INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 8, Issue 4, (2019) E-ISSN: 2226-6348

A Systematic Review of Teacher's Perceptions and Challenges towards STEM Integrations

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To Link this Article: http://dx.doi.org/10.6007/IJARPED/v8-i4/6814 DOI:10.6007/IJARPED/v8-i4/6814

Published Online: 27 November 2019

Abstract

Numerous changes had happened towards our education systems in order to ensure that the best systems are implemented for the students. Science, Technology, Engineering and Mathematics (STEM) are being widely used in various countries and is believed to be the best systems as for now. However, to integrate STEM, it is very important to understand teachers' perceptions related to STEM Integration in school since teachers are the most important people that will help in delivering STEM content towards students. This study attempts to understand teachers' perceptions and challenges experienced towards STEM integration in school by examining existing literature. Articles access from December 2015 to December 2018 across two databases Mendeley and Google Scholar were referred to. This review found that most teachers have negative perceptions towards STEM integration in school. Teachers have wrong perceptions as well towards STEM as they believe it is necessary for them to use technology for them to integrate STEM in school. Teachers also state that they experience challenges in terms of time constraints the most since integrating STEM required more time for both students and teachers to adapt well.

Keywords: Systematic Review, Teacher's, Perceptions and Challenges, STEM Integrations.

Introduction

Science, Technology, Engineering and Mathematics (STEM) was introduced in 2001 by scientific administrators at the U.S National Science Foundation (NSF) to refer to the career fields which require knowledge and skills to be integrated in their field (Judith, 2017). It is believed that STEM integration fits better with the learning style of our students and it is widely used in rapidly growing population area particularly in developed and developing countries (UNESCO, 2010). Teachers are the most important element to ensure that educations are being implemented correctly. Education systems today have developed widely over time compared to the previous years. Nowadays, education focuses on students' abilities and skills instead of paper writing assessments. Teachers as well are expected to be able to adapt to changes in terms of contextual and teaching methods (Stubbs & Myers, 2016).

While dealing with changes and adapting to STEM integration in school, teachers face challenges especially on how to fully integrate STEM in classrooms. Hence, this review is conducted to analyse what are the challenges experienced by teachers in integrating STEM in school.

Literature Review

Teacher's Perceptions towards STEM Integration

Integrated curriculum is defined as a curriculum purposely to draw together knowledge, perspectives and methods in order to enhance and maximize peoples' understanding (Bybee, 2010). Pryor & Kang (2013) supported integrated curriculum definition as a way of transition to STEM-linked curriculum where it provides powerful challenges especially among educators.

STEM integration has grown a lot since the first day it was introduced. The role of teachers in STEM is just as important as the STEM policy-makers where teachers must deliver the lessons to students in a way that a policy-makers had designed it to be. Teachers have to find the best way to ensure that their lessons encourage critical thinking and innovation among students without neglecting the importance of students to understand the context and contents of learning as well (Nadelson & Seifert, 2013). In order to ensure that STEM had been integrated correctly, STEM instructional pedagogy has to be well defined by the teachers in order to allow students to make real-world connections and grow interest in STEM (Gomez & Albrecht, 2013). Besides, it is very important to acknowledge teachers' perceptions towards the implementation of STEM in school since as stated, they are the major element that help STEM integrations in schools. Different teachers may have different thoughts on STEM integrations and by examining the literatures, we are able to classify and make conclusions on teachers' perceptions towards STEM integrations in schools which could help the students in their career choice in STEM field (Mohtar et al., 2019)

Research Questions

The purpose of this study is to examine existing literature on teachers' perceptions and challenges experienced towards STEM integration in school. The following questions were addressed:

1. What are the teachers' perception towards STEM Integration in school?
2. What are the challenges experienced in STEM Integration in school?

Methodology

This systematic literature review used PRISMA's guidelines and flow chart or previously known as QUOROM to classify and analyse articles obtained. According to Haas & Springer (1998), the purpose of doing a systematic research is to increase the number of findings so the results obtained will be relevant to our search. Two important agents used to search for the relevant articles are Mendeley and Google Scholar dated from January 2016 to December 2018. According to Khan et al. (2003), there were five stages of completing a systematic review:-

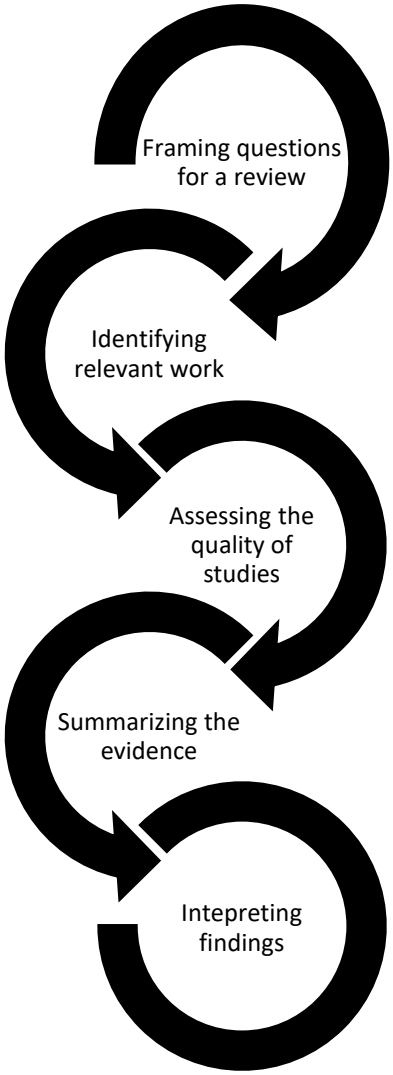

Figure 1: Stages in Systematic Literature Review

Stage 1: Framing Questions for a Review

A research questions have been developed way before classifying and sorting out relevant articles. Two questions have been finalized to ensure that our findings are specific towards a certain scope or field. The questions are 1) What are the teachers' perceptions towards STEM integrations in school? and 2) What are the challenges experienced in integrating STEM in school?

Stage 2: Identifying Relevant Work

The following search terms have been applied to search for the databases: "teacher" OR "pre-service teacher" AND "perceptions" AND "STEM OR Engineering" AND "Integration OR Implementation".

Stage 3: Assessing Quality of Studies

Relevant articles were sorted out using Mendeley and Google Scholar. There are plenty of articles to be chosen, however only the articles related to our research questions were selected. Articles discussing teachers' perceptions towards STEM and the challenges experienced were included in this literature review. For methodology, both qualitative and

quantitative designs were taken as long as the scope of search are about teachers' perceptions and challenges towards STEM in school.

Stage 4: Summarizing the Evidence

There were more than 100 articles from Mendeley and Google Scholar discussing about STEM. Some of the articles are duplicate from both search engines. Screening had to be done in order to obtain the most relevant articles to be included in this literature review. Finally, a total of 24 articles were confirmed and the PRISMA flows below will explain the searching process:

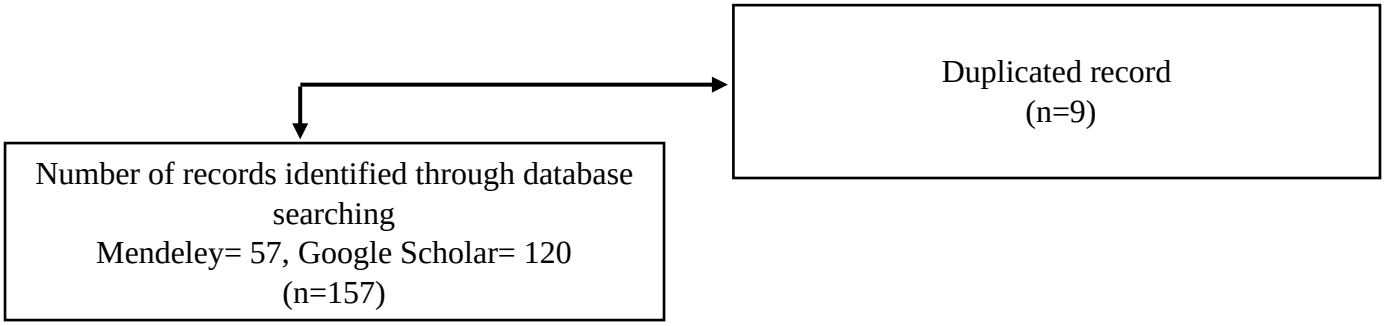

Figure 2: PRISMA Flows Chart

Stage 5: Interpreting Findings

Findings were interpreted based on the research questions. There are 17 articles discussing on teachers' perceptions towards STEM integrations in school and 7 articles discussing about challenges experienced in integrating STEM in school.

Table 1.
Number of Study Based on Research Questions and Methods

Methods	Research Question 1	Research Question 2	Both
Quantitative	4	-	
Qualitative	12	4	4
Mixed Method	3	1	

Results

Teachers' Perception towards STEM Integration in School

This section will discuss about the findings of teachers' perception towards STEM integration in school. The list of articles discussed about this are grouped according to their research methods as stated below:

Table 2.
List of articles reviewed on Teachers' Perceptions towards STEM Integration in School

Methods	Author
Quantitative study, n=4	Nausheen Pasha-Zaidi and Ernest Afari (2015) S. Seleen Guzey, Micheal Harwell, Mario Moreno, Yadira Peralta & Tamara J. Moore (2016) Abdul Halim Abdullah, Raja Haffizah Soffia Raja hussin, Sharifah Nurarfah S. Abd Rahman, Mohd Hilmi Hamzah, Umar Haiyta Abdul Kohar & Juhazren Junaidi (2017) S. Seleen Guzey, Tamara J. Moore, Micheal Harwell & Mario Moreno (2016)
Qualitative study, n=12	Eric A. Stubbs and Brian E. Myers (2016) H. El-Deghaidy & N. Mansour (2015) Dawne Bell (2015) Brian K. Sandall, Darrel L. Sandall & Abraham L.J. Walton (2018) Anne T. Estapa & Kristina M.Tank (2017) Minjung Ryu, Nathan Mentzer & Neil Knobloch (2018) Heba El-Deghaidy, Nasser Mansour, Mohammad Alzaghibi & Khalid Alhammad (2016) Greg Pearson (2017) Lynn D. English (2017) Ozlem Ozeakir Sumen & Hamza Callisici (2016) Lieve Thibaut, Stijin Ceuppens, Haydee De Loof, et al (2018) Ibrahim Delen, Salih Uzun (2018)
Mixed Method study, n=3	Isha DeCoito and Philip Myszkal (2018) Brandt W. Pryor, Caroline R. Pryor & Rui Kang (2015) Edy Hafizan Mohd Shahali, Lilia Halim, Mohammad Sattar Rasul, Kamisah Osman & Rurazidawati Mohamad Arsad (2018)

Studies involving pre-service teachers and existing teachers show both positive and negative perceptions towards STEM integration in school. Some teachers agree and show high confidence in integrating STEM in schools (Decoito & Myszkal 2018). Teachers also believe that STEM integration in school gives positive effect towards students and helps in promoting the 21st century of learning and skill building practice (Mansour, 2015; Eric A Stubbs & Myers, 2016).

Pre-service teachers show positive perceptions towards STEM and believe that STEM is efficient, easy to retain and fun to teach and they are able to integrate STEM in their learning environment since STEM is all about solving problems and drawing concepts from given procedure (Delen & Uzun, 2018; English, 2017; Sümen, 2016). As much as teachers showing positive perceptions, students are also showing the same perceptions towards STEM integration in school (S Selcen Guzey, Moore, Harwell, & Moreno, 2016).

However, there are several negative and wrong perceptions among teachers regarding STEM, which make it difficult for it to be integrated it in school (Eric A Stubbs & Myers, 2016). First of all, in order to integrate STEM in school, teachers believe that technology is necessary to teach and link STEM with real life (Mansour, 2015; Stubbs & Myers, 2016). This is a wrong perception towards STEM since STEM is a way of teaching and learning by letting students to explore things themselves while teachers only act as facilitators, without in need of technology.

Negative perceptions towards STEM integrations are due to several reasons which are low teaching abilities and teachers are underprepared to teach STEM (Bell, 2015; El-Deghaidy, Mansour, Alzaghibi, & Alhammad, 2017; Mansour, 2015; Sandall, Sandall, & Walton, 2018; Stubbs & Myers, 2016; Thibaut et al., 2018). STEM education is the core content that has to be mastered by all teachers for them to be able to integrate STEM efficiently in school (El-Deghaidy et al. 2016; Estapa & Tank, 2017; Sandall et al. 2018). Since STEM only stands for Science, Technology, Engineering and Mathematics, the only focus is towards teachers who teach these subjects. However, we have to agree that STEM actually involves all subjects being integrated together. Since there is less focus towards other subjects, such as Design and Technology (D&T), teachers feel hesitatant on what they are able to contribute to STEM education since they have limited understanding and lack of professional development programme eventhough it is necessary (Bell, 2015; Sandall et al., 2018).

Apart from that, teachers believe that collaboration among teachers, parents and students are important aspects to be done and teachers themselves must be mentally and physically ready and willing to integrate STEM in their existing curriculum in order to produce a high quality way of teaching (El-Deghaidy et al., 2017; Estapa & Tank, 2017; B. W. Pryor, Pryor, & Kang, 2015; Sandall et al., 2018). Time management is an important factor to integrate STEM in school efficiently. This is supported by Sandall et al. (2018) where they stated that teachers and students do not have enough time to integrate STEM in the classroom.

In context with assessments, teachers explain that, more integration in school is not necessarily better for the students since they will experience changes in the syllabus and make it harder for them to focus in school. If changes are to be done, then the traditional assessments also should be replaced since it will not be relevant to evaluate students accordingly (Pearson, 2017; Sandall et al., 2018).

Challenges Experienced in STEM Integrations in School

This section will discuss about the findings of challenges experienced by teachers in integrating STEM in school. The list of articles discussed about this are grouped according to their research methods as stated below:

Table 2.
List of articles reviewed on Challenges Experienced in STEM Integrations in School

Methods	Author
Quantitative study, n= 0	
Qualitative study, n=8	Micheal Timms, Kathryn Moyle, Paul Weldon & Pru Mitchell (2018) Greg Pearson (2017) Lyn D. English (2017) Kristin Lesseig, David Slavit, Tamara Holmlund Nelson & Rya August Seidel (2017) Lieve Thibaut, Stijin Ceuppens, Heydee De Loof, et al. (2018) Ibrahim Delen & Salih Uzun (2018) Samantha Bernstein-Sierra & Adrianna Kezar (2017) Emily A. Dare, Joshua A. Ellis & Gillian H. Roehrig (2018)
Mixed Method study, n= 1	Siddika Seleen Guzey, Tamara J. Moore& Micheal Harwell (2016)

Integrating a new syllabus or program in school is surely not an easy task. There are many challenges faced by the teachers in order to ensure that only the best learning and teaching method is used in the classroom. One of the challenges is to find the best way to integrate STEM in school (Siddika Selcen Guzey, Moore, & Harwell, 2016). Since STEM education is considerably new, teachers experience lack of role model to follow as their guideline on how STEM should be integrated in school (Delen & Uzun, 2018; Ryu, 2018). Pre-service teachers are not getting enough exposure or training on how to focus on implementing STEM in school. Besides, they are trained more on theories instead of practical (Delen & Uzun, 2018; Ryu, 2018).

Not only that, teachers are having difficulties in understanding STEM content whether it offers deep conceptualization and understanding in learning or not (Siddika Selcen Guzey et al., 2016). Teachers also feel that STEM field does not align well with the community and there are even bias among the academic educators (Bernstein-sierra & Kezar, 2017). Teachers show low content knowledge and self-confidence in teaching STEM and unfortunately these can be related to one of the reasons why teachers find it difficult to integrate the new curriculum into the existing ones (Lesseig, Nelson, Slavit, & Seidel, 2016; Pearson, 2017). Materials to be used for STEM are also lacking as well as the integrated assessment. Teachers have to find their own alternatives despite their busy schedule in order to obtain STEM materials for teaching purposes (Dare, Ellis, & Roehrig, 2018).

Another challenge discussed is related to time constraint. Teachers need to complete the syllabus within the time given as well as using STEM in their teaching which obviously takes a lot of time for both teachers and students (Lesseig et al., 2016; Ryu, 2018). Teachers are also in huge dilemma since integrating STEM means they have to give students some time for them to fail, learn and to explore things by themselves (Lesseig et al., 2016). Basically, integrating STEM in school is not an easy task especially for the teachers since they play one of the important roles in implementing the right method for teaching and learning in school.

Discussion

The discussion was prepared according to the findings explained in results. The Results show that most of the articles discussed more towards teachers' perceptions in STEM integration in school. They are only several articles discussing on the challenges experienced by the teachers. This could be due to lack of materials and research related to challenges in STEM education since STEM introduction towards education is relatively new and is slowly being implemented in school. All of the selected articles discussed based on teachers' perspective or based on their own personal experience related to STEM integration. Overall, the review found that teachers have negative perceptions towards STEM integration although there are some of them who have positive perceptions towards STEM integration in school. Teachers who have negative perceptions towards STEM are among those who have wrong perceptions in STEM or lack the understanding of STEM. Lack of professional development, content knowledge and lack of confidence in teaching make it hard for the teachers to integrate STEM in school. A total of 24 articles are successfully described with 4 of them using quantitative method, 16 of them using qualitative method and 4 of them using mixed method.

Conclusion

This study is conducted to answer two research questions which are 1) what the teachers' perceptions towards STEM integration in school are and 2) what the challenges experienced by the teachers in integrating STEM in school are. Studies have found that, there are different opinions among teachers when it comes to STEM integration. Teachers with low content knowledge tend to feel insecure and not confident in integrating STEM in the classroom. On the other hand, teachers with great background feel that STEM is a very good system and they are confident in their ability to integrate STEM very well in the classroom. The main challenge discussed is related to time constraint. Teachers believe that time is the major challenge in integrating STEM since one period of lesson will only take about 40 minutes and in order to integrate STEM well, teachers believe that students and teachers need more time.

Based on the findings, it is believed that in order to integrate a new curriculum in school, a professional development programme is required especially to all teachers, so they are well equipped with the correct understanding and content knowledge to be shared with their students. Changes is not necessarily better, however, with enough time allocated, a preparation and enough training will produce great teachers for the society.

Acknowledgement

This work was supported by Universiti Kebangsaan Malaysia grant GG-2019-065

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