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Εθνικόν και Καποδιστριακόν
Πανεπιστήμιον Αθηνών

Ποιοτική μεθοδολογία έρευνας στη Διδακτική των Μαθηματικών

Ενότητα 2: Η εξέλιξη της έρευνας και η πρόσφατη στροφή

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Τμήμα Μαθηματικών

Quality of research in Mathematics Education

What is quality in mathematics education research?

What are the main assumptions about research?

- Research is authentic inquiry – attempt to answer significant questions
- Research advances knowledge in the field (practitioners of all kinds)

What are the characteristics of research in ME? (1)

Bishop (1992, p. 712) claims that '*some activities, such as the mere accumulation of data, the reporting of accidentally occurring incidents, the detailing of abstract analyses, the offering of "armchair" speculations, the planning of a curriculum or a lesson, the designing of some teaching materials, or the setting of an examination, do not, of themselves, constitute research activities, although each may make a contribution to the research process at some stage*'.

What are the characteristics of research in ME? (2)

- Zan (1999)
- Research requires personal commitment
  - The choice of the problem of the theoretical framework, of the methodology, of the process of data analysis, of the interpretations involves the researchers' decisional processes.
  - These decisional processes depend on the researcher's epistemology, beliefs and values and need to become explicit.

What are the main changes in Research in Mathematics Education?

- A new research domain (about 50 years, since 1960 the first research journals)
- Research has involved significantly the last 30 years with the predominance of qualitative research methodologies
- New theoretical perspectives and research methodologies
- Major challenges with respect to standards for research quality
- There is a dynamic and ongoing discussion of research quality versus a set of criteria and personal accounts about research

Theoretical perspectives and quality of research in ME

- (Killpatric, 1992)
- Positivistic (behavioristic) view
  - teaching and learning as a system of interacting variables
- Interpretivist view
  - Meaning that the teaching and learning of mathematics have for the participants by living in a classroom
- Critical view
  - Change the environment
- Quantitative/qualitative – analytical/ systemic approach – precision/authenticity

Challenges about defining criteria

- The difference between quality of a study and quality of a report
- Can we talk about the same criteria for the different research paradigms?
- Are the criteria relevant to the current research in the field?
- Are the criteria shared by all researchers in the field?
- Are the criteria refer to specific parts of the research or to the research as a whole?

Killpatrick's criteria (1)

- Relevance
  - What is the use of it?
  - For whom? (eg. to teachers? To researches?)
  - Basic versus applied research (the link between research and practice)
- Quality – relevance and usefulness are bound togethter

Killpatrick's criteria (2)

- Validity
  - Has our research method allowed us to investigate what we intended to investigate?
  - What is it that we have studied? What is the case of?
  - What are the consequences of the research?

Killpatrick's criteria (3)

- Objectivity
  - Different opposing opinions
  - Researchers need to reflect on their own biases and provide evidence on their role in their study
  - Researchers need to refute their own conclusions to strengthen their argument.

Killpatrick's criteria (4)

- Originality
  - Relative and not absolute
  - Old things with a new light
  - It does not mean a lack of connection to prior research

Killpatrick's criteria (5)

- Rigor and Precision
  - Rigor versus relevance
  - Negative and positive sides (rigidity, inflexibility, procedural; accuracy)
  - Moving from the precision of measurement to the precision of meaning
- "Care taken in observation, the attention to detail, the willingness to test alternatives than from fidelity to any standard procedure" (p. 27)

Killpatrick's criteria (6)

- Predictability
  - Eg. predict how students or teachers will respond to a task
  - Patterns of regularity
  - Traditionally a cause-effect relation
  - Prediction is not possible in a classroom (not a closed system)
  - How well the inferences made from the literature review and the theory allow us to anticipate what will happen in a particular phenomenon

Killpatrick's criteria (7)

- Reproducibility
  - Research procedure, observations, patterns of results clearly stated to be reproduced
  - Make the research public
  - Reproducibility is related to generalisation

Killpatrick's criteria (8)

- Relatedness
  - Both to mathematics and to the educational process
  - What about studies that mathematics is only a placeholder?
  - The interdisciplinary character of research in Mathematics Education (try theories from other research domains)

Why do we need criteria?

- To assess our own work and the work of others
- The offer us lenses through which the research landscape can be viewed.

Task1: What are the criteria of the international research journals of the quality of Research (1)

- **Educational Studies in Mathematics** is an international journal of research and scholarship in mathematics education. It aims to illuminate **issues of principle, policy and practice in the field** and to promote **the development of coherent bodies of theorized knowledge** which can be brought to bear on these issues.
- The journal seeks to publish **original articles** which address the aims set out above, **make a significant contribution to the field**, and are **interesting and accessible to a diverse international readership**.
- Many **different forms of research and scholarship** can contribute to the aims of the journal, and that these will draw on **differing perspectives and approaches**.

Task1: What are the criteria of the international research journals of the quality of Research (2)

- A submission should **make explicit the theoretical and methodological framework** within which this evidence has been gathered and analysed. A submission should show **critical awareness of other possible approaches**.
- The submission will be evaluated in terms of appropriate criteria of **rigour**, intended to ensure that the analysis is well-founded, that it develops a **cogent argument**, and that it **takes account of other relevant research** and scholarship in the field.

Task1: What are the criteria of the international research journals of the quality of Research (3)

- **Journal for research in mathematics education**
- Criteria: **Worthwhileness , Coherence, competence, openness, ethics, credibility, other qualities (clarity – originality)**
- **Wothwhileness** has to do with the potential of a research study for adding to and deepening our understanding of issues associated with mathematics teaching and learning

Task1: What are the criteria of the international research journals of the quality of Research (4)

- **Coherence**. Thoughtful researchers first give serious attention to identifying interesting and worthwhile research questions and then to selecting the **research methods and techniques that best fit the nature of those questions**.
- **Competence**. The study it must include the effective application of appropriate data collection, analysis and interpretation techniques.
- **Credibility**. The claims made and conclusions drawn should be **justified** in some acceptable way.

Task1: What are the criteria of the international research journals of the quality of Research (5)

- **Openess.** A) Good researchers are **cognizant of the personal biases** and assumptions that underlie their inquiry
- b) the conceptual/theoretical bases for a study and the research methods and techniques used **should be described in sufficient detail** to allow the research community to scrutinize them thoroughly.
- **Originality**. An original study is not a necessarily one that has never been done before. Rather, originality can also result **from looking at an old question in a novel manner,** using a **new technique of analysis, synthesizing evidence in a different way**, or **providing a new interpretation for old data**.

The role of the researchers' epistemological choices

- There is not agreement among the researchers about the criteria
- Problem- led perspective versus method-led perspective
  - In the first we have multiplicity of methods to access the problem. The method is related to the problem
  - in the second, quality criteria are linked to the method used (eg sociological, anthropological, ethnographical research)
- Design research versus phenomenological research

An example to illustrate epistemological differences

- The relation between relevance and utility
- Research on teachers' decisions and the factors that frame them
- The recognition of the teachers' role is very important
- Usefulness is not to use the research results immediately in the classroom but to influence teachers' decision making.
- The relation between theory and practice and the responsibility of the researcher.

A dynamic dimension of quality of research in mathematics education (ME)

- Simon (2004)
- “In mathematics education research, as in mathematics, there is a need to reflect on the state of the field, endeavor to make canons for quality explicit, and consider the process by which new researchers are acculturated into the field”

Issues of research quality (1)

- An empirical research study as an argument:
  - Justification of the research questions (importance in relation to what is known)
  - Justification of the methodology
  - Justification of the analysis of data (make clear the chain of reasoning that lead to interpretations – present a part of the data- convince the communtity that data analyzed were central to the problems)
  - Justification of conclusions (contribution to knowledge linking to other research)

Issues of research quality (2)

- Theoretical Research as an argument (based on prior empirical and theoretical work)
- Description is generally not enough
  - Researcher's responsibility to frame his or her case as a paradigm case, articulating what is a case of and explicating conclusions
- When is empirical work at a level for publication?
  - It makes a contribution to knowledge
  - It warrants for the claims to be strong

Issues of research quality (3)

- Rigorous application of methodologies is not sufficient
  - Methodology must respond to the different purposes and contexts of research
  - Analysing qualitative data is much like solving a mathematics problem – each step leads to greater insight as to what might be tried subsequently
- Research questions evolve

Issues of research quality (4)

- What are we looking for? – An epistemologically based question
  - " what is" versus "developing an empirically based construct fo account for interesting aspects of the data"
- Building on the work of others to
  - show the importance of your research questions
  - Relate the new contributions to existing knowledge

Researching Research: the role of theories in research and practice (1)

- Lerman, Xu and Tsatsaroni (2003) (need to consider the social dimension)
- (Pais and Valero (2012) (need to consider the political dimension)
- The theoretical and analytical lenses we deploy in the research underlie ideological motivations and trends of which we are not aware.
- What is the object of research in mathematics education reported in journals, books, conference proceedings?
- Issues of relevance of research and a broadening perception of the specificity of mathematics; research that addresses social, cultural, political dimensions

Researching Research: the role of theories in research and practice (2)

- Bergsten (2007) investigates the role of theory through comparing three studies that all investigate learning and teaching the limit of functions
- “A research framework defines the world in which the research live, pointing to difficulties to compare research results within different frameworks” (p. 1638)
- This paper poses different issues about the important role of theory in research in terms of the research questions, the methodological choices, the interpretations and the nature of findings. How these different parts of a research are linked (consistency and coherency) is related to the quality of research.

Typical format of a research report (1)

- *Abstract: What was done and found*
  - summarise the research aim, its design, and the main results.
- *Introduction: What is the problem?*
  - the area of concern (setting the scene);
  - the problem (usually stated as a research question); and
  - the significance of the problem (the theoretical and/or practical reasons for exploring the research questions

Typical format of a research report (2)

- *Literature review: What is already known?*
  - Theoretical framework
    - theories related to the research study
    - It frames the design, the entire discussion and provides explanatory power for the data
    - the lens that you use to interpret what is happening and why
  - A synthesis of literature review
    - Summarize the studies that are related you your research goal.
    - What common threads hold these studies together?
    - What does your study come to contribute (possible gaps)

Typical format of a research report (3)

- *Methodology: How was the research undertaken?*
  - Why were your methods of data collection and analysis used? (collection versus generation/construction)
  - How do they fit with the theoretical framework outlined above?
  - Provide information about participants, the context of the study, the process of data collection (research instruments) and the process of data analyis

Typical format of a research report (4)

- *Results and discussion: What was found?*
  - Results and discussion separate or integrated
  - summarize the evidence that was collected and analyzed in terms of your research questions
  - interpret these data
  - draw hint at some conclusions (relate to relevant research)
- *Conclusion: So what?*
  - Summarise your research findings
  - Discuss consequences, implications, limitations.
  - Claims follow logically from results section.

Example of the methodological part of a paper: data analysis (1)

We first used open coding (Strauss, 1987) to generate initial categories, for example, choice of representations in solving problems, the use of rules in solving problems, and ways of conducting calculations. The initial categories were constantly compared with new data and refined. We scrutinized various aspects of the talk during the whole-group work, such as how problems are solved, what solutions are presented to the whole class, and how they are chosen for presentation. We identified relationships and hierarchies among the categories and created core categories that are "the central phenomenon around which all the other categories are related" (Strauss & Corbin, 1990, p. 116). Some of the categories that were developed through this process were related to the mathematics addressed in class. These categories were linked with the five aspects in the framework, in line with the description in the previous section

Example of the methodological part of a paper: data analysis (2)

Then, for each probability problem worked on in class, we examined references related to these categories. When noteworthy, we also counted the number of problems where specific references were made. For example, for the aspect "Essential features and the strength of probability theory," we examined and counted the number of problems where references were made to (a) uncertainty, (b) the unique fundamental characteristic of probability theory, namely, the emphasis on the extent of the predictor's knowledge rather than on the objective situation, (c) the role of probability theory in mathematics or in other domains. Likewise, for the aspect "Approaches to probability," we examined the approaches used and counted the number of problems where specific approaches were used, and so on. In addition to the authors, two other researchers who specialized in the field of mathematics education participated in analyzing about 15% of the data. All disagreements were resolved by discussions, so that a consensus was reached. Then, the rest of the data were analyzed. Finally, statistical analysis was performed using the Chi-square test for comparing respective percentages of problems between the two classes of each teacher and between the two teachers.

Task 2: Analyzing reviews

- You have been given a review of a researcher for a paper submitted in an international journal.
- Work in groups of 4 persons for 15 minutes to highlight how the researcher sees the quality of the research in his review (in general and more specifically in terms of the particular parts of the paper (literature review, research goals/questions, methodology, results, conclusions).
- Summarize your group observations so that one member of the group to present them for 2 minutes in the class.

Questions addressed

- What are the emerging issues in relation to the quality of the study in each review?
- Are there differences in relation to the different theoretical perspectives (qualitative – quantitative, psychological- sociocultural-social-sociopolitical)?

Task 3: Evaluating a proposal for a short-oral presentation

- Work in groups of 4 persons. Read the short oral and identify
  A. the research goal and the research questions
  B. The theoretical concepts that frame the study
  C. The methodological part
  D. The main findings
- Discuss in your group if you judge that this study
  - Addresses an important question
  - It offers justified arguments in A,B,C and D
  - The way that A, B, C, D link
  - What you think that it should change
- (15 minutes)
- Prepare a short presentation to report in the class (2 minutes)

Reflections

- If you would like to design a research state 3 things that would be the most important to consider?

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Τέλος Υποενότητας

Quality of research in Mathematics Education

Χρηματοδότηση

- Το παρόν εκπαιδευτικό υλικό έχει αναπτυχθεί στο πλαίσιο του εκπαιδευτικού έργου του διδάσκοντα.
- Το έργο «**Ανοικτά Ακαδημαϊκά Μαθήματα στο Πανεπιστήμιο Αθηνών**» έχει χρηματοδοτήσει μόνο την αναδιαμόρφωση του εκπαιδευτικού υλικού.
- Το έργο υλοποιείται στο πλαίσιο του Επιχειρησιακού Προγράμματος «Εκπαίδευση και Δια Βίου Μάθηση» και συγχρηματοδοτείται από την Ευρωπαϊκή Ένωση (Ευρωπαϊκό Κοινωνικό Ταμείο) και από εθνικούς πόρους.

Σημειώματα

Σημείωμα Ιστορικού Εκδόσεων Έργου

Το παρόν έργο αποτελεί την έκδοση 1.0.

Σημείωμα Αναφοράς

Σημείωμα Αδειοδότησης

Διατήρηση Σημειωμάτων

Οποιαδήποτε αναπαραγωγή ή διασκευή του υλικού θα πρέπει να συμπεριλαμβάνει:

- το Σημείωμα Αναφοράς
- το Σημείωμα Αδειοδότησης
- τη δήλωση Διατήρησης Σημειωμάτων
- το Σημείωμα Χρήσης Έργων Τρίτων (εφόσον υπάρχει)

μαζί με τους συνοδευόμενους υπερσυνδέσμους.

Σημείωμα Χρήσης Έργων Τρίτων

Το Έργο αυτό κάνει χρήση των ακόλουθων έργων:

Εικόνες/Σχήματα/Διαγράμματα/Φωτογραφίες