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# INSTRUCTIONAL DESIGN MODELS FOR TECHNOLOGY INTEGRATION IN THE CLASSROOM

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## Abstract

The technological progress made in recent decades has led education systems around the world to adopt reforms aimed at emphasizing the digital skills training of future graduates. The measures generated real challenges for the teaching staff who, on the one hand, had to adapt to the new requirements and update their knowledge in the field of information technology, and, on the other hand, they were put in a position to find ways of integrating technology in the classroom adapted to the level and specifics of the students class, to the resources available and, above all, to the characteristics of the taught subjects/disciplines. The present study describes 3 instructional design models intended to facilitate the integration of technology in teaching activities: RAT and SAMR, models that offer teachers support in evaluating the level of technology integration in teaching-learning activities, and TPACK, a slightly more complex model which focuses the attention on the 3 main components of teachers' knowledge (content knowledge, pedagogical knowledge and technological knowledge) and on the interaction between them.

**Keywords**: Instructional Design Models, Technology, Education, RAT, SAMR, TPACK.

## 1. INTRODUCTION

Along with the advance of technology and its integration in most fields of activity of contemporary society, the need to train the digital skills of future generations was increasingly felt, skills that would allow them to better integrate on the labor market. Educational institutions have therefore been challenged to cope with these transformations by adapting pedagogical practices to the efficient, varied and constantly changing resources provided by technology.

The new context also required developing a series of studies and research to investigate schools' access to technological resources, the teaching staff's training level in ICT-based teaching and assessment field and, more importantly, the impact of classroom technology use, depending on students' age, on their particularities and the specifics of the studied subjects (Woods D., 1999; Hughes, J. E., 2000; MacArthur, Charles A.; Ferretti, Ralph P.; Okolo, Cynthia M.; Cavalier, Albert R., 2001; Gary S. B., Gunter G. A, Gunter R., 2010; Boles S. R., 2011; Hunter, J., 2015; Johnson, A. M., Jacovina, M. E., Russell, D. E., & Soto, C. M., 2016; Ertmer, P.A., Addison P., Lane M., Ross E., Hilton J. ed., 2018; Mónica de Jesús Chacón-Prado, 2022). The results promptly appeared and highlighted, adding to the field's progress, the virtues and limits of technology use in teaching-learning-assessment activities. Considering the first point, we mention aspects such as increasing interest in studying the subjects that were explored using such technology and, at the same time, heightened learning motivation, better tailoring to students' learning styles, instant access to varied information, research skills strengthening, logical thinking and imagination stimulation, visual culture development, problem solving abilities improvement (Stephens, Robert P.; Lehr, Jane L.; Hicks, David;

Thorp, Daniel B.; Ewing, Thomas, 2005; Oyewale, Gbemisola Mary, Jonathan OluropoFamilugba, 2021; Shelly, Gary B.; Gunter, Glenda A.; Gunter, Randolph E., 2010; Skinner, Jon, 2011; Costley, Kevin C., 2014). However, the use of classroom technology should be done with caution, consistent with the studied lessons' purpose and objectives. Otherwise, it would entail precisely the opposite effects, facilitating students' involvement failure and attention deviation from the subjects under discussion. The field literature identifies two varieties of hindrances that bring harm by using technology in the classroom. "External barriers", i.e. limiting teachers' access to resources, training and support, and "internal barriers", such as teachers' attitudes, knowledge, skills or beliefs, and their resistance against technology (Johnson, A. M., Jacovina, M. E., Russell, D. E., & Soto, C. M., 2016, p. 13).

The present study supports teachers interested in using technology in the educational process and presents three models of Instructional Design intended to provide them with a guiding framework in the design of classroom activities. First, we shall discuss RAT, which is an acronym for "Replacement", "Amplification", "Transformation", a useful assessment framework for understanding the role of technology in teaching. Then, SAMR, "Substitution", "Augmentation", "Modification", "Redefinition", a slightly more elaborate variant of RAT, useful in designing, implementing and evaluating learning experiences. And last but not least, TPACK ("Technological Pedagogical and Content Knowledge"), a somewhat more complex model developed to assist teachers/trainers in the activities of integrating technology into teaching.

## 2. RAT

The RAT model was developed in 1998 by Joan Elizabeth Hughes, a specialist in educational psychology, and was a PhD student at the time at the University of Michigan. In a 1998-1999 study, Hughes investigated how teachers integrated technology into their teaching activities, how they learned about the use of technology in education, and what knowledge they developed as they successfully integrated it into the classroom. (Hughes J.E., 2000, II). Its results were included in the doctoral thesis Teaching English with technology: Exploring teacher learning and practice, that was defended in the year 2000 at the aforementioned institution.

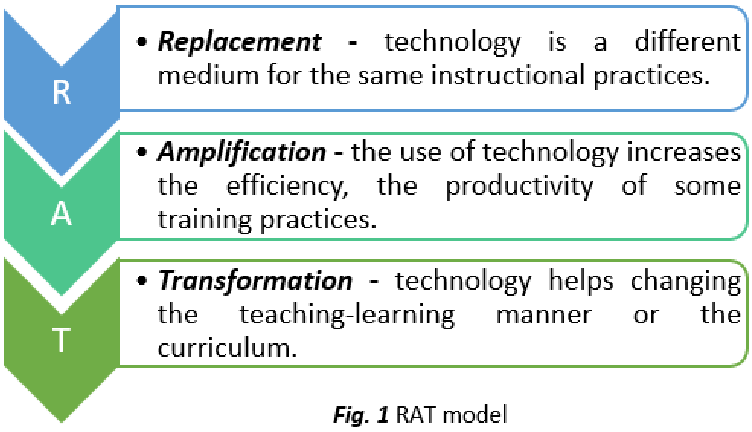


***Fig. 1*** RAT model

Hughes proposes a taxonomy that allows teachers to self-assess their level of technology integration in the classroom. According to her, technology can be integrated in the classroom in three ways: "technology as replacement", as "technology as amplification" and "technology as transformation" (Hughes J. E., 2000, p. 12). To ensure that she pays attention to all aspects of instructional events in which technology has been incorporated, the author has developed an infrastructure to help her examine specific features of the following themes: a. instructional method, b. student learning processes; c. curricular objectives (Hughes J.E., 2000, p. 30). For each of these, Hughes has also made a list of dimensions that can be replaced, amplified or transformed, a list that can be consulted in the table below.

**Table 1 Dimensions (within Themes) for Guiding Analysis of Technology Use (Hughes, 2000, p. 31)**

| Instructional Methods | Student Learning Processes | Curriculum Goals |
|---|---|---|
| Teacher' s role<br>Interaction with students<br>Assessment of students<br>Professional development<br>Preparation<br>Administrative tasks | Activity task<br>Thinking process – mental process<br>Task milieu (individual, small group, whole-class, others)<br>Motivation<br>Student attitude | „Knowledge" to be gained, learned, or applied<br>„Experience" to be gained, learned, or applied |

### 2.1. Technology as replacement

According to the RAT model, at this stage technology is used only to replace and not to change established instructional practices, student learning processes, or content objectives (Hughes J. E., 2000, p. 32). The use of technology is therefore only a different means for achieving an already established educational goal. For better understanding, Hughes gives the example of an English teacher asking students to recognize parts of speech by highlighting or underlining examples in a text entered into an electronic file. The activity replaces the classic practice of underlining/circling a word with a pencil on a worksheet, while the teacher's instructional method, the students' learning process, as well as the content objectives, remain unchanged (Hughes J. E., 2000, p. 32).

## 2.2. Technology as amplification

In this stage, the use of technology is carried out with the aim of amplifying, increasing the efficiency of current instructional practices, of the students' learning patterns or of the content objectives (Hughes J. E., 2000, p. 34). This can be achieved, for example, by designing materials with the help of programs such as MS Power Point, Google Slides, Prezi, Visme, Slides, etc., materials that can contain, in addition to text, images, maps, plans, short videos, graphics etc. and therefore can help to better understand complex information. It may also be here included the use of online databases or other electronic resources such as, for example, the professional journals.

## 2.3. Technology as transformation

"Technology as transformation" involves the use of technology for transforming instructional methods, student learning, and/or content. As in the previous stage, technology as transformation can increase the efficiency, the productivity of the teaching-learning activity, but with a different goal (Hughes J. E., 2000, pp. 36-39). It is presented as an example the case of an English teacher who asks her middle school students to use StorySpace software to write hypertext narratives. With this instance, the English curriculum content objectives were completely different from the traditional ones because the teacher also included the instruction for hypertext writing. Technology allowed her, therefore, the transformation of the students' learning objectives, while the latter, instead of writing "linear" stories, as the teacher called them, had the opportunity to write intertextually (Hughes J. E., 2000, p. 40).

## 3. SAMR

Developed in 2006 by Ruben R. Puentedura, the model aimed at improving the quality of teaching and learning by encouraging teachers to use technology in classroom activities. SAMR stands for "Substitution", "Augmentation", "Modification", "Redefinition", for levels of technology integration respectively, and allows teachers to advance from the lowest level to the highest possible level (Romrell, D ., Kidder, L.C., Wood, E., 2014, p. 4). The 4 levels are in their turn subdivided into 2 groups: "Enhancement" and "Transformation". "Enhancement" encompasses the tasks of "Substitution" and "Augmentation" as technology is used to change or improve tools already in use. "Transformation", instead, encompasses "Modification" and "Redefinition", as it promotes learning opportunities that, without technology, could not be easily achieved (Gillespie, R., 2022).

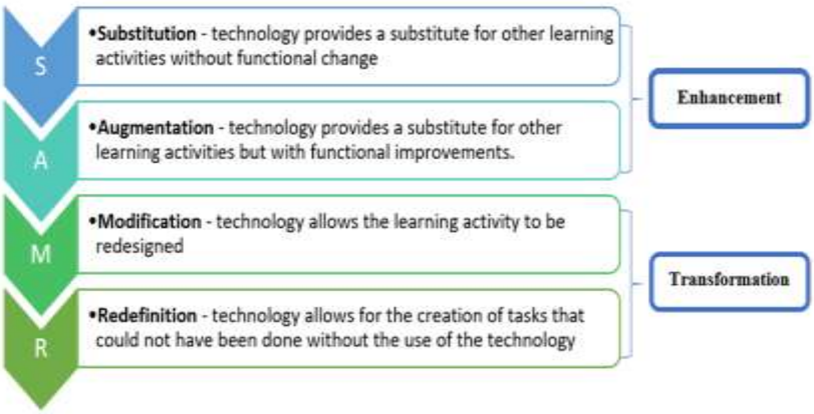


*Fig. 2* SAMR model (Source: Romrell, D., Kidder, L. C., Wood, E., 2014)

In the lines below we reproduce some of the characteristics of each level separately:

**Substitution** – this is the lowest level of technology integration and involves replacing conventional materials with their digital variants, without generating "functional changes" (Hamilton, E. R.; Rosenberg, J.M.; Akcaoglu, M., 2016, p. 4). Take the example of students who, instead of writing down the main ideas of the lesson in a notebook or on a worksheet, insert them into an electronic MS Word / Notepad file. Or we can just as well give the example of a teacher who replaces traditional tests with electronic tests/quizzes made on various online platforms.

**Augmentation** – technology acts as a direct substitute with functional enhancements. The content remains the same but is delivered differently to facilitate learning, to make accessible content with a higher level of complexity. For exemplifying, materials created with the help of electronic programs may be cited — a Power Point/Google Slide/Prezi presentation, a short video, an interactive map etc..

**Modification** – technology is used to redesign parts of the task and transform student learning. For example, students can reconstruct Marco Polo's route in the East with the help of Google Maps, research the cities that were crossed by this traveller or do various research in the Google Docs application that they can share with their colleagues.

**Redefinition** – technology profoundly transforms learning and involves the creation of new tasks that were previously unthinkable. With the help of online platforms, students can connect with peers/teachers/experts from various parts of the world to discuss issues of interest, get support in solving problems, develop certain skills etc..

## 4. TPACK

Developed in 2006, by Punya Mishra and Matthew J. Koehler, the TPACK model had a strong impact in the academic literature. From 2009 to 2019, more than 1200 studies, around 315 dissertations and 26 books have been written with this model as main subject of investigation (Zhang, W.; Tang, J., 2021, p. 367).

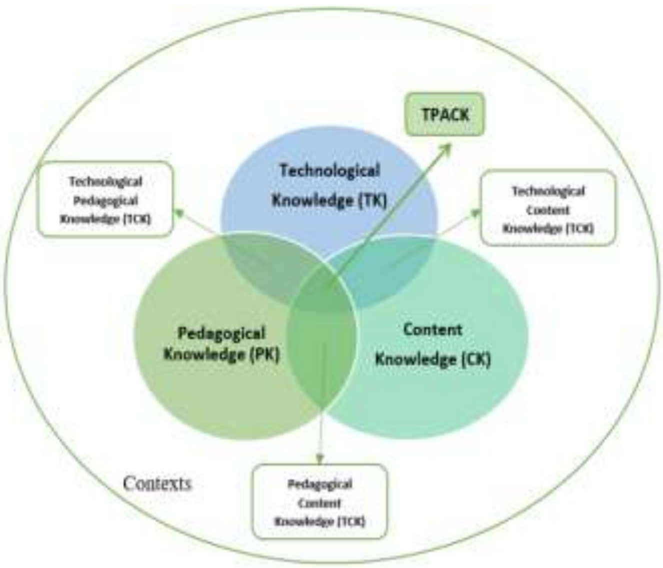


***Fig. 3*** TPACK Model (Source: Koehler M., Mishra, P., 2009, 63)

TPACK is based on an older framework, PCK (Pedagogical Content Knowledge), devised by Lee Shulman (1986, 1987) and first described in Teachers College Record (2006) under the title Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge (Koehler M., Mishra, P., 2009, 62). According to this model, there are 3 main components of teacher knowledge: content knowledge (CK), pedagogical knowledge (PK), and technology knowledge (TK). The model draws attention to the relationship and interactions between the three components, presented as pedagogical content knowledge (PCK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK). In turn, the interaction between the last components (PCK, TCK and TPK) generates TPACK (Technological Pedagogical and Content Knowledge).

**I. Content knowledge (CK)** – is the knowledge that teachers have, knowledge that must be taught to students. In the case of the History discipline, for example, this can be knowledge about certain events, historical processes, knowledge about the concepts specific to the discipline, knowledge related to the types of historical sources and the methodology of working with them etc..

**II. Pedagogical knowledge (PK)** – represents teachers' knowledge of teaching-learning processes and practices or methods. This involves understanding how students learn, classroom management skills, teaching methods and techniques, teaching aids, teaching activities planning, student assessment (Koehler M., Mishra, P., 2009, 63).

**III. Pedagogical content knowledge (PCK)** - according to the authors, this type of knowledge is similar to that mentioned by Schulman and to that which aimed at the pedagogical knowledge being applied in the teaching of a specific content (Koehler M., Mishra, P., 2009, 64). This includes knowing how teaching approaches fit with particular content and also knowing how content elements can be structured to be better taught.

**IV. Technological knowledge (TK)** – it is difficult to exemplify because it is in continuous transformation; Koehler and Mishra emphasized that any "definition of technology knowledge is in danger of becoming outdated by the time this text has been published" (Koehler M., Mishra, P., 2009, 64). However, they admitted that the definition of technological knowledge (TK), used for this model, is similar to the one proposed by the Committee of Information Technology Literacy of the National Research Council (NRC, 1999), according to which technological knowledge is knowledge that “enables a person to accomplish a variety of different tasks using information technology and to develop different ways of accomplishing a given task” (Koehler M., Mishra, P., 2009, 64).

**V. Technological Content Knowledge (TCK)** – involves knowing how technology and content interact. The recorded progress in various fields (medicine, history, physics) coincided with the development of new technologies that allowed a better data interpretation. The discovery of X-rays, by Roentgen, for example, or the carbon-14 dating technique had a notable influence on medicine and history. Likewise, the advent of the computer had an impact on physics and mathematics, placing a stronger emphasis on the role of simulations in understanding phenomena. Thus, technological content knowledge implies that teachers need to know which technologies are best suited for certain subject-specific topics and how content dictates or even changes technology or vice versa (Koehler M., Mishra, P., 2009, 65).

**VI. Technological Pedagogical Knowledge (TPK)** – is the understanding of how the application of certain technologies can change teaching and learning. TPKs become important because most software programs were not designed for educational purposes. Microsoft Office Suite, for example, was designed for the business environment, as were Web-based technologies such as blogs or podcasts. They were developed for entertainment or communication purposes (Koehler M., Mishra, P., 2009, pp. 65-66). Therefore, teachers must find ways to use them for pedagogical purposes to promote students’ access to information and to promote a better understanding of the proposed topics.

**VII. TPACK** – is the basis of teaching efficiency with the help of technology. It represents a form of emerging knowledge that exceeds all three components (knowledge, pedagogy, technology), which requires “...an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students’ prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones”. (Koehler M., Mishra, P., 2009, p. 66).

## 5. CONCLUSIONS

Integrating technology into the classroom can be both a challenge and an opportunity for inexperienced teachers. A challenge — because they see themselves placed in front of a field that is little or even not known at all, an extremely fluid field that requires continuous theoretical and practical training. It is known, on one hand, that technology is constantly evolving and sometimes it can be difficult to adapt to its pace, and teachers, on the other hand, do not have enough time resources to keep up with such transformations. An opportunity — because in the field of education there is a rich scientific literature and research that supports teachers, providing them with instructional design models, real guides that allow them to evaluate their level of technology integration in the classroom, but also to designs its activities based on such resources.

The three models described in the present study, RAT, SAMR and TPACK, have the merit of emphasizing the importance of using technology in teaching-learning activities with the aim of increasing motivation and improving the school results of students. By applying these models, teaching-learning activities become more interactive, and the teaching staff can more easily adapt their resources to the needs of the student group. Of course, each of these has its advantages and limitations: RAT and SAMR help teachers assess their level of technology integration in the classroom and identify vulnerable areas, but they have been criticized for their hierarchical structure and the rigidity it implies ( Blundell, C, Mukherjee, M, Nykvist, S., 2022), as well as for the lack of detailed instructions necessary for instructors in implementation activities (Bajracharya, J. R., 2021, p. 8); TPACK, in turn, has the merit of emphasizing the knowledge that must be possessed by the teacher (content knowledge, pedagogical knowledge and technological knowledge) and the relationship between them, but it is a model that requires a lot of effort, increased attention and sufficient time. It was also criticized for the lack of a detailed structure for the realization of lesson plans in which the three components, contents, pedagogical and technological knowledge, are simultaneously integrated (Bajracharya, J. R., 2021, p. 8).

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