Enabling Creativity and Inquiry through Science and Mathematics in Early Years Education

What have we learned?

The Final Report

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The project CREATIVE LITTLE SCIENTISTS has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 289081.

Presentation outline

- Background to the 'Creative Little Scientists' project
- What do we mean by creativity in early years science and mathematics?
- Potential for creativity and inquiry in policy and practice
  - Findings from policy and teacher surveys
  - Findings from fieldwork in schools
- Implications – practices, teacher education, policy.

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Context

Importance of early years science

- Rationale for science education
- Changing perspectives on young children
- Aims for science education in the early years

New insights into learning and teaching

- Perspectives on science development and learning
- Role of the teacher – environment, scaffolding
- Assessment – new roles and priorities

Issues in policy and practice

- Challenges of inquiry-based approaches
- Beyond the rhetoric of creativity – reviewing potential
- Changing policy climate across Europe

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Research Questions

1. How are the teaching, learning and assessment of science and mathematics in Early Years in the partner countries conceptualised by teachers and in policy?
   What role if any does creativity play in these?

2. What approaches are used in the teaching, learning and assessment of science and mathematics in Early Years in the partner countries?
   What role if any does creativity play in these?

3. In what ways do these approaches seek to foster young children's learning and motivation in science and mathematics?
   How do teachers perceive their role in doing so?

4. How can findings emerging from analysis in relation to questions 1-3 inform the development of practice in the classroom and in teacher education (Initial Teacher Education and Continuing Professional Development)?

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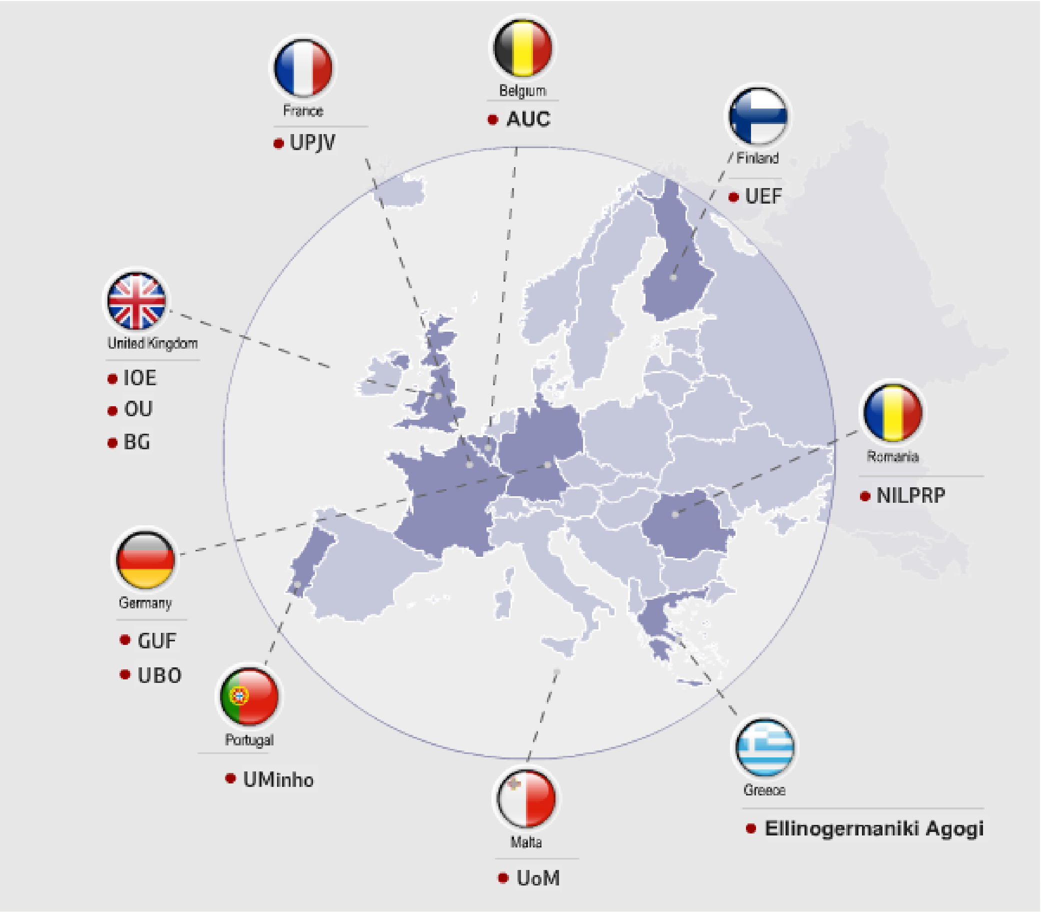
Project Partners



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Project Processes

1. Conceptual framework
   Research Questions
2. List of Mapping and Comparison Factors
3. Policy and teacher surveys
   Comparative Report
4. Report of practices:
   Fieldwork in schools
5. Guidelines for teacher training
   Exemplary training materials
6. Final Report & Recommendations

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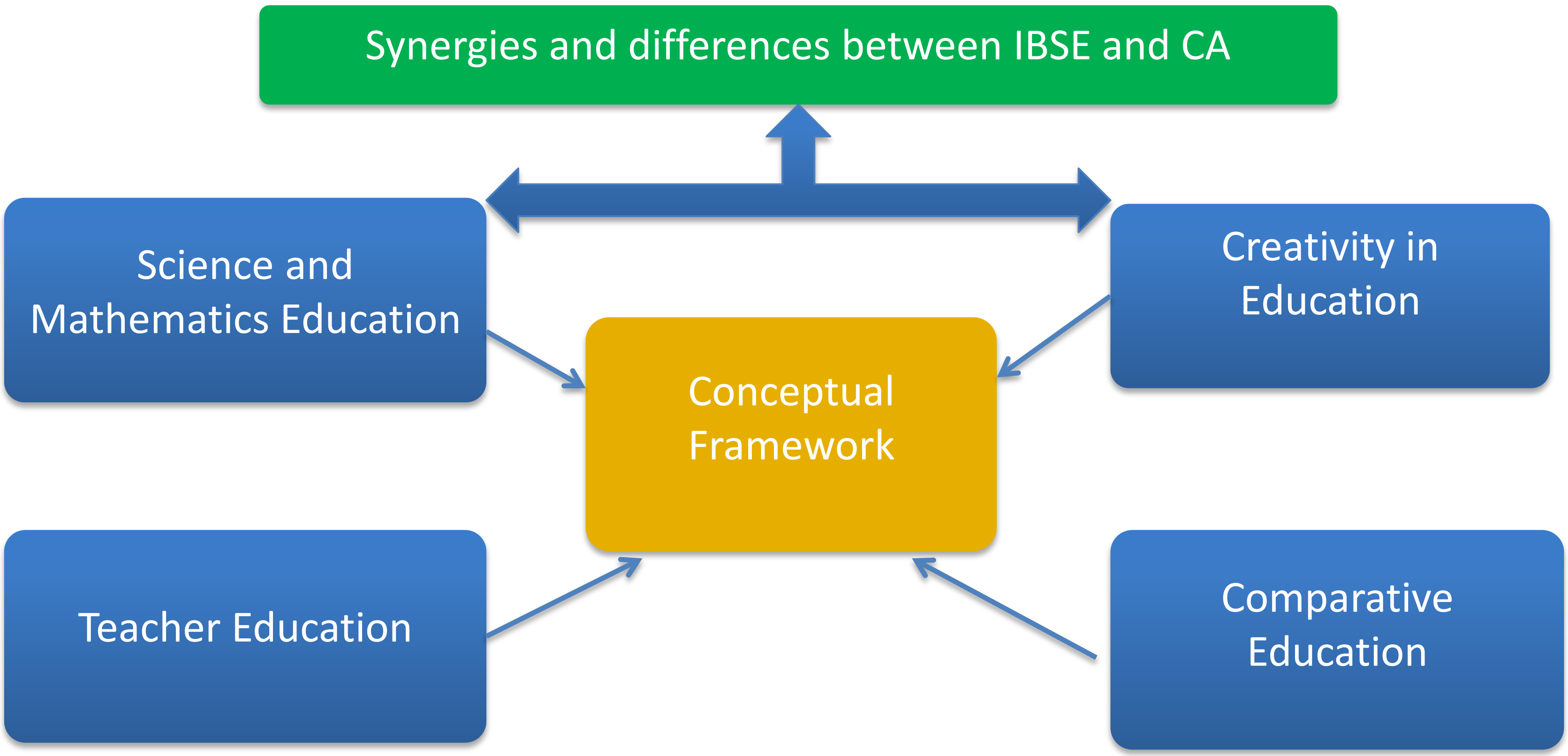
What do we mean by creativity in early science?

Synergies and Differences between IBSE and CA



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What do we mean by creativity in early science?

Comparing IBSE and CA

Inquiry-based Science Education

- Widespread promotion of IBSE
- Varied definitions – what scientists do, how students learn, pedagogical approach
- Features include: questioning, giving priority to evidence, formulating explanations & connecting to scientific knowledge, communicating and justifying explanations

(for example Minner et al 2010)

Creative Approaches

- Problem finding & problem solving, playful exploration, individual, collaborative and communal engagement
- Roles of innovation, originality, ownership and control, connection making
- Involves risk taking, independent judgment, resilience
- Importance of intrinsic motivation, curiosity

(for example Chappell et al 2008)

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What do we mean by creativity in early science?

Synergies between Inquiry-Based and Creative Approaches

- Play and exploration
- Motivation and affect
- Dialogue and collaboration
- Problem solving and agency
- Questioning and curiosity
- Reflection and reasoning
- Teacher scaffolding and involvement
- Assessment for learning

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Creativity in learning

Factors from the Conceptual Framework (Creative dispositions)

- Sense of initiative
- Motivation
- Ability to come up with something new
- Ability to connect what they have learnt during lessons with topics in other subjects
- Imagination
- Curiosity
- Ability to work together
- Thinking skills

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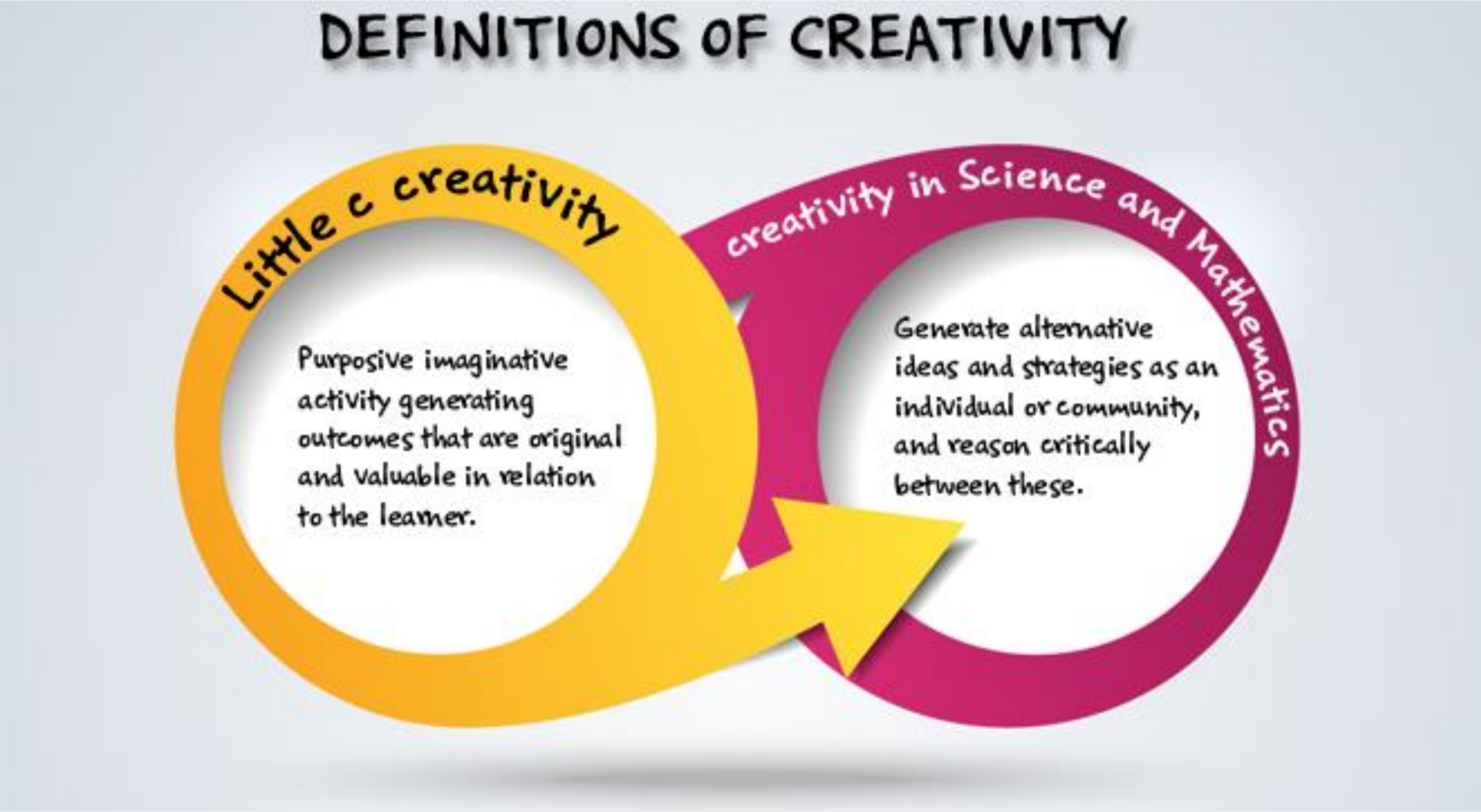
Creativity in early science and mathematics



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Background to the project

Project Processes

- Conceptual framework
  Research Questions
- List of Mapping and Comparison Factors
- Policy and teacher surveys
  Comparative Report
- Report of practices:
  Fieldwork in schools
- Guidelines for teacher training
  Exemplary training materials
- Final Report & Recommendations

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Strands and Dimensions (1)

Conceptual Framework Strands	Dimensions linked to Curriculum Components ‘The vulnerable spider web’ van den Akker (2007)
Aims/Purpose/ Priorities	Rationale or vision: Why are children learning?
	Aims and Objectives: Toward which goals are children learning?
Teaching, Learning and Assessment	Learning activities: How are children learning?
	Pedagogy: How is the teacher facilitating learning?
	Assessment: How to measure how far children’s learning has progressed?

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Discussion of Findings

Strands and Dimensions (2)

Conceptual Framework Strands	Dimensions
Contextual factors	Content: What are children learning?
	Location: Where are children learning?
	Materials and resources: With what are children learning?
	Time: When are children learning?
	Grouping: With whom are children learning?
Contextual factors TEACHERS	Teacher Personal Characteristics
	Teacher General Education and Training
	Teacher Science and Mathematics Knowledge, Skills and Confidence
	Initial teacher training
	Continuing Professional Development

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Project Processes

1. How are the teaching, learning and assessment of science and mathematics in Early Years in the partner countries conceptualised by teachers and in policy? What role if any does creativity play in these?

Conceptual framework

Research Questions

List of Mapping and Comparison Factors

Policy and teacher surveys

Comparative Report

Report of practices:

Fieldwork in schools

Guidelines for teacher training

Exemplary training materials

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Scope

Policy Survey (over 100 policy documents)

- Policy documents related to Curriculum, Assessment and Pedagogy in Mathematics and Science in each partner country
- Documents for both Pre-school and Primary school
- Included both statutory requirements and guidance for teachers

Teacher Survey in 9 languages (815 participants)

- 348 Pre-school teachers
- 467 Primary school teachers

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Aims and Objectives

Factors from the Conceptual Framework

- Knowledge and understanding of science content
- Understanding about scientific inquiry
- Science process skills
- Capabilities to carry out scientific inquiry
- Social factors
- Affective factors
- Creative dispositions

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Aims and Objectives

- Main emphases on cognitive dimensions
  - Process skills
  - Understanding scientific ideas
- Limited attention to
  - social and affective dimensions
  - nature of science
- Role for creativity in relation to investigating, curiosity
- Limited emphasis on creativity in developing scientific ideas

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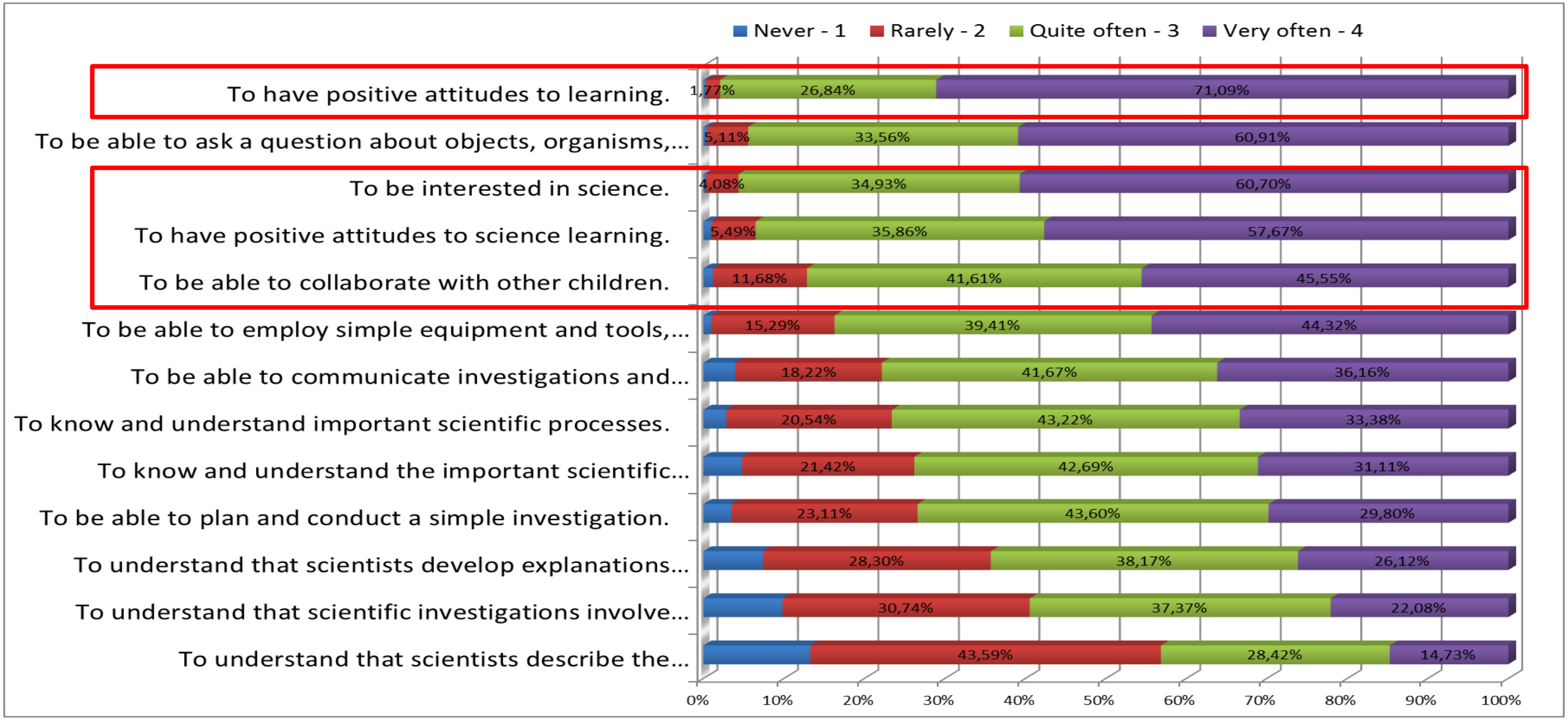
Teacher Survey Findings

Aims and objectives



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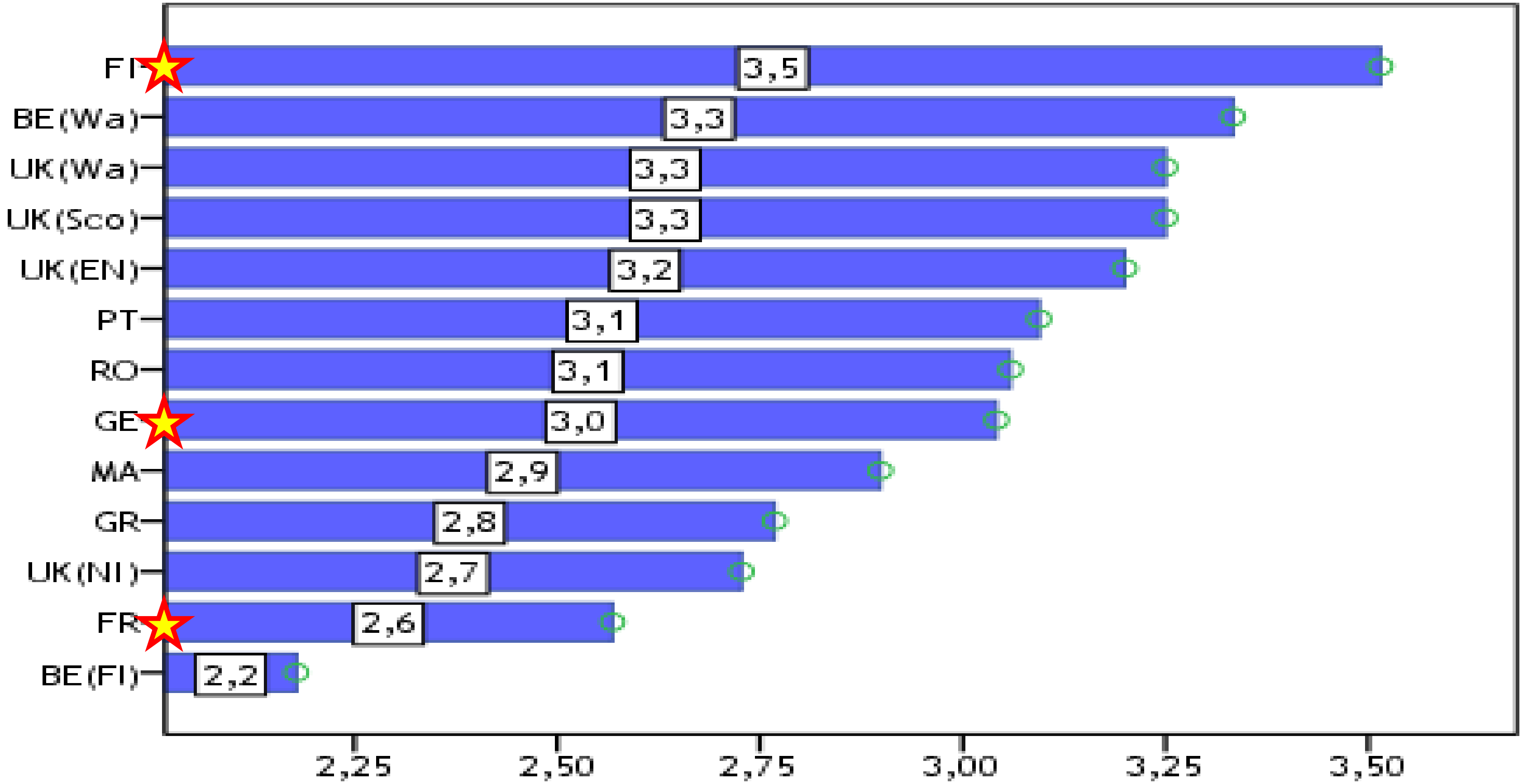
Aims and Objectives

Differences between partner countries



Mean of a.To know and understand the important scientific ideas (facts, concepts, laws and theories).

Learning activities

Factors from the Conceptual Framework

- focus on cognitive dimensions, such as:
  - questioning
  - designing or planning investigations
  - gathering evidence, e.g. observing, running experiments (using equipment, manipulating materials, collecting data)
  - making connections
- focus on social dimensions, such as:
  - explaining evidence
  - communicating explanations

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Learning activities

- Observing, communicating and questioning (pre-school) most emphasised
- Some emphasis on investigating and use of equipment (in primary)
- More varied emphasis on planning investigations or using data to construct explanations.

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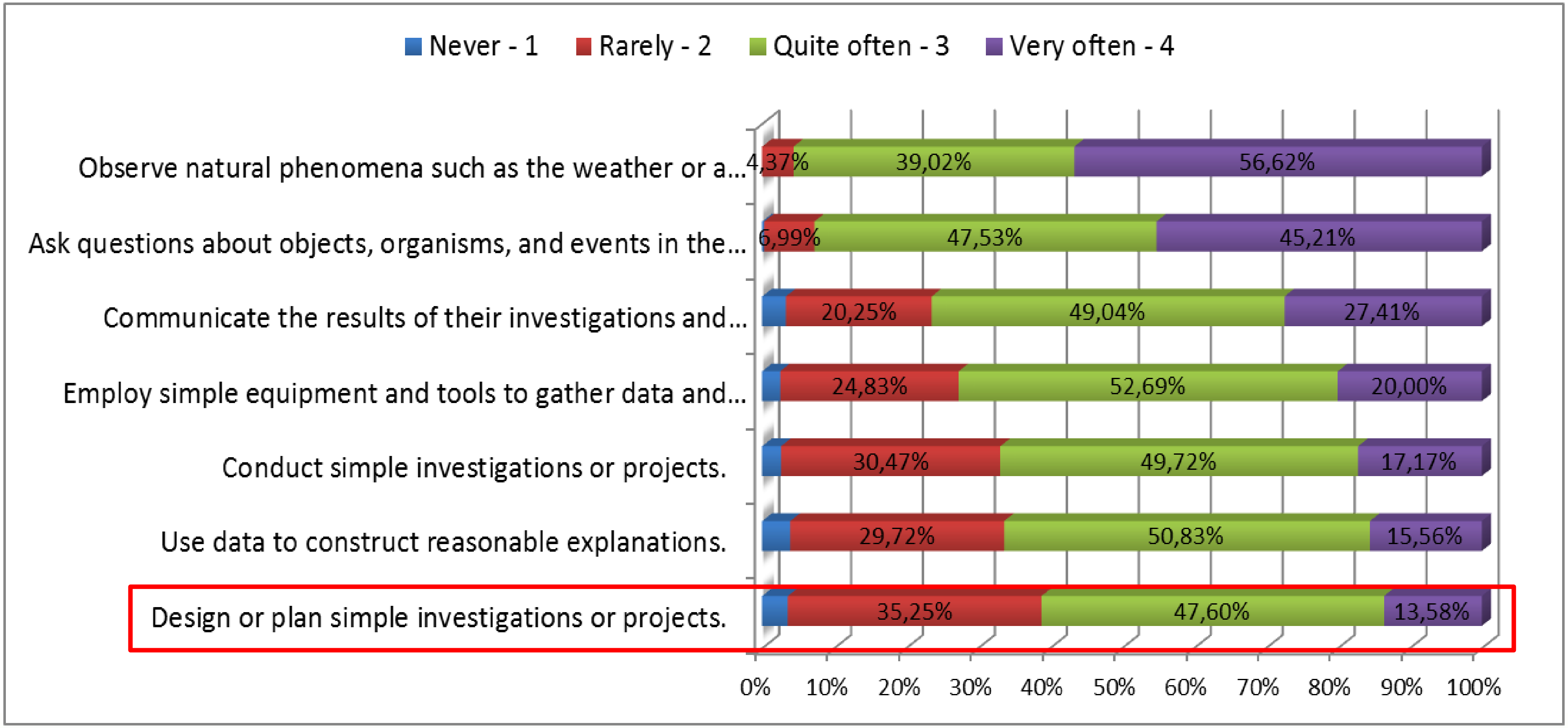
Teacher Survey Findings

Learning activities



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Pedagogy

Factors from the Conceptual Framework

- Play and exploration
- Motivation and affect
- Dialogue and collaboration
- Problem solving and agency
- Questioning and curiosity
- Reflection and reasoning
- Teacher scaffolding

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Pedagogy

- Common emphasis on
  - Play, autonomous learning in preschool
  - problem solving and children trying out ideas
  - Promoting inquiry skills
- More limited attention to affective and social dimensions
  - Varied contexts for learning – drama, history, field trips
  - reflection or connecting explanations to scientific ideas
  - Role of imagination or discussion of alternative ideas

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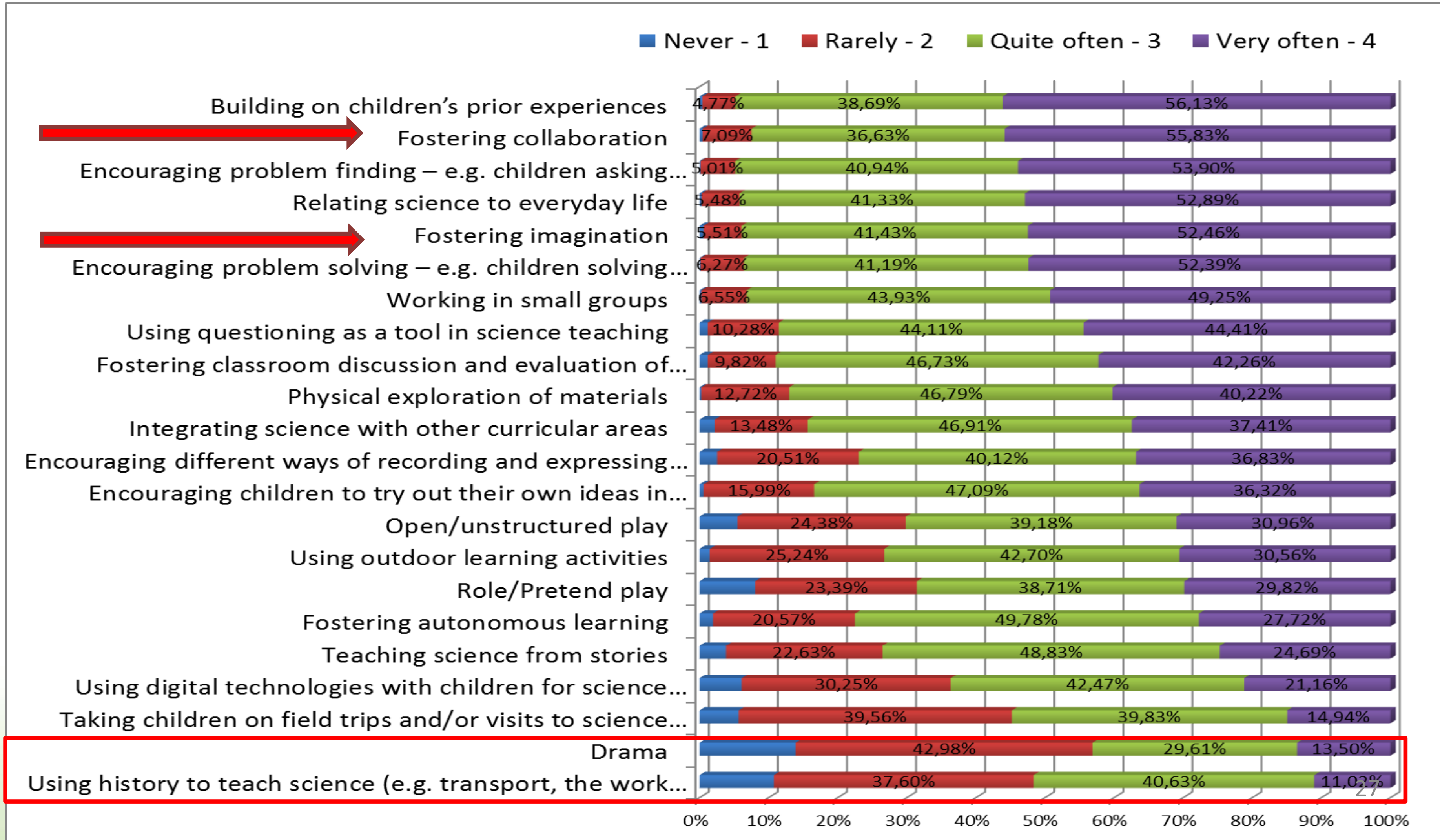
Teacher Survey Findings

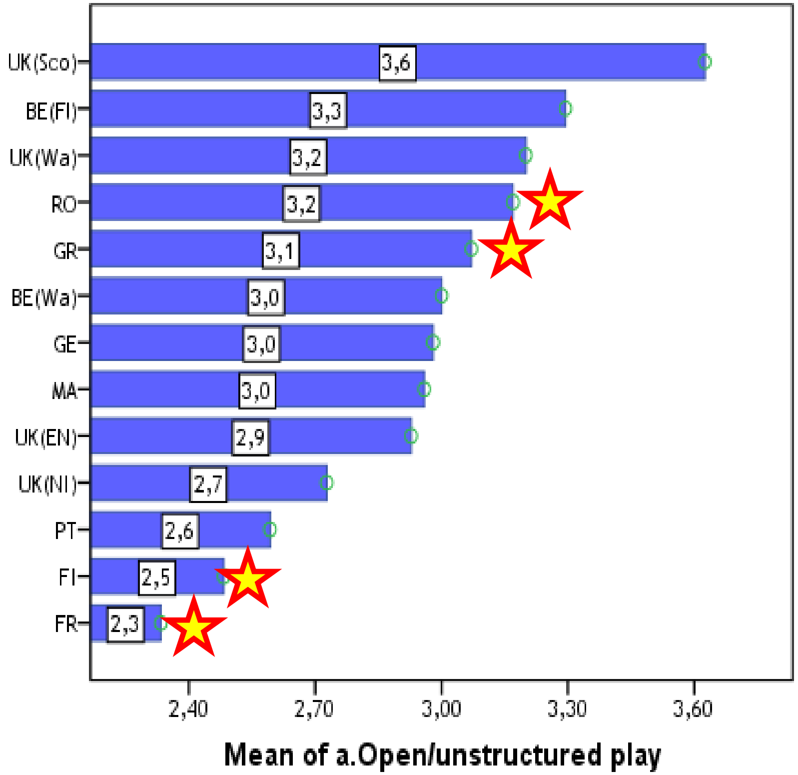
Pedagogy

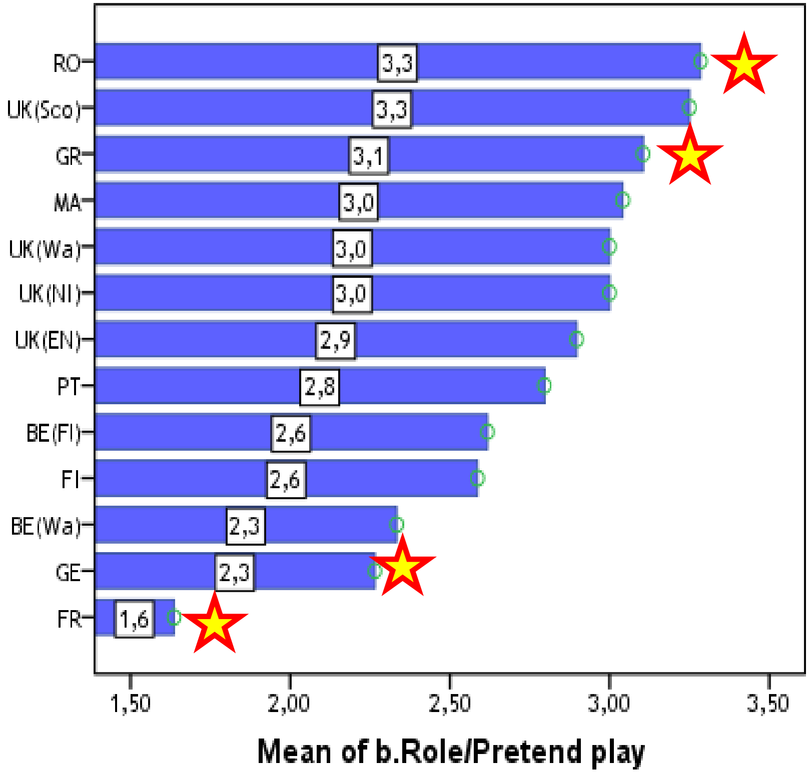


Teacher Survey Findings

Pedagogy

Differences between partner countries





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Assessment

Factors from the Conceptual Framework

- *Assessment function/purpose*
  - formative (assessment for learning)
  - summative
  - recipient of assessment results
- *Assessment way/process*
  - Strategy
  - Forms of evidence
  - Locus of assessment judgment

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Assessment

- Wide variation in extent of policy requirements
- Often lack of coherence between rationale and aims in policy and assessment requirements
- Greatest focus on scientific ideas.
- Some references to understandings and skills of inquiry
- Neglect of social and affective dimensions
- Limited guidance on assessment strategies
- Limited attention to multimodal assessment or involvement of children

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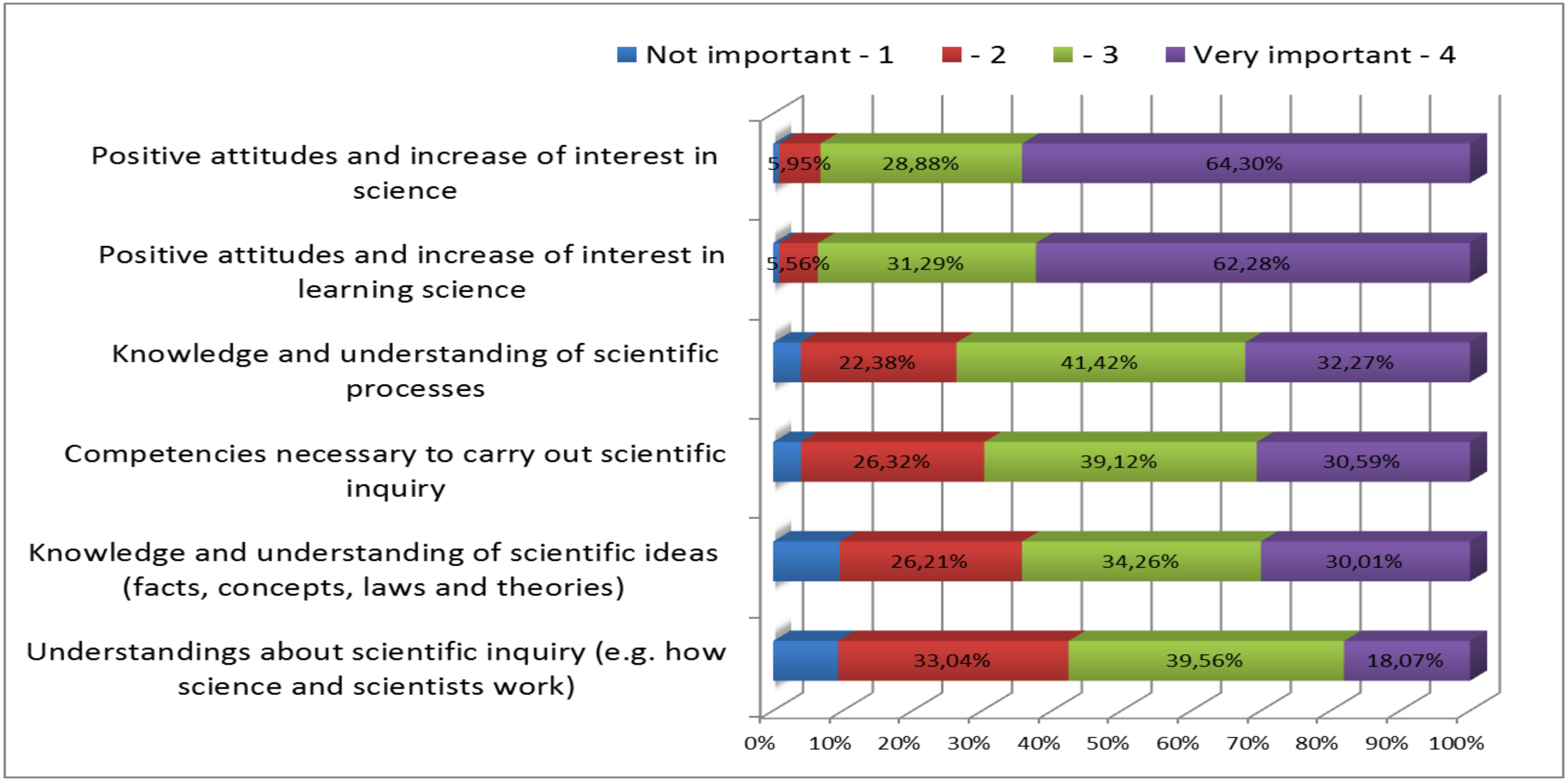
Teacher Survey Findings

Assessment Purposes



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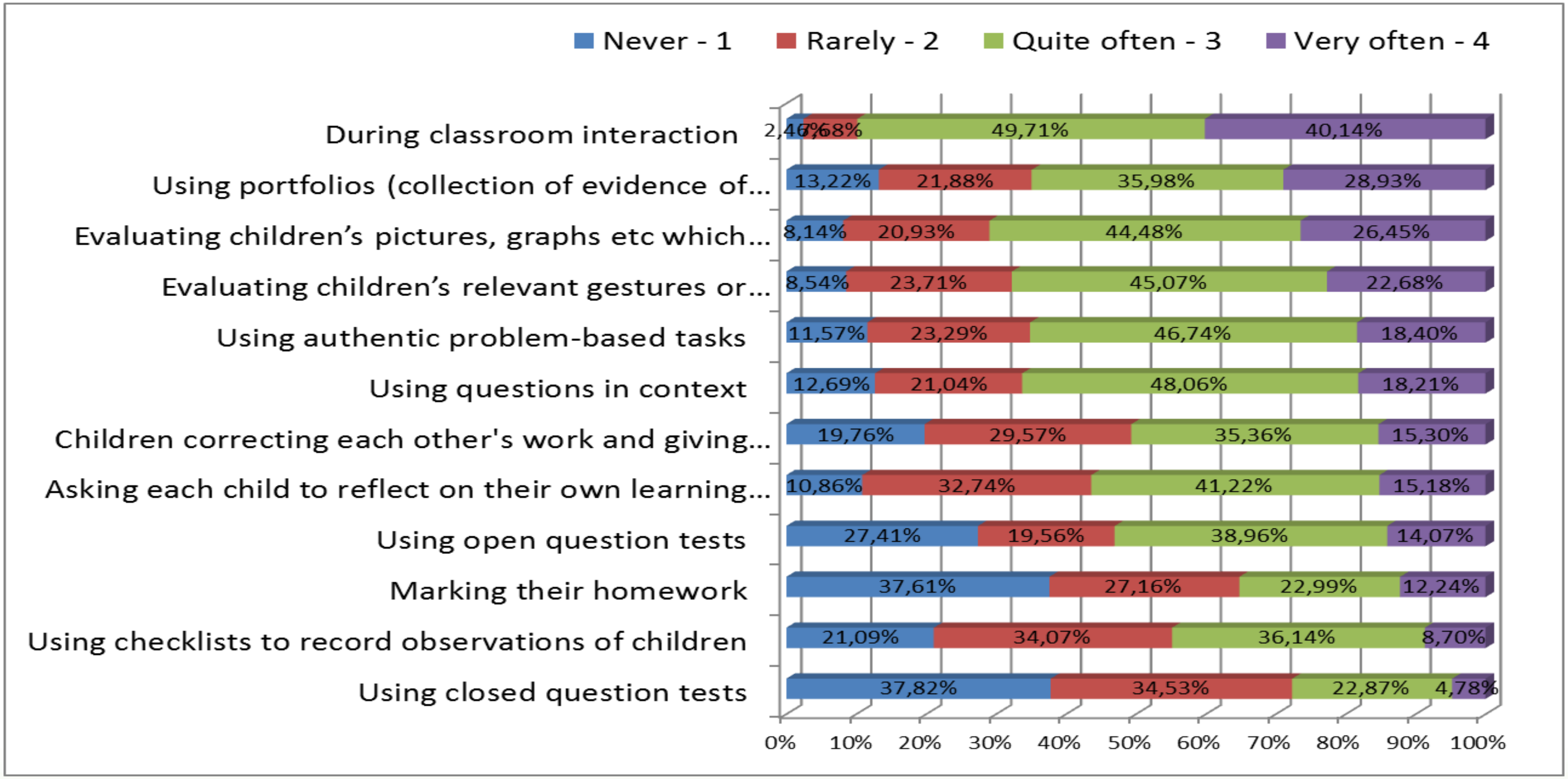
Teacher Survey Findings

Assessment Processes



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Creative attributes

Factors from the Conceptual Framework

- Sense of initiative
- Motivation
- Ability to come up with something new
- Ability to connect what they have learnt during lessons with topics in other subjects
- Imagination
- Curiosity
- Ability to work together
- Thinking skills

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Creative attributes in Assessment

- Limited emphasis on creative attributes
- Thinking skills mentioned in primary policy in majority of countries
- References to curiosity - greater in preschool
- Very little focus on sense of initiative or ability to come up with something new

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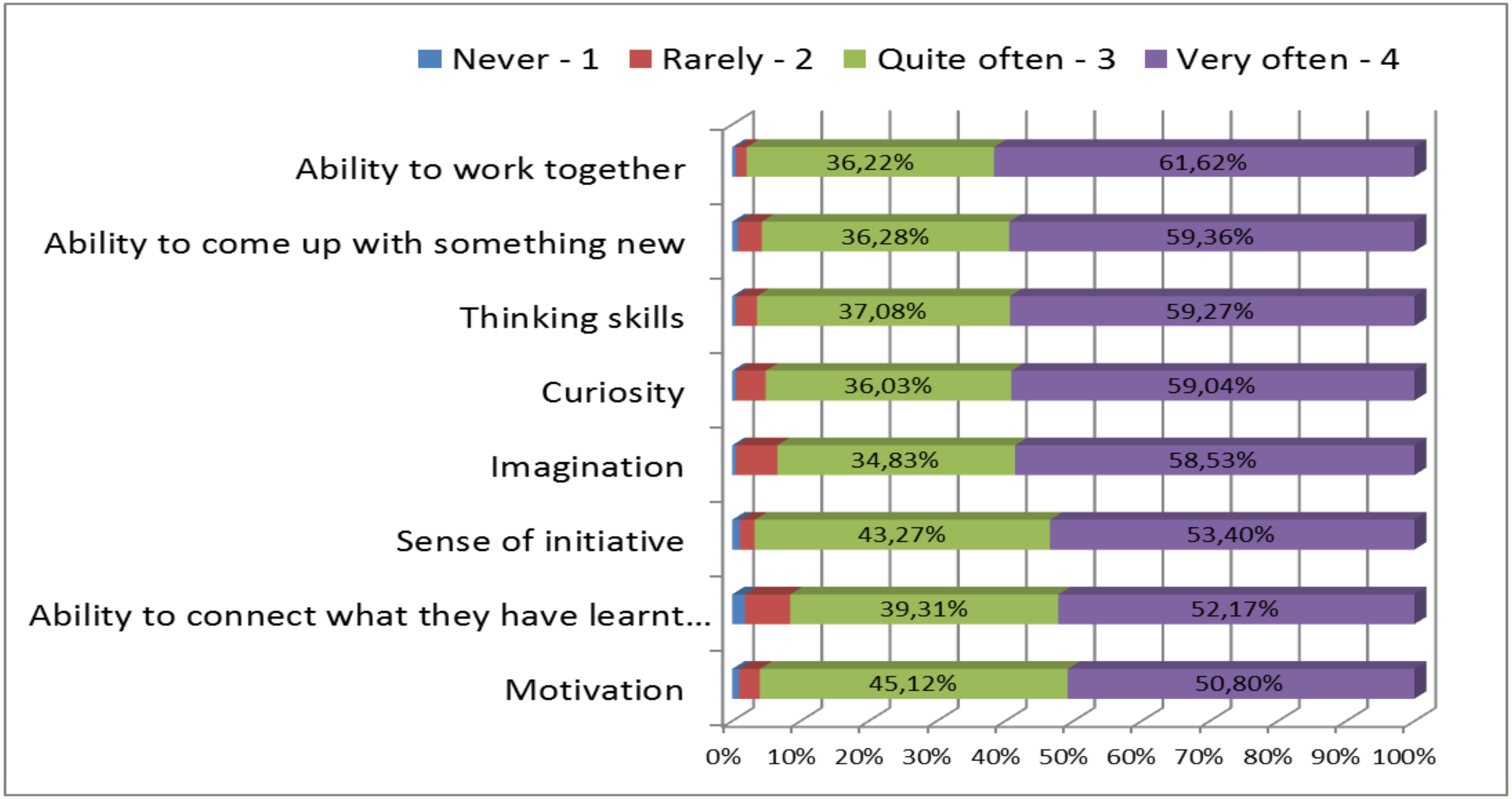
Teacher Survey Findings

Creative attributes in Assessment



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Implications

- Potential for inquiry and creativity in early years science and mathematics
- Complex relationships between policy and practice and between different dimensions of policy
- Areas for further exemplification and support included:
  - social and affective dimensions of science learning
  - planning investigations and evaluating ideas and explanations
  - nature of science
  - approaches to assessment
  - mutimodal approaches to representing and expressing ideas
  - scope for autonomy – for both children and teachers

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Project Processes

2. What approaches are used in the teaching, learning and assessment of science and mathematics in Early Years in the partner countries?
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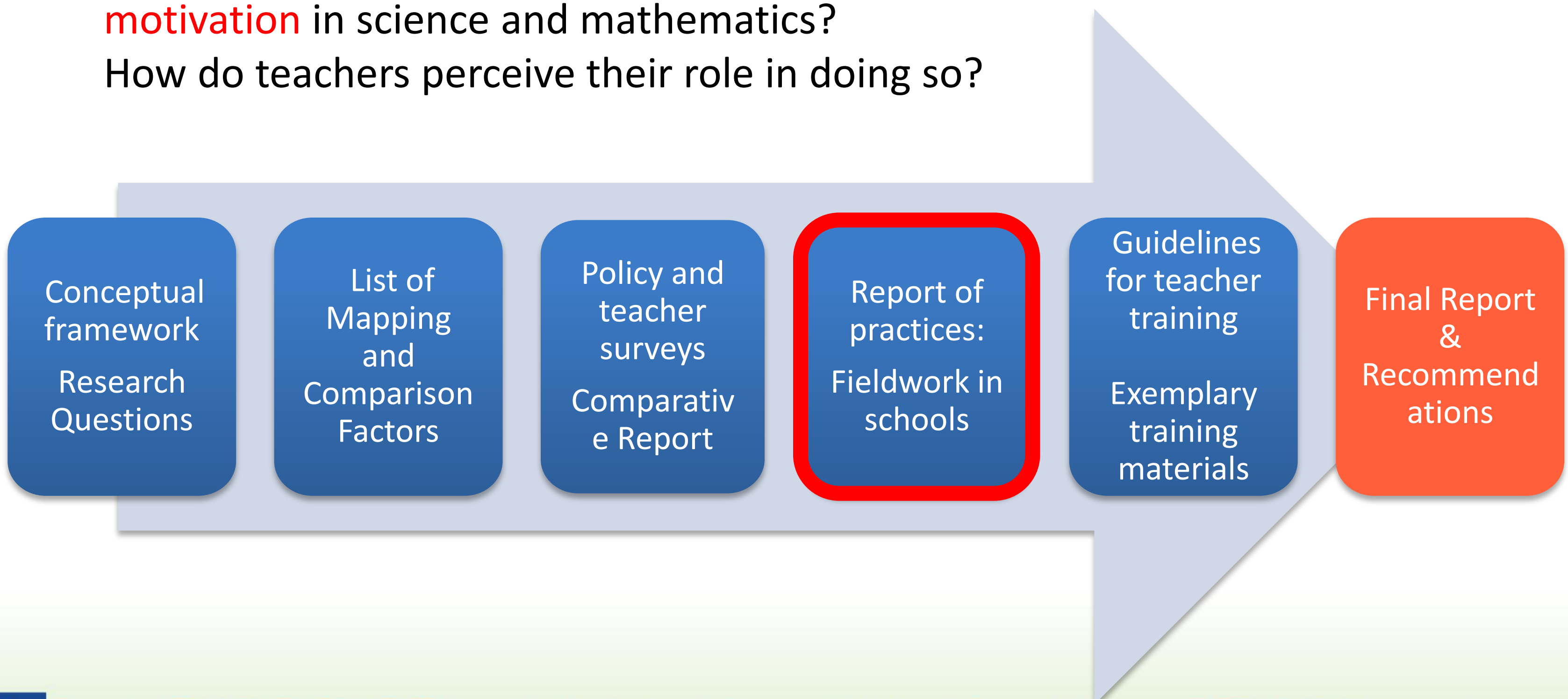

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Research Instruments

1. Wider site context – policy, management, staff development etc.
2. Case pedagogical context – policy, space, records etc.
3. Case observation pedagogical interactions and outcomes
   - Core instruments: digital images, fieldnotes, audio recording, time line
   - Repertoire instruments: Laever's scale, Fibonacci tools, conceptual drawing, teacher journals
4. Case oral evidence – perspectives of children and teachers – individual/group interviews, using for example digital images, 'learning walk', looking at children's work

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Findings from fieldwork in schools

Data collection

- Schools to illustrate potential for creativity
- Diversity of intake and setting
- Visits over 4 days (over a period of time)
- Minimum 4 sites (schools/preschools) and 6 cases per partner
- 3 episodes per case (both science and mathematics)
- 71 case studies and 218 episodes.

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Episodes from the project

Key features of our findings:

- About the potential for creativity
- Children's capabilities
- Factors that seem to contribute to opportunities for inquiry and creativity.

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Learning Activities: Generating and Evaluating ideas

- *Observing and making connections* most common
- Rich, motivating contexts important in *generating* and *evaluating* ideas, questions and interests.
- *Purposes for inquiry* were linked to children's everyday experiences and scope for children's decision making.
- Teacher's role and flexibility to build on these, as well as in fostering the social dimensions of inquiry.
- Greater scope of child-initiated activity and creative engagement in preschool.

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Episode Sand box: Making a wall

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Episode Measuring Tables: Taking measurements to give the carpenter for their new tables

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Episode Float and Sink: How can the dove rescue the little ant who fell into the river?

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Pedagogy

- Opportunities for *play* limited in primary.
- The roles of varied forms of representation (incl. ICT) and the *processes* of representation in developing children's thinking needed greater recognition
- Few examples of use of outdoor resources/areas, more in preschool
- Assessment approach informal and formative, but limited involvement of children in assessment

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Opportunities for play, exploration, planning investigations and problem solving

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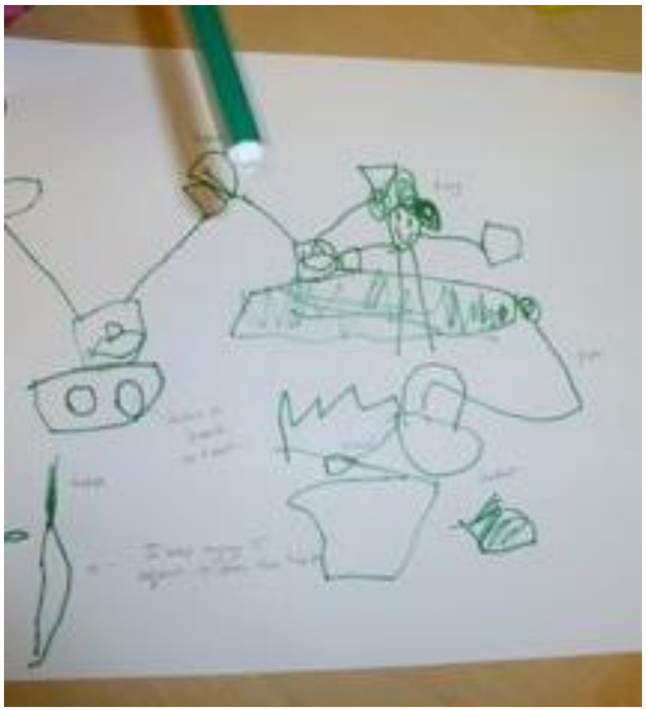
Rich materials, motivating contexts, scope for autonomy

research,



Opportunities for reflection on learning

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Findings from fieldwork in schools

Emerging findings: potential for creativity

- Scope for autonomy across varied settings
- Opportunities for play, investigation and problem solving
- Rich materials and contexts for learning indoors and outdoors
- Strong focus on affective and social dimensions of learning

However

- Limited explicit attention to the nature of science although evidence of potential
- Approaches to assessment mostly implicit
- Further attention needed to varied modes of representing and expressing ideas and role in learning
- Influence of school, teacher and policy factors

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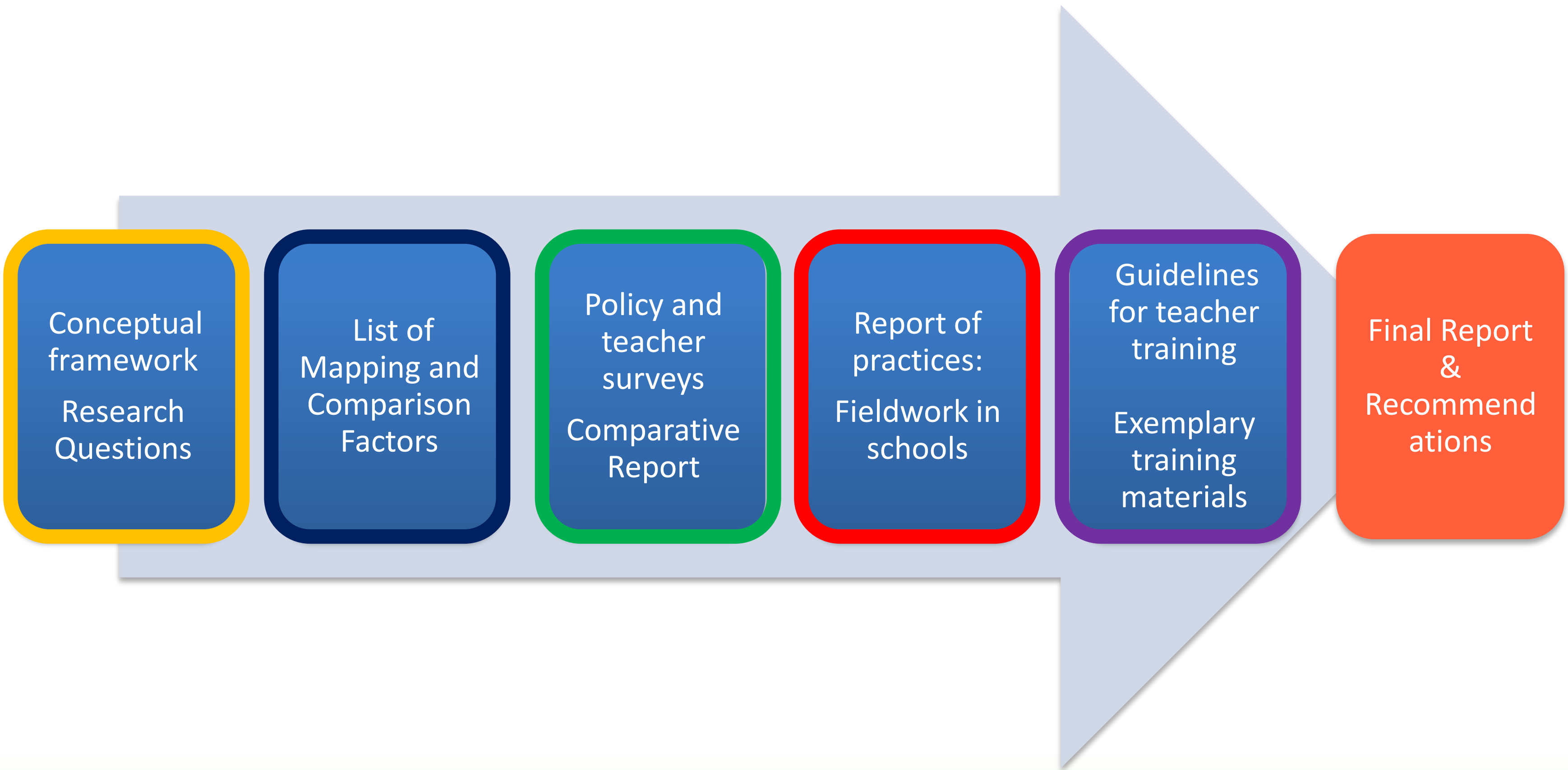
Project Processes



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Implications

Teacher Education Materials

- Curriculum Design principles and teacher outcomes for teacher education based on Creative Little Scientists findings
- Exemplar materials for use in teacher education related to each design principle
  - Selected episodes from fieldwork – with context and commentary illustrated by extracts from data
  - Classroom extracts, photographs, interviews
- Suggested approaches to using exemplar material

All materials will be available on Creative Little Scientists website: **www.creative-little-scientists.eu**

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