Presentation on Research Methodology

for

TeComp workshop – Department of Mathematics

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by

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Why Learn about Research Methodology

- As an Individual
  - To become better researchers ourselves
  - Need for knowledge of the discipline
  - Ability to get involved in competitive research projects
  - To complete Requirement for a Degree
- As a Professor/Instructor
  - To help students to initiate research as a way of thinking and to acquire research skills
  - Improves motivation of students
  - Improves retention
  - Ability to better engage students

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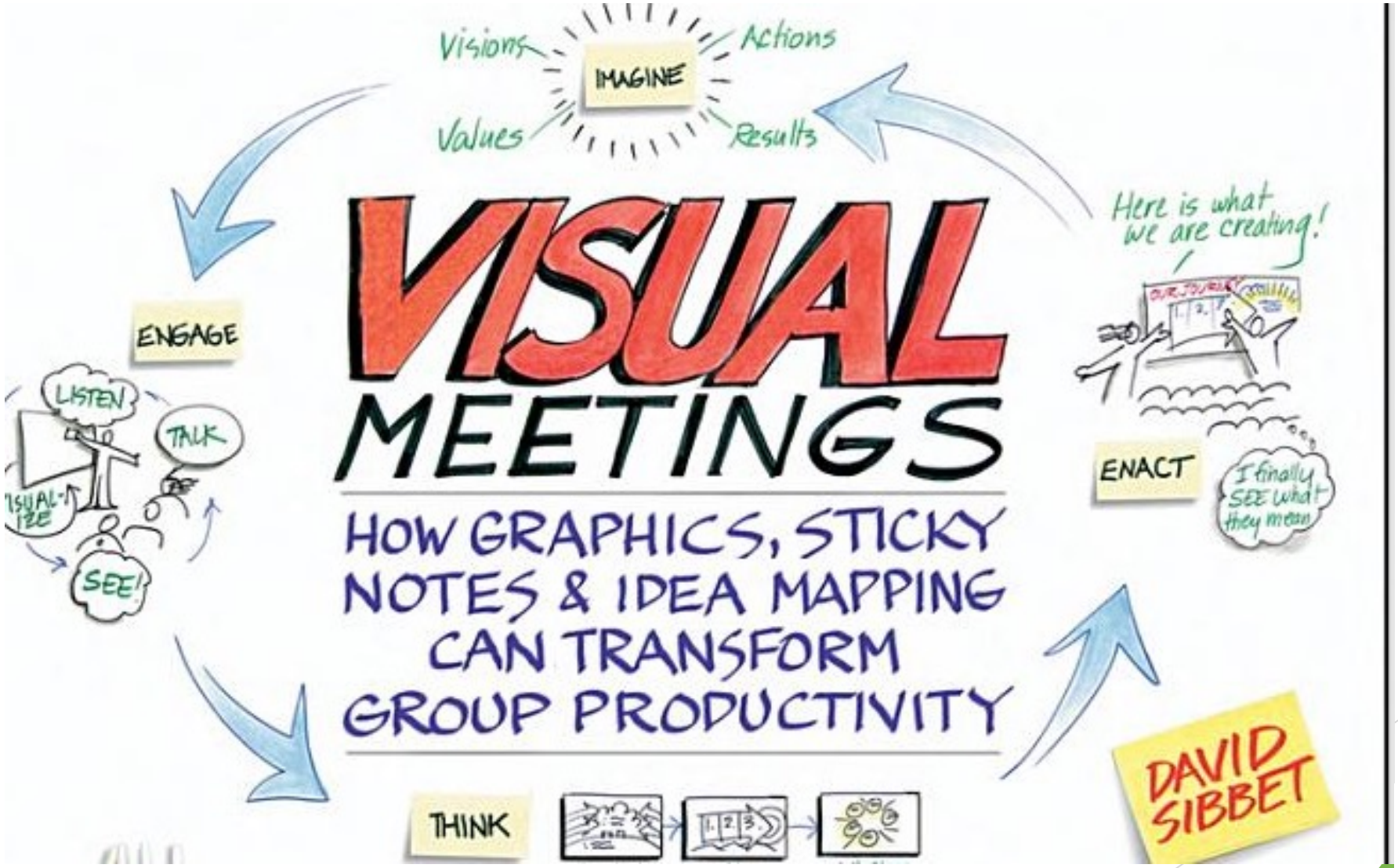
Fig 1. Visual Presentation



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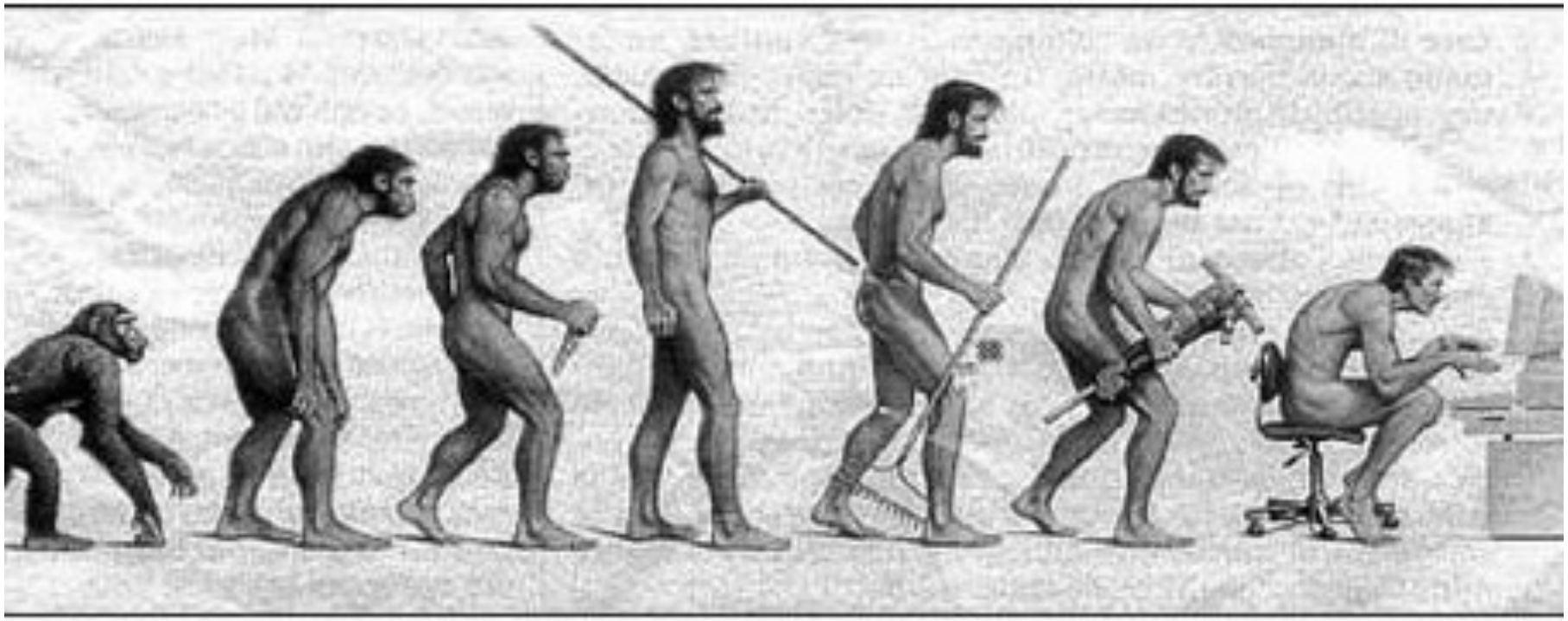

Fig 2. Evolution of Design

What type of Field would this have relevant?

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Meaning and Purpose of Research

- Research is done and has been done to advance Society
- To make changes to Policy (case Study)
- To find cure for Disease (Experimental)
- Modern Design of Buildings
- Improvement in Computer
- Improvement in Medicine
- Improvement in Student Achievement
- To Describe certain Phenomenon (Quantitative)
- Add to the breadth and depth of Scientific Knowledge (Quantitative/Qualitative)
- To complete requirements for a degree program (LOL)
- To get Funding (Action Research)

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Involving Students in Research

- First instructors have to become familiar with sound research methodology
- Here the intent is not to make students researchers overnight
- The intent is rather to teach students the research way of thinking and research skills

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How to help students develop research Skills

- Two alternatives
  - One:
    - Involve the students directly in a real research project that the faculty is conducting.
      - Here the student will be directly involved in a discovery or applied research or parts of it and in so doing learn research skills

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How to help Students develop Research Skills (contd.)

Second Alternative

- Construct (develop) an instructional project for the students so that they will have the opportunity to go through all or some of the steps involved in research methodology.

- This is not a real discovery or applied research; but students will still go through the research experience.
- Faculty needs to put in lot of time in developing a project of this type beforehand.

Faculty knows the answers.

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Some Definitions of the term Research

- A systematic process of inquiry in order to discover, interpret or revise facts, events, behaviors, or theories, or to make practical applications with the help of such facts, laws or theories
- A structured inquiry that utilizes acceptable scientific methodology to solve problems and creates new knowledge that is generally applicable
- A careful systematic study and investigation in some field of knowledge, undertaken to establish facts or principles
- A systematic investigation to find answers to a problem

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The Process for Research

- Research must use procedures, methods and techniques which have been tested for their validity and reliability
- Research must be designed to be unbiased
- Research must be designed to be objective
- Research should be conducted within a framework of a set of principles for the type of methodology

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A Paradigm for the Research

- Two Paradigms
  - Quantitative : traditional, experimental or empirical
  - Qualitative: Constructivist or naturalist, or interpretive approach (Creswell, 1994)
- Assumptions of the paradigms
  - Quantitative researchers view reality as objective, independent of the researcher
  - Qualitative Reality is constructed by the individuals involved in the research

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Characteristics of Research

- Controlled - Establishing causality
- Rigorous
  - Methods and procedures used need to be relevant, appropriate and justified
- Systematic - Certain sequence has to be followed.
- Valid and Verifiable
  - – Results are correct and can be replicated
- Empirical
  - Conclusions drawn are based on hard evidence
- Critical Scrutiny
  - — Methods, procedures and results must be able to withstand critical scrutiny by others

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Table 1. Quantitative and Qualitative Paradigm Assumptions (Source Creswell, 1994)

Assumption	Question	Quantitative	Qualitative
Ontological Assumption	What is the nature of reality?	Reality is objective and singular apart from the researcher	Reality is subjective and multiple as seen by participants in the study
Epistemological assumption	What is the relationship of the researcher to what is being researched	Researcher is independent from what is being researched	Researcher interacts with what is being researched
Rhetorical Assumption	What is the language of research	Formal based on set definitions – Impersonal voice	Informal Evolving decisions – Personal voice
Methodological Assumption	What is the process of research?	Deductive Process – cause and effect. Accurate and reliable through validity and	Inductive process – Emerging design; Accurate and reliable through verification

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A Step-by-step Model for Doing Research

- Deciding
  - Formulating a research problem
  - Conceptualizing the research design
- Planning
  - Constructing an instrument for data collection
  - Selecting a sample
  - Writing a research proposal
- Doing
  - Collecting data
  - Processing Data
  - Writing a research report

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Formulating a Research Problem (Deciding)

- Decide what you want to find something about
- Ask Effective Research Questions
  - Why is it important?
  - Who cares (or should care) about the question?
  - To what body of theory will it contribute?
  - Has it been asked before?
  - Can it be answered with the time, expertise, and resources available?
- Review the literature
- Identify variables
- Construct hypotheses

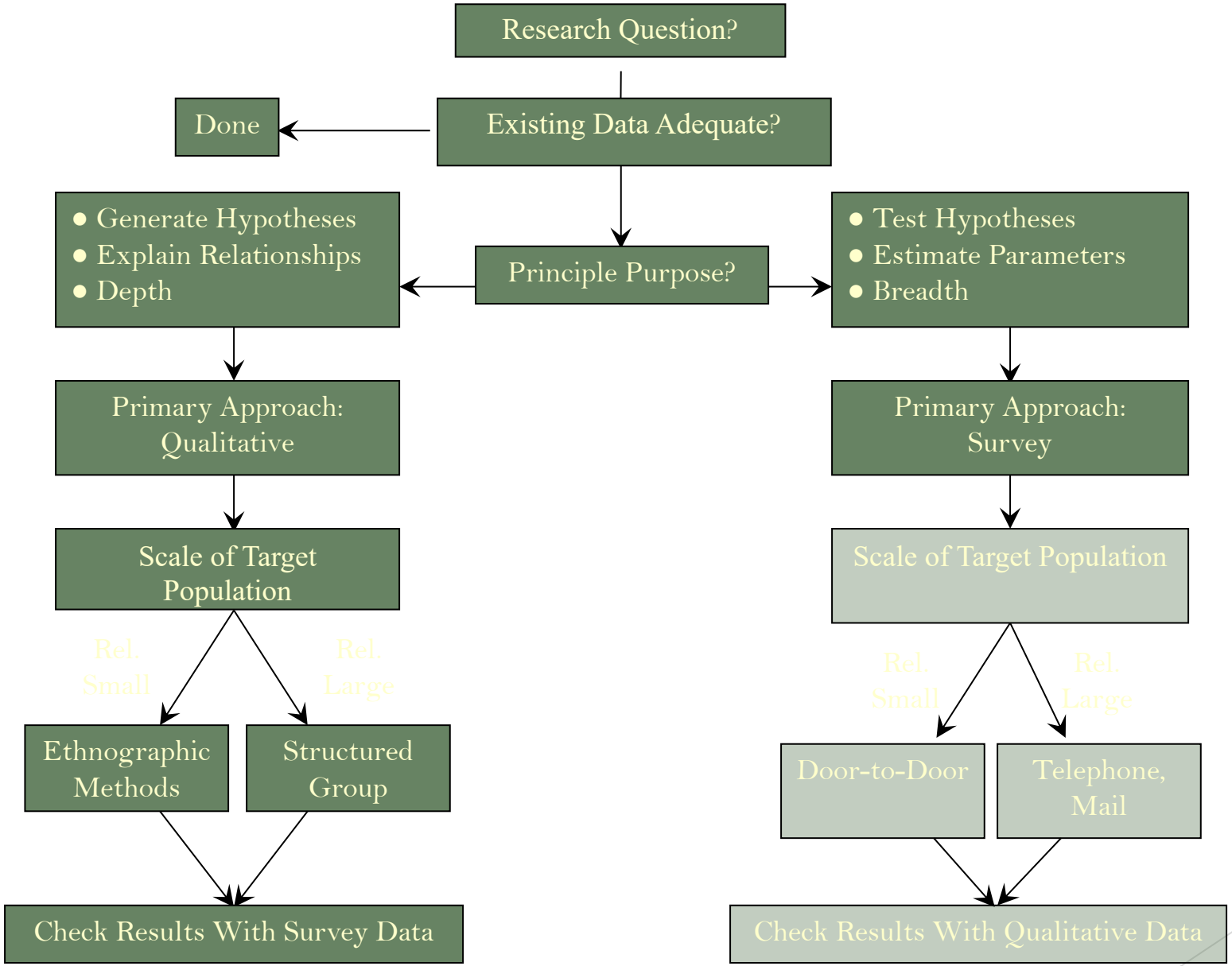
Table 2. Relevant Situations for Different Research Strategies (Robert K Yin)

Strategy	Form of Research Question	Requires control over behavioral events	Focuses on contemporary events
Experiment	How, Why	Yes	Yes
Survey	who, what, where, how many, etc..	No	Yes
Archival analysis	Who, what, where, …	No	Yes/No
History	How, Why	No	No
Case Study	How, Why	No	Yes

Conceptualizing the Research Design

- Research Design
  - Study design
  - Sampling
  - Measurement
- Selecting a study Design
  - Experimental or non-experimental
  - Before and after study
  - Status Study
  - Trend study

Fig. 3 Research Decision Tree



Selecting a Topic for Research

- How to Pick a Topic
  - Start with a Big question
    - Why is this topic important
    - E.g. How to Improve Assessment of Students
    - A particular Grade ?
    - Subjects in the School?
  - Has this Question been studied
  - Who has studied
- Narrow the Topic
  - Use the Reporter Question Format
    - Who, What, Where, Why, When

Topic Selection

- Who
  - Who is the group or person to which you would like to limit your research
- What
  - What about the braod topic is of interest?
- Why
  - Why do you think this is an important topic?
- When
  - On what time period do you wish your research focused?
- Where
  - What geographic region? What country? Slovakia?

Sample Mathematics or Mathematics Education Topics for research

- What Do We Know About the Preparation of Elementary Teachers?
- What Should We Teach Teachers About Mathematics?
- What Should We Teach Teachers About Mathematics and Language
- Control of mechanical system by moving coordinates and locomotion in fluids
- Mathematical models for the control of forest fires
- How should content be organized in the curriculum
- Optimal Harvesting of Natural Resources
- **Fundamental Theorem of Poker.**
- Fishers Fundamental Theorem of Natural selection

The Role of Theory

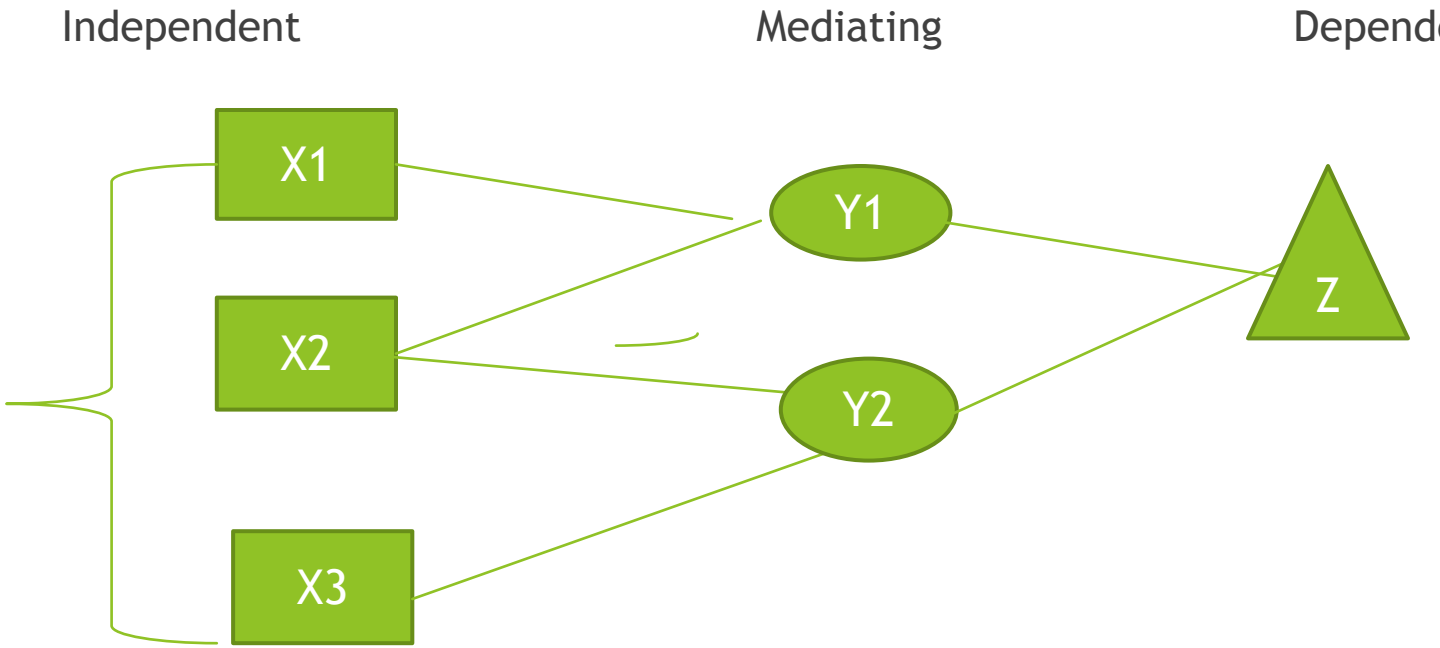
- What is Theory?
- Positivist Definition:
  - A statement of relationship between abstract concepts that cover a wide range of empirical observations
  - Treats concepts as variables
  - Generate hypothesis for research
  - Systematize knowledge
- Interpretive Definition
- Emphasizes understanding rather than explanation
- Objectivist

Objectivist grounded theory resides in the positivist tradition and thus attends to data as real in and of themselves and does not attend to the processes of their production.

Role of Theory

- Critical Theory developed in the early 20,s by the Frankfurt School of Social Research at University of Frankfurt – the idea that academic work could be freed from capitalistic power
- Use to ground the research
- Theories vary in terms of their breadth or scope
- Grand Theories
  - Used to explain large categories of phenomenon
  - Most common in the Natural Sciences – (e.g. Darwin s Theory of evolution)
- Middle–range theories
  - Working hypothesis of every day activities
- Substantive theories
  - Restricted to particular setting or particular group

Fig. 4. Theoretical Framework



Three Independent variables Influence a single Dependent Varaible (Two mediating Variables Controlling for the effects)

Theory Contd.

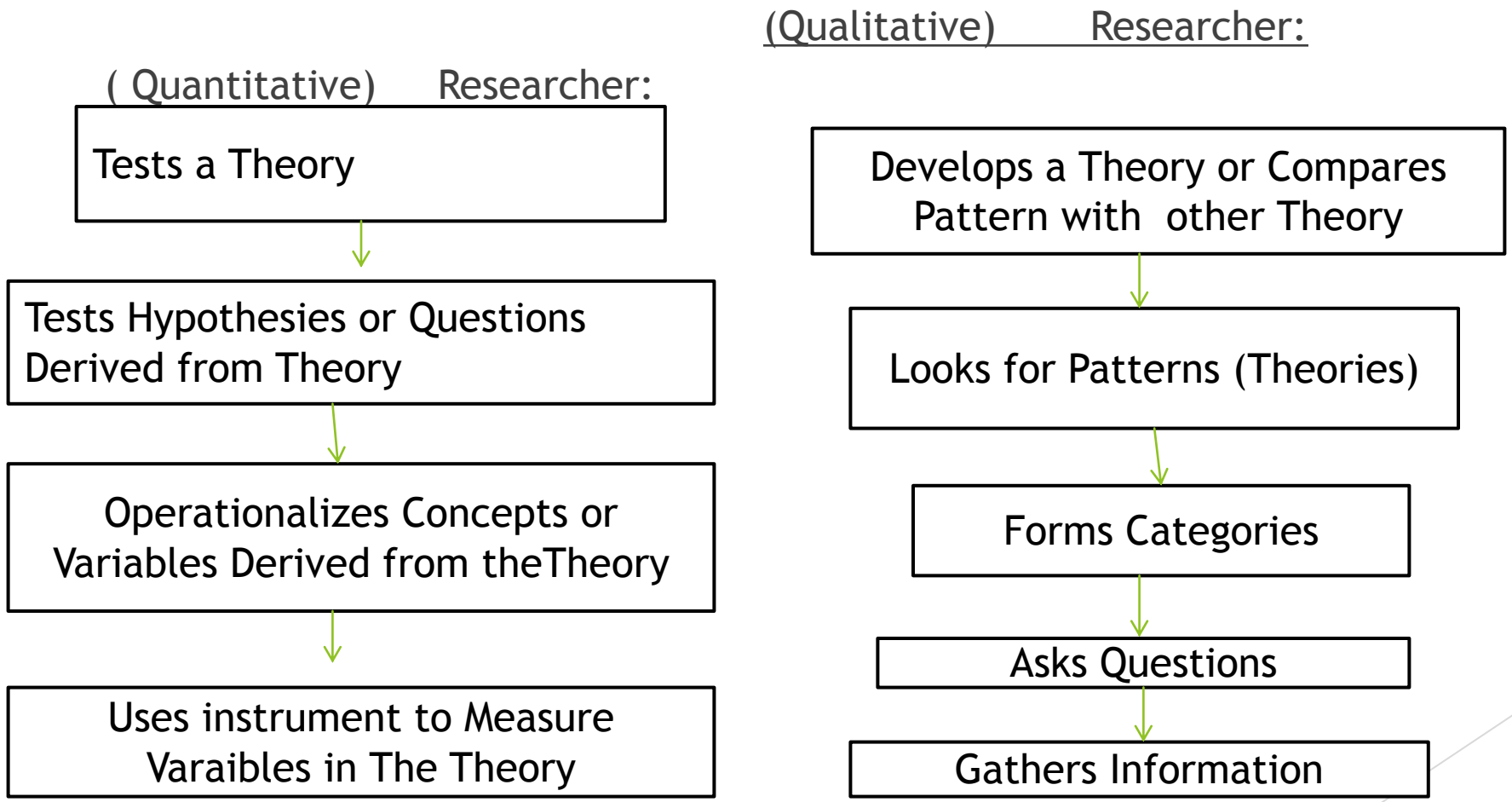
Theory Use differs based on types of Study

- Quantitative Study
  - Employs an accepted definition of Theory based on interelationships of variables
- Qualitative Study
  - Employs an inductive form of approach to theory

Inductive and Deductive Reasoning

- **Inductive reasoning:** The process of arriving at a general conclusion based on observations of specific examples - from particular examples to general principles.
- **Deductive reasoning:** The process of proving a specific conclusion from one or more general statements - from general principles to particular examples.

Quantitative Vs Qualitative Placement of Theory



The Role of Literature

- Results of other studies related to current topic
- Relates your research to ongoing research in Field
- Provides Direction for the Research Question
- Relates theory to topic
- Methodological Review

Table 3. Criteria and Method For Using Literature in Qualitative Study (Creswell, 1994)

Use of the Literature	Criteria	Examples of Suitable method Types
Literature used to frame the problem in the introduction	Some literature must be available	Typically used in all qualitative studies regardless of type
Presented in a separate section as "Review of the Literature"	Traditional, positivist approach to literature review	Used with studies employing strong theory and literature background at beginning of study (ethnography, Critical theory)
Literature presented at the end of the study used to compare and contrast findings of the qualitative research	Most suited for the "inductive" process of qualitative research - does not guide the research , rather acts as an aid once categories are	Used in all types of qualitative research – but most common in grounded theory – used to contrast findings with existing theory

Library Research

- Start with General resources
  - Encyclopedias
  - Books
  - Internet (sparingly) Not quite reliable
- Use a Broader Database
  - Research Library Group
- Bibliography
  - Get references from footnotes or articles you read
  - Keep track – Use note cards
- Minimize time
  - Read Abstracts
  - Read introductions of articles to see if they apply

A Research Map of the Literature

- Enables the person to understand how his or her study of the topic adds to, replicates, extends the literature of research already done
- Visual renderings of the literature
- Can be organized in different ways
- Researcher builds a visual picture of existing research about the topic

Fig. 5. Sample of a Partial Literature Map

(Armstrong's Research Map on Calculus Achievement)

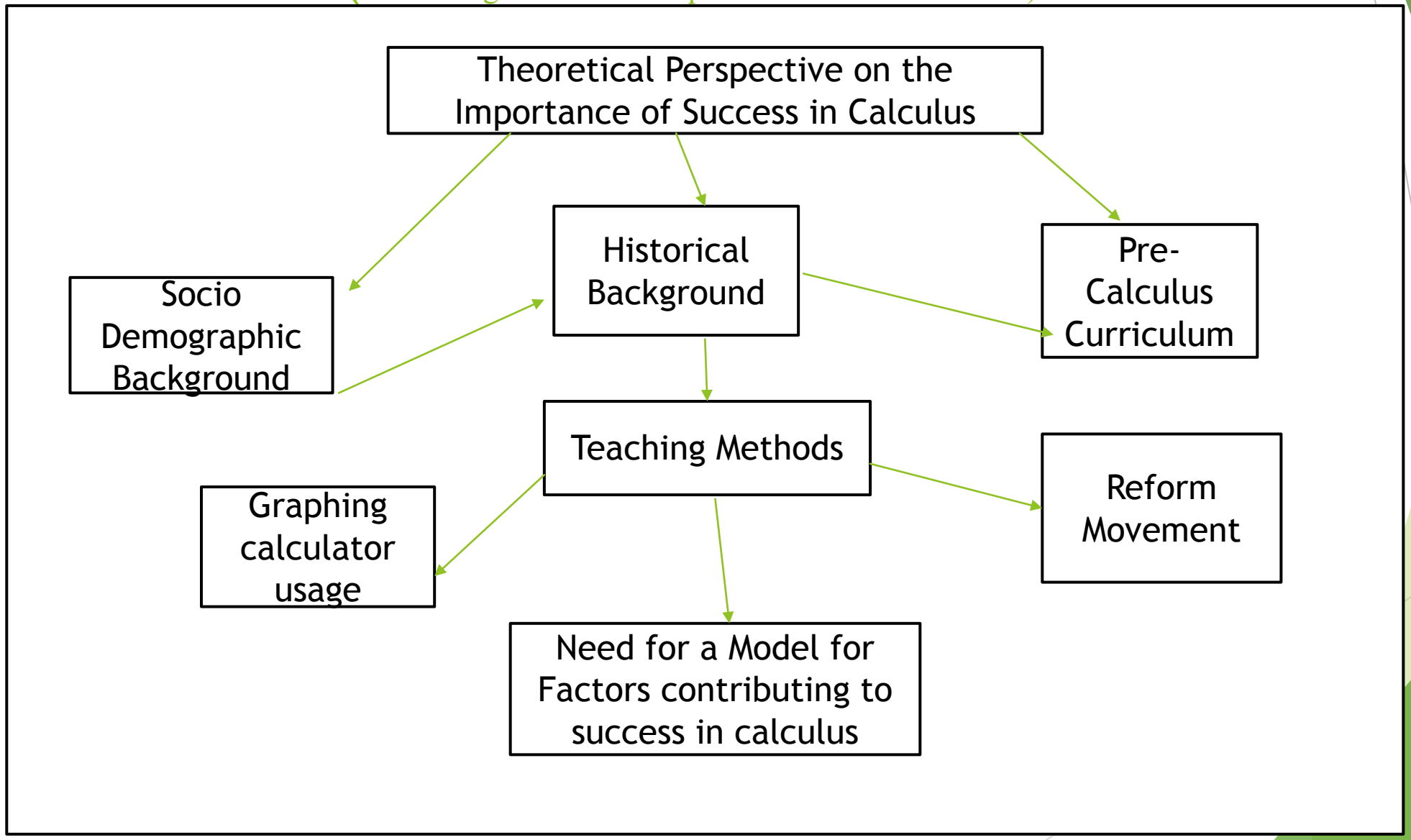
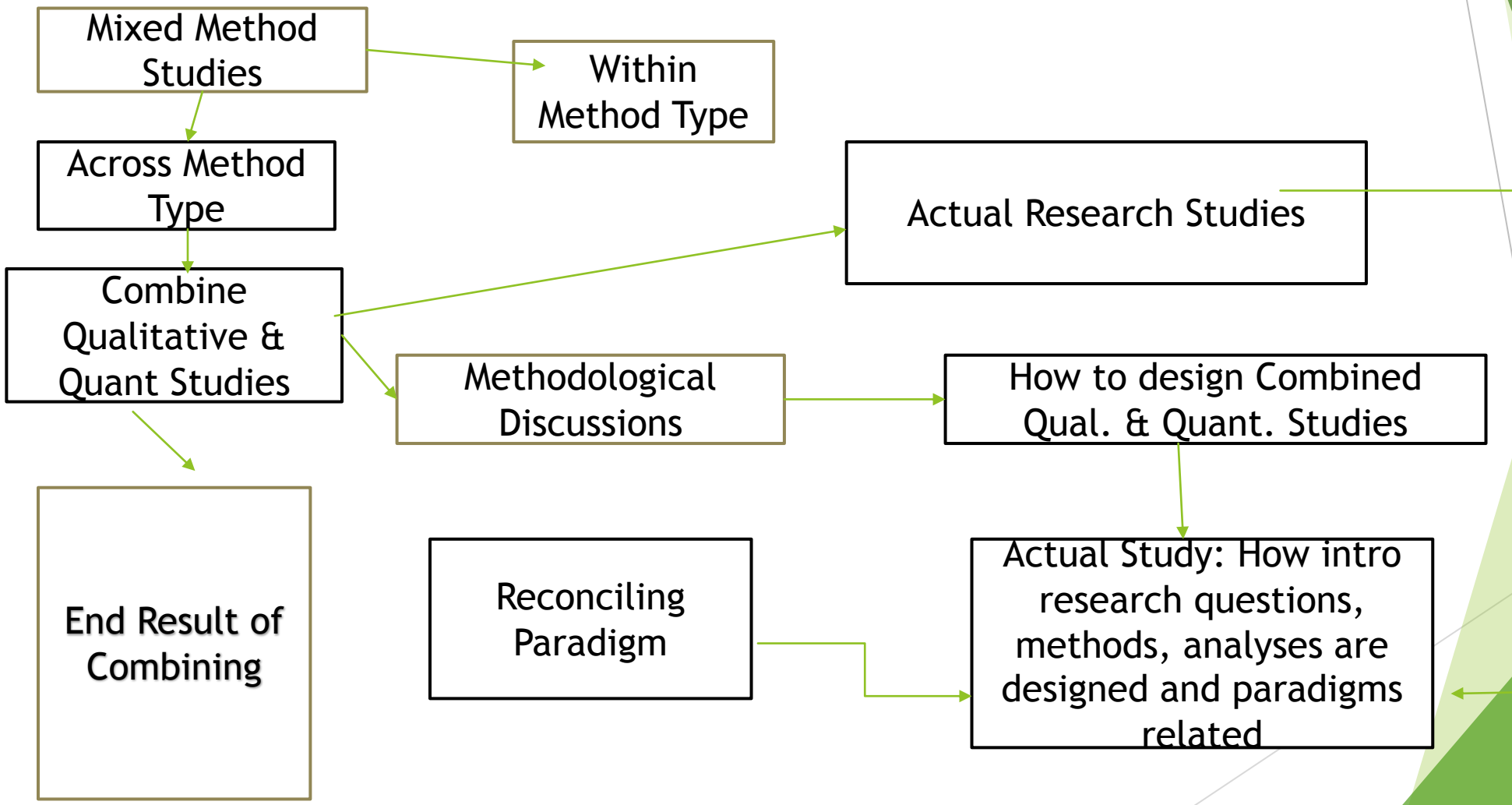


Fig. 6. Research Map on Mixed Method Studies

(Creswell, 1994)



Activity 1

1. Write a one-sentence research question relevant to your field or interests.
2. What data would be required?
3. What disciplines? Types of knowledge?
4. What research approach would be appropriate?
5. What specific methods would be Utilized?

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