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RECONFIGURAREA SPAȚIILOR DE ÎNVĂȚARE: FUNDAMENTE NEUROCOGNITIVE PENTRU MEDII EDUCAȚIONALE VIRTUALE ȘI LABORATOARE CREATIVE

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Odată cu dezvoltarea tehnologiilor digitale și a inteligenței artificiale, oamenii devin supraveghetori ai proceselor generate de mașini, ceea ce reconfigurează educația spre viziune și idei. În acest context, învățarea digitală nu mai este doar un instrument administrativ, ci capătă importanță strategică în organizarea eficientă a conținutului, deschizând noi perspective pedagogice.

Mediile educaționale sunt tot mai bogate în tehnologii electronice și mobile, iar cadrele didactice integrează metode inovatoare de predare-învățare-evaluare, centrate pe nevoile cursantului. Armonizarea procesului instructiv cu noile realități digitale necesită extinderea repertoriului de tehnici și regândirea demersului pedagogic la toate nivelurile. Tranziția către era digitală presupune o organizare mai eficientă a activităților de E-learning, ilustrată prin studii de caz și sprijinită de resurse esențiale pentru practicieni și cercetători.

Cuvinte-cheie: *spații de învățare, modelul Mayer SOI, neuroștiințe, medii educaționale virtuale, laboratoare creative.*

RECONFIGURING LEARNING SPACES: NEUROCOGNITIVE FOUNDATIONS FOR VIRTUAL EDUCATIONAL ENVIRONMENTS AND CREATIVE LABS

With the development of digital technologies and artificial intelligence, humans are becoming supervisors of machine-generated processes, which reconfigures education towards vision and ideas. In this context, digital learning is no longer just an administrative tool but gains strategic importance in the efficient organization of content, opening new pedagogical perspectives.

Educational environments are increasingly rich in electronic and mobile technologies, and teachers are integrating innovative teaching-learning-assessment methods centered on the learner's needs. Harmonizing the instructional process with new digital realities requires expanding the repertoire of techniques and rethinking the pedagogical approach at all levels. The transition to the digital era involves a more efficient organization of E-learning activities, illustrated through case studies and supported by essential resources for practitioners and researchers.

Keywords: *learning spaces, Mayer SOI model, neuroscience, virtual educational environments, creative labs.*

REFIGURER LES ESPACES D'APPRENTISSAGE: FONDEMENTS NEUROCOGNITIFS POUR LES ENVIRONNEMENTS ÉDUCATIFS VIRTUELS ET LES LABORATOIRES CRÉATIFS

Avec le développement des technologies numériques et de l'intelligence artificielle, l'humain devient le superviseur de processus générés par les machines, ce qui reconfigure l'éducation autour de la vision et des idées. Dans ce contexte,

l'apprentissage numérique n'est plus seulement un outil administratif, mais acquiert une importance stratégique dans l'organisation efficace du contenu, ouvrant de nouvelles perspectives pédagogiques.

Les environnements éducatifs sont de plus en plus riches en technologies électroniques et mobiles, et les enseignants intègrent des méthodes innovantes d'enseignement, d'apprentissage et d'évaluation, centrées sur les besoins de l'apprenant. L'harmonisation du processus instructif avec les nouvelles réalités numériques nécessite d'élargir le répertoire des techniques et de repenser la démarche pédagogique à tous les niveaux. La transition vers l'ère numérique implique une organisation plus efficace des activités d'E-learning, illustrée par des études de cas et soutenue par des ressources essentielles pour les praticiens et les chercheurs.

Mots-clés: *espaces d'apprentissage, modèle SOI de Mayer, neurosciences, environnements éducatifs virtuels, laboratoires créatifs.*

РЕКОНФИГУРАЦИЯ ОБРАЗОВАТЕЛЬНЫХ ПРОСТРАНСТВ: НЕЙРОКОГНИТИВНЫЕ ОСНОВЫ ДЛЯ ВИРТУАЛЬНЫХ ОБРАЗОВАТЕЛЬНЫХ СРЕД И КРЕАТИВНЫХ ЛАБОРАТОРИЙ

С развитием цифровых технологий и искусственного интеллекта человек становится наблюдателем за процессами, генерируемыми машинами, что переориентирует образование на видение и идеи. В этом контексте цифровое обучение (E-learning) перестает быть просто административным инструментом и приобретает стратегическое значение для эффективной организации контента, открывая новые педагогические перспективы.

Образовательная среда все больше насыщается электронными и мобильными технологиями, а преподаватели внедряют инновационные методы преподавания, обучения и оценивания, ориентированные на потребности учащегося. Гармонизация учебного процесса с новыми цифровыми реалиями требует расширения арсенала методик и переосмысления педагогического подхода на всех уровнях. Переход в цифровую эру предполагает более эффективную организацию деятельности в рамках E-learning, что иллюстрируется тематическими исследованиями и подкрепляется важными ресурсами для практиков и исследователей.

Ключевые слова: *образовательная среда, модель SOI Майера, нейронаука, виртуальные образовательные среды, креативные лаборатории.*

Introduction

Digital learning emerges as one of the viable solutions to current challenges. Learning environments are becoming increasingly enriched with electronic and mobile technologies, while teachers integrate innovative teaching, learning, and assessment methods and techniques aimed at supporting pedagogically efficient, accessible, and learner-centered educational activities.

With the development of digital technologies and artificial intelligence, people increasingly take on the role of supervisors, while machines assume the task of generating and performing routine activities. In this context, humanity is turning towards aspects related to vision, ideas, and purpose. Thus, digital learning (E-learning) is no longer perceived merely as a technical and administrative tool, designed solely for content delivery. The organization and efficient delivery of content through learning activities acquires strategic importance, opening new perspectives for the evolution of pedagogy.

Harmonizing the educational process with the new digital contexts requires an expansion of the repertoire of tools and techniques used daily, as well as a rethinking of the instructional process at all educational levels. This transition to a digital era entails a more effective organization and implementation of E-learning activities. The alignment of education with the present digital environment is illustrated through case studies from various disciplines and is supported

by useful appendices and essential resources for researchers, practitioners, and educators.

Digital learning provides us with tools that practitioners can apply independently and that incorporate a variety of aspects such as: face-to-face learning, didactic guidance and independent, blended and distance learning. Online learning is represented by a series of theories centered on the role of technology in education. These topics include:

- specific activities to achieve learning outcomes;
- the uses of technologies for learning and their role in the design of the educational process;
- current education systems and their future developments;
- professional skills and approaches with reference to the personality of the learners;
- learning curriculum design for mobile technologies;
- professional development of the practicing pedagogue in a diverse learning environment;
- sustainability, organisational barriers and learning communities.

Currently, there are many influential pedagogical theories in the digital age. Some of the most important include: *constructivist learning theory,* which argues that learning is an active process, in which students build new knowledge based on their previous experiences [11, p. 14]; *problem-based learning theory*, which argues that learning is most effective when students are involved in solving real problems [2, p. 5]; *collaborative learning theory*, which argues that learning is most effective when students work together to achieve a common goal; *game-based learning theory*, which argues that games are a great way to learn new things in a fun and engaging way [9, p. 367], and *technology-based learning theory*, which argues that technology can be a great way to personalize learning and give students access to learning resources and experiences from around the world [18, p. 5].

These pedagogical theories can be combined to create a learning environment that is both effective and engaging for students. In the digital age, it is important for schools to adapt to new technologies and use them to improve the quality of education.

The transition from physical space to virtual environment: a pedagogical and neurocognitive reassessment of the learning process

Over the past twenty-five years, research has made significant strides in identifying effective learning strategies—defined as techniques learners employ to enhance their knowledge acquisition. In their work, Logan Fiorella and Richard E. Mayer present eight evidence-based strategies designed to deepen understanding: summarizing, mapping, drawing, imagining, self-testing, self-explaining, teaching, and enacting [13, p. 720].

The central focus of these strategies is to promote generative learning—the active process by which learners make sense of new information to construct meaningful mental models. This approach enables them to apply what they have learned to solve novel problems.

Each strategy is explored systematically in dedicated chapters that:

a. describe and illustrate the learning technique,
b. examine its underlying cognitive theory,
c. synthesize the existing research to evaluate its effectiveness,
d. outline the boundary conditions for its optimal use,
e. propose practical implications for implementation, and
f. identify promising avenues for future research [14, p. 25].

Virtual learning environments involve practical teaching, recognition, modelling and communication activities (see fig.1).

Regardless of the type of learning we choose; it is important to be aware of our learning style. Some people learn better by reading, while others learn better by listening or observing. It is also important to find learning methods that are interesting and engaging. If learning is fun, we are more likely to remember it and be able to apply it in our daily lives.

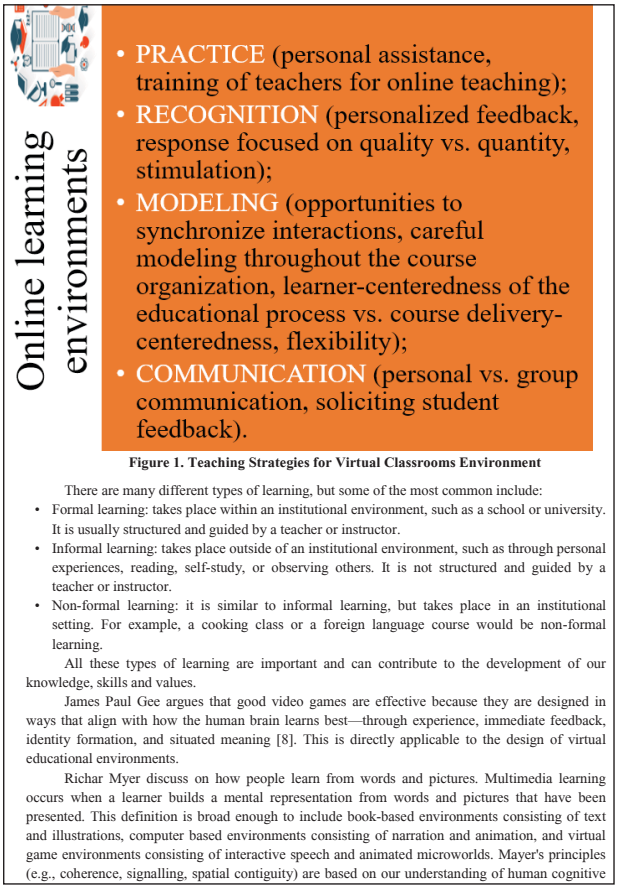

Figure 1. Teaching Strategies for Virtual Classrooms Environment

There are many different types of learning, but some of the most common include:

- Formal learning: takes place within an institutional environment, such as a school or university. It is usually structured and guided by a teacher or instructor.
- Informal learning: takes place outside of an institutional environment, such as through personal experiences, reading, self-study, or observing others. It is not structured and guided by a teacher or instructor.
- Non-formal learning: it is similar to informal learning, but takes place in an institutional setting. For example, a cooking class or a foreign language course would be non-formal learning.

All these types of learning are important and can contribute to the development of our knowledge, skills and values.

James Paul Gee argues that good video games are effective because they are designed in ways that align with how the human brain learns best—through experience, immediate feedback, identity formation, and situated meaning [8]. This is directly applicable to the design of virtual educational environments.

Richar Myer discuss on how people learn from words and pictures. Multimedia learning occurs when a learner builds a mental representation from words and pictures that have been presented. This definition is broad enough to include book-based environments consisting of text and illustrations, computer based environments consisting of narration and animation, and virtual game environments consisting of interactive speech and animated microworlds. Mayer's principles (e.g., coherence, signalling, spatial contiguity) are based on our understanding of human cognitive

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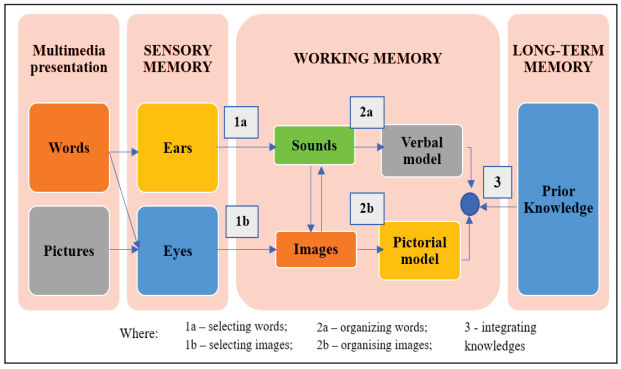

Figure 2. A cognitive theory of multimedia learning [16, p. 103]

According to the Mayer SOI model (selection-organization-integration) based on Wittrock generative learning model, meaningful learning involves three primary cognitive processes and their interactions with three main memory stores, as shown in Figure 2 [19, p. 85; 17, p. 47]. First, learners must select the most relevant incoming sensory information (such as words or graphics)—briefly stored as an exact copy in sensory memory—for subsequent conscious processing in working memory. Next, they must organize the selected information into a coherent mental representation in working memory by building relevant connections based on the underlying structure of the material (such as enumeration, process, or hierarchy). Finally, they must integrate the new representation constructed in working memory with relevant knowledge structures stored in long-term memory (such as schemas, categories, or principles). The processes of organization and integration are referred to as generative processing, which involves building a new mental representation based on relevant existing knowledge.

Open pedagogy is a learning process that gives students more freedom and control over their own learning. It is an approach to education that emphasizes curiosity, discovery and independent learning (see fig. 3).

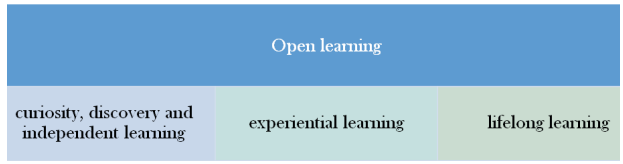

Figure 3. Essential Features of Open Learning

In open pedagogy, students are encouraged to ask questions, explore ideas, and find their own answers. They are also encouraged to work together with other students and share their knowledge and ideas.

Open pedagogy is an approach to education that focuses on the student. It is a way to help students learn, and become self-taught throughout their lives, by teaching others.

Here are some of the characteristics of open pedagogy:

- have more freedom and control over their own learning process;
- focuses on curiosity, discovery and independent learning;
- are encouraged to ask questions, explore ideas and find their own answers;
- are encouraged to work together in a diverse and creative learning environment to share their knowledge and ideas;
- emphasis is placed on experiential learning and student engagement in learning;
- emphasis is placed on lifelong learning.

Open pedagogy has a number of benefits for learners regardless of age:

- they are much more involved in learning;
- learn more efficiently;
- develops critical thinking and problem-solving skills;
- become lifelong teachers.

Formal learning is often seen as the most important form of learning, as it is the one that leads to degrees and certifications. However, informal and non-formal learning can be equally valuable, as they can help us develop skills and knowledge that are useful to us in our daily lives.

For example, if we learn to cook in an informal class, we can develop skills that will help us prepare healthy and delicious meals. If we learn a foreign language in a non-formal course, we can develop skills that will help us communicate with people from all over the world.

Open pedagogy is an approach to education that is growing in popularity. It is an approach that focuses on the student and gives students more freedom and control over their own learning.

The role of generative artificial intelligence and creative labs in developing critical thinking and creativity

The units of competences are deduced from the competences specific to the discipline and are correlated with examples of learning activities. In order to achieve the specific competences, different types of learning activities are proposed, which capitalize on the student's concrete experience in other school subjects and which integrate different learning contexts, as well as the integration of modern information and communication technologies into the teaching-learning process, using the most efficient and innovative digital resources.

The neural basis of navigation by humans was investigated with functional neuroimaging of brain activity during navigation in a familiar, yet complex virtual reality town. Activation of the right hippocampus was strongly associated with knowing accurately where places were located and navigating accurately between them. Getting to those places quickly was strongly associated with activation of the right caudate nucleus. These two right-side brain structures function in the context of associated activity in right inferior parietal and bilateral medial parietal regions that support egocentric movement through the virtual town, and activity in other left-side regions (hippocampus, frontal cortex) probably involved in nonspatial aspects of navigation. In this study, fMRI identified the hippocampus's role in spatial navigation. For virtual education, this is crucial because 3D virtual worlds and complex online platforms require spatial navigation. The cognitive load of "getting lost" can impede learning, while well-designed spatial layouts can aid memory formation [15].

Learning environments are culturally dependent on the influence of individuals on professional achievement and motivation. Learning environments make up three important factors in Juvonvel and Wentzel's view [12, p.226]:

1. The value of education, especially what we call "academic subjects".

2. Social influences and social support (both from teachers, parents, friends and colleagues), society's interests in the professional field, society's expectations, compliance and societal pressure in relation to the exercise of professional tasks.

3. Learning strategies.

Also, the environment represents a dynamic reality and not a static one, a decoration, an arrangement of furniture and paintings, regardless of the form of organization, physical or online. This is a structure built socially, but also individually, through the particular experiences of each one, for example physical learning environments [5, p. 14]:

• **Collaborative learning spaces** (coworking space) also offer access to other complementary services that contribute to facilitating their activity: stable and fast wifi, relaxation place (bean bags, sofas), meeting rooms for offline or online meetings, coffee, tea, etc. From another point of view, the capacity and compartmentalization of coworking spaces can be

found in various forms: spaces with separate rooms of different sizes; open-space spaces. Subsequently, the concept of coworking was successfully implemented in the development of modern educational spaces launched based on pedagogical models of neoliberal influence. Management practices in this open space for learning are closer to those of the collaborative world, including a focus on facilitating and sustaining resources for students who come from a community with a very low GDP per person. Students and their teachers come with their personal history (task completed), impregnate the space and turn it into their place for learning.

• **Learning labs** are a structure for collective involvement in learning through teaching. In learning labs, teams of teachers (usually the teacher and assistant per subject) commit to learning and attempting a instructional activity in a classroom with students. The classroom is a flexible space that focuses on group work and brainstorming, training sessions, presentations, workshops, and other events. The benefits of learning labs are understanding the complexity and ambiguity of empirical work, developing practical skills, understanding the nature of science, cultivating an interest in science and an interest in learning science, and developing teamwork skills.

• **Fab Lab -** manufacturing laboratories are guided by the principle of building, modifying or repairing things by themselves, conceptualized as open sources of manufacturing (open-source), the disciples being guided by the direct help of professionals or certified experts.

• **Creative spaces** (makerspaces) are dedicated areas where students can use practical techniques and tools to do something new, discover problems and solutions, and consider how learning discrete skills and concepts can be applied in real life. They are an approach to defining and designing the right space for the school addressed to current needs and trends. Creative spaces is not just a science lab, a woodworking workshop, a computer lab, or an art room, but it can contain elements that are found in all of these familiar spaces. Therefore, it must be designed to accommodate a wide range of activities, tools, and materials. The diversity of activities are essential to the design, realization and exploration process and are what differentiate STEAM production spaces and laboratories from single-use spaces. A possible range of activities could include: cardboard construction, prototyping, woodworking, electronics, robotics, digital fabrication, construction of bicycles and kinetic machines, textiles and sewing, etc. [6, 8].

• The **Future Classroom Lab** (FCL) was created based on the concept of "learning zones" and collaborative spaces that highlight different aspects of the learning and teaching process, and at the same time, help teachers to rethink both the applicability of teaching methods regarding the use of ICT and the design of the learning space according to the objectives of the lesson. FCL is composed of six educational spaces: the area of interaction, exploration, creation, development, presentation and communication, focused on the development of collaborative and interpersonal skills, identification, formulation and problem solving, responsibility and adaptability, creativity and intellectual curiosity, critical thinking and systemic approach, self-training, information and media skills, social responsibility and communication skills [3, p. 9].

• The **Creative Artificial Intelligence Lab** is a classroom of the 21st century, a dynamic, ever-evolving space where cutting-edge technologies such as artificial intelligence (AI) are calling us to rethink what students need to learn and how this learning can best be structured to prepare them for the future [10]. AI technologies have been around for over 50 years, but the development of new algorithms, the increase in computing power, the availability of enormous amounts of data have led to major advances in the field of AI in recent years. One of the most excit-

ing advancements is the emergence of generative AI, a technology that can help produce entirely new creations with just a few directives. From creating realistic and artistic images to producing music and copywriting, the potential of generative AI can be used in future-proof classrooms to help students learn and demonstrate their creative thinking skills, as AI's creative tools can serve as potent platforms in active, student-centered learning, motivating young learners to empower and develop their individuality and future prospects [4, p. 119].

Physical learning environments are rapidly transforming into digital learning platforms. It is vital for the educational institution to get involved as soon as possible in this process of educational evolution. An important step in the creation of learning environments was the digitization of libraries and the transformation of educational resources, which involved physical presence, into distance learning. Following this year, it has become clear that the classic learning environment also needs to undergo a change. It should be noted that the learning environment itself undergoes a permanent metamorphosis with the changes that humanity endures, in response to all the challenges that arise in a permanent regime.

Self-Efficacy and educational framework adaptation: from practitioners to students in a digital age

Practitioners often face technical limitations when seeking to assess the applicability of AI systems in the teaching-learning-assessment process and address potential issues. AI evaluation remains immature in many cases. The difficulty of reliably assessing the capacities of the models of applicability in education clearly highlights the fact that the methods and practices in the educational field are far from being systematized and thus offer a rather irregular coverage, at the level of educational policies and practices. As a result, those who do the work to ensure the responsible development and use of such models often face the limits of current scientific understanding of technology. Of course, as with all new technologies in education, the use of AI promiscuously empowers ethical uncertainty such as:

1. Will generative AI tools, DeepSeek, Perplexity, ChatGPT, Bard, Open AI, AlphaCode, GitHub Copilot, Cohere Generate, Claude, Synthesia, etc. allow plagiarism or complicate evaluation?
2. How can schools stay fully informed about how generative AI models are built and trained?
3. What safety and unbiased measures are currently in place?
4. What are the policy makers in empowering these new learning methodologies and tools?
5. How can we best integrate these new learning environments into our education system to prepare the learning generations to adapt to the new professional and life conditions, to achieve success and more?

But the most important question we should ask ourselves would be: "What does an effective and friendly learning environment look like?".

Traditional classroom design has been the environment that facilitates learning at the primary, secondary, and tertiary education levels. The traditional classroom design is structured in such a way as to encourage a fixed configuration of student chairs. Thus, students are positioned as passive listeners. The notion of «sage on stage» by [1, p. 32] describes traditional classroom design and the traditional approach to learning. Teachers become the main source of knowledge, while students are passive absorbers of this knowledge in the preaching of their teachers. In addition to listening to lectures, other participatory activities, such as small group discussions, cooperative learning, and assessment, become discriminated against due to traditional classroom design. Rather, the delivery of information is largely one-way – from teacher to listeners – except for those students who ask questions. Essentially, this form of learn-

ing design speeds up the delivery of information and allows instructors to complete the delivery of their programs for proper learner assessment. However, this form of design has been criticized as ineffective in engaging students. It affects the development of skills regarding collaboration, interpersonal communication, and the confidence to speak in front of an audience.

These are essential skills today, in the corporate world. Due to these shortcomings in the traditional design of the classroom and its learning approach, policymakers are moving towards the design and active learning of the classroom of pupils.

Conclusions

The concept of lifelong learning is active in relation to all social strata and professional fields, ranging from 25 to 64 years of the working population, a population that is divided between people employed in the field of work and the unemployed. Recruitment methodologies must maintain continuous employment and career guidance through adaptability, intentionality, lifelong learning, and autobiographical reasoning. Often vocational counselling practices are intuitively developed as a widespread form of response to a particular vocational requirement or construct, as teachers' professional desires and expectations, national policies and career trajectories respond to limited professional commitments, recruitment and remuneration strategies, as well as professional performance.

Recent research and development of integrated training units incorporates practical experiences and builds on the development of learners' cognitive abilities, being of several types: student-centered environments, knowledge-centered environments (science labs), knowledge assessment environments in support of learning, community sustainability-centered environments (learning is focused on articulating ideas and discussing them with peers and community members), and environments that support the design of the learning space.

Although some of these active learning strategies could be carried out within a traditional classroom, effectively implementing active learning strategies to their benefit requires a classroom that better promotes active learning. The models of active learning are diverse, such as the student-centered active learning environment, technology-driven active learning, transformative spaces for learning, interaction, learning, engagement. The common character of all forms of active learning classroom design is that they have tables with mobile chairs, which facilitate group discussion and interaction, through cooperation and evaluation between peers. The teacher's role is to facilitate learning and to allow learning and the exchange of information between disciples. Consequently, this form of classroom design promotes interpersonal communication and effective collaboration, which are "skills and dispositions considered necessary in lifelong learning.

If we look at these approaches, they simply mirror how people bring and create knowledge in an always-connected world. Writing an essay that one person will read, then moving on to the next topic can represent how assessment and learning activities were completed a few decades ago, but in a world where YouTube, TikTok, Minecraft and Wikipedia exist, creating an authentic experience for our students, along with the education of those who learn data privacy issues, intellectual property and creative ethics, these types of practices are much more aligned with the real world.

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