Research Article

Urith N. Ramírez-Mera*, Gemma Tur, Victoria I. Marin

Personal Learning Environments in Online and Face-to-Face Contexts in Mexican Higher Education

https://doi.org/10.1515/edu-2022-0009
received August 24, 2021; accepted February 3, 2022.

Abstract: With the introduction of digital technologies in education and the diversification of learning modalities, research has sought to identify the characteristics of each modality in order to develop successful learning. The Personal Learning Environment (PLE) is a developing concept that takes advantage of digital technologies and their implications in different modalities. This research aims to identify how the educational modality contributes to the development of PLEs in higher education. We compared two case studies in online and face-to-face contexts in Mexican higher education through a case survey methodology using a questionnaire and a descriptive statistical analysis of five categories: self-perception, management of information, management of the learning process, communication and learning experience. Results show that online students focus on the use of information management skills and on self-regulation of the learning process, whereas face-to-face students are oriented towards the use of communication skills. In conclusion, we identify two PLE profiles whose main differences arise from the students' learning approaches, one based on social interaction and the other guided by learning aims, two aspects that may contribute to the development of learning strategies for transition between modalities. Finally, we contribute to the support of face-to-face learning in virtual environments and emergency remote teaching.

Keywords: Higher education; Personal Learning Environment; online learning; face-to-face learning; Mexican education.

***Corresponding author: Urith N. Ramírez-Mera,** Autonomous University of the State of Hidalgo, Actopan, MEXICO, E-mail: urith_ramirez@uaeh.edu.mx
Gemma Tur, University of the Balearic Islands
Victoria I. Marin, University of Leida

1 Introduction

For decades, educational research has focused on understanding how the teaching–learning process is carried out with the use of information and communication technology (ICT; Ghavifekr & Rosdy, 2015). This has caused a series of debates and discourses that make clear how far we are from understanding the duo education–technology concept. To contribute to the development of efficient strategies for ICT integration into education, it is necessary to consider the diversity of educational environments that revolutionise the meaning of learning (Alexander & Bound, 2001), as well as the learning and teaching process. The education system integrates different benefits from available technologies beyond technical instrumentalism (Manyukhina & Wyse, 2019), which may include equal opportunities to education access and, therefore, discipline-specific competencies, generic skills and dispositions, without considering the level of virtualisation of the learning process, which can be paramount for transitions between modalities (Tolman et al., 2020).

Talking specifically about higher education (HE), the expectation is that all college students develop discipline-specific competencies, generic skills and dispositions (Chan, 2016). The role of HE is not only related to economics or employment benefits but also to preparing individuals with generic skills, including the life-long learning process or learning in complex environments (Palletier et al., 2021), for example, a Personal Learning Environment (PLE). Although PLEs show the benefits of ICT, and the fact that they have implications for the development of skills in formal and informal educational settings (García-Martines et al., 2020), teaching and learning strategies must be oriented to include ICT in the learning process and avoid the detriment to student PLEs (Ordaz & Gonzalez-Martínez, 2020).

Taking into account the importance of PLEs in HE and their implications for the development of skills to face the challenges of the learning process, this study seeks to determine students' perceptions of PLEs considering the

learning modality. For this purpose, a conceptualisation of PLEs is made, as well as a description of the study modalities of the context in which this research is developed.

1.1 Conceptualisation of PLEs

The conceptualisation of PLEs has different approaches and it has frequently been re-interpreted (Fiedler & Väljataga, 2020), and its integration into formal education has been continuously studied in order to identify its benefits in light of successful practices. According to Chaves-Barboza et al. (2019), PLEs are ecosystems that allow students to learn independently. PLEs reconcile technological and pedagogical facts (Castañeda et al., 2017), and they link technosocial reality and sociomaterial entanglement (Dabbagh & Castañeda, 2020). In this research, we consider a PLE as a set of tools, sources of information, connections and activities that also includes cognitive processes and strategies (Castañeda & Adell, 2013; Prendes et al., 2016). In the same vein, we repeat Attwell (2007), who explains that a PLE is a philosophical, ethical and pedagogical experience that is not new software, but a new approach for using technologies for learning. A PLE structure is characterised by a focus on students; it is collaborative, open and customisable, with distributed and infinite content and a close association with student improvement (Haworth, 2016; Yen et al., 2016). Considering the transformation of learning in HE, an "enthusiastic implementation" of online and hybrid learning models for the diversification of learning paths that personalise and adapt learning has been introduced (Pelletier et al., 2021). PLEs are a relevant concept for facing these complex learning processes: PLEs are dynamic, but not persistent, environments (Kühn, 2017) and can be physical, digital or hybrid (Caldwell et al., 2012).

PLE research is closely related to sociodeterminist and technodeterminist perspectives (Castañeda et al., 2016). It focuses on highlighting PLE benefits, uses and implications for good practices in the educational process (e.g., Tomé et al., 2019), but it is also important to foster empirical research (Castañeda et al., 2016) and think about the consequences for teaching methods as well as institutional learning (Dabbagh & Castañeda, 2020). Although PLEs promote student empowerment and learner agency (Castañeda & Tur, 2020), we are still reflecting on their uses and searching for an effective pathway to follow considering the diversification of the learning context (e.g. online learning, face-to-face [F2F] learning, blended learning [b-learning] or emergency remote teaching).

1.2 Online Learning vs F2F Learning

Education research on the emergence of new spaces, such as a virtual classroom, is an interesting area for comparative analysis because the virtual mode of teaching and learning introduces new forces and elements (Manzon, 2007). Various studies have concluded that there are significant differences associated with the modalities of education. Furthermore, there is strong evidence on students' preferences regarding learning modalities and the transition between them: students prefer F2F learning the most (e.g., Nasution et al., 2021), so differences in motivation and outcomes could be expected. For example, in online learning, the students' learning outcome achievements are equal to or greater than their achievements in F2F learning (Brinson, 2015), and they also have more intention to engage at a higher level than those in F2F learning (Li et al., 2014). Although "online learning [is] perceived as less social interaction, lacking social presence, and synchronicity in communication, online learning actually has some advantages to the students" (Bali & Liu, 2018, p. 5), but it may be less intimidating and the quality and quantity of interaction may be increased in online classes (Ni, 2013). Miertschin et al. (2015) argued that there is a relationship between students' time management behaviours, the development of time management skills and online education. Some studies have not found significant differences between online and F2F learning in terms of learning gains related to grades and motivation (Reece & Butler, 2017); in fact, Soltanimehr et al. (2019) considered the superiority of online methods for teaching theoretical topics and their equal efficacy with the traditional method for the instruction of skills.

Furthermore, students in online programmes must have the ability and willingness to understand the learning process and its aims, attitudes for communication, the responsibility and will for learning, specific skills for learning and linking professional practice and theoretical knowledge with the support of ICT, autonomy, self-regulation for learning and digital skills (Moreno & Cárdenas, 2012). Referring specifically to ICT uses, Gros et al. (2012) found significant differences in the uses of ICT in academic tasks: online students' activities were confined to the tools found in the virtual campus, while among the students in the F2F context, there was a greater diversity

associated with social networks, information repositories, YouTube, mobile telephones and online documents.

Despite the long list of comparative studies between online and F2F learning, we found little evidence of comparative research with PLEs, which could include elements of both and put the focus on the individual rather than on the learning mode. For example, Gerkushenko et al. (2014) performed a comparative analysis of PLEs with Russian and Slovakian students, Halimi et al. (2014) compared PLEs with LMSs (Learning Management Systems), while Mödritscher et al. (2011) compared three PLE recommending strategies. Yen et al. (2016) defined three levels of PLE management: level of initiative, level of sense control and level of self-reflection. Even when there is no evidence of comparative PLE research of learning modalities, the PLE experiences take place in different modalities as fully online courses, b-learning programmes and F2F learning supported by an online learning platform (Castañeda & Tur, 2020). However, investigation is needed to investigate how ICT improves learning environments and strategies (Bartolomé et al., 2018) and how we can tackle the educational emergency based on empirical research on online learning and F2F learning.

2 Research in Context

In the Mexican context, there are different levels of digital technology integration in education (Consejo Nacional de Ciencia y Tecnología [CONACYT], 2014) that permit a diversification of HE programmes: open learning, online learning, b-learning and F2F learning. In this study, we focus on online learning and F2F learning in HE. In addition, PLE research is a relevant topic but has still not been thoroughly analysed in the Mexican context, and an analysis of PLEs with different learning models does not exist. Previous projects have focused on the institutional PLE (iPLE) design (García et al., 2014), the development of strategies for PLE integration in formal contexts (Meza & Cejas, 2016), the learning strategies with PLEs in HE (Ordaz & Gonzales, 2019) or the security and reliability of information management in PLEs (Ramírez-Mera & Tur, 2019). None of this prior research considers the learning modality as an important research aspect. Therefore, in this research, we explore how students in online learning and F2F learning modalities perceive their learning and how this can be translated into features of their PLE.

2.1 Research Question

The purpose of this research is to examine the influence of the learning modality on PLE perception and learning strategies. Therefore, we explore how students perceive five specific aspects of PLEs: self-perception, management of information, management of the learning process, communication and learning experience. We addressed the following question: Are there differences in students' perceptions of PLEs in HE depending on the learning modality (online learning or F2F learning)? If so, what are these differences?

3 Method

Considering the complexity of comparative HE designs (Kosmützky, 2018) and the purposes of comparative research for understanding and uncovering how meaningful relationships form in complex education realities (McNess, 2004), comparative studies are commonly implemented in HE (e.g., Kaliisa et al., 2017; Oleksiyenko et al., 2020). Therefore, considering the nurturing that this type of study adds to the field, we elaborated on a quantitative comparative study with a case survey methodology because it can establish summative validity for the theories developed in case studies (Jurisch et al., 2013).

Given that the online environment is regarded as a geographical place (Chen et al., 2017), we use geographical and locational dimension entities as a unit of analysis (Manzon, 2007). Under Bereday's (1964) Model for Undertaking Comparative Studies, we follow the juxtaposing comparative research approach so that it can involve multiple objects existing in different conceptual dimensions and objects of analysis (Admson & Po, 2019); the only requirement is that the objects have enough in common to make the analysis (Bray, 2004). Alsaaty et al. (2016) mentioned that the effectiveness of online learning and the F2F learning approach could be classified as follows: (a) the sameness of online and F2F learning modalities of learning, (b) the superiority of the online modality relative to the F2F learning modality, (c) the superiority of the F2F learning modality relative to the online modality and (d) the integration of a hybrid model. In this research, we consider the first of these categories, which supposes that the online and F2F learning programmes are similar since their curricula are equivalent.

3.1 Instrument

Taking into consideration that questionnaires and statistical analysis are the building blocks of survey design (Klandermans & Smith, 2002), we implemented the adapted questionnaire, CAPPLE, by Ramírez-Mera & Tur (2019) in an online and an F2F learning context, which provides evidence of its relevance, reliability and usefulness in quantitative studies. The CAPPLE instrument has values from 1 to 5, where 1 means "totally disagree" and 5 means "totally agree".

The CAPPLE tool was developed within the context of the Spanish research project "Competencies for permanent learning based on PLE use: an analysis of future professionals and proposals of improvement", which aimed to describe how final year university students perceived their learning and how this could be translated into features of their PLE (Prendes et al., 2016). The original instrument was validated through a complex and comprehensive process that included experts' judgment, cognitive interviews and a pilot test using Cronbach's alpha for each item in a different dimension (Prendes et al., 2016). The adapted questionnaire CAPPLE was adapted for the Mexican context by adjusting the terms and wording of the items and was then validated by Cronbach's alpha test for the five dimensions with an alpha of .964 (Ramírez-Mera & Tur, 2019). The tool is based on the definition of a PLE by Castañeda and Adell (2013), and therefore, it is divided into five dimensions connected to the specific strategies and tools used habitually by students: self-perception, management of information, management of the learning process, communication and learning experience. The tool has been implemented in different contexts (e.g., Prendes et al., 2019; Ramírez-Mera & Tur, 2019; Román & Prendes, 2020; Serrano et al., 2019).

Once the questionnaires were completed, we analysed the full questionnaire data using IBM SPSS Statistics 21. We ran a normality test, and the results proved that we had a non-normal distribution in both case studies ($p < .05$).

3.2 Participants

We analysed two case studies in a Mexican university using administration students in their first year at the Autonomous University of Querétaro (UAQ). We considered one case study in an online environment (Degree in Administration, group 1) and another one in an F2F environment (Degree in Administration, group 2), resulting in two groups with related characteristics. In both case studies, the students are enrolled in nine courses: Basic Accounting, Basic Administration, Algebra, Office Software, Foundations of Law, Culture and Language, Culture Workshop, Investigative Techniques and Sports.

We collected information from the full number of participants in each case study: 30 students in F2F learning and 32 students in online learning. In the F2F study case, 25% of participants were male and 75% were female, while in the online study case, 15.6% of participants were male and 84.4% were female; the ages of the students in F2F environments ranged from 19 to 37 years, and those in online environments ranged between 22 and 58 years.

4 Analysis and Results

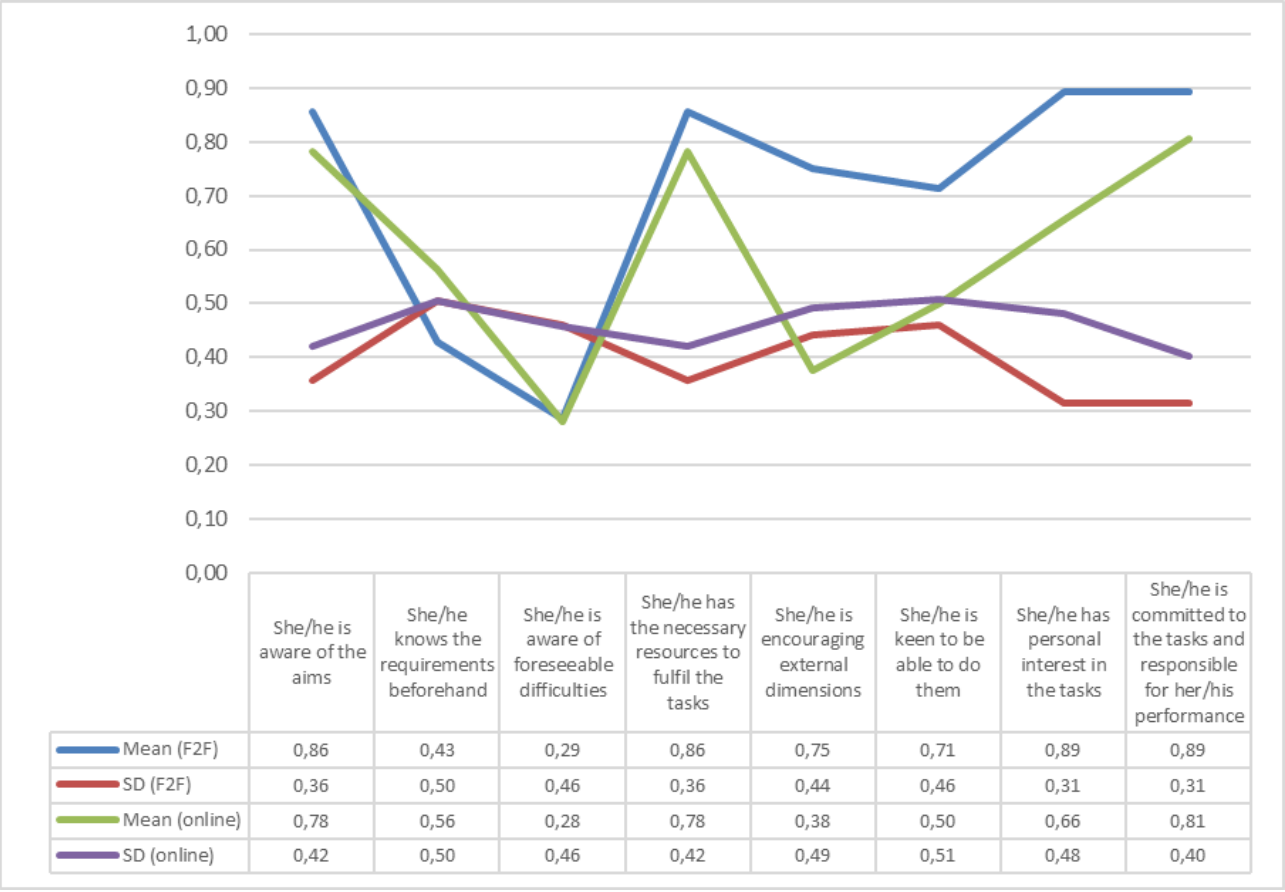
For the data analysis, we performed a full analysis of the instrument. Then, we ran an inferential test to identify significant differences between both case studies. Finally, we ran descriptive statistical tests to obtain a global view of the two case studies. We created a description of each case study with the most relevant results that contributed to answering our research question. The following sections describe the five dimensions of PLE: self-perception, management of information, management of the learning process, communication and learning experience.

4.1 Self-Perception

The situations that motivated interest in learning were the same in online learning and F2F learning: attending classes and reading and listening to traditional and online resources. Establishing aims helps students to make good use of their time on the internet (online: mean = 4.63, SD = 0.744; F2F: mean = 3.86, SD = 0.932). The motivation to carry out tasks was enhanced if students had the necessary resources to fulfil the tasks, but we found differences between the two. Online students were more motivated when they were committed to the task and responsible for their performance. F2F students were encouraged by external factors (Figure 1): they decided what to learn based on the demands of their colleagues (mean = 3.21, SD = 1.287).

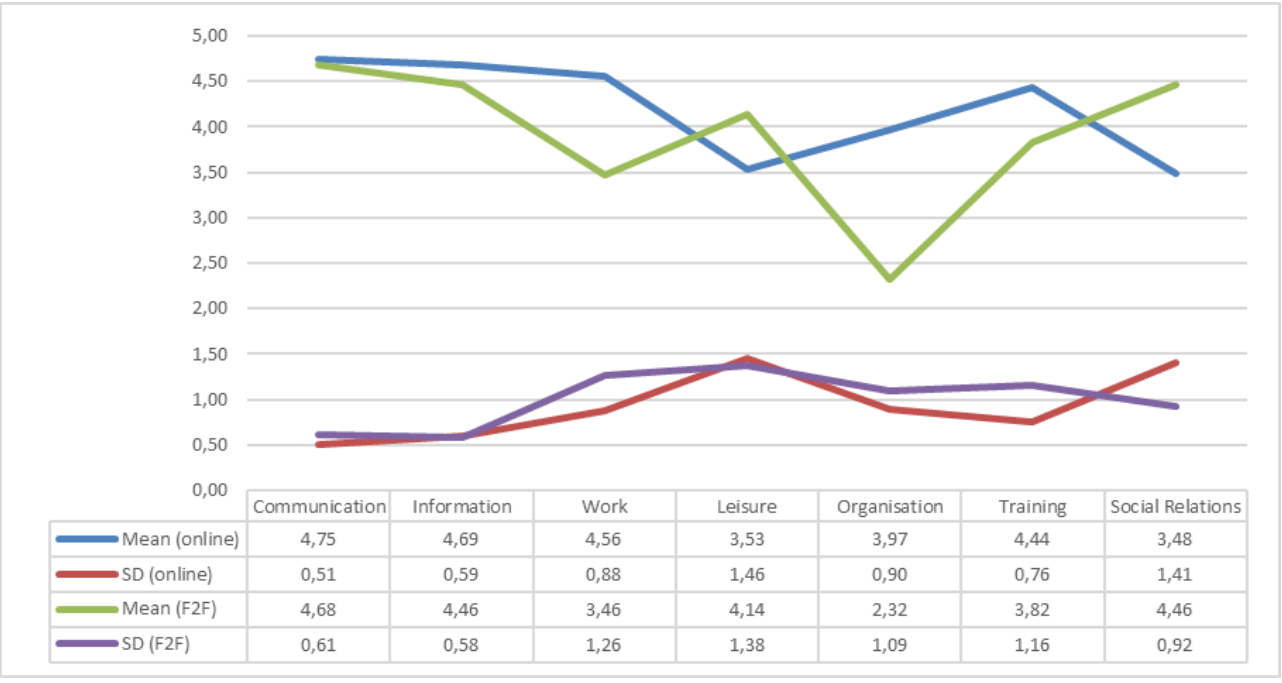
We found significant differences in the reasons for using the internet (Figure 2), especially in leisure, work, organisation and social relations aspects.

We found significant differences when students established aims to help them make good use of their time on the internet (Table 1).



	She/he is aware of the aims	She/he knows the requirements beforehand	She/he is aware of foreseeable difficulties	She/he has the necessary resources to fulfil the tasks	She/he is encouraging external dimensions	She/he is keen to be able to do them	She/he has personal interest in the tasks	She/he is committed to the tasks and responsible for her/his performance
Mean (F2F)	0,86	0,43	0,29	0,86	0,75	0,71	0,89	0,89
SD (F2F)	0,36	0,50	0,46	0,36	0,44	0,46	0,31	0,31
Mean (online)	0,78	0,56	0,28	0,78	0,38	0,50	0,66	0,81
SD (online)	0,42	0,50	0,46	0,42	0,49	0,51	0,48	0,40

Figure 1: Motivational situations for learning. With permission. Own elaboration.



	Communication	Information	Work	Leisure	Organisation	Training	Social Relations
Mean (online)	4,75	4,69	4,56	3,53	3,97	4,44	3,48
SD (online)	0,51	0,59	0,88	1,46	0,90	0,76	1,41
Mean (F2F)	4,68	4,46	3,46	4,14	2,32	3,82	4,46
SD (F2F)	0,61	0,58	1,26	1,38	1,09	1,16	0,92

Figure 2: Reasons for using the internet. With permission. Own elaboration.

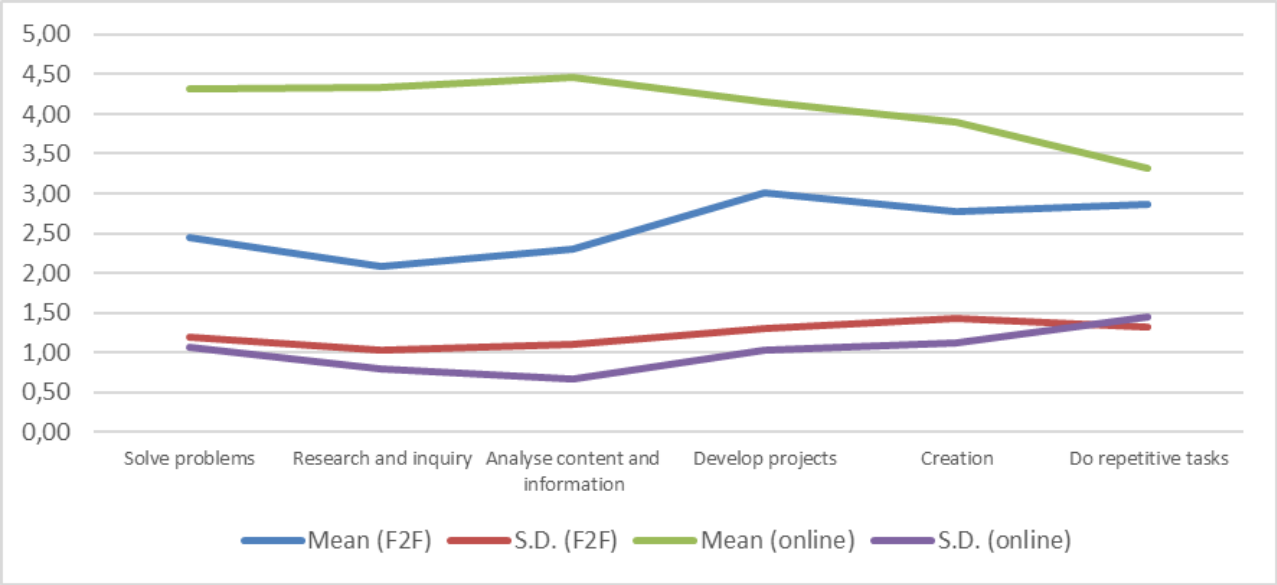


Figure 3: Common activities in the web. With permission. Own elaboration.

Table 1: Establishing aims and uses of internet time. With permission. Own elaboration.

Value	Establishing aims helps to make good use of internet time
Mann-Whitney U Test	210.000
Wilcoxon signed-rank test	616.000
Z	-3.708
Asymp. Sig. (2-tailed)	.000

Note. Grouping variable: Educational modality

4.2 Management of Information

Concerning the management of information, in both study cases, students preferred to download documents onto their computers and take notes with a specific tool as they read on the screen (online: 66.6%, F2F: 71.4%); when they found a video or audio clip, students listened or watched and took hand-written notes (online: 65.5%, F2F: 41.7%) and students stored information on their computers and on the internet (online: 78.1%, F2F: 89.3%).

We found significant differences in the activities that students did online: online students used the internet for research and inquiry, to analyse content and information and to solve problems, while F2F students had mean < 3 in the same activities (Figure 3). Online students preferred video (mean = 4.41, SD= 0.911) and multimedia (mean = 4.31, SD = 0.859) more than F2F students (mean = 3.71, SD = 0.804; mean = 4.36, SD = 0.911).

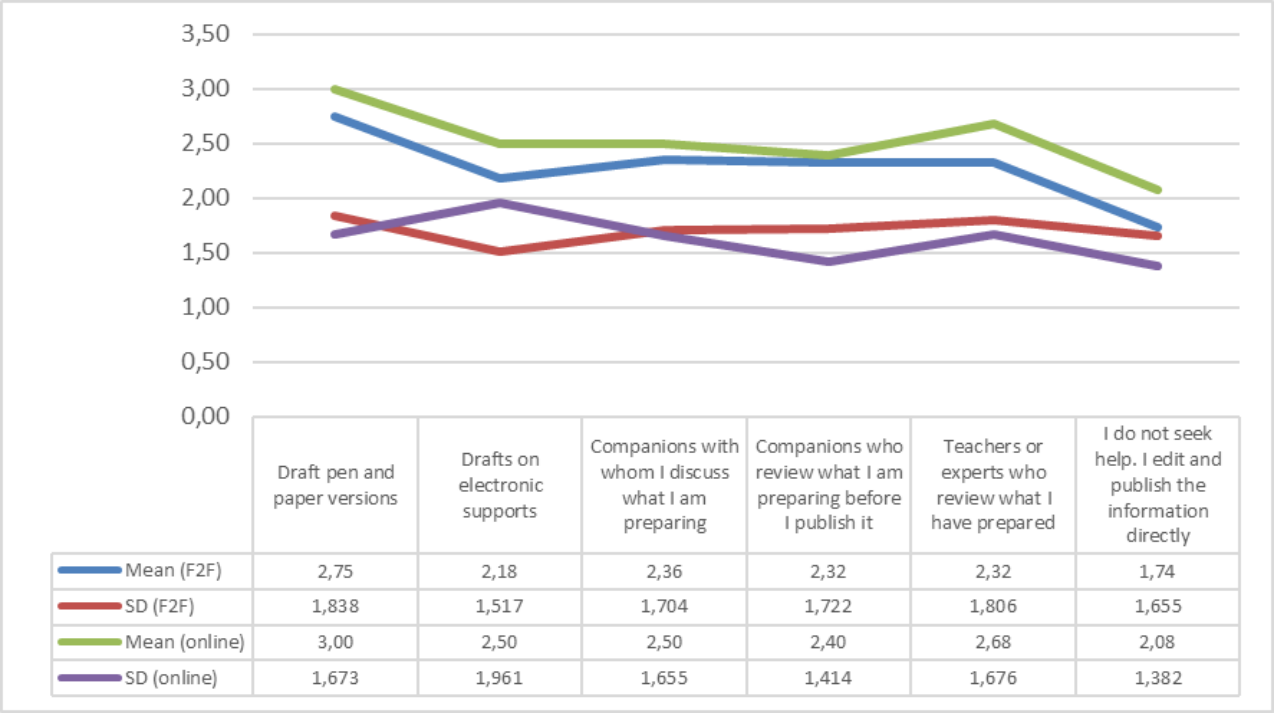
Regarding how students prepared information that will be uploaded to the internet, students had low values with means under 2.75 (Figure 4).

Concerning the ethical aspects, students were conscious about copyright (online: mean = 4.58, SD = 0.643; F2F: mean = 3.89, SD = 0.994) and license issues (online: mean = 4.08, SD = 1.412; F2F: mean = 3.68, SD = 1.056). This result shows that online students have a higher awareness of ethical issues.

Students followed the same strategies for retrieving information: using pen and paper to represent ideas or knowledge (online: mean = 4.13, SD = 1.185; F2F: mean = 4.11, SD = 1.449), using other ideas and previous knowledge (online: mean = 3.88, SD = 0.641; F2F: mean = 3.75, SD = 0.752) and locating information they had organised and categorised for ready retrieval (online: mean = 4.06, SD = 1.153; F2F: mean = 3.43, SD = 1.200).

4.3 Management of the Learning Process

We found that students in online learning were less familiar with online courses offered by firms and institutions (40.0%) than F2F courses (41.7%). However, both online and F2F learning students did not take Massive Open Online Courses (MOOCs). Regarding the criteria for selecting information, we found that students preferred reliable information, which starts from a clear idea and the most up-to-date information. F2F students were aware that they interpreted information according to their point of view (mean = 4.32, SD = 0.670), while online students



	Draft pen and paper versions	Drafts on electronic supports	Companions with whom I discuss what I am preparing	Companions who review what I am preparing before I publish it	Teachers or experts who review what I have prepared	I do not seek help. I edit and publish the information directly
Mean (F2F)	2,75	2,18	2,36	2,32	2,32	1,74
SD (F2F)	1,838	1,517	1,704	1,722	1,806	1,655
Mean (online)	3,00	2,50	2,50	2,40	2,68	2,08
SD (online)	1,673	1,961	1,655	1,414	1,676	1,382

Figure 4: How students prepare information to be uploaded to the internet. With permission. Own elaboration.

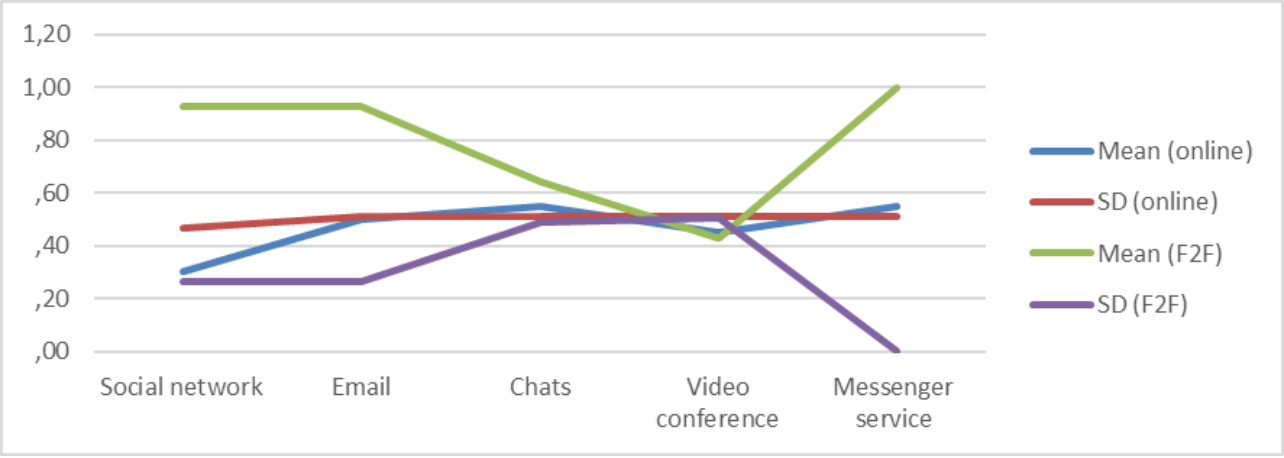


Figure 5: Tools to favour collaboration and communication with others. With permission. Own elaboration.

value the opinion of a group of users (mean = 4.48, SD = 0.570).

4.4 Communication

Online students valued the contribution and criticism by other students (mean = 4.40, SD = 0.913) more than F2F students (mean = 3.59, SD = 1.394). The use of F2F learning has more influence on the external environment and social interaction than in online learning. We found significant differences when students communicated with others: students in F2F contexts communicated more than students in the online context (Figure 5).

Even when students needed to communicate online, students in F2F learning hardly ever communicated (mean = 3.54, SD = 1.774), but when they did it, they used social networking tools (mean = 4.50, SD = 0.694), while online students preferred basic tools (mean = 4.00, SD = 1.323). Regarding teamwork, students has differences

	I have no problems	I am efficient	It gives me a positive experience	It is useful for my work	I enjoy learning	It is fun	It is pleasant	It is satisfying	I am more efficient	It is beneficial to my work
Mean (F2F)	0,79	0,71	0,68	0,68	0,61	0,61	0,57	0,75	0,71	0,79
SD (F2F)	0,42	0,46	0,48	0,48	0,50	0,50	0,50	0,44	0,46	0,42
Mean (online)	0,60	0,43	0,43	0,65	0,48	0,43	0,27	0,39	0,30	0,52
SD (online)	0,50	0,50	0,51	0,49	0,51	0,51	0,45	0,50	0,47	0,51

Figure 6: Feelings about using digital tools. With permission. Own elaboration.

in their use of Google Docs (online = 36.7%, F2F = 75%), sharing resources (online: 60%, F2F: 60.1%) and building together (online: 32%, F2F: 50%).

4.5 Learning Experiences

When we asked students how they felt when they used different digital tools and applications, online students had fewer positive experiences (Figure 6).

Regarding the learning experience, online and F2F students looked for similar characteristics in the digital tools they used regarding aesthetic aspects. F2F learning students placed more value on the ease of learning new digital tools (F2F = 82.1%, online = 33.3%), their flexibility (F2F = 64.3%, online = 47.8%), their originality (F2F = 53.6%, online = 34.8%) and interface friendliness (F2F = 64.3%, online = 43.5%).

5 Discussions

In this research, we analysed five aspects related to the PLE perception and learning strategies in Mexican HE by considering one case study each in online and F2F modalities. We found that there are differences in the perception of the PLE approach in online and F2F modalities that may indicate a diversification of the PLE model according to their bases and characteristics.

We found that motivation in both cases does not have significant differences (Reece & Butler, 2017), but F2F learning students are influenced by their perception of other students or colleagues (Bali & Liu, 2018); on the other hand, students in online learning are influenced by the requirements and the opinions of other users. Concerning learning skills and strategies for learning with ICT, while online students prefer to use the internet for communicating, training and working, F2F students use it for leisure and social relations (Gros et al., 2012).

We noticed different priorities in each case study regarding social issues and curricular aims, two aspects that have a direct impact on the learning process (Moreno & Cardenas, 2012). While for online students, learning networks are based on the curricular tasks of the educational programme, the PLE structure of F2F students is determined by physical social interaction. With this fact, we do not suggest that certain PLEs are better or worse, but rather how the students' perception of learning differs; online students perceive less social interaction in the learning process (Bali & Liu, 2018) and F2F students place a lower value on curricular aims. Although we do not have strong evidence for this conclusion, we argue for the need to rethink the learning strategies developed in F2F and online learning as well as the construction

of emergency remote learning and its pedagogical and didactic basis.

While the use of the internet differs according to the modality, we found that online students have better skills for managing their time on the internet (Miertschin et al., 2015). This aspect may be related to the learning experience that students in online learning develop over the years in this modality: the day-to-day activities in combination with the consciousness of need and usefulness that conclude in the development of skills and habits for managing information, decoding information, time management, self-learning processes and ethical considerations. Consistent with other research results (e.g., Dabbagh & Kitsantas, 2012; Muthupoltotage & Gardner, 2018), we observe the role of self-regulated learning (SRL) in PLE construction and the importance of establishing aims to manage time, which may be related to the performance phase of SRL. Yen et al. (2016) argued that the development of digital skills and SRL in particular are required for surviving in the digital world, and it may be a critical competence for digital learners.

We noticed the importance of peers' opinions and contributions specifically in online learning; however, we raise the possibility of including mentoring in PLE construction and learning strategies. Olome and Okute (2021) mention that mentoring is a more effective approach for skill acquisition in education than the conventional teaching approach; as a result, this places a positive emphasis on learning within mentor–protégé relationships, as self-efficacy in mentoring is a worthwhile strategy for influencing personal learning (Pan et al., 2011). We noticed the students' behaviour in online environments and multiple problems in collaborative work and communication (Abou-Khalil et al., 2021). Although technologies help improve collaborative and individual learning, we found that online students have less interest in teamwork, including participation and interaction with others outside the LMS. Despite the students in online environments developing all their activities in a digital format, they do not share them outside the LMS. This fact may result in serious consequences for sharing knowledge and the creation of learning communities because it may indicate that knowledge produced in HE is closed and the interactions with others outside their learning environment are null, stopping the construction of virtual spaces for debate and critical thinking, as well as challenging the collaborative nature of PLEs as learning networks (Tu et al., 2012).

The feelings and emotions that students perceive when they use certain digital tools are quite different in both case studies. Students in online learning have fewer positive experiences and are not concerned about aspects such as satisfaction and pleasure. Although we found that online students assign a lower relevance to the learning resource format than F2F students, both case studies preferred information in video and multimedia formats. With this information, we can concur with other studies that concluded that video and audiovisual resources are preferred because they are easier to consume (Anagnostopoulou & Izqueirdo, 2020). At the same time, we open a discussion about the role of online learning resources for F2F and online learning. While for online students digital learning resources are their main source of access to learning and information, F2F students use learning resources as complements and extra information, a fact that affects the management of PLE construction.

Taking into account the aims of PLEs, we have a critical view about the aims of HE in the online and F2F contexts, and we consider it important to recognise whether these provide the same opportunities to students in different educational modalities as well as the ability to move from F2F to online leaning or for facing emergency remote learning. If the PLE structures in online and F2F learning have different bases, students' aims for learning may be different, as well as their purpose for pursuing HE. On the other hand, this aspect may indicate that both educational programmes have gaps in their curricula, a common problem detected in HE (Wiseman et al., 2017). In order to contribute to the development of the didactic basis for emergency remote learning, we suggest considering overcoming space-time barriers and exploiting flexibility in the methods and styles of learning and developing diversification of teaching–learning paths.

6 Conclusion

The aim of this research is not to find gaps in Mexican educational programmes but to contribute to the development of strategies with a PLE approach in Mexican HE, taking into consideration the characteristics of educational modalities and contributing to the support of F2F learning in online environments and emergency remote teaching. Furthermore, through examining how students learn in F2F and online contexts, we highlight how to move from F2F to online learning via a PLE approach. In this research, we identify two PLE profiles whose main differences arise from students' learning approaches: F2F students' PLEs are based on social interaction, while the PLEs of students in online learning are guided by the learning aims.

The F2F students' PLEs have a higher degree of access to the internet for communication, social relationships and information. We suggest considering the personal networks between peers and companions because of their importance in task setting. The learning strategies must reflect the peers' and teachers' demands, so students should have a personal interest in the tasks, engage in activities related to research and inquiry and analyse content and information, including ethical issues, which are not frequent activities. Criticism and interpretation skills must be developed. Media designers should reconsider the importance of digital tools, chosen according to their flexibility, topicality, interface and originality. Students should be satisfied and feel efficient with the digital tools.

In contrast, the online students' PLEs are based on information, work and training tasks, with few peer or companion networks; the communication is minimal and performed through basic tools, so it does not promote pleasure or satisfaction, an important aspect needed for the creation of a significant learning experience. The learning strategies must consider the tasks' requirements and their aims beforehand and include video and multimedia resources. Teachers should boost peer-to-peer networks so that students can improve their teamwork and identify its advantages.

In both modalities, the use of MOOCs or other digital resources that contribute to the learning process should be included, which may encourage students to acquire certain advances in digital skills for the cultivation of their PLE regardless of educational modality. The digital tools should be up to date and reliable; it is essential that they be genuinely useful and beneficial for working. We also found the necessity of contributing to knowledge sharing outside the schooling context so that students can contribute to free-access content and the decolonisation of information.

The learning process needs to be examined so that HE in different modalities allows students to design, manage and cultivate their PLE for their own benefit and to enforce strategies of transition learning–teaching processes (Tolman et al., 2020). In addition, this research describes two PLE profiles developed in F2F and online Mexican contexts that may help to support digital learning models. By understanding how students move in online and F2F contexts, it is possible to develop teaching strategies according to the learner profile and re-educate students so that they can successfully navigate new learning environments and prioritise activities and learning aims. We found that even though online students have skills in information management and management of the learning process, they must develop communication skills, the reverse of the skill acquisition process in F2F learning.

Although the study has shown some insightful findings for its context, it needs to acknowledge important limitations. The most important one refers to the small sample size of the groups, making the results difficult to generalise. Second, the study method relies solely on self-reports by students. New studies should consider bigger groups and include other data sources to offer more possibilities for the generalisation of results. We also suggest conducting a multilevel comparative analysis (Manzon, 2007), which may provide insights for understanding meaningful relationships from complex educational realities and particular social phenomena.

As a future research direction, it is important to consider aspects related to online and traditional tools and how they improve PLEs in formal and informal contexts. In the same vein, future research should focus on metacognitive processes in hybrid contexts considering the digital gap as a result of the COVID-19 pandemic. However, the importance of establishing strategies for the integration of a PLE approach on new modalities after emergency remote teaching and due to the widespread use of hybrid models (Pelletier et al., 2021) should be a permanent consideration for improving education in the future.

Acknowledgement: This research was partially funded by FEDER/Spanish Ministry of Science and Innovation/ State Research Agency/Grant number EDU2017-84223-R.

Conflict of Interests Statement: The authors have no conflicts of interest to disclose.

Reference

Abou-Khalil, V.; Helou, S.; Khalifé, E.; Chen, M.A.; Majumdar, R.; Ogata, H. (2021). Emergency Online Learning in Low-Resource Settings: Effective Student Engagement Strategies. Educ. Sci. 11, 24. https://doi.org/10.3390/educsci11010024

Admson, B., & Po, T. (2019). Juxtaposing comparative education and teacher education. In M. A. Peters (Ed.), *Encyclopedia of Teacher Education* (pp.1-17). Springer, Singapore. https://doi.org/10.1007/978-981-13-1179-6_307-1

Alexander, S., & Bound, D. (2001). Learners still learn from experience when online. In J. Stephenson (Ed.), *Teaching & learning online, pedagogies for new technologies* (pp. 1-13). https://doi.org/10.4324/9781315042527

Alsaaty, F. M., Carter, E., Abrahams, D., & Alshameri, F. (2016). Traditional versus online learning in institutions of higher

education minority business students' perceptions. *Business and Management Research, 5*(2). http://dx.doi.org/10.5430/bmr.v5n2p31

Anagnostopoulou, V., & Izquierdo,V. (2020). The role of audiovisual resources in active learning methodologies. *Πανελλήνιο Συνέδριο Επιστημών Εκπαίδευσης, 1*, 3-12.

Attwell, G. (2007). The personal learning environments: The future of eLearning? *ELearning Papers, 2*(1), 1–8.

Bali, S., & Liu, M. C. (2018). Students' perceptions toward online learning and face-to-face learning courses. *Journal of Physics: conference series, 1108*. http://dx.doi.org/10.1088/1742-6596/1108/1/012094

Bartolomé, A., Castañeda, L., & Adell, J. (2018). Personalization in educational technology: the absence of underlying pedagogies. *International Journal of Educational Technology in Higher Education, 15*(1). http://dx.doi.org/10.1186/s41239-018-0095-0

Bereday, G. (1964). *Comparative Method in Education*. Holt, Rinehart & Winston.

Bray, M. (2004). Methodology and Focus in Comparative Education. In M. Bray & R. Koo (Eds.), *Education and Society in Hong Kong and Macao: Comparative Perspectives on Continuity and Change* (pp. 237-350). CERC Studies in Comparative Education. http://dx.doi.org/10.1007/1-4020-4449-6

Brinson, J. R. (2015). Learning outcomes achievements in non-traditional (virtual and remote) versus traditional (hands-on) laboratories: a review of the empirical research. *Computer & education*, (57), 218-237. http://dx.doi.org/10.1016/j.compedu.2015.07.003

Caldwell, G., Bilandzic, M., & Foth, M. (2012). Towards visualising people's ecology of hybrid personal learning environments. *MAB '12: Proceedings of the 4th Media Architecture Biennale Conference* (pp. 13-22). https://doi.org/10.1145/2421076.2421080

Castañeda, L., & Adell, J. (2013). La anatomía de los PLEs. In L. Castañeda & J. Adell (Eds.), Entornos Personales de Aprendizaje: Claves para el ecosistema educativo en red (pp. 11-27). Alcoy: Marfil. Retrieved from: http://digitum.um.es/xmlui/bitstream/10201/30408/1/capitulo1.pdf

Castañeda, L., Cosgrave, M., Marin, V., & Cronin, C. (2016). Personal Learning Environments: PLE Conference 2015 Special Issue Guest Editorial. *Digital Education*, (29). https://bit.ly/3eIaKi0

Castañeda, L., Dabbagh, N., & Torres-Kompen, R. (2017). Personal Learning Environments: Research-Based Practices, Frameworks and Challenges. *Journal of new approaches in educational research, 6*(1), 1-2. https://doi.org/10.7821/naer.2017.1.229

Castañeda, L., & Tur, G. (2020). Resources and Opportunities for Agency in PLE Related Pedagogical Designs: a Literature Exploration. *IxD&A*, (45), 50-68.

Chan, R. Y. (2016). Understanding the purpose of higher education: An analysis of the economic and social benefits for completing a college degree. *Journal of Education Policy, Planning and Administration, 6*(5), 1-40.

Chaves-Barboza, E., Trujillo-Torres, J., Hinojosa-Lucena, F., & Cáceres-Reche, P. (2019). Personal Learning Environments (PLE) on the bachelor's degree in early education at the University of Granada. In P. Novais et al. (Eds.), *ISAml 2018* (pp. 381-388). https://doi.org/10.1007/978-3-030-01746-0_45

Chen, M., Lin, H., & Lu, G. (2017). Virtual geographic environments. *International Encyclopedia of Geography: People, the Earth, Environment and Technology*. https://doi.org/10.1002/9781118786352.wbieg0448

Consejo Nacional de Ciencia y Tecnología [CONACYT] (2014). *Fundamentos sobre calidad educativa en la modalidad no escolarizada*. https://bit.ly/3eHytis

Dabbagh, N. & Castañeda, L. (2020). The PLE as a framework for developing agency in lifelong learning. *Education Tech Research Dev, 68*, 3041–3055. https://doi.org/10.1007/s11423-020-09831-z

Dabbagh, N., & Kitsantas, A. (2012). Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *The Internet and Higher Education, 15*, 3-8. http://doi.org/10.1016/j.iheduc.2011.06.002

García, M. F., Navarro, F. G., & Espinosa, G. E. (2014). Entornos Personales de aprendizaje en Universidades Publicas Mexicanas, Estudio de caso Sistema de Universidad Virtual, Universidad de Guadalajara. https://bit.ly/3cCoZTF

Gerkushenko, G., Gerkushenko, S., Shabalina, O., Kamaev, V., Davtyan, A., & Hostoveckey, M. (2014). Comparative analysis on Personal Learning Environment of Russian and Slovakian students. In A. Rosipliosi & S. Greener (Eds.), *Proceedings of the European Conference on Social Media* (pp. 183-192). Academic Conferences and Publishing International Limited.

Ghavifekr, S., & Rosdy, W. A. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *IJRES, 1*(2), 175-191. http://bit.ly/2XIGcTz

Gros, B., Garcia, I., & Escofet, A. (2012). Beyond the net generation debate: A comparison between digital learners in face-to-face and virtual universities. *The International Review of Research in Open and Distributed Learning, 13*(4), 190-210. https://doi.org/10.19173/irrodl.v13i4.1305

Haworth, R. (2016). Personal Learning Environments: a solution for Self-Directed Learners. *TechTrends, 60*, 35-364. http://doi.org/10.1007/s11528-016-0074-z

Halimi, K., Seridi-Bouchelaghem, H., & Faron-Zucker, C. (2014). An enhanced personal learning environment using social semantic web technologies. *Interactive Learning Environments, 22*(2), 165-187. https://doi.org/10.1080/10494820.2013.788032

Jurisch, M., Kremar, H., & Wolf, P. (2013). Using the case survey method for synthesizing case study evidence in information systems research. *Proceedings of the Nineteenth Americas Conference on Information Systems*. https://bit.ly/2zlCtVI

Kaliisa, R., Palmer, E. & Miller, J. (2017). Mobile learning in higher education: a comparative analysis of developed and developing country contexts. *British Journal of Edcuational Teaching, 00*(00). https://doi.org/10.1111/bjet.12583

Klandermans, B., & Smith, J. (2002). Survey research: a case for comparative designs. In B. Klandermans & S. Staggenbord (Eds.), *Methods of social movement research* (pp. 3-31). University of Minnesota Press.

Kosmützky, A. (2018). International Team Research in Comparative Higher Education: Shedding Some Light on its Social Side. *Journal of comparative and international higher education, 10*, 14-23. https://bit.ly/3btNr9Q

Kühn, C. (2017). Are Students Ready to (re)-Design their Personal Learning Environment? The Case of the E-Dynamic.Space. *Journal of New Approaches in Education Research, 6*(1), 11-19. http://dx.doi.org/10.7821/naer.2017.1.185

Li, F., Qi, J., Wang, G., & Wang, X. (2014). Traditional classroom vs e-learning in higher education: difference between students' behavioural engagement. *i-jet, 9*(2), 48-51. http://dx.doi.org/10.3991/ijet.v9i2.3268

Manyukhina, Y., & Wyse, D. (2019). Learner agency and the curriculum: a critical realist perspective. *The Curriculum Journal, 30*(3), 223-243. https://doi.org/10.1080/09585176.2019.1599973

Manzon, M. (2007). Comparing places. In M. Bray, B. Adamson, & M. Mason (Eds.), *Comparative Education Research* (pp. 97-138). Springer Netherland. https://doi.org/10.1007/978-1-4020-6189-9

McNess, E. (2004). Culture, Context and the Quality of Education: Evidence from a Small-Scale Extended Case Study in England and Denmark. *Compare: A Journal of Comparative Education, 34*(3), 315-327. https://doi.org/10.1080/0305792042000257158

Meza, J. M., & Cejas, R. (2016). Los Entornos Personales de Aprendizaje como estrategia de aprendizaje desde la Teoría del Actor-Red. *Didáctica, innovación y multimedia, 11*(33). https://bit.ly/2VGOJr6

Miertschin, S. L., Goodson, C., & Stewart, B. (2015). Time management skills and student performance in online course. *122nd ASEE annual conference & Exposition* (pp. 26.1585.1-26.1585.16). http://doi.org/10.18260/p.24921

Mödritscher, F., Petrushya, Z., & Law, E. L.-C. (2011). The applications of pattern repositories for sharing PLE practices in networked communities. *Journal of Universal Computer Science, 17*(10). http://doi.org/10.3217/jucs-017-10-1492

Moreno, O., & Cárdenas, M. (2012). Educación a distancia: nueva modalidad, nuevos alumnos. Perfiles de alumnos de Psicología en México. *Perfiles educativos, 34*(136), 118-136. https://doi.org/10.22201/iisue.24486167e.2012.136.31767

Muthupoltotage, U., & Gardner, L. A. (2018). Rules governing the use of personal learning environments for self-regulated learning: an activity theory approach. *Research-in-Progress Papers, 20*. https://bit.ly/3eEw0Fr

Nasution, A., Surbakti, A., Zakaria, R., Wahyuningsih, S. & Daulay, L. (2021). Face to Face Learning vs Blended Learning vs Online Learning (Student Perception of Learning). *Journal of Physics: Conference Series*, (1783). https://doi.org/10.1088/1742-6596/1783/1/012112

Ni, A. Y. (2013). Comparing the Effectiveness of Classroom and Online Learning: Teaching Research Methods. *Journal of Public Affairs Education, 9*(2), 199-215. https://doi.org/10.1080/15236803.2013.12001730

Oleksiyenko, A., Blanco, g., Hayhoe, R., Jackson, L., Lee, J., Metcalfe, A., Sivasubramaniam, M., & Zha, Q. (2020). Comparative and international higher education in a new key? Thoughts on the post-pandemic prospects of scholarship. *Compare: A Journal of Comparative and International Education*. https://doi.org/10.1080/03057925.2020.1838121

Olom, P., & Okute, L. (2021). Effect of mentoring approach on skill acquisition among business education students in tertiary institutions in cross river state. *Nigerian Journal of Bussines Education, 8*(1), 159-165.

Ordaz, T., & Gonzales, J. (2019). Valoración de estrategias de construcción del conocimiento en los entornos personales de aprendizaje. *Apertura, 11*(2), 6-21. https://doi.org/10.32870/Ap.v11n2.1598

Pan, W., Sun, L.-Y., & Chow, I. H. (2011). The impact of supervisory mentoring on personal learning and career outcomes: The dual moderating effect of self-efficacy. *Journal of Vocational Behaviour, 78*(2), 264–273. http://doi.org/10.1016/j.jvb.2010.05.001

Pelletier, K., Brown, M., Brooks, D. C., McCormick, M., Reeves, J., Arbino, N., Bozkurt, A., Crawford, S., Czerniewicz, L., Gibson, R., Linder, K., Mason, J., & Modelli, V. (2021). EDUCASE Hrizon Report, teaching and learning edition. Boulder: EDUCASE.

Prendes, M. P., Castañeda, L., Solano, I., Roig-Vila, R., Aguilar, M. V., & Serrano, J. L. (2016). Validation of a questionnaire on work and Learning habits for future professionals: exploring personal learning environments. *Relieve, 22*(2). http://dx.doi.org/10.7203/relieve.22.2.7228

Prendes, M. P., Román, M., & González, V. (2019). How University Students Use Technologies to Learn: A Survey about PLE in Spain. *Education in the Knowledge Society, 20*. https://doi.org/10.14201/eks2019_20_a10

Ramírez-Mera, U., & Tur, G. (2019). Seguridad y fiabilidad en la gestión de la información de los entornos personales de aprendizaje (PLE) en la Educación Superior. *EDUTEC, 70*, 18-33. https://doi.org/10.21556/edutec.2019.70.1435

Reece, A., & Butler, M. B. (2017). Virtually the Same: A Comparison of STEM Students Content Knowledge, Course Performance, and Motivation to Learn in Virtual and Face-to-Face Introductory Biology Laboratories. *Journal of College Science Teaching, 46*(3), 83-89.

Román, M. M. & Prendes, M. P. (2020). Personal Learning Environments: quantitative instrument for university students (CAPPLE-2). EDUTEC, *73*, 82-104. https://doi.org/10.21556/edutec.2020.73.1709

Serrano, J. L., Carrera, X., Brescó, E., & Suárez-Guerrero, C. (2019). Tratamiento crítico de la información de estudiantes universitarios desde los entornos personales de aprendizaje. *Educ. Pesqui., 45*. http://doi.org/10.1590/s1678-4634201945193355

Soltanimehr, E., Bahrampour, E., Imani, M., Rahimi, F., Almasi, B., & Moattari, M. (2019). Effect of virtual versus traditional education on theoretical knowledge and reporting skills of dental students in radiographic interpretation of bony lesions of the jaw. *BMC Medical Education, 19*. https://doi.org/10.1186/s12909-019-1649-0

Tolman, S., Dunbar, M., Slone, K. B., Grimes, A., & Trautman, C. A. (2020). The transition from teaching F2F to online. In L. Kyei-Blankson, E. Ntuli, & J. Blankson (Eds.), *Handbook of Research on Creating Meaningful Experiences in Online Courses* (pp.67-84). https://doi.org/10.4018/978-1-7998-0115-3.ch006

Tomé, M., Herrera, L., & Lozano, S. (2019). Techers' opinions on the use of Personal Learning Environments for intercultural Competences. *Sustainability, 11*. https://doi.org/10.3390/su11164475

Tu, C.-H., Sujo-Montes, L., Yen, C.-J., & Blocher, M. (2012). The Integration of Personal Learning Environments & Open Network Learning Environments. *TechTrends, 56*(3), 13-19. http://doi.org/10.1007/s11528-012-0571-7

Wiseman, J., Davies, E., Duggal, S., Bowes, L., Moreton, R., Robinson, S., Nathwani, T., Birking, G., Thomas, L., & Roberts, J. (2017). *Understanding the changing gaps in higher education participation in different regions of England*. BMG Research. https://bit.ly/3buHCZD

Yen, C.-J., Tu, C.-H., Sujo-Montes, L., & Sealander, K. (2016). A Predictor for PLE Management: Impacts of Self-Regulated Online Learning on Students' Learning Skills. *Journal of Educational Technology Development and Exchange, 9*(1), 29-48. https://doi.org/10.18785/jetde.0901.03.