Bridging the Gap between Understanding and Participation: An Experiment-Based Concept

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Background

- Univ. of Cologne
  - strong science program (ranks among the top universities in Germany)
  - largest teacher education facility in Germany
  - very strong Geography program
- Water:
  - cross-cutting theme for natural and social sciences as well as teaching subjects,
  - wide range of sometimes conflicting interests of different stakeholders
  - key substance in the context of education for sustainable development
- EU-WFD:
  - achieving "good status" for all bodies of water by a set deadline
  - promoting water management based on river basins
  - getting citizens involved more closely
  - ...
- Education for Sustainable Development (ESD)
  - recognized as a key component in the German national education standards for Geography

Status

- EU WFD provided a starting point for many re-naturalization and revitalization efforts of water bodies.
- Water bodies are often close to schools and provide ample opportunities for observing, monitoring and learning by doing.
- Sustainable river remediation requires participation of and stewardship by the local population.
- A change in attitudes from the perception of environmental protection as being a primary responsibility of a government body to the notion of citizens responsibility requiring participation by local stakeholders can best be facilitated by employing schools as a multiplying and broadcasting platform.

Example: Renaturalization of the Pulheimer Bach (1)

Status in 2006

Status in 2007

Green Classroom Project

Example: Renaturalization of the Pulheimer Bach (2)

Local Activity: Green Classroom Project

Regional / State Support:
LUMBICUS - A mobile Lab

Continuous Support:
Monitoring Devices

Opportunities arising from river restoration projects for ESD Pedagogy

Opportunity	Learning Objective	Learning Concept*	Challenges
Observe river development and direct and indirect effects	Process understanding	Academic learning	Complex interactions and feedbacks in natural systems
Analyze upstream effects upon downstream properties and processes	Spatial and temporal dimensions	Multidimensional learning (time and space)	Issues of scale (large distance relationships, long term effects)
Monitor cause and effect relationships	Contextual dimensions	Multidisciplinary learning	Establishing a cross disciplinary learning schedule
Support community building	Participation and sense of ownership / responsibility	Emotional learning	Developing a benefit to the students and interest beyond the classroom

*Eilam E. and Trop T. (2011) ESD Pedagogy: A Guide for the Perplexed. THE JOURNAL OF ENVIRONMENTAL EDUCATION. 42(1). 43-64, 2011

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Water provides intrinsic links to a wide range of subjects and disciplines:

- Natural Sciences
  - Physics
  - Chemistry
  - Biology
  - Geography
- Social Sciences
  - Economics
  - History / Cultural Development

➔ Water related topics intrinsically lend themselves to cross disciplinary teaching and ESD pedagogy

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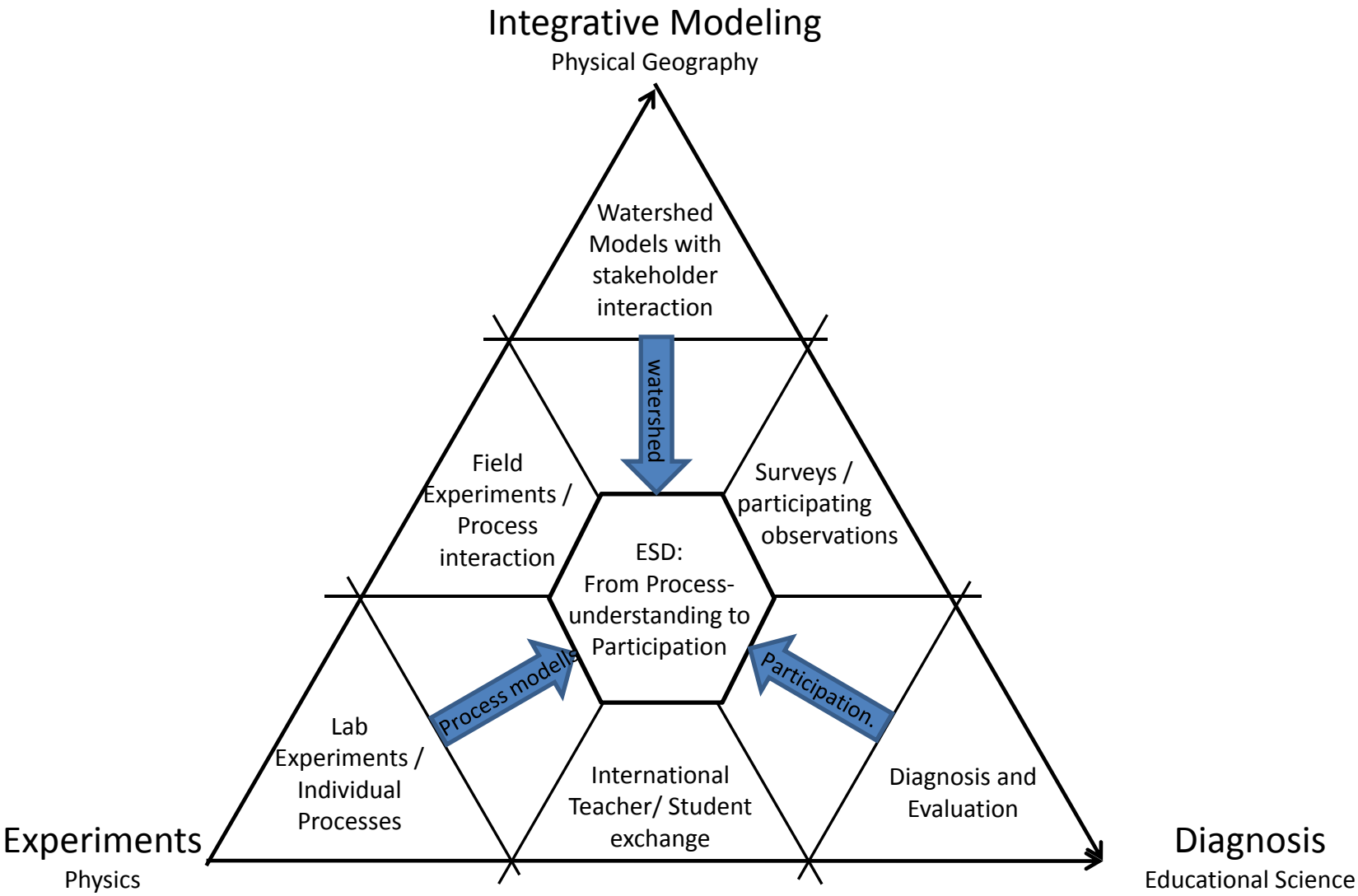
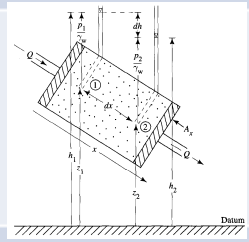
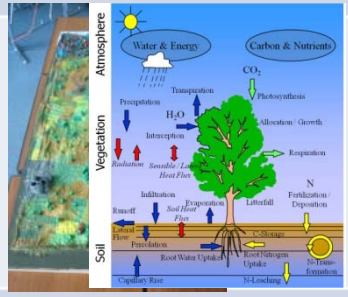
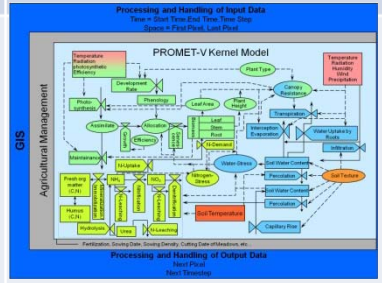
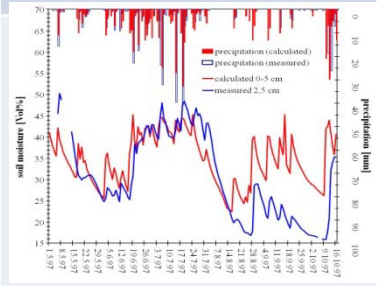
Some characteristics of teacher certification programs in Germany

	Benefit	Drawback with respect to ESD
2 – 3 disciplines / subjects are taught independently of each other	Solid process understanding and disciplinary methods	Little cross-links between disciplines, ESD requires integration across disciplines
Study programs have modular structure	Clear organization, amplification of disciplinary perspective	Reduces holistic perspective
Science classes and education classes are usually taught independently of each other	Solid science education, solid knowledge of education theories and methods	Missing links between the science subject and the methods and concept for educational transfer
ESD is linked to the national education standards in Geography	Clear mandate to teach ESD	Methodological approach and inclusion into teacher certification programs is lacking

Example Research Concept



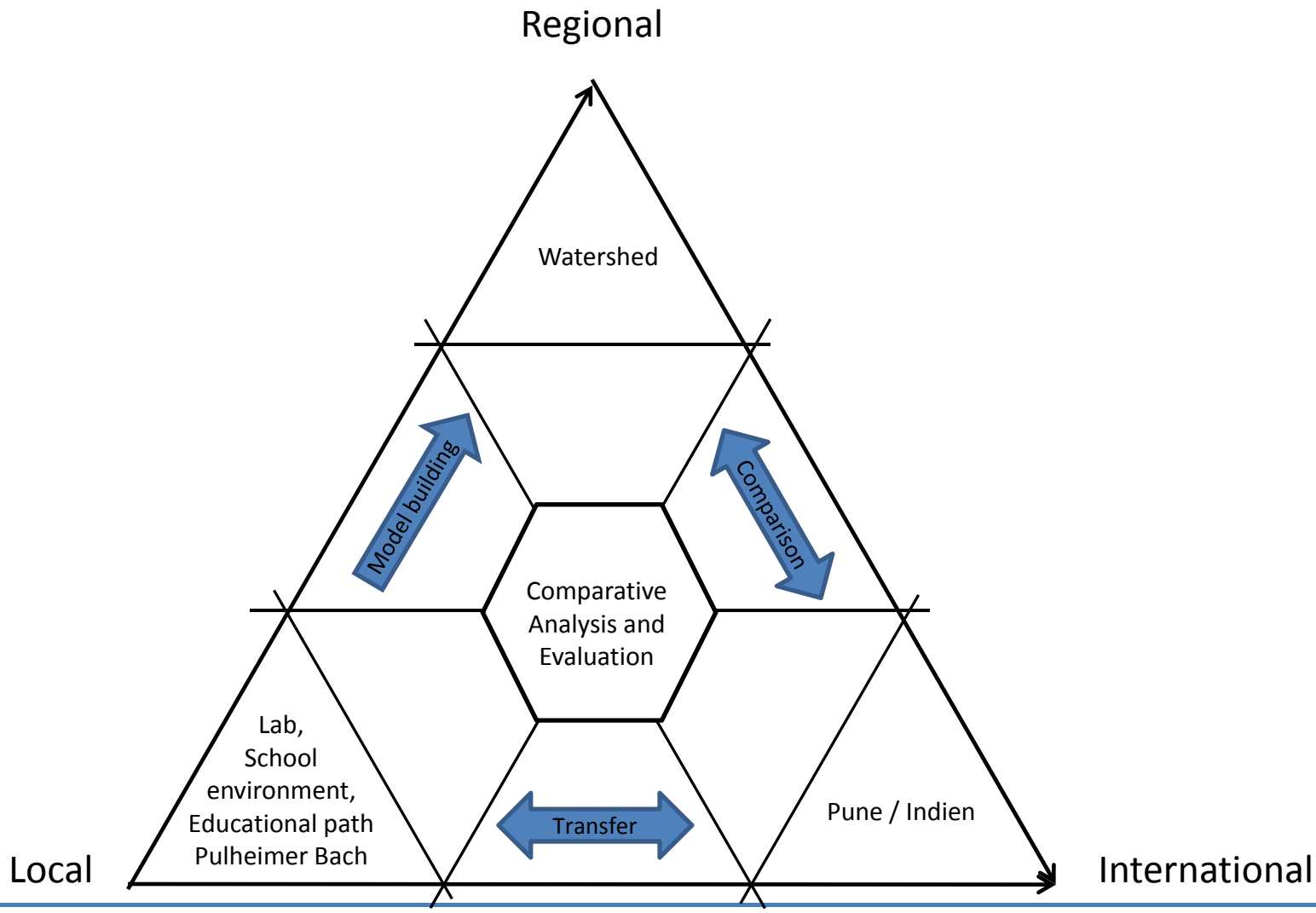
Integration across disciplines

	Observation	Conceptualization	Description	Validation
Physics / Chemistry	Observation	Conceptualization	Process description	Validation
			$V_x \equiv \frac{Q}{A_x} = -K_{hx} \cdot \frac{dh}{dx}$	Reproducibility in Lab
Geography	Observation	Conceptualization	Model	Validation
				
ESD pedagogy	Observation	Conceptualization	Process description	Validation
	Surveys of teachers and students, participating observations	Analysis of surveys	Class protocols	Evaluation of learning success by comparison with reference

Research Approach

			Comparison	
			Traditional / Reference	ESD
Local / Regional Scale	University	Target group: students pursuing teacher certification	Traditional disciplinary teacher certification courses	Teacher certification courses with specific BNE training classes (interdisciplinary, problem driven, new methods)
		Methods	Disciplinary seminars and labs	Cross-disciplinary seminars and labs, combined lab-/ and field work
			Compare argumentation skills, evaluate participation indicators of different student groups (traditional vs. ESD)	
	Schools	Target group: pupils	Academic learning with limited links to real world problems and subjective involvement	Emotional learning based on **hand on projects** with many cross links between science curriculum and relevance to own environment. e.g. schools at Pulheimer Bach
		Methods	Traditional school labs and practical	**Experiment-oriented, cross disciplinary practical** in schools aiming at developing ESD skills and experience
			Compare argumentation skills, evaluate participation indicators and indicators of ability to contribute to environm. protection	
Inter-national Scale	University / School	Target group: pupils	student exchange programs (very seldom in the context of teacher education)	Establish exchange programs with partner universities abroad, specifically for teacher ed. programs, e.g. BVIEER / Poona
		Methods	Compare argumentation skills, evaluate participation indicators of student groups with / without access to international cooperation	

Spatial Scaling Approach



ESD Research Objectives

- Develop cross disciplinary programs with local relevance
  - Integration through corresponding experiments (field and lab experiments) and use of same outdoor location
  - Identify and employ cross disciplinary concepts though model analogies (e.g. Ohm's law)
- Analyze the relevance of outdoor observation, tangible and physical models for academic learning as well as emotional learning
  - Does the approach of integrating models and real world experience improve emotional learning and support the understanding of models as well as their credibility?
  - How do students and pupils perceive the limits of (physical/conceptual) models?
- Analyze disciplinary and cross-disciplinary learning success
  - Is there a motivational benefit from using a cross disciplinary common anchor (e.g. a river renaturalization project which provides a starting point for classroom research in different subjects)?
  - Is there a change in understanding and relevance by transferring similar concepts across disciplines?
  - What are the methodological challenges in developing and implementing integrative ESD programs?
- Analyze the willingness to participate
  - Does the local experience reflect on the willingness of the pupils/students/teachers/parents to participate?
  - Does the understanding of spatial relationships analyzed at local rivers affect the understanding of regional to global interactions?
  - Does the change in understanding spatial and temporal relationships reflect upon behavior?

Conclusion

Traditional teachers education programs in Germany are discipline oriented and do have limited cross disciplinary aspects and cross disciplinary methodological approaches

- ➔ New toolset for ESD oriented approaches in teacher education programs are needed
- ➔ Universities and practitioners / schools must jointly develop new approaches for teacher training programs

Understanding scaling issues (temporal and spatial) is of key importance to ESD

- ➔ River restoration projects provide many opportunities to analyze spatial and temporal dependencies which may provide a suitable empirical basis to scale up to regional and global issues

Gap between understanding basic processes and complex systems

- ➔ Moving from physical / tangible model to numerical and integrated models may provide a means to better understand and analyze complex systems behavior, to build confidence in models and to better understand and convey options of human management
- ➔ Suitable and sufficiently simple models must be developed from the existing scientific models

Sustainable river restoration requires local participation

- ➔ Manifold opportunities for water education and ESD
- ➔ Emotional learning by hands on experience supports the development of a sense of relevance
- ➔ Better integration of Science – Education – Application is needed. Teacher education and schools are a key facilitator to support this integration