# The SAMR model in the age of Artificial Intelligence: A pedagogical framework for effective integration of AI technologies into the learning process

**Panka LAZAROVA, Ivan DIMITROV**

University of Plovdiv Paisii Hilendarski,
Faculty of Mathematics and Informatics, Plovdiv, Bulgaria
p.valeva@uni-plovdiv.bg, ivandimitrov@uni-plovdiv.bg

**Abstract:** *The article examines and describes the enhancement of the SAMR model with artificial intelligence in the context of pedagogical planning. A survey was conducted among a small experimental group of teachers teaching at the lower secondary level. Most results indicate that respondents use artificial intelligence in their methodological training, and the comparison of this AI use covers the first level of "Substitution" in the SAMR model.*

**Keywords:** Technology integration, SAMR model, AI.

## 1. Introduction

Training design is a key step that every teacher goes through in their daily work with students. Artificial intelligence has a significant impact on education by offering new opportunities to improve the teaching and learning process and facilitate the work of teachers (Velcheva, 2024). To ensure the effectiveness and meaningful use of these technologies, a pedagogical framework is needed to support the planning and evaluation of their application. There are many models for implementing technologies in the learning process that are part of teaching practices. Such is the SAMR model developed by Dr. Ruben Puentedura, widely used in research publications to describe and categorize the integration of technologies into educational practices (Blundell et al., 2022). SAMR offers a four-stage structure - substitution, amplification, modification, and redefinition - which, combined with artificial intelligence, can guide teachers in improving the learning process. Applying the SAMR model in the context of artificial intelligence allows for a transition to a deeper level of technology use in the learning process, leading to the creation of practical forms of learning. In this way, AI transforms from a learning tool into a means of developing critical thinking and creativity in the learning process.

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## 2. Theoretical framework of the SAMR model

Created as an analytical tool for classifying and evaluating the implementation of technology in education, the SAMR model outlines four interrelated levels of technology integration. These levels describe the degrees of technology integration that occur in education as it transitions from traditional to digital in order to achieve a complete transformation of learning. (Puentedura, 2010). The SAMR framework serves as a guide for teachers when planning and reflecting on the use of digital tools in the learning process. The model has two phases and four levels.

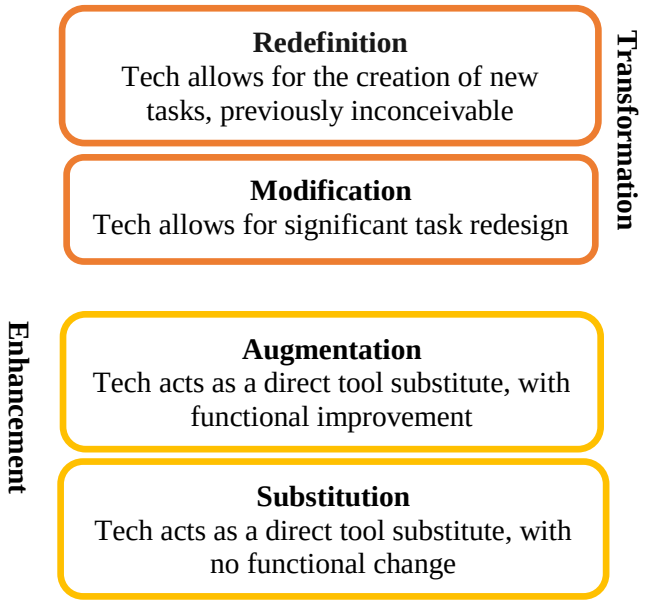


**Figure 1.** The SAMR model, Dr. Ruben R. Puentedura

The first phase (Improvement) covers the initial two levels. The lowest level of substitution is when a specific activity in the educational process can take place without the use of technology. In the next level of expansion, certain technological resources are utilized and functional improvements are added. The second phase (Transformation) covers the highest levels. *A modification in which technology allows the definition of significant tasks that could not be performed without digital resources, i.e., educational activities are designed by technological resources.* And the level of redefinition, where new forms of learning are created and digital tools are indispensable (Morales-Garcia et al., 2022). SAMR encourages teachers to "move up" from lower to higher levels of teaching with the help of technology, which, according to Puentedura, leads to improved levels of teaching and learning.

## 2.1 Comparative characteristics between traditional teaching and the SAMR model

The education system should enable students to be researchers and innovators - to be able to independently research information, experiment, make hypotheses, reach the necessary conclusions on their own, try to solve problems, work together and communicate with each other, show initiative, think critically and be creative (Shopova, V., Radev, V., 2025). The significance of SAMR can be clearly outlined in the different levels compared to traditional teaching. We will look at an example in a history lesson on the topic "Ancient Egypt – social life, religion, culture, and achievements." The objectives of the lesson are for students to recognize key characteristics of Egyptian civilization, understand the importance of the Nile River for the life and development of Ancient Egypt, and use digital tools to research and present information. The lesson is structured according to SAMR and illustrates the transformation of the learning process through technology.

**Table 1.** History lesson

| Traditional | SAMR levels | Goal |
|---|---|---|
| Students use a paper textbook, notebook, and pen to take notes. | (Substitution)<br>Students read an electronic textbook or PDF with text about Ancient Egypt instead of a paper textbook. They answer questions in Google Forms instead of on paper. | It facilitates access to information, but does not change the nature of the task. |
| Students use a standard map and a paper test. | (Augmentation)<br>Students use interactive maps of the Nile River (Google Earth or TimeMaps) to locate important cities and temples. They use an online dictionary or quiz (Kahoot or Quizizz) to test their knowledge. | It increases engagement and provides immediate feedback. |
| Students work in their notebooks to create a timeline for the history of Ancient Egypt. | (Modification)<br>Students work on a shared online document (Google Doc) to create a timeline. They add images, videos, and links to virtual museums (the British Museum). The teacher comments and guides the process in real time. | Cooperation and deeper understanding through collaboration and joint work. |
| The knowledge from the lesson remains in the classroom. | (Redefinition)<br>Students create a virtual tour of Ancient Egypt (Canva, Google Earth Projects, Thinkling). They | Students become creators of educational content, combining historical |

| | | |
|---|---|---|
| | include 3D models of pyramids or famous pharaohs, audio stories, and short video clips.<br>The project is published online, and students present their work at a virtual exhibition. | knowledge with digital skills and creativity. |

In summary, Table 1 shows that at level (Substitution) an analog tool is replaced with a digital one (reading PDF/Google Forms). At the next level (Augmentation), there is added functionality (quiz in Kahoot/interactive map). At level (Modification), collaboration and task reworking appear (joint online timeline). And finally, at (Redefinition), there is a product of the educational activity that students have created (virtual tour/digital project) and can share with the world. The project method allows for teamwork, dialogic communication, critical thinking, and creativity (Velcheva, I., Kartaleva, I., 2025).

The SAMR model is cited as one of the most widely accepted models for integrating ICT into classrooms (Champa et al., 2020). However, a critical understanding of SAMR requires a distinction between its practical application and its theoretical basis. Numerous publications emphasize the need for more specific criteria for migration between levels and for empirical studies that link SAMR levels to specific learning outcomes (Hamilton et al., 2016).

## 3. Adaptation SAMR(AI)

With the introduction of AI into the learning process, we should consider the SAMR model in the context of artificial intelligence. The fusion of the model and AI can be formulated as follows: at the substitution level, AI can perform routine functions (e.g., automatic generation of dictionary translations or automatic assessment). At the amplification level, AI provides additional functionalities (image generation based on description/prompt). When modified, the tasks change significantly, for example, text summarization, note-taking, quizzes with a generative model, which changes the role of the teacher. When redefined, AI enables new forms of learning—creating a virtual tour with AI text, images, and a virtual tour guide. In this case, SAMR can serve as a tool for exploring how artificial intelligence affects the user (Kohnke et al., 2025). Is it possible for AI to support teachers and accelerate the transition through some of the SAMR levels? Let’s take a look at Figure 2.

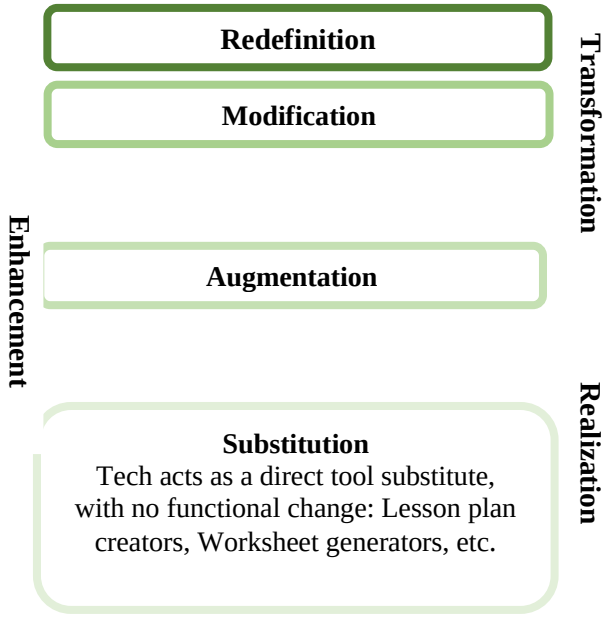


**Figure 2.** SAMR(AI)

We observe a real key difference in that with artificial intelligence, replacement can happen quickly. This is because AI tools today can perform many tasks that, before the advent of AI, were performed by teachers. For this reason, "Substitution" is simply "Realization." In the article "SAMR and AI Chatbots," Dr. Nick Jackson reclassifies the substitution component of SAMR as the realization of AI capabilities (Jackson, 2023). Next are the benefits for teachers, who can use AI to replace repetitive tasks, create worksheets, etc. However, substitution is not the ultimate goal. In his article "The Turing trap: The promise peril of human-like artificial intelligence," Erik Brynjolfsson of Stanford University argues that the true potential of AI lies not in its ability to automate human tasks (thus replacing the need for humans), but rather in its ability to extend human capabilities, to help us be better at what we can do now, enabling us to expand our capabilities in ways we have not yet imagined. (Brynjolfsson, 2022). Today, the development of AI tools for education is mainly focused on automating teaching tasks in order to save teachers time on existing tasks by replacing and supplementing them.

The practical implications for educational policy and professional development require three additional elements:

- a criteria section to help teachers classify AI applications according to SAMR levels and assess their pedagogical added value;
- training in digital and ethical literacy to prepare teachers to design tasks at the levels of modification and rethinking;
- a research design that combines qualitative and quantitative methods for measuring learning outcomes, engagement, and long-term effects of AI integration.

These elements would allow SAMR to function not only as a descriptor but also as an operational framework for validating the pedagogical effectiveness of AI technologies.

In conclusion, the theoretical framework based on SAMR and enriched with empirical and ethical perspectives from the field of AI offers a systematic path for the meaningful integration of AI into the learning process: it guides from basic applications to transformative practices, while calling for critical evaluation, pedagogical training, and evidence-based research (Inbal et al., 2024).

## 4. Methodology

The methodological framework of this study is based on the principles of the pragmatic and constructivist approach, which view education as a dynamic process of interaction between technology, teacher, and student. The underlying principle is that the effective integration of artificial intelligence (AI) into the learning process cannot be viewed solely as a technological act, but rather as a pedagogical transformation in which the tool serves to expand opportunities for learning, thinking, and creativity. Therefore, the methodology aims not only to describe the use of AI technologies, but also to analyze their pedagogical value through the framework of the SAMR model. Using SAMR as a theoretical axis and AI as a researched phenomenon, we seek to answer the question: how can technological innovations become a means of pedagogical transformation?

In response to the question, 20 teachers teaching foreign languages, humanities, and natural sciences at the lower secondary level were surveyed on whether they use AI in their teaching practice and, if so, for what purpose. By completing the survey, the level of knowledge and experience of teachers with AI in the educational process will be examined. On the other hand, the survey aims to understand respondents' knowledge of any of the frameworks for planning the learning process with technology. The data obtained will be used to analyze and position pedagogical experience according to SAMR levels.

## 5. Results

The results of the study provide a multifaceted picture of how teachers integrate artificial intelligence (AI) into the learning process and how these practices are positioned within the SAMR model. The analysis showed that the majority of participants (about 47%) use AI technologies at the substitution level - i.e., as a means of functionally improving existing pedagogical activities. When asked, "Have you used artificial intelligence tools in your teaching practice (e.g., ChatGPT, Grammarly, Copilot, Gemini, Quizizz, etc.)?" 11% answered "rarely," 42% "sometimes," and 47% "yes, often."

Examples include using chatbots to automatically generate lesson plans, presentations, images, and tests. When asked "For what purposes do you most often use artificial intelligence tools?", 21% responded with image generation, 16%

with presentation generation, 37% with test generation, and 26% with lesson plan generation. Rarely does artificial intelligence reach a level of modification where it leads to a significant change in the design of the learning task for example, using generative models for collaborative writing or designing solutions to real-world problems.

These data confirm Hamilton's observations that most teachers apply technologies mainly at the "replacement" and "augmentation" levels, while transformational levels require a higher degree of pedagogical innovation and institutional support (Hamilton et al., 2016).

Analysis of the survey responses provided a deeper understanding of these trends. Most participants describe AI as an “assistant” that “saves time” but does not significantly change the pedagogical model. This attitude reflects a focus on efficiency rather than transformation, which is characteristic of the first two levels of SAMR. At the same time, other respondents who are experimenting with AI in project-based learning are automating routine activities through AI, thereby freeing up time for more in-depth discussions with students. This corresponds with Hilton’s observations that, with appropriate pedagogical design, technology can be a catalyst for transition to higher cognitive levels of thinking and creativity (Hilton, 2016).

It is interesting to note that a large proportion of participants do not plan their practices based on technological frameworks. When asked, "Are you familiar with SAMR, TPACK, RAT, UBD, etc.?" 21% responded that they had little experience with them, 16% said they prepared lesson plans with them, and 63% responded "yes" but had no experience with them.

This confirms the criticism of authors such as Hamilton, who emphasizes the need for professional development focused on "pedagogical literacy in technological frameworks" rather than simply technical competence (Hamilton et al., 2016).

Teachers' responses also reveal ethical concerns related to the reliability of AI-generated content, copyright, and dependence on technology. When asked, "What risks or challenges do you associate with integrating AI into education?", 32% responded with copyright, 42% with the reliability of information, and 26% with dependence on technology.

These topics are particularly relevant in the context of the rapid introduction of generative models into educational practice (Holmes et al., 2023).

In summary, the results of the survey of the small experimental group confirm that in most cases these teachers use artificial intelligence as a tool for improvement rather than for transforming the learning process. It follows that the main pedagogical priority is not simply the implementation of artificial intelligence, but the creation of conditions for meaningful integration, where technology serves learning, not the other way around.

## 6. Conclusions

In the context of the dynamic development of artificial intelligence (AI), education faces the challenge of combining technological potential with pedagogical mastery. This experiment shows that the SAMR model provides a framework for analyzing the implementation of technology in the learning process and an opportunity for AI integration, helping a small group of teachers transition from instrumental to transformative use of technology. The results show that most respondents apply AI at the levels of replacement and improvement, while modification and rethinking remain limited. SAMR requires new ways of thinking, in which AI is not seen as a substitute for the human role, but as a partner in the learning process, but only if it is integrated into a well-planned pedagogical structure.

The article highlights the importance of meaningful technological integration, where AI is used not only to improve pedagogical effectiveness, but also to create new forms of learning that encourage creativity, critical thinking, and interaction. In the era of artificial intelligence, the success of education will depend not on the quantity of technology, but on the quality of its pedagogical application.

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