ALLIES

Digital Training Tools in Steel Structure Integrity

PR2: NEW METHODOLOGIES FOR TEACHING USING DIGITAL TOOLS

Project coordinator:

Co-funded by the European Union

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein. Project: 2021-1-RO01-KA220-HED-000032181

Revision	Date	Author/Organisation	Description
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3rd	-	-	-

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1. General tools used in Blended Learning methodologies

1.1. Definition of Blended Learning

Before starting to discuss the tools used in Blended Learning (BL) methodologies, it is important to know what we are referring to when we mention this methodology. It has been defined in different ways with the passage of time and educational evolution, as well as it has had several denominations (Salinas et al., 2018).

As Bartolomé (2004) states "the simplest and also the most precise definition describes it as that way of learning that combines face-to-face teaching with non-face-to-face technology" (p. 11), that is, the union of education from its traditional conception and online or virtual education. This methodology provides the possibility of rotation and flexibility (Salinas et. al, 2018), making it possible for training to be adjusted to the needs of the student body.

It is worth noting that the COVID-19 pandemic contributed to the implementation of this methodology globally, making visible the opportunities and possibilities it offers, along with other online teaching proposals (Dhawan, 2020). As we can find in Kumar et al. (2021), during the pandemic, the use of BL meant: "improved student performance, increased student interest, higher level cognitive processing, increased focus towards individual student requirements and meeting the demands of current times" (p.85190).

The circumstances surrounding COVID-19 gave rise to the development, forced in a certain way, of a new educational landscape more closely linked to online media which, although already applied in certain training spaces - especially non-formal ones - has taken on greater consistency due to this exceptional situation (Pereira et al. 2021).

Since then, in recent years, it has been seen that this methodology allows "improving learning standards, increasing passing rates of examinations, adding time flexibility, and removing distance barriers" (Kumar et al. 2021, p. 85151).

1.2. General tools used

The Blended Learning methodology is based on several tools that make its implementation possible. Firstly, a blended learning methodology requires a learning management platform (LMS - Learning Management System), which makes it possible to share content and monitor student progress. In addition, authoring tools are necessary, in other words, those that enable the creation of content and activities; collaboration tools, where students can work in groups on the same document; and communication tools, to be able to contact students, hold meetings, tutorials, resolve doubts...

Below, we are going to take a closer look at each of the 4 axes that constitute Blended Learning:

- LMS Platform

These Learning Management Systems (LMS) consist on software in which learning content is added and organised in order to promote an education that relies on new technologies and the digital environment for the monitoring and transmission of knowledge. On these platforms,

content can be added in a variety of formats, as well as activities and assessments (Bit4Learn, 2023).

In general terms, we could say that, in general terms, an LMS platform allows:

- Content management and distribution
- Extraction of data from the educational process

Among the benefits of using LMS, we find: (1) cost reduction; (2) management efficiency; (3) accessibility to information; (4) personalisation; (5) immediacy; (6) data collection (reports); (7) multimedia content; and (8) improved communication (CAE, n.d.). In addition, they point out as an advantage, in some cases, the possibility of commercialising the content generated.

Some of the most widely used LMS platforms are:

LMS PLATFORMS	Blackboard Learn	Saba LMS
	Moodle	Grovo
	Canvas	360Learning
	Smiledu	Lessonly
	Neo LMS	Schoology
	ATutor	Edmodo
	Plataforma Q10	Schoox
	Litmos	eFront
	TalentLMS	Adobe Learning Manager

❖ Authoring tools

Authoring tools are understood to be those used to create the training content to be shared with learners. These tools can have different characteristics, as resources can be created in several formats. In the next section, we will see some tools for the creation of different types of content.

❖ Collaboration tools

Collaborative tools are those technologies and platforms used to enhance communication, interaction and collaboration between students and teachers in blended learning environments. The use of these tools is essential to encourage active participation by enabling direct and instant communication regardless of the geographical location of the interlocutors.

In addition to this, they allow teamwork among students, being a space where they can share ideas, resolve doubts, collaborate in the development of activities, among others.

Collaboration tools	Google Classroom	NextCloud
	Microsoft Teams	Monday
	Slack	TickTick
	Trello	MindMeister
	Google Docs	BinFire
	Basecamp	Asana
	GitHub	Mural
	Dropbox	

Among the most widely used collaborative tools are:

Tools for the creation of presentations, infographics and graphic content. There are some that are more basic and intuitive and others that are more complex for those trainers with more creative and design knowledge:	Canva Genially Tableau Articulate Adobe Photoshop Adobe Ilustrator Piktochart Gimp
Tools for audio editing and podcast creation. As with the visual design aspect, these programmes can be very simple or professional in use:	Audacity Adobe Audition Onceaudio GarageBand Reaper
Tools for creating and editing videos and animations:	InVision Filmora Adobe Premiere Pro Adober Premiere Rush Avidemux VideoPad DaVinci Resolve BeeCut
Tools for the creation of interactive content (game format):	Educandy Hot Potatoes WordWall Educaplay H5P Cerebrity Interacty JClic
Other tools to obtain resources or generate other types of content:	DaFont MyFonts Flaticon Exe Learning Courese Lab Coggle Easy Generator

- Communication tools

These tools are used to interact and exchange information between students and teachers both synchronously and asynchronously, thus promoting virtual communication.

There are different ways of communication, each one of them with its own characteristics and functionalities:

Communication tools	E-mail Discussion forums Online chat Videoconference Online comments Educational social networking

2. Microlearning tools used in Blended Learning

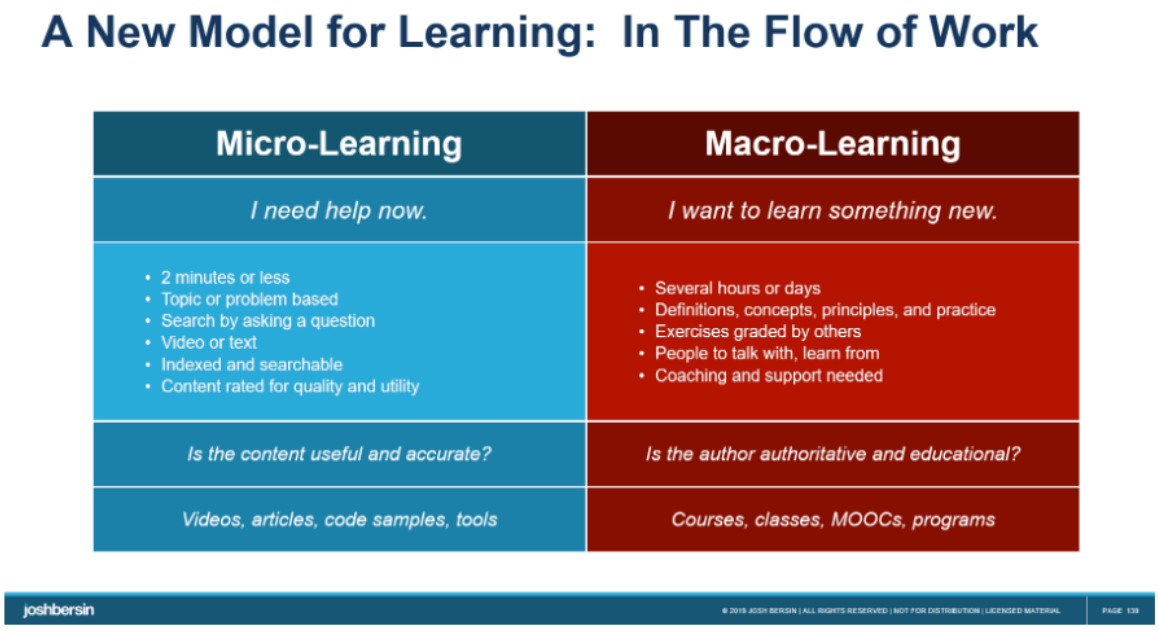
2.1. Definition of microlearning

When we refer to microlearning, we are alluding to learning based on pills of short training content, interconnected and whose activities have a short duration (Trabaldo et al. 2017). These can be presented in different formats, such as videos, infographics, text documents, podcasts... And, in addition, it has the characteristic of being accessible at the time and place of one's choice.

Microlearning arises to adapt to current training needs where the pace of life has led to a paradigm shift, also in the field of education, "learning in the digital age is increasingly associated with mobility and ubiquity, and takes place in contexts where the line dividing formal and informal learning is increasingly blurred" (Trabaldo et al. 2017, p.1). Among the benefits of microlearning are (IEU, January 14, 2021):

- Greater brevity and condensation of content, making training accessible to people who have less time for it. In turn, a reduction in training time also results in lower training costs.
- Flexibility both in terms of access (where and when the student wants/can) and in terms of form (greater adaptability to different formats).
- Efficiency. There is less dispersion of content and unnecessary information. It is much more to the point.

In this way, content can be kept up to date, be based on the most popular technologies and media, and be better adapted to society and its characteristics.



Reference: Josh Bersin (January 26, 2020).

2.2. Microlearning tools in Blended Learning

There are many tools based on the essence of microlearning, i.e. brevity and forcefulness in content and form. It is worth mentioning that within the different Blended Learning channels, microlearning contents can be shared, among them the following stand out:

Microlearning tools used in Blended Learning	Educational podcasts Short texts (articles, blogs...) Microvideos Interactive flashcards Infographics Interactive presentations Simulations Mini-games or gamified contents Visual schemes/concept maps Micro-assessments Gifs Wikis

3. Specific Digital Learning Tools used in STEM disciplines

3.1. A brief clarification of STEM

STEM or STEAM education is based on interdisciplinary learning that brings together four - or five - broad areas of knowledge: Science, Technology, Engineering and Mathematics; Arts was later included, hence four (STEM) or five (STEAM) areas can be mentioned. What makes this methodology interesting, therefore, is that, as Peykova and Garvo (2021) point out, "STEM education removes the traditional barriers between the four disciplines by integrating the four subjects into one" (p.21), and not only that, but it also makes use of an educational perspective where practical and project-based work, whether individual or collaborative, predominates.

The practical application of knowledge, learning by doing, shows multiple benefits in learning, among them: the development of skills and activities through problem solving; favours autonomy and self-learning; promotes teamwork and communication among peers; and stimulates creativity (Robotix, July 21, 2021). Promoting education and interest in STEM disciplines is key to develop a more advanced society, able to meet the challenges and seize the opportunities of the modern world.

3.2. Digital Learning tools in STEM

It should be noted that "the inclusion of digital tools in education process (either by teachers or by students themselves) can contribute in increasing students' motivation for the different aspects of the teaching and learning processes" (Peykova & Garvo, 2021, p.22). And not only that, as

> At the same time, we also consider that new approaches based on STEM education, made from this idea of practices, can have an impact on the development of computational thinking in children, given the prominence that this form of problem solving undoubtedly has in the activity carried out by science, engineering and mathematics (Ibid., pp.3-4).

While digital tools and STEM disciplines have a greater incision at earlier ages of cognitive development, there are also tools and approaches for students in higher education or vocational training. For younger students, there are a multitude of specific digital tools based on STEM disciplines: Microsoft MakeCode, Scratch, Lego Learning System, Elementari, Birdbrain Technologies, Minecraft Education... In addition, general tools mentioned above are also used: LMS platforms, databases or collaborative tools.

One of the main applications of digital tools in STEM is simulation and modelling. Students can use specialised software to create virtual models of physical, chemical or biological phenomena. This allows them to explore hypothetical scenarios, conduct virtual experiments and better understand fundamental concepts. These tools give them hands-on experience without time or resource constraints, enriching their understanding of scientific principles.

Data analysis and programming tools also play a key role in STEM higher education. Students can use programming languages such as Python, R or MATLAB to analyse and visualise data, solve complex mathematical problems and develop algorithms. These skills are crucial in fields such as artificial intelligence, machine learning and data science. In addition, data analytics tools

allow them to explore large data sets and extract meaningful information to make informed decisions.

Collaboration and communication are essential components of STEM education at higher education level, and digital tools facilitate interaction between students and teachers. Online learning platforms, such as Moodle or Canvas, allow students to access educational materials, participate in discussion forums and submit assignments. In addition, online collaboration tools, such as Google Drive or Microsoft OneDrive, allow students to work in teams, share documents and make collaborative edits in real time.

Another important aspect of the use of digital tools in STEM higher education is access to academic databases and digital libraries. These sources provide students with access to a wide range of scientific articles, books and academic resources that support their research and study. With just a few clicks, students can find up-to-date and reliable information to delve deeper into specific topics and keep abreast of the latest developments in their fields of study.

In short, the use of digital tools in STEM higher education has revolutionised the way students acquire knowledge and skills in these disciplines. From simulations and modelling to data analysis, programming and online collaboration, these tools provide an enriched learning experience, enhancing understanding, technical skills and the ability to tackle complex challenges. By leveraging these digital tools, higher education students can more effectively prepare themselves to meet the requirements of the technological age in which we live. Following, we will find some specific tools used in the different disciplines that make up STEM education for learning and creating.

Simulation and modeling	ANSYS MATLAB COMSOL AutoCad SolidWorks Mathematica
Programming	GitHub GitLab Visual Studio Code
Calculation	Wolfram Alpha MathCAD Maple
Virtual Labs	Labster Virtual Chemistry Lab TeachEngineering
Chemistry	ChemDraw Avogradro Spartan
Physics	Tracker PASCO Capstone LabVIEW
Biology	NCBI Geneious BLAST

Virtual and augmented Reality	Unity Unreal Engine Merge Cube
Machine Learning	TensorFlow Scikit-learn Keras

4. Specific Digital Learning tools used in the field of steel structures

4.1. Specific tools in steel structures

Using digital tools in the teaching of steel structures offers significant benefits for students. These tools provide an enriched learning experience and facilitate the understanding of key concepts, while promoting the development of technical and professional skills.

Steel structures training	Soldamatic (Welding Simulator | SOLDAMATIC | Seabery (seaberyat.com)) Miller Augmented Arc (AugmentedArc® Augmented Reality Welding System | MillerWelds) Realweld (REALWELD Trainers | Lincoln Electric) Guideweld (guideWELD® LIVE real welding guidance system - Realityworks)
Steel structures design	BIM Steel Structures Inc. (https://www.bimsteelstructures.com/) Tekla Structures (https://www.tekla.com/products/tekla-structures) Consteel (https://consteelsoftware.com/) StruCad (http://www.steeltechgroup.com/strucad.html)) AXISVM (https://axisvm.eu/)
Building energy modeling	BEM software (https://www.energy.gov/eere/buildings/building-energy-modeling)
Structural analysis	Structural Engineering Software for Steel Structures (Free Structural Analysis Software for Educational Institutions | Dlubal Software) REVIT software (Structural Analytical Model Automation - AEC Tech Drop (autodesk.com))
Graphical design	Rhino (https://www.rhino3d.com/)
Heat transfer simulation	COMSOL (https://www.comsol.com/)
3D scanning of steel structures	Knowledge center https://lechnerkozpont.hu/en
Non-destructive testing simulation	CIVA (https://www.extende.com/civa-in-a-few-words)

References

Bartolomé, A. (2004). Blended Learning. Conceptos Básicos. *Pixel-Bit. Revista de Medios y Educación, 23*, pp.7-20.

Bersin, J. (January 26, 2020). The Disruption of Digital Learning: Ten Things We have learned. *JOSH BERSIN*. https://joshbersin.com/2017/03/the-disruption-of-digital-learning-ten-things-we-have-learned/

Bit4learn (2023). ¿Que es un LMS? : tipos, marcas comerciales y opensource. *Bit4learn*. https://bit4learn.com/es/lms/

CAE (Computer Aided E-learning) (n.d.). 9 Ventajas de las plataformas educativas o LMS. *CAE: Computer Aided E-learning*. https://www.cae.net/es/plataformas-educativas-o-lms-ventajas/

Dhawan, S. (2020). Online Learning: A Panacea in the Time of COVID-19 Crisis. *Journal of Educational Technology Systems, 49* (1), pp.5-22. DOI:10.1177/0047239520934018

IEU (January 14, 2021). Microlearning: estrategia educativa para el 2021. *Universidad IEU.* https://ieu.edu.mx/blog/camino-universitario/microlearning-estrategia-educativa-para-el-2021/

Kumar, A., Krishnamurthi, R., Bhatia, S., Kaushik, K., Ahuja N. J., Nayyar, A. & Masud, M. (2021). Blended Learning Tools and Practices: A Comprehensive Analysis. *IEEE Access*, 9, pp. 85151-85197.

López, V., Couso, D., Simarro, C. (2019). Educación STEM en y para un mundo digital: el papel de las herramientas digitales en el desempeño de prácticas científicas, ingenieriles y matemáticas. *RED. Revista de Educación a Distancia, 62.* DOI: http://dx.doi.org/10.6018/red.410011

Pereira, M.O., Peixoto, L., Vilaça, T., Gomes, F. & Teixeira, P. (2021, July 7). Exploring blended learning tools to transform a laboratory course unit in engineering: challenges, setbacks and rewards. *Active Learning in Engineering Education Workshop; International Conference on Active Learning in Engineering Education. (PAEE/ALE'2021)*, Braga - Portugal. DOI: https://doi.org/10.5281/zenodo.5098351

Peykova, D.Y. & Garvo, K. (2021). Digital Tools For Stem Education. *Anniversary International Scientific Conference Research And Education In Mathematics, Informatics And Their Applications, Remia'2021.*

Robotix (July 21, 2021). Las 8 razones para introducir el aprendizaje práctico. *ROBOTIX blog*. https://www.robotix.es/blog/8-razones-introducir-aprendizaje-practico/

Salinas Ibáñez, J., de Benito Crosetti, B., Pérez García, A. & Gisbert Cervera, M. (2018). Blended learning, más allá de la clase presencial. *RIED. Revista Iberoamericana de Educación a Distancia*, 21 (1), pp.195-213.

Trabaldo, S., Mendizábal, V. & González Rozada, M. (2017). Microlearning: experiencias reales de aprendizaje personalizado, rápido y ubicuo. *IV Jornadas de TIC e Innovación en el Aula* (La Plata, 2017).