

INTEGRATING EDUCATION, TECHNOLOGY, AND SDG'S: A THREE-PRONGED COLLABORATION

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ABSTRACT

Social and technological evolutions are forcing changes in education worldwide. An important guide for such changes are the sustainable development goals (SDG's) adopted by the United Nations. SDG 17 calls for partnerships built on shared vision and goals. In this study, statistics reveal the need, in adult education, for more strategic transversal skills, such as communication, interaction, networking, global international communication, and social participation skills, rather than formal instruction. A case study is presented illustrating a real example of how a tripartite collaboration between schools, institutions, and enterprises can work to engage students around the SDGs. The project was a virtual reality exploration of the planet Mars, in which young adult students at risk of exclusion were engaged to collaborate, solve problems, and work toward gender equality. The authors correlate the case study activities to several learning taxonomies, and propose the basis of an action-oriented framework for developing a smart pedagogy of digital transformation.

Keywords: Smart pedagogy, Adult education, Sustainable development, Lifelong learning, Education technology, Artificial intelligence, Virtual reality, Serious games.

Introduction

Clearly, we are in a period of significant educational change. The social and technological evolution of this second decade of the 21st century is obliging us to re-examine our understanding of learning, and to modify our teaching processes accordingly. For the first time, we have access to a large body of analytics data that can actually give us a concrete measure of where we are succeeding, and where we need improvement. The advent of artificial intelligence (AI) as an educational tool will provide us with much faster feedback than we have ever had before, but it will also render the data we use much more complex. It will also provide the possibility

of a very fine-grained level of personalisation, in both the learning offer provided to students, and the feedback data received by educators. As an example, AI-driven facial recognition software is already being used in schools, both for security (Tate, 2019) and to monitor student engagement (Krithika & Lakshmi Priya, 2016).

The ubiquitous availability of information using Internet search engines has already begun changing the role of teachers from source of subject matter information to guide and facilitator through the complex maze of today's information-rich and technologically complex world. A valuable model to help teachers with this daunting responsibility is the set of 17 sustainable development goals (SDG's) for 2030 adopted by the United Nations (United Nations, 2015). SDG 4 focuses on quality education, but to achieve this quality, it is necessary to teach about all the other SDG's.

In May 2019 the authors had the opportunity to present this study at the Spring Conference of the Association for Teacher Education in Europe (ATEE) in Riga. The data and reflections included here are the result of their previous research, and call upon a case study on Catalan education (Spain). The project in the study was designed to detect educational needs among youngsters and illustrate how to respond to those needs, via a tripartite partnership between schools, institutions, and private enterprise (SDG 17) to foster the educational objectives of SDG 4 and all the other SDG's.

SDG 17: Partnerships

The text of SDG 17 includes the following:

A successful sustainable development agenda requires partnerships between governments, the private sector and civil society... These inclusive partnerships, built upon principles and values, a shared vision, and shared goals that place people and the planet at the centre, are needed at the global, regional, national and local level (United Nations, 2015).

The shared vision and goals referred to in the text are the heart of the ensemble of SDG's. If we want to optimize education to include them all, a tripartite partnership facilitates the task greatly. Each member of the triad carries with it a set of "natural" SDG's:

- Schools:
 - SDG 4 – Quality Education
 - SDG 5 – Gender Equality
 - SDG 10 – Reduced Inequalities
- Institutions (e.g. ministries, government agencies, NGO's):
 - SDG 3 – Good Health and Well-Being
 - SDG 11 – Sustainable Cities and Communities

- SDG 16 – Peace, Justice, and Strong Institutions
- Private enterprise:
 - SDG 7 – Affordable and Clean Energy
 - SDG 8 – Decent Work and Economic Growth
 - SDG 9 – Industry, Innovation, and Infrastructure

Of course, responsibility is shared across the board, with the above list indicating the lead sector. The remaining SDG's can be dealt with in education through the synergy that comes from these three sectors' collaboration.

Demand for 21st Century Skills

Although there is no real consensus on which 21st century skills should be taught at school, there is a wide agreement that those should be more than mere “school subjects.” They must be understood as real “transversal competences” for solving complex problems and living together in a hyperconnected world (OECD, 2017).

Communication, creativity and collaboration are among the most well-accepted characteristics of the future digital citizen. When comparing the skills that the World Economic Forum defended in 2016 as essential in our modern world and the skills that The Catalan College of Economists proposed for empowering the next generations of workers, we find several correlations, as shown in Table 1:

Table 1. Comparison among skills defended by The World Economic Forum and The Catalan College of Economists, as competences in demand (2016–2017). Comparison by the authors

| World Economic Forum 2016 | Col·legi d'Economistes de Catalunya 2017 |
|------------------------------|---|
| Complex problem-solving | Creativity |
| Critical thinking | Complex problem-solving |
| Creativity | Decision-making |
| Human Resources management | Human Resources management |
| Coordination & Networking | Emotional intelligence |
| Emotional intelligence | Cognitive flexibility |
| Decision-making | Service orientation |

This double list includes skills connected to high level thinking processes (such as critical thinking and decision making), emotional and social growth (emotional intelligence and networking), and strategic behaviour (human resources management). These are skills in demand both for

lifelong learning and labour markets, and they are part of the transversal personal and professional abilities that the new generations should have in their curricula. Often, this demand is not met through official adult education courses, and it can produce disaffection for lifelong learning and low demand for traditional adult education.

In Catalonia, public adult education schools offer formal, certified studies. This includes basic literacies, levels of primary and secondary studies for young adults who didn't succeed in regular schools, and courses for immigrants who did not complete studies in their home countries. Adult education institutions also offer studies for students to prepare the secondary education certificate, and the access exam for vocational education. There is, however, no clear offer of transversal studies where adult learners can develop global skills, learn how to organise personal networking, or practice decision making. The authors of this article have reviewed the official data for adult education in Catalonia, and compared the specific demand for instructional education, cross curricular learning, and global skills for lifelong learning. Data for adult education in Catalonia is public and available on the Statistics web of the Department of Education, for courses from 1998 to 2018 (Departament d'Educació, 2019). The result is clear: the current general formal education offer is far from

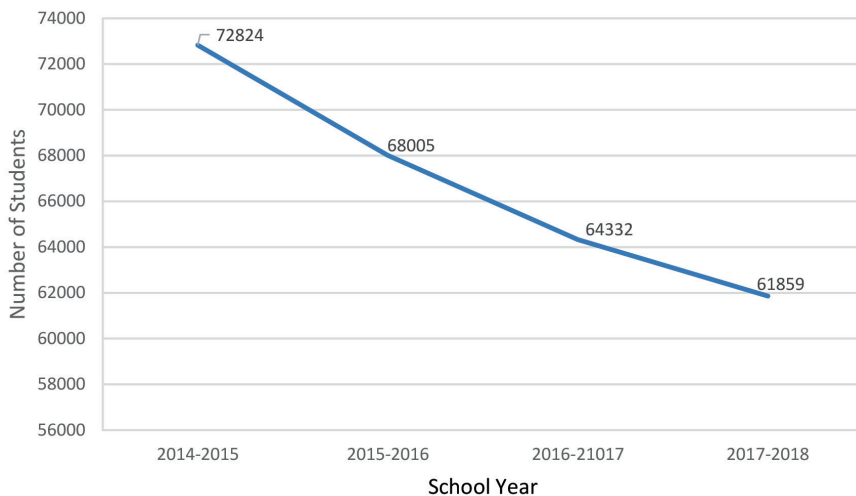


Figure 1. Students in adult education, in Catalonia. Source: Departament d'Ensenyament. Subdirecció General d'Organització, Coneixement i Sistemes d'Informació. School Year 2017–2018 (publicly available data)

<http://ensenyament.gencat.cat/ca/departament/estadistiques/estadistiques-ensenyament/cursos-anteriors/curs-2017-2018/formacio-persones-adultes/>

including the most demanded competences for the new labour markets. This is not limited to adult education; universities are also trying to adapt to changing needs by collaborating with private enterprises (Gallon & Lorenzo, 2014, p. 132).

In the school year 2017–2018, the overall global demand for adult education in Catalonia came from a total of 61.859 student (37% from immigrant students and 63% from local students). This represents a clear decrease from 2016–2017 (64.332 students), 2015–2016 (68.005 students) and 2014–2015 (72.824 students). Figure 1 shows a clear decline of interest in official studies for adult education in Catalonia.

In 2017–2018, the demand for general studies and access to compulsory education was only 27% of the total request. This includes official training

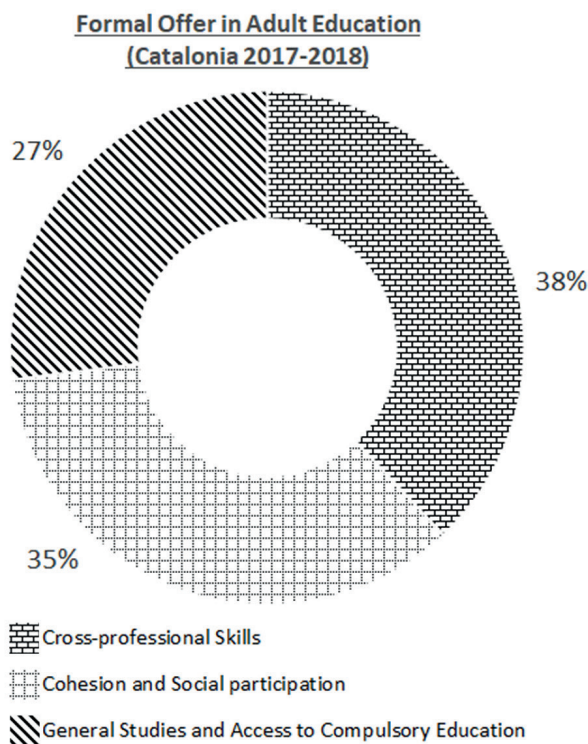


Figure 2. Demand for cross-professional and social skills by young adults in Catalonia. Source: Departament d'Ensenyament. Subdirecció General d'Organització, Coneixement i Sistemes d'Informació. School Year 2017–2018 (publicly available data)

<http://ensenyament.gencat.cat/ca/departament/estadistiques/estadistiques-ensenyament/cursos-anteriors/curs-2017-2018/formacio-persones-adultes/>

for access to different vocational education studies and levels, together with preparation for the selective exams required to access other official studies. At the same time, 65% of the total demand was for more transversal studies such as cross-professional and communicative strategies. As Figure 1 shows, 38% included foreign languages and digital competences, and 35% were studies related to cohesion and social participation skills, including local language (Catalan), instrumental language (Spanish), and instrumental learning (competences at primary education level). These ratios show how strategic studies in communication, interaction, networking, global international communication, and social participation skills seem more attractive to young adults, and represent two thirds of the total demand (Figure 2).

Figure 3 breaks the demand down by segment. It clearly shows that the combined interest in transversal and social studies for lifelong learning far outstrips the demand for traditional instructional learning and access to university studies.

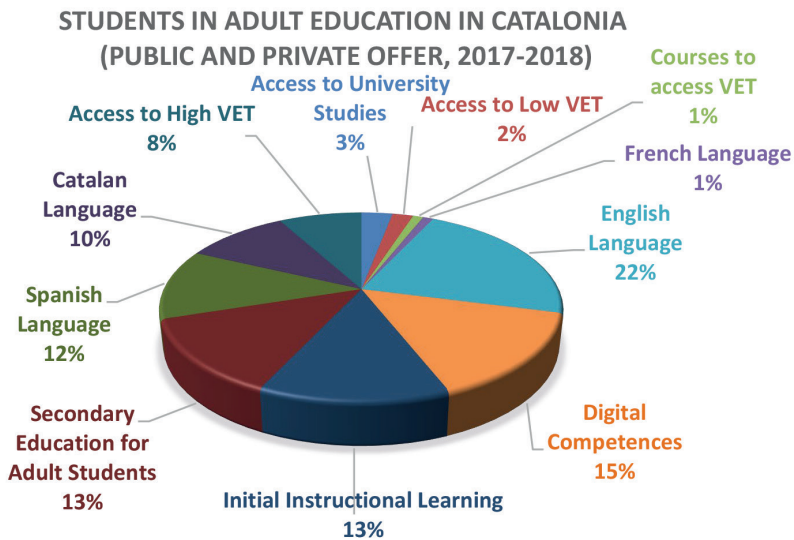


Figure 3. Demand for studies in adult education in Catalonia (segmented). Source: Departament d’Ensenyament. Subdirecció General d’Organització, Coneixement i Sistemes d’Informació. School Year 2017–2018 (publicly available data). <http://ensenyament.gencat.cat/ca/departament/estadistiques/estadistiques-ensenyament/cursos-anteriors/curs-2017-2018/formacio-persones-adultes/>

In response to this demand, the Department of Education in Catalonia is exploring different strategies to present alternative content with digital methodologies. In the 2018–2019 school year, the department started a series of case studies, collaborating with government agencies and private industry, to motivate students, favour engagement, and develop lifelong learning skills. They included workshops for vulnerable students using virtual reality (VR) and gamified activities.

These activities were organised by the educational service devoted to kids with social needs, in vulnerable situations, and at risk of marginalisation.

Case Study

Activity: Workshop based on an adventure in a 3D videogame. The mission of the participants is to recuperate a technological artefact that has fallen on the surface of the planet Mars. To accomplish this, teams must take into account the hostile atmosphere, questions of survival, management of technology, and their dependency on one another in this environment. They must organise itineraries, solve problems, and take collective decisions about tasks related to basic skills and literacies (e.g. plurilingual communication, maths, map-reading, collaborative problem-solving).

Participants: Students at risk of exclusion (one group of 16–18-year-olds, at low secondary level at a state school, and one group of 18–23-year-olds, in a state penitentiary school).

Languages of research: Catalan and English.

Place: A public secondary school, and a penitentiary school in Barcelona (Catalonia, Spain),

Coordinating Institution: Subdirecció general de Transformació Educativa, Direcció General d'Innovació, Recerca i Cultura Digital. (Catalan Department of Education).

Provider enterprises: NetLanguages (experts in foreign language teaching), Humantiks (experts in Serious Games), and International House (expert organization in language teacher training and professional development).

Other partners: Schools, Department of Justice (Catalonia).

Overview: This experience represents a tripartite partnership, where responsibility between schools and institutional administration is also shared with private enterprises, as outlined in SDG 17 of the 2030 Agenda.

Teaching and Learning techniques: Collaborative work, task-oriented approach, problem-solving adventure, gamified routines in a 3D virtual reality.

Hypothesis: The educational adventure, designed as a serious game, can empower gender equity (SDG 5) and it activates the leadership role of girls

in promoting peace and justice within the team (SDG 16). It demonstrates the risk to life on land (SDG 15) and it allows students to explore ways to assure good health and well-being (SDG 3), among other UN-2030 sustainable development goals.

Assessment: Participants and researchers applied qualitative analysis and action-reflection (satisfaction surveys, and interviews with students and teachers), and quantitative gender comparison of interests and skill development consciousness.

Results of Research: Data shows that girls left the initial leadership to boys, but once engaged in the game, girls are willing to accept team-leadership to advise and direct the boys from a distance. Girls were initially reluctant to use the VR glasses, and boys were more adventurous when using them to navigate on Mars. Girls were more creative when exploring possible solutions for specific tasks. When using basic literacies and skills to solve the given tasks, gender seems to have a meaningful impact on different levels and kinds of assertive behaviour. Full collaboration is better accepted in mixed gender teams than in mono-gender teams. Teachers detected different patterns of self-regulation during the 3D-game than in ordinary classes. Both boys and girls declared that they were aware of how important it is for them to learn new digital technologies as preparation for future jobs. Both boys and girls were equally sensitive to issues of climate change and social inclusion, during and after the game.

This type of activity provides multiple paths for exploring and implementing the UN-2030 SDG's in an educational context. It can also offer excellent opportunities for research. It helps teachers and institutions detect adolescents' interest in learning about technology, it promotes digital professional development among educators, it generates initial analysis of gender preferences and attitudinal tendencies during collective debates, and it favours action-oriented team mediation among young citizens. These and other 21st century skills are widely demanded in the labour market, and they are necessary in adult schools, and very well considered by the students themselves.

More experiences should be developed in different educational ecosystems, and more studies of digital psycho-pedagogy and educational technology are necessary to develop a proper knowledge base of the state-of-the-art in smart pedagogy, related to readiness and acceptance of VR, and other emerging digital technologies at school, among teachers, families, and students (Lorenzo & Gallon, 2019) (Borawska-Kalbarczyk, Tołwińska, & Korzeniecka-Bondar, 2019)

Theoretical Correlations

The study of the theoretical correlations between different cognitive paradigms can help develop a framework for smart pedagogy and digital transformation. The most common pyramid of cognitive processes (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956) is widely used in education to explain high level thinking processes, to plan activities, and analyse educational proposals, in six levels of complexity (knowledge, comprehension, application, analysis, synthesis, evaluation). The revision of these levels, almost half a century later, presented a more dynamic approach, transforming nouns to verbs and changing the tip of the pyramid: remember, understand, apply, analyse, evaluate, create (Anderson, et al., 2001).

Comparing those two cognitive continua with more a modern pyramid of gamification, the highest concepts in the pyramid show similar levels of complexity (Werbach & Hunter, 2012). The alignment between these learning levels can create an interesting analytical paradigm for educators, that provides reflection space for academia: a first level of explicit components (objects, ideas, elements), a second level of mechanics (relationships, dependences and organic relevance) and a third level of dynamics (social transformation, integral changes and ethical evolution). These three levels correlate with explicit, implicit and meta-cognitive information, and can be used to describe assessment levels and evaluation challenges.

Assessing and classifying personal experience and decision making using serious games (Csikszentmihalyi, 1990) already provides a potentially useful way to develop social behaviour studies in virtual spaces. New sequences of activities and new pedagogical ideas can emerge when exploring teaching and learning hierarchies in correlation with ethical behaviour and well-being in the digital world (Marope, Griffin, & Gallagher, 2017). Marope's UNESCO team has developed a well-adapted representation of the information continuum in education, that can be integrated into real life when learning about the world:

1. Remember Data
2. Understand Technology
3. Apply knowledge
4. Analyse skills
5. Evaluate values
6. Create attitudes.

A transversal overview these different learning taxonomies can offer interesting correlations, as shown in Figure 4.

A complete chart would integrate artificial intelligence by adding the micro level of machine learning, and the meso level of smart technologies

to explain, apply, and transform future technology development in education. Table 2 presents the authors' proposed basic framework for developing a smart pedagogy of digital transformation, following the three domains of social cognitive development: explicit information, implicit knowledge, and abstract meta-reflection (Lorenzo Galés & Gallon, 2018, p. 26).

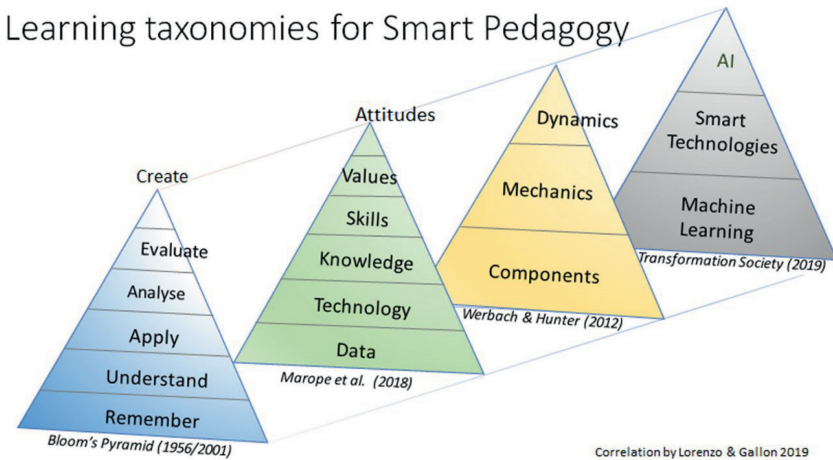


Figure 4. Correlation between cognitive taxonomies and learning theories

Table 2. Proposals for a smart pedagogy framework – correlation between teaching and learning goals for transforming education. Source: the authors

| Smart Pedagogy for Digital Transformation | Students' Cognitive Processes | Teaching and Learning Paradigms | Ethical challenges |
|--|-------------------------------|---------------------------------|---|
| Level 3: To evaluate and encourage the transfer of sustainable transforming practices | Create | Creating attitudes | Monitoring AI Dynamics (promoting Ethics) |
| | Evaluate | Evaluating values | |
| Level 2: To facilitate processes and develop networks for building transformational education | Analyse | Analysing results | Appropriate mechanics of Smart Technology (personalising teaching and learning processes) |
| | Apply | Applying technology | |
| Level 1: To identify digital learning goals for transforming educational ecosystems | Understand | Understanding information | Exploring the components of Machine Learning (avoiding bias, spotting defective algorithms) |
| | Remember | Remembering data | |

Future Challenges

We should want to have AI behave at our best, not copy our worst.

Martin Ciupa

Throwing technology at educational processes will not give us a pedagogy that can claim to be “smart.” If we aren’t capable of coupling higher level thinking, serious analysis, and value-oriented actions to it, we’ll just have proliferation of means without meaning.

The technologies that define the fourth industrial revolution, especially artificial intelligence, are so powerful that their deployment at great scale automatically implies equally great social and economic changes. As educators, we have a responsibility to help our students understand the role of these technologies, how they fit into a changing world, and their use for achieving the greater good.

This means that to identify truly transformative digital learning goals, we must be ready to face questions of cognitive bias in AI algorithms. For example, how should we intervene on an unjust algorithm? If it used statistical analysis to decide who would be a successful coder, an AI agent would most likely never pick a woman, because of the gender biases that exist today. This would not be a desired outcome for SDG 5’s aim of gender equality. Can we develop both algorithms and human methodologies for detection and verification of fake news? The processes inside deep learning algorithms are invisible, even for the programmers who created them. Can we instruct an algorithm to reveal its processes, so that we can maintain traceability, and through it, accountability?

Our facilitating processes must help us to personalise teaching and learning without isolating students in a solitary digital bubble. If an algorithm is constantly encouraging a student to work on problem areas, might it not miss an opportunity to facilitate the student’s work in areas of strength and ability? We human educators must ensure that over-automation does not lead to systemic damage, simply because no one questioned the decisions of an AI agent.

One of our greatest challenges, then, will be to offer students the wealth of potential empowerment that AI represents, and at the same time help them develop the critical thinking that will allow them to remain vigilant on questions of human-machine collaboration, the balance between personalisation and community needs and values, or responsibility issues.

Above all, it is important that the use of these technologies, in education as in other aspects of professional and personal life, be imbued with a humanistic, ethical purpose, connected to notions of sustainable development at individual and collective levels.

A smart pedagogy for the digital age is one with head in the sky, and feet on the ground. It's a pedagogy that helps students acquire the skills they need to thrive in 21st century society, regardless of what professions or interests they pursue. And it's a pedagogy that adapts to new relationships between humans and machines in a way that reminds us of our own best qualities, and encourages us to realise our greatest human potentials.

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