TECHNOLOGY-ENHANCED TEAM-BASED LEARNING

TEAM-BASED LEARNING - DALLA VERSIONE ANALOGICA A QUELLA DIGITALE

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ABSTRACT
The paper presents an experimentation of technology-enhanced TBL carried out at the University of Foggia, a.y. 2023-24. This contribution outlines the educational implications of digital TBL and discusses how digital tools have been implemented in the learning environment. The design of instruction implied a partial rethinking of TBL methodology; this included the implementation of self-reflective questions, assessment rubrics and e-portfolio for formative and summative assessment.

Il contributo presenta una sperimentazione di Team-Based Learning (TBL) arricchita dalle tecnologie condotta presso l'Università di Foggia nell'anno accademico 2023-24. Sono delineate le implicazioni educative del TBL digitale e come gli strumenti digitali sono stati implementati nell'ambiente di apprendimento, portando ad un parziale ripensamento della metodologia TBL con l'introduzione di domande auto-riflessive, rubriche di valutazione ed e-portfolio per la valutazione formativa e sommativa.

KEYWORDS
TBL, digitalization, formative assessment, collaborative learning
TBL, digitalizzazione, valutazione formativa, apprendimento collaborativo

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1. Introduction

In 1979 Larry Michaelsen, professor of management at University of Oklahoma's Business School, invented the Team Based Learning (TBL), a new innovative active and interactive learning methodology aimed to solve the problem of teaching in an efficient way to large classes. In fact the development of TBL was linked to the increment of Michaelsen's course from 40 to 120 students in those years (Michaelsen et al., 1982; Michaelsen et al., 2023).

When TBL was developed, the late 70s, the common learning environment was almost entirely based on analogue media. The learning environment was purely physical and almost no electronic devices used to be present in the classroom, except in some specific programs or experiments. The unique electronic device that had entered the classroom was the hand calculator (Reynolds, 1970). At the time the history of computer adoption in education was at its early stage but just the 70s and 80s can be considered the turning point in the research and development of educational technologies. In fact, although the learning environment was totally analogue, just in those years academic and industrial researchers were laying the foundation for the subsequent development of technologies and digital revolution.

In a broader perspective, we could identify some milestones of innovative educational technologies even before. The first step can be considered the invention of the Learning machine of Sidney Pressey, called "Automatic Teacher". This was the first machine developed in mid 1920 at Ohio State University and it was a multiple choice device. That machine was focused on the multiple choice test, the same element of I-Rat and T-Rat in the TBL. The most famous learning machine was the learning machine of the behavioural psychologist Burrhus Skinner in 1954, similar to the Pressey's one but more focused on reinforcement. These machines were the first electronic devices centered around some of the crucial elements of the TBL: the Socratic method or "vanishing" (Fry, 1960). The development of modern educational technology is linked to these learning machines and with the idea that a machine can help and enhance learning in school and university and stimulate the active participation of students.

Coming back to Michaelsen's age, in the 70s the development of the modern personal computer was still in its infancy. Researchers, on the Skinnerian path, were studying information technology as a model for learning, and in the USA the very important technologies were being tested. Among these, we can cite the most relevant for the future digital revolution. The Arpanet network (the first step toward the internet) was founded in 1958 and in the 70s it was tested in some universities. In addition the University of Illinois was developing the Plato (Programmed Logic for Automatic Teaching Operations) project, the first modern computer based e-learning platform (Cope & Kalantzis,2023). Only three years after the TBL invention, in 1982 IBM introduced the first personal computer for all to be used «on your desk, in your home or in child's schoolroom» (Menichetti, 2017, p.

129) but only in the 90s the computer started to be used widely in school and university classrooms (Firmin & Genesi, 2013).
Despite this ferment in the educational technologies research, the original TBL was entirely based on analogue media because the common student's life was analogue. In the analogue era all learning tools were paper based and the book was usually considered the only valid medium to archive deep learning. Students used as learning technologies only ballpoint pens and paper notebooks, where they took notes, in addition to the print books to be studied at home. In original Michaelsen's all TBL units phases - Preclass study, I-Rat, T-Rat, appeal, T-App and mini lecture – were based on concrete tools (McCarter, 2022). For the Preclass study and home study, as in all forms of the flipped classroom, the tools used were the most common: paper handouts, printed articles and books. The multiple choice tests of I-Rat and T-Rat were printed on a paper sheet, physically distributed among students and filled out with pens. Another option for the T-App compilation were the big paper voting cards to be raised simultaneously by the teams for the peer assessment. In addition, to represent topics by graphics, push pins were used for labelling and identification of activities. For instance, push pins were very useful to identify a precise place or a city in a geographic map or to label a part of the body. In the T-app the artefacts were handwritten on paper or designed-created with physical materials. Therefore, the final gallery walk was full of posters, papers and concrete creations. The gallery walk constituted itself an analogue learning experience.
Nowadays, the analogue traditional TBL units elements can be replaced by a digital version that makes use of digital tools. Indeed, today in a post-pc era the students and teachers live in an on-life dimension (Floridi, 2015) and the TBL can be held in a total digital form with a BYOD (Bring Your Own Device) approach. In this way, paper can be replaced by digital tools such as laptops, post-pc devices such as tablets/smartphones, and collaborative Virtual Learning Environment (VLE). All digital devices and apps used in the digital world like Google apps and Moodle are easy to use because most of them are part of the daily life of the students (Brown & Hocutt,2015). Furthermore, the use of digital tools can increase the digital competence as well as provide disciplinary knowledge (Nagarajan, 2020). The switch to digital media usually has cognitive, social, emotive effects besides the learning ones. These digital tools, if used in a methodologically correct way, could enhance speed, collaboration, flexibility, inclusiveness, effectiveness and motivation (Jones & Issroff, 2005). The novelty is the extension of the physical classroom and the constitution of a new third space of the didactics where students can extend their learning process in new ways (Rossi, 2019). This third space, if properly integrated in the physical space can be an opportunity to enhance learning and develop new competencies. Moreover, the digital version of TBL can also provide learning analytics and stimulate research in education.

The present study intends to analyse the educational implications and challenges arising from the design and implementation of five fully digitalized TBL units, carried out in the Docimology course held at University of Foggia during the 2023-2024 a.y.

2. Methods

Drawing from the established frameworks of ADDIE (Analysis, Design, Development, Implementation, Evaluation) and SAMR (Substitution, Augmentation, Modification, Redefinition), a series of five digitalized TBL units were designed and implemented (Michaelsen & Sweet, 2008; Puentedura, 2013). The ADDIE model provides a systematic approach to instructional design, ensuring the alignment of learning objectives, instructional strategies, and assessment practices (Branch, 2009). By adopting this model, the learning needs were carefully analysed, the learning objectives set, the course syllabus defined, the appropriate learning activities designed, the necessary digital resources developed, and then the digital TBL units were implemented and their effectiveness evaluated. As a complement of the ADDIE framework, the SAMR model guided the transformative integration of technology within the TBL approach. This model encourages educators to move beyond the mere substitution of traditional methods with digital tools, toward the redefinition of learning experiences that leverage the unique affordances of technology (Puentedura, 2013). The SAMR model was strategically adopted and implemented to make TBL experimentation with digital tools practicable (Hamilton et al., 2016). In order to fully understand the implications and effectiveness of the methods and materials used, it is essential to detail the TBL unit elements developed and implemented in the course, on the basis of the traditional TBL unit (See Figure 1).

Figure 1. Digital TBL unit

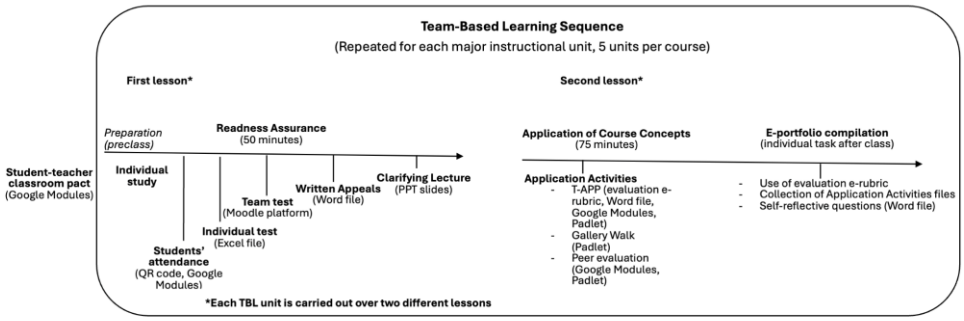

Figure 1. Digital TBL unit (adapted from Michaelsen & Sweet, 2011 p. 42).

3. Results

3.1. Design of the activities.

1. Before the start of the course, a classroom pact between the students and the teacher was undersigned. The classroom pact, a pivotal document, clarified various aspects of the experimentation and defined students' rights and obligations of their commitment in the activities. Students were required to attend classes and participate in TBL activities, with a maximum of two allowed absences, excluding test days.
2. Afterwards, students' groups were formed by instructors based on data collected from an introductory questionnaire, submitted through Google Modules. The questionnaire collected information about gender, age, previous education, studies progression, birth, commuter status, and so on. This allowed instructors to create heterogeneous groups and promote further socialization among participants as well (Frame et al, 2015). Changing group membership was not permitted. Students were required to fully engage in TBL activities, as each one of them contributed to their individual final evaluation. Indeed, students' non attendance in the mandatory TBL activities resulted in a traditional exam.
3. At the beginning of each class, students' attendance was electronically detected through a QR code scan, which redirected them to a Google Module, to be filled out with their name, surname, student ID, and email address.
4. The docimology course consisted of five TBL units, in addition to an introductory lecture.

3.2. Technology–enhanced TBL.

Each TBL unit was carried out over two lessons.
- In the first lesson, students had to answer the I-Rat test, on the basis of the materials assigned to them to be studied at home, as preclass study, following the flipped classroom model (Brame, 2013). The I-Rat was administered as follows: students individually completed a multiple-choice test consisting of 10 questions, on a paper sheet. For each question, students were allowed to express the confidence level of each answer on a scale ranging from 0 to 3, where 0 expressed the lowest level of confidence and 3 the highest one. They had a total of 3 points to assign across the different answer options based on their confidence. For instance, if they were very confident in answer A, they could assign all the 3 points to A. If they were undecided between B and C but favoring C, they could assign 1 point to B and 2 points to C. After completing the test, students took a photograph of the sheet and subsequently, at home, they entered the test answers and corresponding confidence levels into a Google spreadsheet and sent it to the

instructor through Google Modules. The use of Google Sheets instead of Excel was motivated by the fact that not all students had access to the Office package, and this approach allowed for a digital solution accessible to everyone. In the header, the Google Spreadsheet contained a unique keyword (referred to as a "check digit") that served as an identifier for each student. Once the digital sheet was fully completed, a random number was automatically generated in the sheet header. As counterproof, the instructor kept and stored the paper-based answer sheets. This allowed the instructor to cross-check and verify the answers and confidence levels entered by the students in the digital spreadsheets against the physical paper sheets, ensuring the accuracy and integrity of the data.

After having done the I-Rat test individually, students performed in teams the T-Rat test, containing the same questions as of the I-Rat. In the traditional T-Rat, each question's item is presented with an opaque coating covering the possible answer options. Students indicate their response by scratching off the coating on the rectangle corresponding to their chosen answer. If the selected answer is correct, a star symbol is revealed within that rectangle, providing immediate feedback to the student. This immediate reinforcement of correct responses allows the student to progress to the next question (Bangert-Drowns et al., 1991). On the other hand, in case of a wrong answer, the correct one is not immediately revealed, but rather students have to scratch off multiple times to gradually uncover the right solution. The scratch-off format encourages active engagement and can enhance learning outcomes compared to traditional multiple-choice assessments (Haladyna & Rodriguez, 2013). Trying to replicate such a modality in the digital T-Rat format, that allowed immediate feedback in case of correct answer or the possibility to retry in case of wrong answer, has not been so easy to implement. In fact, the most suitable tool at this end was Moodle platform, on which students took the test and had more attempts for each question. This approach aligns with the recommendations for the use of technology in assessment to enhance engagement and feedback processes (Redecker & Johannessen, 2013). Right after the T-Rat completion, the lecturer provided feedback to the students, presenting the correct answers and explaining the rationale behind them (Sadler, 1989). Immediate feedback allowed students to identify gaps in their understanding and assess their individual readiness and performance in relation to their team members (Sibley & Ostafichuk, 2014).

After the instructor feedback on the test answers, students' teams had the possibility to take a written appeal, if they strongly believed that one or more of the answers provided by the lecturer were incorrect, by uploading the appeal Word file on the Moodle platform. Only teams whose written appeal was accepted by the lecturer could obtain an additional point.

At the end of the T-Rat and appeal, a short clarifying lesson was held on the topics studied for the tests. Such lessons allowed the instructor to clarify misconceptions,

reinforce critical concepts, and provide additional explanations based on the students' performance and the arguments they had constructed during the I-Rat and T-Rat (Nicol & Macfarlane-Dick, 2006).

- In the second lesson of the TBL unit, teams worked collaboratively to solve a problem or case study that requires the application of the course content, realizing the T-App. The T-App allows students to apply the knowledge they have gained to a more complex, real-world problem or authentic task (Michaelsen & Sweet, 2008). After having been assigned a problem scenario, students engaged in small-group discussions to collaboratively determine and justify the most suitable solutions. The groups wrote their answers in a Word document, and then the team leader saved it as PDF, shared it with the other team members, and uploaded it on Padlet.
In the digital version, the traditional gallery walk was replaced by an “e-gallery walk" on Padlet, where students could assess and provide feedback on the T-Apps created by their peers. Each group had to mark the most suitable answers to the problem provided by their peers with a star and a motivational comment; and the less suitable one with a motivational comment only. This differentiated feedback approach aimed to reinforce the strengths of the high-performing teams while providing constructive criticism to those in need of improvement (Lipnevich & Smith, 2009). This digitally-mediated approach aligned with the principles of TBL, allowing for collaborative knowledge-sharing and constructive evaluation (Sibley & Ostafichuk, 2014). Furthermore, compared to the traditional one, the e-gallery provided the key advantage of enabling students to visualize and asynchronously access their peers' work also outside of the classroom setting. Lastly, for the T-APP assessment, teams were provided with an evaluation rubric, specifically designed by the lecturer to let them better understand what to assess and how to assess their own and other’s assignments and to promote reflective and self-regulated learning.
In the experimentation, in order to constrain the summative assessment on the students final grade, the TBL activities (I-Rat, T-Rat, T-App) have been assigned 15 points out of 30 with an increasing percentage in respect to the degree of interaction and collaboration required by the task (I-RAT 25%, T-RAT 35%, T-APP 40%), to make students understand the importance given to the collaborative and metacognitive aspect. The remaining 15 points have been assigned to the e-portfolio assignment. The e-portfolio, containing both the recording of achieved results and a dedicated space to the student's biography and documentation of the path taken, assumed a dual value (formative and summative), inviting students’ critical reflection and awareness of what was learned, how it was learned and their own characteristics.

3.3 The e-portfolio.

In order to develop metacognition, understood as self-reflection and self-observation, the three extra elements, in respect to the traditional model, have been designed and implemented in the revised digital TBL unit (see Figure 1): e-portfolio compilation, self-reflection questions, and assessment rubrics. An electronic portfolio (e-portfolio) can be defined as a digitalized collection of student work, reflections, and evidence of learning that is typically housed within a learning management system or dedicated e-portfolio platform (Cheng & Chau, 2013). The use of electronic portfolios, or e-portfolios, has been identified as a valuable tool for promoting deep learning, self-regulated skill development and reflection in higher education contexts (Nguyen & Ikeda, 2015; Dunne & Logue, 2021). Reflection on the learning process allows students to connect learning experiences to broader personal and professional goals, facilitating their understanding of the applicability of acquired knowledge in real contexts, thus promoting a sense of relevance and purpose. As the final step of the course, students were required to individually create an e-portfolio using Google Sites application. The e-portfolio was structured around three distinct sections: "Home", "Who I am", and "My project". In the "Home" section, students were expected to include a brief self-introduction, as well as visual documentation, such as photographs capturing the significant moments and experiences they shared with their team during the TBL units. This section enabled students to reflect on and showcase their collaborative learning journey (Thibodeaux et al., 2019). The "Who I am" section provided an opportunity for students to document aspects of their personal and professional backgrounds, including their career aspirations, passions and notable achievements. This facilitated the development of a holistic learner profile and supported the cultivation of student identity (Wakimoto & Lewis, 2014). Finally, the "My project" section served as a repository for the students' T-APP files and associated self-reflection responses. This section allowed for the systematic organisation and presentation of authentic assessment artefacts, further reinforcing the students' learning and growth throughout the course. Upon completion, students were required to share the link to their e-portfolio with the instructor. This enabled the teacher to access and evaluate the students' e-portfolios as part of the overall course's assessment and feedback process. Furthermore, the e-portfolios included self-reflection questions aimed at encouraging students to reflect on their learning, enhancing their understanding of thinking processes and cognitive strategies, and fostering their responsibility through conscious decisions on how to proceed based on the analysis of strengths and weaknesses identified (Tanner, 2012). The use of self-reflection questions, thus, added an individual and subjective component to the collective reflection dimension proposed by the traditional TBL structure.

Moreover, the assessment rubrics, for both T-App and e-portfolio, were specifically designed to guide students' efforts, produce higher-quality work, consequently achieve better results and reduce performance anxiety towards the task (Andrade & Du 2005). The rubrics helped students develop evaluation and self-evaluation skills both during and after the task. During the task, they provided a description of the different levels of competence, while at the end they allowed students to assess whether the competence requirements had been met in the final product and at what level (Bonaiuti & Dipace, 2021).

4. Discussion

The experimentation has been designed to be carried out in a 1st year university students class. The study design, the materials developed and implemented, in fact, besides the achievement of the course learning objectives set out in the syllabus, aimed at fostering students reflection, self-reflection and Learning to Learn competences of new university students. Reflection and learning are deeply interconnected. Through critical reflection individuals are able to give meaning and create assumptions from the situations they experience, integrating theoretical and practical competencies (Mezirow, 1997; Schön, 1983; Moon, 1999). In the learning process, many times students have to face confusing and unclear situations from which they can construct knowledge and learn, by adopting a reflective approach able to relate specific situations and evaluate them from different perspectives (Biggs, 2012). Therefore, reflection is fundamental for the interpretation and acquisition of academic activities, and it is a way to question and consider underlying assumptions and improve teamwork. However, students can't engage themselves in reflective processes, indeed they need support from educators, who should implement specifically designed learning activities. Reflective learning can take many forms like writing, visuals, orally or performance, but writing is the most used one, including online journaling, diaries, learning portfolios, electronic portfolio (Syzdykova et al., 2021), reflective journaling and reflection essays. Other reflective approaches include group-based or collaborative discussions between peers and supervisors, video-based reflections, and reflective analysis (Veine et al., 2020; Chan & Lee, 2021).

Moreover, due to the accelerated changes, technological advances and global challenges of today's world, the 21st century education is characterized by Lifelong Learning (LL), an approach that promotes the constant search for knowledge, skills and competencies by individuals throughout their own life. LL includes three dimensions: Personal, Social and Learning to Learn dimensions. The Personal dimension focuses on self-regulation of learning. The Social dimension involves the ability to interact, collaborate and communicate effectively with others. The Learning to Learn dimension trains individuals to acquire new knowledge and skills

independently and effectively throughout their lives, encompassing critical thinking skills, metacognition and a growth mindset. In addition to employability skills, Lifelong Learning aims to empower people to become autonomous learners and reflective and responsible citizens able to contribute to societal well-being (García-Toledano et al., 2023). On the basis of the theoretical framework outlined, it is evident how both reflection, self-reflection and Learning to Learn competences represent key elements for students, that go beyond the mere course learning objectives set by the lecturers, that will accompany students throughout their lives. Furthermore, reflection, self-reflection and Learning to Learn competences include typical elements of the active learning methodology, a student-centered approach that motivates students to build knowledge, become more responsible and self-directed learners and, at the same time, develop skills and attitudes that go beyond simple knowledge (Wyszomirska et al., 2021; García-Toledano et al., 2023; Chan & Lee, 2021). Because of all these reasons, TBL has been adopted as the learning methodology of the course. In fact, Team based learning (TBL) is a collaborative active learning methodology (Nawabi et al., 2021) able to highly engage students, improve learning (Ruder, 2021) and develop critical reasoning, higher cognition, effective communication, collaborative teamwork, lifelong problem-solving skills (Wyszomirska et al., 2021), academic performance, interprofessional learning and self-directed learning (Yeung et al., 2023). It consists of small students' groups who work together in class to apply content to simple or complicated problems with the feedback of the subject specialist. This process allows students to both apply the instructor content to the real-world problems and foster content understanding (Nawabi et al., 2021). Through preclass preparation and peer interaction, students, by challenging each other, obtain a deeper understanding of the learning content (Yeung et al., 2023).

"TBL, when properly implemented, includes many, if not all, of the common elements of the evidence-based best teaching practices.

1. Cooperative learning;
2. Feedback or "assessment for learning";
3. Reciprocal teaching;
4. Whole-class interactive teaching;
5. Requiring concept-driven decisions;
6. Visual presentations and graphic organizers".

(Michaelsen & Sweet, 2011, p. 41)

Furthermore, active methodologies can help to prevent students' university dropout, a problematic and worldwide phenomenon of the countries covered by OECD statistics according to which, on average, one third of students who enroll at university leave their studies without obtaining a degree, especially given after the first or second year of study (Aparicio-Chueca et al., 2021; Lorenzo-Quiles et al., 2023; Aina et al., 2022). Especially for this reason, the digital TBL experimentation

has been carried out in a first year student course, to further engage and motivate students. Last, but not least, many studies have proved that the use and implementation of educational technologies in the learning processes can create engaging learning experiences for students, facilitate communication between students and instructors, provide customized feedback to students (Chugh et al., 2023); support student engagement (Bedenlier et al., 2020); develop ICT skills, digital literacy, active citizenship interdisciplinary and collaborative skills; improve student self-regulation and self-efficacy; increase participation and involvement in courses (Bond et al., 2020).

5. Conclusions

With the aim of developing students' self-regulatory processes and increasing their engagement and participation, the course was structured starting from the expected learning outcomes, outlined in the syllabus and declined according to the Dublin descriptors, following a backward design model (Wiggins & McTighe, 1998, pp. 7-19) and implementing the five TBL units using technological tools. In a lifelong learning perspective, self-regulation is the cross-cutting competency that allows students to actively and consciously manage their learning process from the meta-cognitive, motivational, and behavioral perspectives, both individually and socially (Zimmerman, 1998 and 2001), enabling them to learn how to learn and to cope with subsequent professional development needs (Gianetti, 2006).

The course adopted a continuous assessment method, an approach that prioritises the process over the product, and assigns low value to each task, providing students with the opportunity to practise, make mistakes, and receive feedback on their learning without significant impact on their final grade (Gedye, 2010). This approach also allows the teacher to continuously monitor students' learning process, following the principles of just-in-time teaching. This type of assessment is particularly suitable for analyzing open tasks and problem situations, like those of T-APP, that require students to not only apply their knowledge but also their skills and competencies (Giannandrea, 2022). This implies that both evaluative and self-evaluative aspects become learning objectives and are pursued during the design phase. Moreover, continuous assessment, being ongoing rather than occurring at the end of the teaching process, combines the quantitative aspects of summative assessment with the qualitative aspects of formative assessment (Holmes, 2018).

The TBL activities allow the instructor to perform both formative assessment, through immediate and recursive feedback provided to students at the end of each assignment (Burgess et al., 2020), and summative assessment, indicating the levels reached by students at a given time and expressing the final judgment highlighting their final outcomes (Boni, Cusinato & Parmigiano, 2018).

The administration of I-Rat and, subsequently, of T-Rat and T-App combined individual assessment with group assessment, fostered the assumption of responsibility and promoted dynamics of collaboration and cohesion of cooperative learning. The peer assessment took place through the e-gallery walk performed on Padlet, during which students learnt how to provide feedback to their peers first and, then, had the opportunity to put into practice what they were learning, according to the principles of learning by doing. This attention to student participation in assessment process reflects the concept of formative assessment as a learning moment based on two dimensions: experience and reflection (Bonaiuti & Dipace, 2021), which is useful in preventing cheating, reducing performance anxiety and promoting active participation (Tinterri et al., 2023), that generate positive implications for motivation and students' perception of self-efficacy, which are significant factors in reducing the risk of dropout (Biasi et al., 2017).

Last, but not least the use of technology throughout the experimentation has supported the whole process and educational objectives, since its implementation promotes self-regulatory processes, as it allows for better management of one's learning process (Giannetti, 2006) and develops students' digital competences, one of the eight key competences according to the EU Parliament and Council Recommendation (2006), recognized as crucial for personal development, active citizenship, social inclusion and participation. However, the implementation of educational technology in the learning process brings about some challenges as well. Firstly, it is necessary to pay attention to the tools chosen, which must meet usability and accessibility criteria, in order to be as inclusive as possible. Secondly, it is necessary to carry out not only a progressive reassessment of the traditional classroom setting, (Gabbari et al., 2016) but also a diagnostic evaluation of students' digital literacy level to provide quality education for all (Agenda 2030, goal 4). Finally, although the course adopted a BYOD approach, which is commonly applied in universities, by requiring students to access technological tools, it posed challenges in managing different devices and potential issues related to social discrimination (Calvani, 2013).

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