = what you will do)

Data (interviews, scales, documents)

Paradigms & Methodologies

- **Paradigms**
  - Positivist
  - Post-positivist
  - Pragmatic
  - Constructivist
  - Critical-advocacy
  - Participatory
  - ….
- **Methodologies**
  - Experimental
  - Survey research
  - Case Studies
  - Ethnography
  - Grounded Theory
  - Action research
  - ….

Mixed Methods Definition

Mixed methods research is a type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the purpose of breadth and depth of understanding and corroboration.

(Johnson, Onwuegbuzie & Turner, 2007)

Mixed Designs

Design Type	Timing of quan and qual phases	Relative weighting of quan and qual components	Mixing – when quan and qual phases are integrated	Notation
Triangulation	Concurrent	Equal	During interpretation or analysis	QUAN + QUAL
Embedded	Concurrent or Sequential	Unequal	One is embedded within the other	QUAN(qual) *or* QUAL(quan)
Explanatory	Sequential, quan then qual	Usually quan is given priority	Phase 1 informs phase 2	QUAN -> qual
Exploratory	Sequential, qual then quan	Usually qual is given priority	Phase 1 informs phase 2	QUAL -> quan

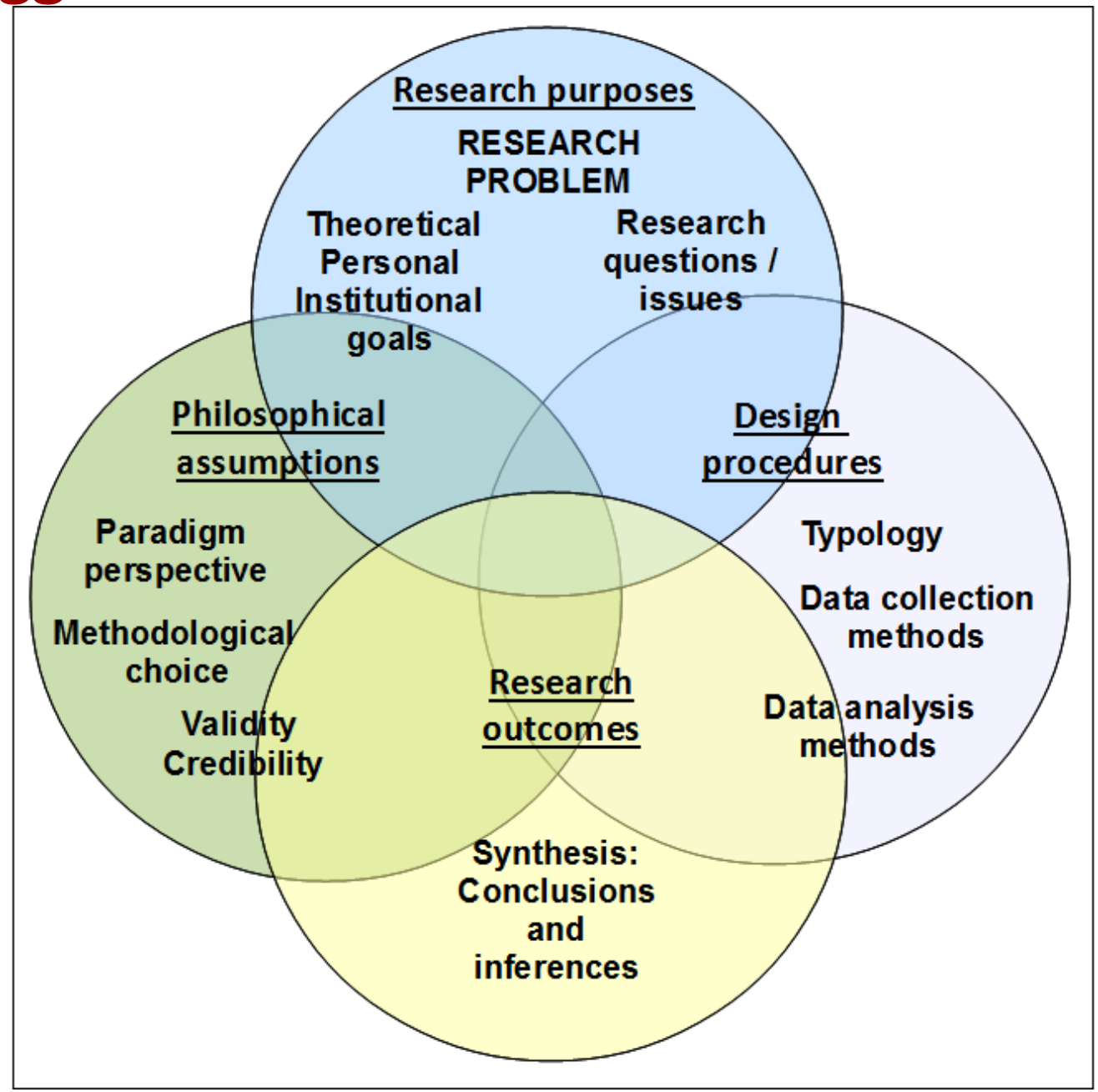
Adapted from Creswell and Plano Clark (2007)

Validity/Credibility Criteria

Quantitative Research Criteria	Qualitative Research Criteria
Validity: project and instruments measure what is intended to be measured	Credibility: establishing that the results are credible or believable
Generalizability: results are applicable to other settings, achieved through representative sampling	Transferability: applicability of research findings to other settings, achieved through thick description
Reliability: findings are replicable or repeatable	Dependability: researchers account for the ever-changing context within which the research occurs
Objectivity: researcher limits bias and interaction with participants	Reflexivity: researchers examine their own biases and make them known

From Lincoln & Guba (1985)

Suggested Framework for Research Study



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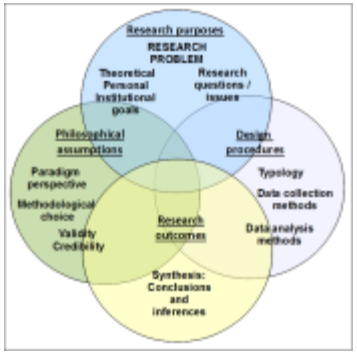
Developing a holistic approach to learning and teaching Object Oriented Programming (OOP)

- University of Saint Joseph, Macau (affiliated to Catholic University of Portugal)
- Course taught 2 semesters (2008 – 2009)
- First year programming students (26 participants in iteration 1; 72 in iteration 2)
- Multiple Majors
  - Information Systems
  - Business Technology Management
  - Business Administration
  - Design



Philosophical assumptions

Paradigm perspective
Ontology: Multiple realities
Epistemology: Pragmatism
Axiology: Ethical considerations
Inquirer stance: Insider researcher; Study of self

Methodological choice
Theoretical perspective: Interpretivism
Methodology: Action research
Methods: Mixed methods

Research validity/credibility
Pilot trials: data collection instrument
Validity checks: dialogic, outcome, catalytic, democratic, process, peer
Self-reflexivity: journal to record critical episodes

Research purposes

Theoretical personal/professional goals
- Gap in literature
- Improve teaching practice and learning outcomes of students
- Practical interest in professional development

RESEARCH PROBLEM
How can knowledge of students' approaches to learning to program enhance learning and teaching in introductory OOP courses?

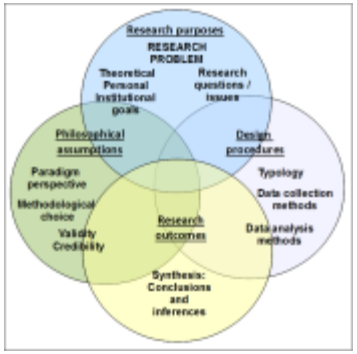
Research issues
RQ1. How can students' approaches to programming be aligned with desirable learning outcomes in an introductory OOP course?
RQ2. How can the learning/teaching activities in an introductory OOP course enhance the ways in which students learn to program?
RQ3. To what extent does the learning context influence the learning approaches of the students?
RQ4. How does the learning environment influence the learning experiences of the students?

Design procedures

Typology
RQ1: Theoretical framework from literature review
RQ2: Creation of a learning context
RQ3 & RQ4:
Action research: two cycles
Formative feedback during course
Summative evaluation: Two-phase mixed methods sequential explanatory design with participant selection model

Data collection methods
MIXED: Student journals, course questionnaires, student assessments, classroom observations, validation group
QUAN: Revised two-factor Study Process Questionnaire
QUAL + quan: Semi-structured interviews, using repertory grid technique

Data analysis methods
QUAN: Statistical analysis; Correlations
QUAL + quan: Content analysis and thematic categorization
Integration



Research outcomes

Synthesis: Conclusions and inferences

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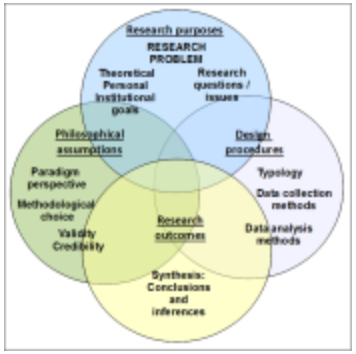
Research Purposes

Goals

Problem

Issues



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Methodology

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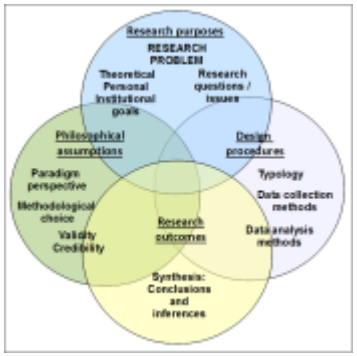

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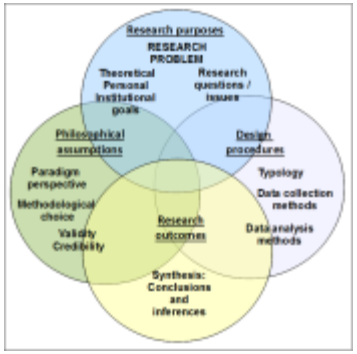

Research Outcomes *Conclusions & Inferences*

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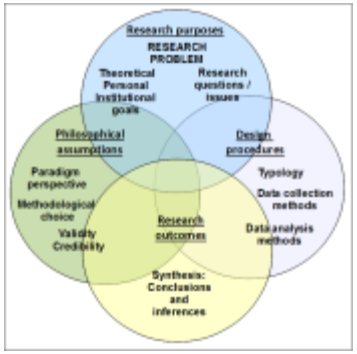

Epistemology	Theoretical Perspective	Methodology	Methods
Pragmatism	**Interpretivism**	**Action research**	**Mixed methods**

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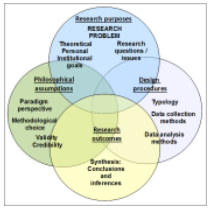
Relation of Research Issues to Action taken



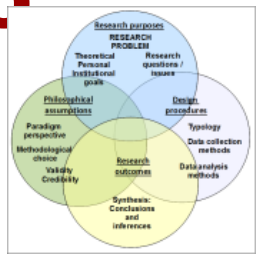
RQ1. How can students' approaches to programming be aligned with desirable learning outcomes in an introductory OOP course?

- Design of a theoretical framework derived from the literature

RQ2. How can the learning/teaching activities in an introductory OOP course enhance the ways in which students learn to program?

- Creation of a learning context
  - to enable students to experience a variety of educationally critical ways of learning to program;
  - to enhance the learning experiences with multiple learning media.

Relation of Research Issues to Data Collection Methods



RQ3. To what extent does the learning context influence the learning approaches of the students?

- Revised Study Process Questionnaire (R-SPQ-2F)
- Correlation of approach scores with course grades; and with exam marks.
- Identification of a cross-section of students purposefully selected

RQ4. How does the learning environment influence the learning experiences of the students?

- Semi-structured interviews, using the repertory grid technique.
- Content analysis technique using quantification and thematic categorization of the qualitized data, inductively analyzed to identify themes.

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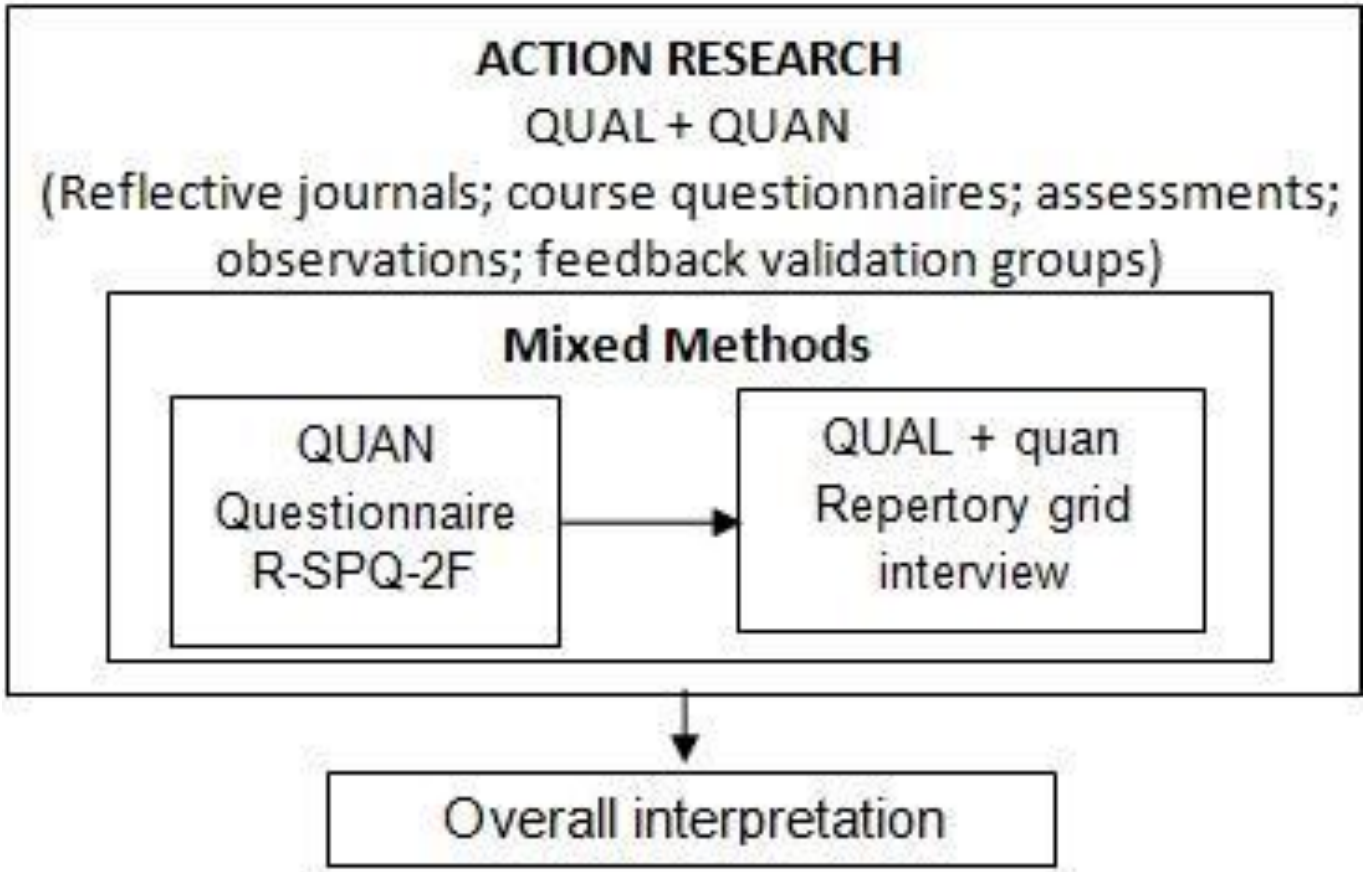
Design Typology



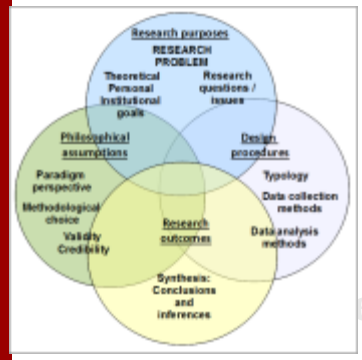


Figure 3: Action research study with mixed methods

Note. QUAL stands for qualitative;
QUAN/quan stands for quantitative.
Capital letters denote high priority or weight;
lower case letters denote lower priority or weight;
→ stands for sequential process. Adapted from (Morse, 2003).

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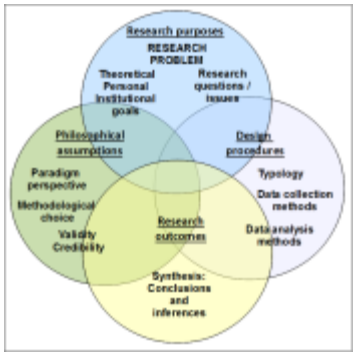
Validity & Credibility Criteria

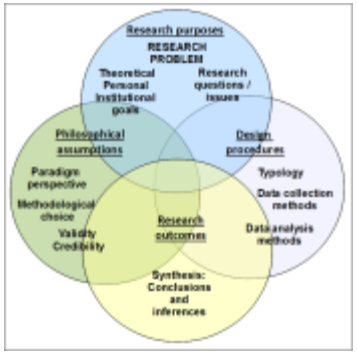
- **Pilot studies** (questionnaire, repertory grid interivews)
- Dialogic and process validity **Intercoder reliability measures** (Krippendorff's alpha)
- **Stakeholders' check** (feedback to participants)
- **Evidence from multiple perspectives** (student journals, questionnaires, student assessments, and teacher observations)
- **Critical friend and validation groups**
- **Informed consent and anonymity** (consent forms)

Quality Criteria for Action Research



- **Dialogic and process validity:** The generation of new knowledge
- **Outcome validity:** The achievement of action-oriented outcomes
- **Catalytic validity:** The education of both researcher and participants
- **Democratic Validity:** Results that are relevant to the local settings
- **Process Validity:** A sound and appropriate research methodology
(Herr & Anderson, 2005)

The Reality of the Research



Reflecting on own practice and dissatisfaction with teaching values

Reflecting
Constructivist teaching
Learning variation

Dialogue and debate with literature

Planning, acting observing, evaluating, reflecting

Reflecting

Reflecting

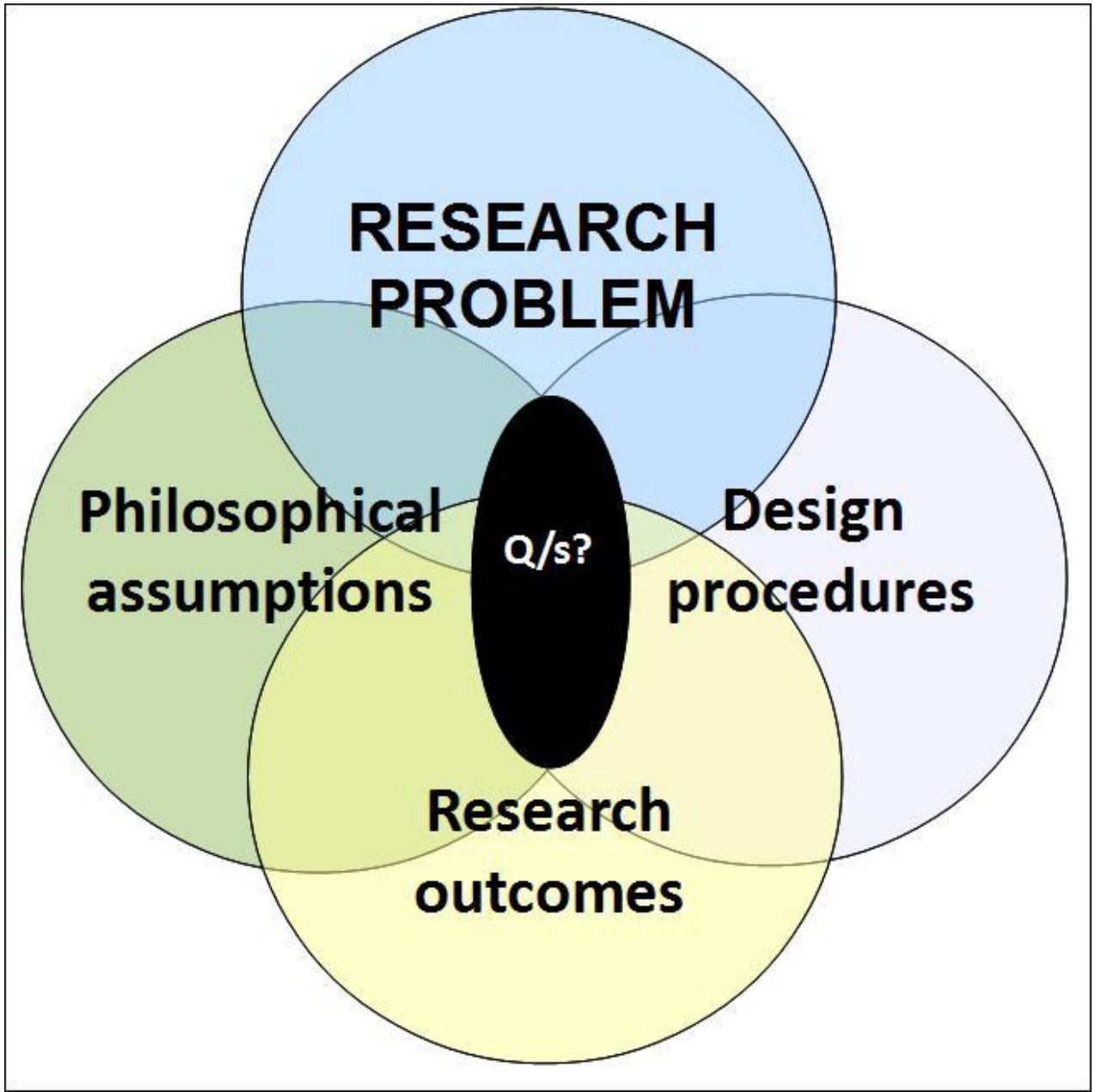
Replanning, acting, observing, evaluating, reflecting

Refining course design
Constructivist teaching
Learning variation

Inclusional epistemologies

Theorising, disseminating:
Holistic approach to learning and teaching

Research Framework



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