The SAMR Model in Education Classrooms: Effects on Teaching Practice, Facilities, and Challenges

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In order to effectively integrate technology into teaching practice, it is essential to know the different existing integration models for its application, as well as to evaluate the degree of its use in the classroom. The objective of this article was to comprehensively review the application of the SAMR model in teaching practice, as well as the facilities, challenges and application in measuring the level of use of technology during the teaching-learning process. For this purpose, a literature review was conducted, selecting various original and theoretical articles from the Scopus and Web of Science databases published during the years 2017-2023.

Keywords: SAM, education, school, technology integration, integration models

INTRODUCTION

The study of information and communication technologies (ICT) in education has made significant progress in recent years, driven by the COVID-19 pandemic. This has led to the emergence of virtual classrooms and the re-evaluation of teaching methods, through the use of software, gamified activities, online resources, and collaborative work. The use of technology has become an imperative necessity for teaching classes and has stopped simply being an option. Although technology has made it possible to conduct classes in ways unimaginable in the traditional environment, its use has been disproportionate and not everything implemented has been useful in achieving effective learning (Krajka, 2021).

This situation raises the need to investigate the level of integration and application of technology by teachers in education. In many educational institutions around the world, it is no longer a question of evaluating whether technology is implemented, but analyzing to what extent its integration is carried out (Lyddon, 2019). It is essential to verify whether it is limited to replacing technology or whether it succeeds

in transforming educational activities, creating completely new products that would not be possible without the use of digital resources (Drugova et al., 2021).

Regarding previous research, we found a scoping review on the application of the SAMR model in the Web of Science (WoS), in which the authors explore the use of digital technologies in teaching and learning strategies in various educational settings, indicating that lower levels of the model were applied more (Blundell et al., 2022). In this regard, another article indicates that the objective is to provide insight into how researchers apply the SAMR model (Tlili et al., 2022).

Scopus has published two literature reviews. The first is to systematic review the literature in the United Arab Emirates, which examines various models for the integration of technology into classrooms, including teacher thinking and action processes (TTAP), the theory of planned behavior, the theory of expectation value of achievement motivation (EVAM), the SAMR model, technology acceptance (TAM), unified theory of technology acceptance and use (UTAUT), and technological pedagogical and content knowledge (TPACK). This study also discusses the impact of technology integration on student learning abilities, as well as the importance of preparing teachers to effectively integrate technology in teaching (Mohebi, 2021).The second article corresponds to a systematic review of qualitative case studies investigating English teachers' perceptions of the impact of iPads on the educational environment (Miles, 2019).

In the databases analyzed, no systematic reviews have been found that address the application of the SAMR model in the educational setting in relation to learning transformation. The research found focuses on the classification of educational practices with digital technology, the use of iPad devices for classes, and the integration models applied to classes. This leads us to identify that there is no systematic research on the application of the SAMR model in education teachers that describes its application at the transformational level. This paper aims to fill that gap.

This study will collect and analyze scientific articles published in journals indexed in databases such as Scopus and Web of Science, in Spanish, Portuguese, and English. Since no systematized information has been found on the effects of implementing this model at its most advanced level, as well as the facilities and challenges involved.

RESEARCH QUESTIONS

Based on the problem statement, the following research questions were formulated:

1. What is the number of annual publication distributions between 2017 and 2023 according to the databases?
2. What data collection techniques/instruments used in the selected studies according to authors, year of publication, and countries?
3. What are the effects of the SAMR model on teaching practice, what facilities does it provide, and what challenges does it face according to the selected studies?

Research Objectives

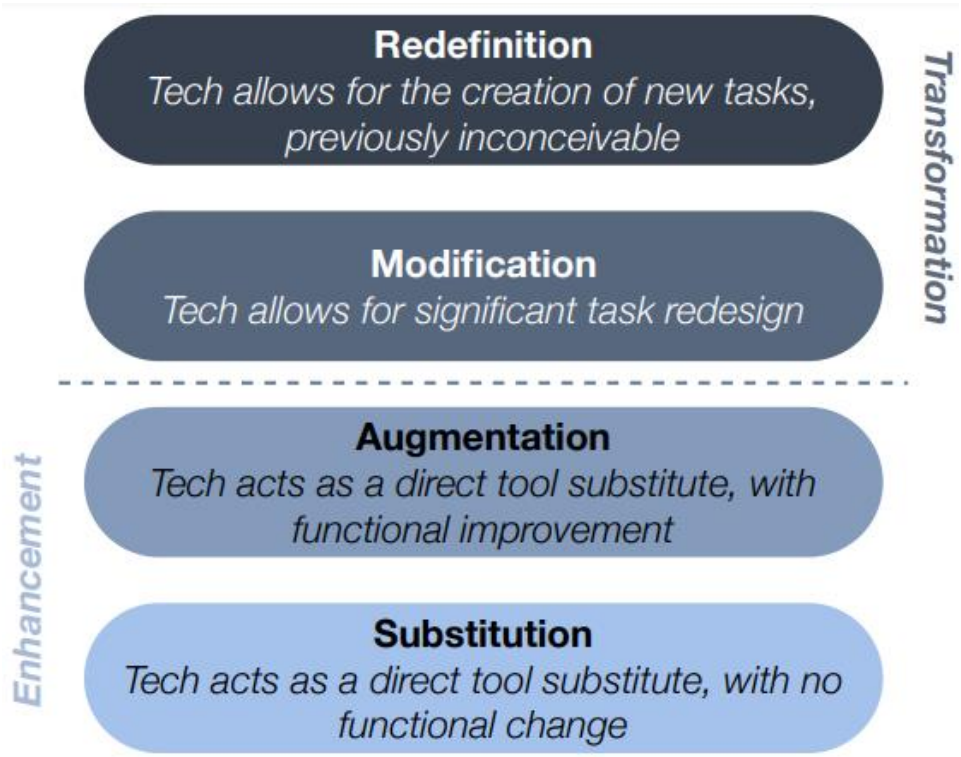
Based on the research questions, the research sought to achieve the following objectives: Investigate and provide a review of the literature on the SAMR model in teaching practice, analyzing its effects, as well as the associated facilities and challenges.

LITERATURE REVIEW

There are many models of technology integration that are included in teaching practice. The SAMR model can be used to determine the extent to which technology has contributed to the improvement of the learning process, activities, study methods, learning outcomes, among others, since this model is based on Bloom's taxonomy (Paulauskaite-Taraseviciene et al., 2022). The SAMR model elaborated in 2006, allows describing the degrees of technology integration that occur in education when moving from traditional education to a digital education to achieve a complete transformation of learning (Puentedura, 2010). This SAMR model has 2 phases and 4 levels.

Phase 1 (Enhancement) comprises the lowest levels, the Substitution level is when an activity can be done even without the use of technology, and the Augmentation level in which some tools of the technological resource are used, and functional improvements are added. Phase 2 (Transformation) comprises the highest levels, such as Modification, where technology allows the definition of significant tasks, which could not be performed without the digital resource, that is, the activity is designed from the technological resource and the redefinition level in which new tasks are designed where the digital resource is indispensable (Morales-Garcia et al., 2022). This model is pointed out as one of the most accepted in the integration of ICT in classrooms (Champa et al., 2020). The SAMR model schematic is shown in Figure 1.

FIGURE 1
THE SAMR MODEL



METHODOLOGY

This study is a systematic review of the literature that focuses on articles related to the SAMR model in the educational context, focusing on the effects on teaching practice, facilities and associated challenges. To conduct this systematic review, the guidelines of the PRISMA 2020 statement were followed (Page et al., 2021), which provides a checklist to ensure the proper conduct of systematic reviews.

A systematic approach allows the evaluation of all available primary study research in relation to a research question, culminating in a secondary study (Kitchenham & Charters, 2007). In this study, a systematic approach based on the PRISMA guidelines was followed to conduct the review, ensuring rigor and consistency in the steps to be followed.

Prisma Guidelines

1. Eligibility criteria are considered:
   The inclusions are as follows.
   a) The types of documents are primary, reflective, or theoretical articles.

b) That the subject areas are in the social sciences.
c) The type of access must be open.
d) These have been published in the period 2017 to 2023.
e) In English, Spanish, or Portuguese.
f) No duplicate items.
g) It is desired that the title and/or abstract are the descriptors sought.
h) The articles must be applied to basic education.

On the other hand, the exclusions are as follows:

a) Types of documents: Other
b) Subject areas: Other than Social Sciences
c) Type of access: not open
d) Period: less than 2017
e) Language: other than English, Spanish, or Portuguese.
f) Duplicate items
g) With descriptors that do not appear in the title and/or abstract
h) Not to be applied to education
i) Failure to recover

2. For sources of information, we worked with Scopus and Web of Science, searching articles for each database for the last time in the second week of June 2023.
3. English descriptors were used as a search strategy, using combinations of keywords and synonyms, with emphasis on the SAMR model variable. The AND operator was used until the appropriate formula was obtained.
    - SAMR Model and education
    - SAMR Model and teachers
    - SAMR Model and school
    - Technology Integration and SAMR Model
    - SAMR Model and integration models
4. For the selection process, repeated articles were eliminated from each database, then among all databases, those articles that did not contain any descriptor in the abstract or title were eliminated. Likewise, with those articles that could be recovered. For this process, we independently worked.
5. A flow chart was developed showing the steps involved.

Search Strategy

The initial search was carried out on 2 June 2023, combining the terms “SAMR model” and “education” in the Scopus and Web of Science databases. Subsequently, on June 4, 2023, the search was expanded using the AND operator as appropriate in the terms “SAMR Model”, “education”, “teachers”, “school”, “Technology Integration” and “integration models”. These searches yielded a number of results, some of which were repeated or were not useful for the case in question. This made it possible to show how the topic of the SAMR model is being worked on in education and to verify that there are no systematic articles on the specific topic, but rather similar articles focused in a different way.

On June 12, 2023, we again started the searches in the same databases; however, this time we applied filters as only publications from 2017 to 2023. The combinations used for best results were: (“SAMR Model” AND “education”), (“SAMR Model” AND “teachers”), (“SAMR Mode “l AND “school”), (“Technology Integration” AND “SAMR Model”), and (“SAMR Model” AND “integration models”). We were able to find 239 in Scopus and 135 in Web of Science. Before selecting the articles to be included, the inclusion and exclusion criteria mentioned above were defined. In total, a 12-day search was carried out. An example of search criteria for both databases is shown below.

Database Scopus

Search date: June 12, 2023

Search string: TITLE-ABS-KEY (samr model AND teachers) AND (LIMIT-TO (OA , "all")) AND (LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017)) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (SUBJAREA , "SOCI")) AND (LIMIT-TO (LANGUAGE, "English") OR LIMIT-TO (LANGUAGE , "Spanish"))

Database Web of Science (WoS)

Search date: June 14, 2023

Search string: SAMR Model and education (All Fields) and 2023 or 2022 or 2021 or 2020 or 2019 or 2018 or 2017 (Publication Years) and Article (Document Types) and All Open Access (Open Access) and English or Spanish (Languages) and Education Educational Research (Research Areas)

Selection Process

For this process, we have worked with peers, since they help to control biases by means of another review using the indicated combinations, thus guaranteeing the soundness of the results obtained. From the database according to criteria a,b,c,d,e, 198 articles were removed from Scopus and 95 from Web of Science, eliminating a total of 293 articles. Duplicate articles were eliminated from each database: 24 from Scopus and 25 from Web of Science. Among all databases, 11 duplicates were also found, resulting in a total of 21 articles for review.

RESULTS

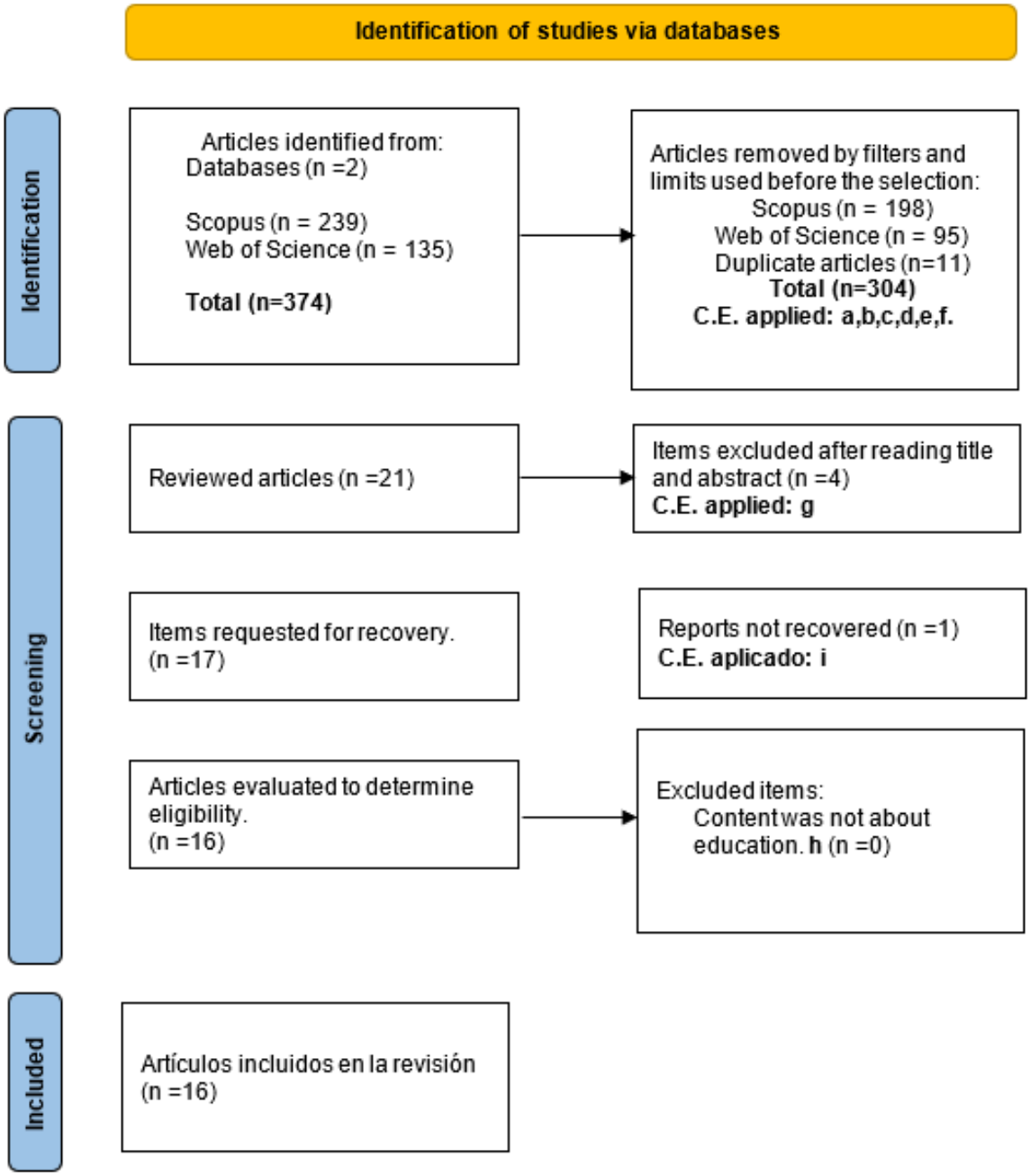
Search Results

In the identification stage, we worked with two databases such as Scopus and Web of Science. According to the combinations of words in English, a total of 374 articles were identified, 239 from Scopus and 135 from Web of Science. Those who did not comply with exclusion articles a, b, c, d, e, f, and duplicate articles from the same database and between them were eliminated, giving a total of 304 articles eliminated.

In the stage of put on screen, a total of 21 articles remained to be examined after those eliminated, the title and abstract were read, and those that did not meet criterion g were eliminated, with a total of 4 articles excluded. There were 17 articles requested for retrieval and only one could not be recovered to be evaluated for eligibility. No articles were excluded according to criterion h, since they were all from primary, secondary and/or higher education.

Finally, in the included stage, we were left with 16 items to be reviewed as shown in Figure 2

FIGURE 2
PRISMA 2020 FLOW DIAGRAM



Most of the results were found in the Scopus database with 64%. And in that database the combined word (SAMR Model AND teachers) obtained the most results with 28%. However, in both the Scopus and Web of Science databases, the combined word (SAMR Model AND education) obtained the most results, 33%.

The following is the list the initial list of publications after applying the combined keywords in each of the databases consulted according to the search and inclusion criteria (Table 1).

TABLE 1
RESULTS AFTER APPLYING THE KEYWORDS

Combined words in English	Database				Total
	Scopus	%	Web of Science	%	
SAMR Model and education	65	27%	45	33%	110
SAMR Model and teachers	66	28%	27	20%	93
SAMR Model and school	27	11%	39	29%	66
Technology Integration and SAMR Model	39	16%	12	9%	51
SAMR Model and integration models	42	18%	12	9%	54
TOTAL	**239**	**64%**	**135**	**36%**	**374**

What Is the Number of Annual Publication Distributions Between 2017 and 2023 According to the Databases?

Regarding the SAMR model in teaching practice as shown below (Table 2) no results were found in 2017 and 2018. Most of the published articles come from the Scopus journal with 81% and 2021 is the year with the most publications with 31% of the total.

TABLE 2
ANNUAL PUBLICATIONS FROM 2017 TO 2023

Year	Scopus	%	WoS	%	Total	%
2017	0	0%	0	0%	0	0%
2018	0	0%	0	0%	0	0%
2019	2	15%	2	67%	4	25%
2020	1	8%	1	33%	2	13%
2021	5	38%	0	0%	5	31%
2022	3	23%	0	0%	3	19%
2023	2	15%	0	0%	2	13%
Total	**13**	**81%**	**3**	**19%**	**16**	**100%**

What Data Collection Techniques/Instruments Used in the Selected Studies According to Authors, Year of Publication, and Countries?

In Table 3 shows that out of the 16 articles, only 11 of them mentioned the instrument used and most of them were interview instruments (Chergui et al., 2020; K. A. Clark et al., 2021; Drugova et al., 2021; Krajka, 2021; Miles, 2019; Shamir-Inbal et al., 2023). Likewise, most of the research comes from the United States: (S. Clark & Lee, 2019; Marlatt, 2019; McClain & North, 2021; Svrcek et al., 2022); and 2 from Latin America: Brazil (Bicalho et al., 2023) and Mexico (Morales-Garcia et al., 2022). On the other

hand, the most frequently applied instrument was the interview (Chergui et al., 2020; K. A. Clark et al., 2021; Drugova et al., 2021; Krajka, 2021; McClain & North, 2021; Shamir-Inbal et al., 2023).

TABLE 3
TECHNIQUES/INSTRUMENTS BY AUTHOR, YEAR OF PUBLICATION, AND COUNTRY

ID	Authors/year	Country	Technical/Instrument
1	Bicalho, Coll, Engel, and Lopes de Oliveira. (2023)	Brazil	Questionnaire/Observation
2	Chergui, Chakir, Tahiri y Mansouri. (2020)	Morocco	Interview
3	Clark, Welsh, Mauchline, France, Whalley y Park. (2021)	United Kingdom	Survey/ telephone interviews
4	Clark y Lee. (2019)	United States	NE
5	Drugova, Zhuravleva, Aiusheeva, and Grits. (2021)	Russia	Interviews/questionnaire
6	Ibáñez. (2021)	Poland	NE
7	Krajka (2021)	Poland	Observation Interview
8	Lyddon. (2019)	Japan	NE
9	Marlatt. (2019)	United States	Observation
10	McClain y North. (2021)	United States	Questionnaire
11	Miles (2019)	United Arab Emirates	Interview
12	Morales, Navarro, and García. (2022)	Mexico	NE
13	Paulauskaite, Lagzdinyte, Gaiziuniene, Sukacke y Daniuseviciute (2022)	Lithuania	NE
14	Shamir-Inbal, Schwartz, and Blau. (2023)	Israel	Interview
15	Svrcek, Rath, Olmstead y Colantonio-Yurko. (2022)	United States	Survey
16	Tunjera y Chigona. (2020)	South Africa	Survey

Note: The acronym NE stands for not specified.

What Are the Effects of the SAMR Model on Teaching Practice, What Facilities Does It Provide, and What Challenges Does It Face According to the Selected Studies?

Table 4 presents a synthesis of the effects, facilities and challenges found in the research with respect to the SAMR model in teaching practice.

In relation to the effects, 4 studies identified the usefulness of the SAMR model to identify and understand the level of technology integration (Bicalho et al., 2023; Chergui et al., 2020; Paulauskaite-Taraseviciene et al., 2022; Svrcek et al., 2022). In addition, others highlighted the benefits of its implementation in the area of English (Krajka, 2021; Miles, 2019), for the learning of mathematics (S.

Clark & Lee, 2019), and for field work (K. A. Clark et al., 2021). Regarding student participation and accountability, two investigations were found that examined the impact of the results on the math census assessments (S. Clark & Lee, 2019; McClain & North, 2021), while two others highlighted the active participation of students (S. Clark & Lee, 2019; Marlatt, 2019). It was found in a research the predominant effect of the SAMR model was on technological and content knowledge (Drugova et al., 2021) and another its ability to assess mobile learning was highlighted (Krajka, 2021). Furthermore, other research highlighted the understanding of the use of technological pedagogical models in teaching and learning (Ibáñez-Cubillas, 2021; Tunjera & Chigona, 2020) and others reported improvements in teaching practice (McClain & North, 2021; Tunjera & Chigona, 2020). On the other hand, in one research reported that more than 50% of the participants only applied the first level of the SAMR model (Morales-Garcia et al., 2022) and in another the learning outcomes did not meet expectations, because their application was at a low level (Shamir-Inbal et al., 2023).

Seven studies were found in relation to application facilities mentioned that it is simple to integrate technology into the classroom using this model (Bicalho et al., 2023; K. A. Clark et al., 2021; Drugova et al., 2021; Ibáñez-Cubillas, 2021; Marlatt, 2019; Svrcek et al., 2022; Tunjera & Chigona, 2020). In addition, it is indicated that the model is functional, since it allows applying what has been learned in other contexts, such as real situations (Bicalho et al., 2023; S. Clark & Lee, 2019; Krajka, 2021; Lyddon, 2019; McClain & North, 2021; Shamir-Inbal et al., 2023). Regarding its optimal application in collaborative activities at distance, only two researches mentioned it (Marlatt, 2019; Miles, 2019). In other studies, highlighted that it is easy to determine at which level of the model one is when applying technology in classrooms (Morales-Garcia et al., 2022; Paulauskaite-Taraseviciene et al., 2022) and in another was indicated that it is easy to add value to learning by using it (Shamir-Inbal et al., 2023).

In relation to the challenges, several perspectives were identified. Some research noted that hasty generalizations may be a problem due to the lack of empirical studies and that the model does not adequately address the complexity of teaching (Bicalho et al., 2023; Krajka, 2021). Other research highlighted the need to verify whether the model actually contributes to learning, as there may be a tendency to replace traditional activities without a positive impact or that students use technology for nonacademic purposes (K. A. Clark et al., 2021; Drugova et al., 2021; Krajka, 2021; Lyddon, 2019; McClain & North, 2021). Eight studies indicate that the most important challenge is for teachers to understand technology and to be trained on an ongoing basis (K. A. Clark et al., 2021; Ibáñez-Cubillas, 2021; Marlatt, 2019; McClain & North, 2021; Miles, 2019; Shamir-Inbal et al., 2023; Svrcek et al., 2022; Tunjera & Chigona, 2020). The importance of having adequate resources and technologies to implement the model effectively is also highlighted (S. Clark & Lee, 2019; Marlatt, 2019; McClain & North, 2021; Miles, 2019; Shamir-Inbal et al., 2023; Svrcek et al., 2022; Tunjera & Chigona, 2020). Other research indicated that the model should be adapted to the specific needs and circumstances of the classroom, considering the content, context, the target and the learning objective (S. Clark & Lee, 2019; Ibáñez-Cubillas, 2021). Another research points out that a culture change is required due to the fact that teachers have resistance to change and do not wish to implement the model due to fear or lack of knowledge (Miles, 2019; Tunjera & Chigona, 2020). Finally other autors highlighted the challenge of adequately understanding the levels and phases of the model (Morales-Garcia et al., 2022; Shamir-Inbal et al., 2023).

TABLE 4
SYNTHESIS OF THE EFFECTS, FACILITIES AND CHALLENGES OF THE SAMR MODEL

Effects	**ID**
The use of ICTs is identified and understood.	1, 2, 13, 15
It was considered beneficial when applied in the classroom.	3, 4 7, 11
Increases students' commitment and responsibility.	4, 10
There was active participation.	4, 9
Predominance is achieved at some levels depending on whether it is technological knowledge (TK) or content knowledge (CK).	5
Provides a framework for evaluating mobile learning	7
Its good application during learning was relatively low.	12, 14
The importance of technological pedagogical models is assumed.	6, 16
It allows teachers to improve their pedagogical practice.	10, 16
Facilities	**ID**
It allows easy integration of technology.	1, 3, 5, 6, 9, 15, 16
It is functional, allowing for the application of what has been learned.	1, 4, 7, 8, 10, 11
It allows the implementation of optimal and collaborative activities.	9, 11
It allows one to evaluate the level that is being applied.	12, 13
It adds value to the learning activities.	14
Challenges	**ID**
It is possible to make hasty generalizations.	1, 7
It is necessary to verify that technology adds value to learning.	3, 5, 7, 8, 10
Teachers must be constantly trained.	3, 6, 9, 10, 11, 14, 15, 16
Access to technology and resources is required.	3, 9, 10, 11, 14, 15, 16
The model should be adapted to the needs and circumstances of each classroom.	4, 6
Resistance to change.	11, 16
Understand the levels of analysis and the layers of the model.	12, 14

DISCUSSION

The pandemic has increased the use of information and communication technologies (ICTs) in education, leading to innovative teaching methods. However, it is critical to understand how these technologies are being applied in education today.

After applying the eligibility criteria, a total of 16 articles related to the SAMR model in teaching practice were found. Most of these articles are primary, reflective, or theoretical and come mainly from the Scopus database. It was observed that 2021 had the highest number of publications, Scopus being the only database that recorded these publications.

On the other hand, no records of publications were found in both databases for the years 2017 and 2018. Furthermore, both databases presented two publications in 2019 and one in 2020. In the last three years, only publications were found in Scopus, and a negative trend is observed in terms of the number of

publications. This suggests that the topic of the SAMR model in teaching practice has not yet been widely researched.

When analyzing the articles, it was observed that not all researchers provided a clear specification of the methodology, so the technique or instrument used in some cases was not mentioned. Of the 16 articles reviewed, only 11 indicated the instrument applied, and it was found that most of them were interviews, since many of them are based on a collection of appraisals and experiences.

Regarding the authors, most of the research was carried out in the United States. However, it is important to note that Mexico and Brazil are the only Latin American countries where research on the subject has been carried out. However, it is necessary to take into account that this disparity shows a lack of balance, since there is no equivalent amount of publications produced in Latin American countries compared to other countries.

Regarding the effects of the SAMR model, most authors emphasize that it is easy to identify and understand technological resources and point out that they are beneficial to classrooms by increasing students' responsibility, commitment, and active participation. The application of the model makes it possible to understand the technological models used in education, which facilitates the incorporation of knowledge of technologies and content.

In addition, several authors report that it was easy to integrate the technology and that its application was functional. They also mention that it is easy to collaborate on online activities, which adds value to learning. However, one author notes that in his research he did not obtain the expected results because the teachers were limited to using the lowest level of the model. This may be because they do not know about resources or have not been previously trained, so it is necessary to indicate that teachers should manage digital competence.

One of the challenges is that the SAMR model tends to generalize and does not adequately address the complexity of teaching; it is also noted that the model is open to interpretation by the teacher (Blundell et al., 2022). A major challenge is to ensure that all students have access to devices such as cell phones, tablets, or laptops. This implies that all schools should have computer labs and teachers trained in up-to-date digital skills. However, it is recognized that this requires a large investment from the state or the institution. It is emphasized that the level of substitution in technological integration in the classroom is the minimum that a teacher can do, and the need for a total redefinition is highlighted, which implies a change in the curricular design. This would allow for the creation of innovative and novel learning experiences that promote the achievement of educational objectives more effectively.

In terms of limitations, it is possible that there are more scientific articles in other databases that have not yet been analyzed, since this research has only considered two databases according to the inclusion criteria. In addition, some articles have not been fully accessible and may lack rigorous filters for an accurate search. However, despite these limitations, this study provides a starting point for future research on the topic.

CONCLUSION

In most of the articles analyzed, the SAMR model offers advantages, but its effective implementation depends to a large extent on teacher training and innovation in educational technology, as well as on factors such as equitable access to technology, curriculum redefinition and significant investments.

It is essential to expand research and knowledge on this topic, since there is little information available in the form of primary or theoretical articles. Furthermore, few studies have been carried out in Latin America, so it is hoped that this article will stimulate further research.

The application of the SAMR model can generate changes in education and improve the teaching-learning process; however, changes must be made in the curriculum, with trained teachers and resources. It is also necessary to know the context, objective, and educational level in which it is applied; therefore, it would be advisable to establish a baseline to measure its use and not to depend solely on subjective perceptions.

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