

Research Methodology for Mathematical Studies

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Abstract:

The methodology of action research is found to be a valuable and a problem-solving tool that can offers opportunities for the improvement, transformation, and reflection of teaching. The area is new in mathematics education research and then the approaches of qualitative research are applied that requires special attention to improve the credibility and the trustworthiness of this approach. It is considered as necessary to be aware of the restrictions or the limitations that are associated with these methods. The interview approach in the research literature is the qualitative methods which are a tool for data gathering. The challenges which are facing by the researchers are based on the reliability, validity, and generability. This paper traces the growth and the changes in mathematics education research. The interdependence with research along with the focusing on the research perspectives, the methods, the approaches of philosophy, empirical and disciplinary.

Keywords: *action research methodology, mathematics education research, qualitative research*

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Introduction

Education research is simply the inquiry, the variety of the disciplinary actions, the curiosity like what is going on in the classroom. The initiation of this intellectual curiosity is performed or done intentionally or and in a systematic manner, that is grounded for the purpose of evaluation of some evidence that results in the data of the research findings which is shared with the peer groups for review and for the purpose of knowledge expansion. The major reasons in following research related to the education are to:

- Evaluating the practice in the classroom using a progressive and systematic way for the processing of the inquiry
- All the failures and the profits should be recorded along with the completion of the goal of student improvement in the learning process and in practice of teaching.
- The findings are examined with respect to the literature of educational research which is already existing.
- The experiences are shared and then distributed to analyze what a researcher knows about the process of teaching and learning.
- The practice of teaching and theory building is verified that relates to the educational methods.

Educational Research Process – This is a cyclic and iteration of a mathematical or computational process in which the information conveys from one to the next. The new concepts of information and learning at every stage affects the previous and succeeding steps that lead to alterations in the research question and research design (Corinne 2016).

According to various researchers, several issues were addressed that are mainly related to the mathematics used in daily life, critical mathematics, community mathematics, the mathematics of school and so on. In Greece, researchers are studying Gypsy and Romany students that the mathematics used in the daily framework, in specific computation that grounds on experiences of children having the involvement in family business. It has also noticed by some of the researchers that school teachers are less interested in what the knowledge students in minority bring with them and also show interests in knowledge building for the purpose of classroom

teaching. The reason for showing little interest as teachers are not interested or because of the unawareness in knowledge building. In 2005 Abreu reported that most of the teachers show cultural differences and have also argued for usual notices that specify ability and equality and treating everyone in the same manner. Gorgorio also stated that the teachers make invisible conflicts related to the culture that may arise during the classroom study that is most probably a result of non-uniformity exists between the different classroom and school cultures.

The role related to social representations in images and expectation of teachers towards the different learner or students is discussed by Gorgorio and Planas in 2005. They have also pointed out some of the teachers who use the perception of public location as their location that helps in evaluating the status of immigrated students in classrooms instead of a knowledge and understanding that is coming directly about their individual students and families. The teachers need to understand the different ways of performing and representing mathematics in a research area. The programs of teacher education address the perception of mathematics for being free from culture and then Moreira in 2007 raised the idea for the introduction of programs related to Teacher Education to make teachers prepare to research about the mathematics locality i.e., that is the everyday use of the mathematics. Researchers from different countries are coming with concerns about educational policies that pushed the adjustment of immigrant students (Civil 2010).

The education research of Tertiary Mathematics is the disciplined inquiry that comes under learning and mathematics teaching at the University level. This educational research can be performed from the social classroom view or from a cognitive perspective of an individual of the classroom community. Various topics has been analyzed and investigated that involves the concepts of mathematics such as functions, analysis, proofs, mathematical cognition that involves solving of the problem, alternative conceptions of students, psychological factors such as the motivation, visualization, methods of teaching such as technology use, lecturing, and writing, new and existing programs. In social science, the educational research of mathematics does not provide results of a certain character that found in mathematics. The observations which are conducted very carefully can

recommend the principles and produce evidence instead of the proofs. When researchers do a research in mathematics education, it shares a pyramiding character which is powerful in comparison to other sciences. All the results obtained from solely relies on careful observations and are separated from the opinion of the investigator that subjects to the community through which more work can be analyzed that is based on them.

The views of Philosophy plays a vital role in the researcher's view in deciding their work and also helps in deciding what kind of research they want to pursue. There is an idea in which individuals build or construct their knowledge actively and then it can be traced again which then results in underline the idea that the medium from individual knowledge to cultural knowledge is done using tools and language which is called as Constructivism. The concept image and concept definition are terms which are most importantly involved in the literature of mathematics education that helps in distinguishing between the definition of formal mathematician and an idea of the person about a specific concept of mathematics for e.g., function. The concept image of an individual is considered as a mental building that comprises of examples, non-examples, universal facts and the existing relationships that a researcher can link with a concept. Evoked concept image is the part of individual's concept image and this image concept activates the ideas that make the understanding easy and helps in noticing several concepts related to the thinking of students.

Various researchers have defined the role of mathematical as a contrast to everyday life that includes, definitions of synthetic and analytical. The definitions of synthetic which are defined as the definitions in everyday life that are most commonly found in the dictionaries and they also describe something that is already present whereas analytical bought concepts into existence (Selden and Selden 1999).

Qualitative Research

In the 1980s and 1990s, mathematics gained a momentum in this literature education and this particular momentum carried the education to the statistics level. The researchers of mathematics provide the basis of epistemology for the purpose of qualitative research and various methods are refined for the collection of the qualitative data by using various strategies such as observations, interviews,

and questionnaires. The discipline of mathematics and statistics education risen up with the help of qualitative methods that is forwarding the education but the benefits of the qualitative research are in dispute politically and scholarly.

All the questions related to the qualitative research in mathematics are modified in the new policy documents which are written by the governmental organizations and researchers. Some of the questions are discussed below which are the most influential policy documents,

- What Works Clearinghouse (WWC) established by Department of Education in the U.S. published the procedures and Standards Handbook for reviewing and synthesize research that often provides suggestions for practice.
- In 2008, The National Mathematics Advisory Panel's Foundations for Success report and this panel was recognized by Department of Education in the U.S and investigated some of the questions such as what is the criteria learned from the research like how children study more mathematics?
- In 2002, The No Child Left behind Act was established and this part of the legislation is referred to as the scientifically based research that helps in informing the practices of education and motivates them.
- SMER i.e., Statistics Effectively in Mathematics Education Research is used which is an effort done jointly among educators of statistics and mathematics.

Philosophical Orientations

The individual response to the questions about the appropriateness of the studies on the basis of qualitative research toward research depends majorly on philosophical orientation. Two other different approaches are identified by Lankshear and Knobel in 2004 to demonstrate the qualitative research. As per the traditional approach, the qualitative studies satisfies the criteria of quality control to which these studies are held traditionally. Then, the second approach is the usage of a unique set of different criteria. This traditional approach is linked with the positivism that helps in assessing the qualitative research and positivists assume that world of physical and social nature exists in a given manner. There are guidebooks that mainly exists for the suggestions that are based on the adaptation of these

elements having quality control for the usage in qualitative studies.

Two deep-seated problems are discussed using the controlled trials in a random manner for the purpose of educational research. Two major concerns related to ethics are identified by Holcomb from a perspective of statistician which are the control group evaluation on the basis of skills or tasks, the control group is taught in a way the experimenter believes that comes from experience. The methodological concerns were raised in 2007 by Schoenfeld (Groth 2010). Schoenfeld in 2000 presented a purpose of mathematical education research that basically focuses the principle framework. The major objective of the mathematical research is to understand the mathematical teaching, thinking and the learning that uses the understanding to improve the instructions related to mathematics at all levels.

EHR Research Program: 1992 -98

Variety of subjects and methods were supported by the EHR research program in between 1992-98. All the projects help in understanding the quality improvement of practices that exist in mathematics and science education in the US. About 350 grants were supported by The Division of Research, Evaluation, and Communication in five majorly different programs of Teaching and Learning related to research. The aim of improving the quality of on the education condition collected data the NCES i.e., National Centre for Educational Statistics also helps in the initiation of CEDCAR i.e., Cooperative Education Data Collection and Reporting projects that finally leads to the document related to SEDCAR. Six inter-related phases were processed by SEDCAR on a very large scale that helps in the framework development for the appropriate standard development and organization. Splinder and Splinder offers three principles for a good ethnography of education,

- The placement of observation in the context
- The emergence of Hypotheses in situ
- Repetitive and prolonged observation

All these criteria are little different from the proposed standards for most of the quantitative research that basically helps in identifying aims, issues and the approaches of ethnographic research (Suter and Frechtling 2000). There are some of the

standards on the basis of which theories, models, and results are judged and these criteria in mathematical education are,

- Descriptive and Explanatory power
- Scope
- Power of Prediction
- Specificity and Rigor
- Triangulation i.e., the multiple evidence sources
- Falsifiability
- Generality
- Replicability
- Trustworthiness

Mixed Method Emergence

Mixed methods include both qualitative and quantitative methods, as various researchers focused and give emphasis on the research design that includes both methods: qualitative and quantitative that also involves the proper planning and the recognition of each and every approach that have potentially contributed. The field of mixed methods is still in the process of development and according to the Tashakkori and Teddlie in 2003 provides the definition of the mixed methods. In a single study, both qualitative and quantitative data are collected and analyzed in which the collection of data is done sequentially or systematically. This also involves the data integration at one or more stages of research. As according to this researcher, both the mixed methods that use both the qualitative and quantitative collection and analysis of data so these studies were mixed marginally. In 2007 Johnson et al, analyzed the mixed method definitions and their study leads to the synthesis of intellectual and practice on the basis of qualitative and quantitative research. The major type of characteristics in this research is the generation of induction, hypotheses or theory, and exploration.

The relevance of research: The research relevance studies the degree to which the examination of research is done and is basically related to or applied to the mathematical education. The indicators of research relevance are research relatedness and its usefulness. The relatedness of research is indicated

as the research relational strength which is in question to teaching and learning mathematics.

Significance of research

The research significance has standards that are described through three indicators which are gap bridging, embedding in research and novelty in research. The Gap Bridging is a kind of research study that initiates by the identification of a gap. The researcher requires that one who requires the comprehensive and critical study to evaluate the efforts made in the research and then relates one another work. In novelty, much of the research has been done on the expansion and reconceptualization of the knowledge.

Literature Review

Kadijevich 2005 studies the basic standards for mathematical educational research. This particular paper has proposed the criteria of grouping for the research quality in the mathematics education have divided into three basic comprehensive standards. The optimization of these three standards is made by performing an analysis of a representative sample for the proposed groups of criteria. The standards are evaluated by suitable indicators and then it is applied to searching the dimensions of mathematics that influences the achievement of mathematics.

Harel 2006 has discussed the framework for the literature education for mathematics in his paper. The researcher also shows Lester's concern related to the political forces in the current scenario of US that helps in defining the education scientific research rigidly and also provides political ideology. This paper also addresses the mathematics role in Mathematics education research.

Winslow 2008 presented the didactical design which has recently played importance in the establishment of links that are productive between research and practice but the didactical engineering shows the requirement of the development. The successful development needs the particular research and structure that organizes and examine the effects.

Hart et al 2009 worked on the design of mixed methods emergence which states that the learning of mathematics along the understanding is considered as a very much complex process and this research method response to the usual generalizability of the results and also helps in the maintenance of sufficient detail about the teaching and learning process to be

useful. This paper helps in increasing the production of this particular arena which is done by managing and maintaining the complex understanding.

Groth 2010 proposed the qualitative inquiry modes within the statistics education research discipline in which the influence of policy documents is studied. This paper discusses the questions which are raised about the qualitative research in the policy documents. All the examples discussed in the paper illustrates the qualitative methods which can further use advantageously to study the process of teaching and learning statistically. This paper has valued the essence the advancement of qualitative research techniques in the statistical education field. Through these techniques, scientific studies were conducted that mainly contributes to the understanding of teaching and learning statistics. This particular paper also helps in the pattern causes which is observed in the quantitative research findings.

Ciltas, Guler and Sozbilir 2012 studied the analysis of the mathematics education research. The investigation is made and then each publication has been subjected to the analysis of the content that is recorded in the database. The data analysis was performed using SPSS software that shows the chart, frequency and the table of percentage in a descriptive manner. According to this study, a large increase is observed in the mathematics education that is related to the studies. The preference is given to quantitative research as the subject under research undergoes learning activities, and uses more than one tool for data collection.

Sharma 2013 described the qualitative methods such as the approach of the interview in the research literature, It is a method of data gathering tool and some of the challenges which are faced by researchers who have done qualitative research in terms of the validity, reliability, and generality. The strength of the qualitative research is that the behavior of participant which is recorded in the natural settings. This research specifically used for the in-depth study of a small region of the group.

Ruthven 2016 examines the integrated tools of the digital computation into school mathematics and the challenge of ecology involves the everyday adaptation practice of school mathematics in respect of tools introduction.

Conclusion

The valuable research i.e., qualitative research which is the advancing field of mathematics education research and it also provides a means for the conduction of scientific studies that are contributing to the understanding of mathematics teaching and learning. The major key strength of the qualitative research is the behavior of participant which is recorded in the natural environment. In-depth study of a small group of people is done by qualitative research.

Because of the complexity, it becomes difficult to understand the natural settings in research and it becomes important for the researcher to be aware of the associated restrictions with these methods. This paper provides recommendations for the improvement in reliability, validity, and generalizability of qualitative research approaches. These researchers require to offer sufficient depth and clarity that helps in judging the quality and the research findings.



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