



Innovation of Mathematical Learning Post-Pandemic: Systematic Literature Review

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Innovation of Mathematical Learning Post-Pandemic: Systematic Literature Review

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Abstract. The occurrence of a global crisis has a major impact in various sectors, including mathematics education. This research presents a original paper in mathematics education. The purpose of this literature review is to see the extent of the preparation of education practitioners in the face of a new era after pandemic the end. This systematic literature review analyzed various innovation offerings in mathematical learning from 14 articles published on the SpringerLink and Taylor & Francis databases. The review selectively looks at research developments from different countries and research targets for post-pandemic. This analysis shows that the curriculum by implementing technology-based learning strategies is the main thing that needs development for post-pandemic learning.

Keywords: Mathematics learning, learning innovation, Post-pandemic

INTRODUCTION

Innovation of learning has become a trend in education department, especially mathematics. Creating innovation in mathematics learning will equip students with in-depth knowledge so they become competent resources¹. New innovations were developed to facilitate the learning process². Innovations developed in the form of curriculum design and they are learning fun based on technology³.

Advances in technology have a major impact on human activities, but sometimes design of technology to facilitate human activities is not utilized to the fullest. Many obstacles exist to apply, such as teachers have complete to prepare teaching materials, require a lot of time outside of lesson hours⁴, difficulty to adapt on learning models⁵, and require training for teachers who are not proficient in technology^{6,7,8}. Many of these causes result in users not interested in learning and developing technology.

Education continues to move in keeping pace with technological developments. even so, there is still tremendous panic and chaos when drastic changes replace people's habits. Pandemic give change for world system. The pandemic happened in a turbulent manner until it became a crisis in various institutions around the world. Changes in habits occur such as turning the palm, quickly but not yet swiftly. Such conditions result in learning being forced to run remotely with utilizing digital technology^{9,10}.

Digitalization in education is a prominent issue^{11,12}. Teachers and students are simultaneously encouraged to utilize technology as an alternative learning. Eachers should filter all new ideas and choose the appropriate learning approach, it's not only for teaching but for learning too.

Collaboration learning and digital technology will reduce the notion of boring while studying math^{13,14}. Learning mathematics with a technological approach prints graduates trained in mathematical knowledge to create innovative products to solve a wide range of problems in ¹⁵. However, learning utilizing technology also takes into account the conditions and situations such as access location, classroom replication training, assessment, cost savings as well as achieving appropriate¹⁶. On the other hand, education practitioner in

education continue to think and find a way out of the problems encounter. Creating new alternatives is the right action for education.

Learning with technology can improve problem-solving skills and ¹⁷ As educators teachers have the burden to develop students' abilities and build a ¹⁸. Likewise, researchers who are required to produce good research, so that they can open their horizons and always raise popular themes¹⁹.

This literature review research aims to see the readiness of educational practitioners in the face of various changes in the future. Design curriculum of mathematics learning and the learning process up to the final assessment of mathematical learning are a major concern. Alertness in online class and offline class. Preparation of researchers in develop a variety of contemporary issues.

This study refers to research conducted by Deruaz. In the study and several colleagues reviewed the bibliography of articles that discuss mathematics learning difficulties (MLD). The article classifies various writings based on their definition of MLD, the origin of the author of the article, the school level included the use of mathematical content and research interests, namely in the form of severe learning difficulties that require special treatment in dealing for them. ²⁰

The study adopted Deruaz's way of analyzing bibliographies. Here we examine the impact of changes in mathematical learning to prepare for post-pandemic. This analysis is based on the involvement of students, teachers, researchers, and the general public in developing the direction of educational achievement.

Questions raised based on these objectives:

1. How to prepare for learning mathematics in the post-pandemic era?
2. What are the preparation strategies in mathematics learning to operate the post-pandemic era?

METHOD

This study uses systematic literature to find out the best innovations in developing the effectiveness of mathematical development in the post-pandemic period. Systematic methodological techniques are used in order to obtain substantive results so as to claim what is known and ²¹.

Database search, researchers choose original paper to obtain concrete results from each writing. All articles were accessed from October 21, 2021 to October 24, 2021 through the scopus indexed database. This literature investigated articles through SpringerLink and Taylor & Francis database. The keywords used while searching are '*impact of change*' '*learning innovation*' '*post COVID*' and '*post-pandemic*'. Then selected articles from these keywords are analyzed to answer research question.

Identifying relevant keywords serves to obtain the appropriate article for analysis. In the first stage researchers considered the keyword '*impact change*'. This keyword shows the various changes that occur when the pandemic develops rapidly. Changes occur in the daily lives of the world community, both lifestyles and new habits are forced to be done. Various sectors are undergoing major changes, including education.

The big changes also occur in learning from various disciplines. Then we expanded the term to the impact of changing mathematical learning. The impact of affordable changes in mathematical learning is trying to develop the learning process in pandemic times and the

future. The impact of these changes suggests innovation to an exciting learning plan and continues to evolve with the times. Interesting learning is also inseparable from the use of technology. Technology does not have to be luxurious and expensive, but most importantly helps students for understanding the various materials taught. In the final stages to use impact of changes in mathematical learning for post-pandemic (Fig. 1).

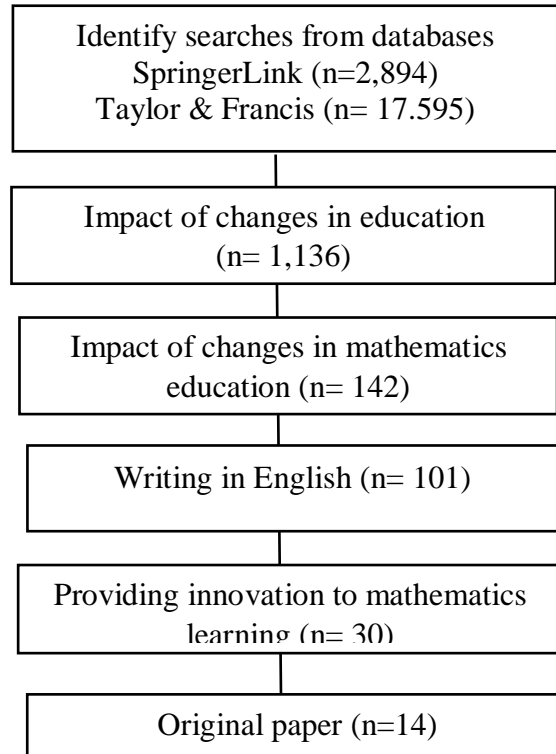


Figure 1. Research inclusion and exclusion criteria

Then, the researcher analyzed the title of each selected article on a database search. This analysis aims to find out the location of the term in the selected paper. Some of the terms are in the title, and some are in the content of their analysis text. In the final stages of the determination of article selection is tightened with one that only offers profitable learning innovation facing a new era of the world. In this final stage, 14 articles are selected accordingly.

Sorting articles in this study is done gradually to get the best illustrations. The articles analyzed were taken from well-known publishers SpringerLink and Taylor & Francis. The collection of articles in the database aims to obtain very good quality.

TABLE 1. Selected Articles

Study	Analytical Techniques	Method
23	Analyze daily reports issued by the ministry of health through tv, radio, internet and other reading media	QL
24	Analyze the views of researchers belonging to Becker, ICME and PME on focusing on research themes for the coming decade	QL

25	Revising the curriculum then looks at students' responses to the effectiveness of learning calculus based on real content.	QL
26	Identify the transformation of teachers who teach with reverse classroom methods	QL
27	Analyze the abilities of students taught by teachers who have been given STEM training for 4 years	QL
28	See the ability of the community in analyzing mathematical links in COVID news	QT
29	Compare two research papers from the <i>serbian Academy of Sciences</i> and <i>arts' Mathematical Institute website</i> .	QL
30	Search for domain characteristics of mathematical talent which then continues on practical review in schools	QL
31	Develop modeling construction through student creativity review	QL
32	Investigate the ability to answer questions independently by students based on digital curriculum design	QL
33	Analyze videos about awareness of the spread of the virus presented in the form of fractal trees	QL
34	Interview students to see their critical math skills and ethical attitudes	QL
35	Examine the history of school mathematics and health discourse to see the relationship between the two	QL
36	Illustrates human behavior by developing structured kinetic equations	QL

Note: QL= Qualitative, QT= Quantitative

Prior to the final sorting analysis of the 14 articles, researchers found one article that developed a new means of curriculum to be conceptualized for the post-COVID 19³⁷ The article does not fall into the category because it lays out curriculum advice on all disciplines and does not focus on mathematics education. In his writings he displays various concepts and directions in designing new curriculum based on technology.

As in the paper written by E. Heyd-metzuyanin. In his research, he described various scientific perspectives and learning potential in project³⁸ The article is included in the list of terms because the project work that students do becomes very important for future appreciation. Researchers eliminate it because they do not offer innovation to future defenders.

RESULTS AND ANALYSIS

Classification of selected articles. After identifying the papers of the two databases as discussed in the methods section. Furthermore, researchers classify articles by categorizing based on what is offered to deal with the new normal. It can be described as follows (Fig. 2).

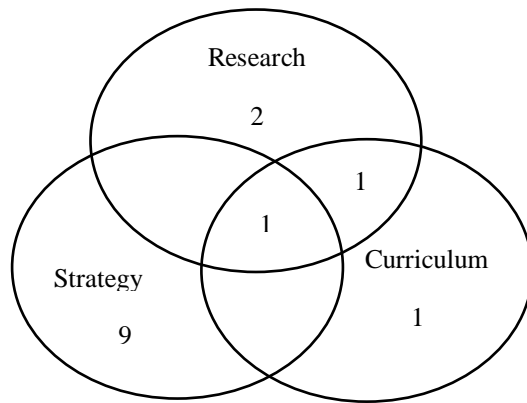


Figure. 2: Learning Innovation

This image presents findings in an article based on innovations offered to carry out the learning process in the post-pandemic. This classification provides answers to questions from this study. Various preparations have begun to be thought and researched to deal with changes in the way of teaching in the future.

The article that provided input on the three main components that the researchers reviewed was written by Snezana Lawrence. In his research suggested a didactic approach to teaching a variety of contemporary topics that allow students to be actively involved in solving mathematical problems, then he emphasized the design of curricula that have international confedative standards such as PISA and TIMMS, and finally the thing expressed in the form of the emergence of research on the use of STEAM is highly recommended to be developed to be a reference for all educational drivers.

Common features concern the country, year of publication and sample targets studied. The countries involved in the analysis include: America, China, Israel, Mexico, Turkey, Siberia, Spain, the Soviet Union, and Vietnam. The number of articles are dominated by the Americans who produce 4 writings and Spanish 2 writings. While other countries just issued 1 article each country about innovation offered for learning after the pandemic. Classification of sample selection can be seen in the following image (Fig. 3).

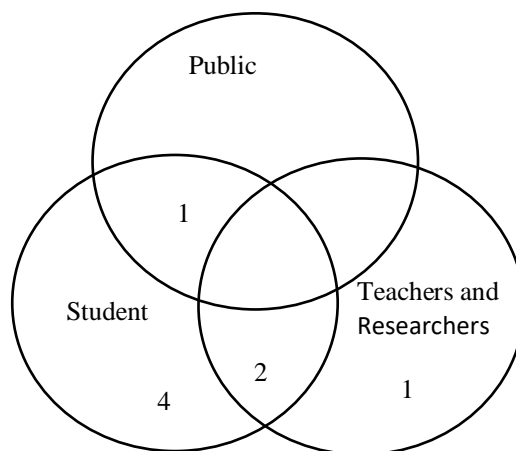


Figure. 3: Target Respondent

The target sample of respondents ranging in age from 14 to 70 years. There are 8 articles that involve respondents in their research, the rest of the selected writings explore information in various media such as videos, articles, and textbooks. The year of publication selected by researchers starts from 2020 to get the latest innovations on math learning and according to the current crisis conditions.

The results of the analysis show that a variety of new alternatives are being constructed for education in the future. It's like teaching and learning strategies. Before the pandemic various learning strategies had developed and implementation was already underway. During a pandemic, strategies that were initially more frequent by manual means then switched through digital technology to glorify each other.

The pandemic period demands that humans limit direct contact with other humans. This is to make the spread of the virus more controlled. All in-person meetings are redirected to online meetings. The same goes for school. Teachers become guides in the process of distance learning despite their limitations.

The pressure of conditions makes everyone accustomed to using digital technology both for teaching and learning and working. Distance learning is starting to feel comfortable. The next stage, after this pandemic is completely over, the learning process only needs to combine the two. Technology users already have the experience to take advantage of it. The meeting process will take place as before but digital technology will continue with side by side.

As education practitioners, they have started to make a big contribution by opening up horizons on how to deal with a new era. Researchers begin to open the gate and show what steps must be taken to achieve the educational goals.

DISCUSSION

Based on the description above provides an overview of how the prepared of students, teachers, researchers, the general public in facing the new situation post-pandemic. Analysis of findings in writing in the form of alignment of new objectives of the curriculum based on digital technology by improving coherence between its components. The idea of mathematics in the curriculum must lead students to be able to apply mathematics in real contexts. The process of solving real problems will train students to think critically so as to produce a mathematically savvy society in a variety of knowledge perspectives.

Illustrations of real content are currently seen in the process of spreading viruses that can be attributed to fractal trees. Other fractal tree forms can also be seen in the process of respiration, tree body and river flow³⁹ and motifs present in Sulawesi⁴⁰

The development of technology-based learning strategies is needed in this era and the future. Creating a flexible learning environment is highly expected here. Provides students with freedom of thought in solving various mathematical problems. These efforts will motivate students to think more deeply about math assignments. Encourage students to learn independently and be actively involved in the learning process.

The most relevant research for the coming decade examines the professionalism of teachers. The ability of teachers to communicate and manage various technologies is a major concern in the teaching and learning process. In addition, the assessment method used is also

a new challenge, it is easier but there are things that cannot be analyzed with technology. Analyzing students' learning outcomes remains mindful of privacy, ethics and performance.

CONCLUSION

The conclusion of this study shows that various countries have begun to examine innovations that can be used in the post-pandemic era. Technology-based curriculum studies are the main focus to improve the quality of education. the use of technology can be started from preparing lesson plans, learning processes to learning evaluations. its use can be in the form of computer aids, use of mobile phones and internet access.

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