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DIGITAL TOOLS AND ACTIVE LEARNING IN AN ONLINE UNIVERSITY: IMPROVING THE ACADEMIC PERFORMANCE OF FUTURE TEACHERS

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Abstract

The use of digital tools forms part of any online educational context. When it comes to the training of future teachers, this point proves crucial in order to transfer this technology to classrooms. In addition to the above, incorporating this type of resources as a part of an active learning proposal will enhance their motivation, self-regulation and autonomy, in addition to having a possible effect on their academic achievement. This research refers to the evaluation of an active educational learning proposal in which a pre-experimental design was used without a control group to study the possible relationship between the use of digital tools and the academic achievement of the students. The sample consisted of 908 students divided into three academic years. The results show that the students who used more tools, actively participating in the proposed activities, obtained better final grades and better marks on the continuous evaluation activities, which they completed in a higher percentage ($p<0.001$). It was possible to conclude that the use of digital tools in an active learning proposal contributes to improving the academic achievement of future teachers, as well as student participation and involvement.

Keywords – Teacher training, Active method, Performance, Educational technology, Online university.

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1. Introduction

When referring to teacher training in the context of an online university, digital tools and, by extension, digital competence, play a key role in the teaching and learning process. For both the professors who teach the subjects and the future teachers, knowledge of digital resources will be a necessary aspect for the teaching of some and the learning of others (Ferrari, 2012; Instefjord & Munthe, 2017; Kumar & Kumar, 2018; Prendes, Gutiérrez & Martínez, 2018; Romero-García, Buzón-García, Sacristán-San-Cristóbal & Navarro-Asencio, 2020; Sánchez-Cruzado, Santiago Campión & Sánchez-Compaña, 2021; Vera & García-Martínez, 2022).

In this sense, it should be stressed that this is not merely a matter of technological knowledge, but rather, in the educational context, the knowledge should also be on a pedagogical and instructional level. It is necessary to consider the final objective in order to employ the tools and be aware of the fact that they

will be one of many possible resources in classrooms (Huber, 2008; Llopis-Nebot, Viñoles-Consentino, Esteve-Mon & Adell-Segura, 2021; Mirete, Maquilón, Mirete & Rodríguez, 2020).

Despite what is mentioned above, in an online context, there is little doubt that these tools take on a more leading role, since they can be the key for a more active learning and teaching experience for the students, a concept which we will examine in greater depth below (Romero-García, Buzón-García & Touron, 2019). Consequently, teacher training in digital competence is essential (Guillén-Gámez, Cabero-Almenara, Llorente-Cejudo & Palacios-Rodríguez, 2022; Moreno-Guerrero, López-Belmonte, Pozo-Sánchez & López-Núñez, 2020; Prendes et al., 2018; Salinas & de Benito, 2020). In addition, in reference to online education, it should be emphasized that this constitutes a paradigm change that cannot be understood as a mere change in context, as it involves restructuring at all levels (instructional design, methodology, interaction and resources, among others) (Peñalosa-Castro & Castañeda-Figueiras, 2021; Peters, Guitert-Catasús & Romero, 2021; Romero-García et al., 2019; Sangrà, 2020). It is not the emergency education that took place during the health crisis caused by the COVID pandemic (Hodges, Moore, Lockee, Trust & Bond, 2020; Maile-Cutri & Mena, 2020; Mattar, 2022; Sangrà, 2020).

In relation to teacher training and the development of the digital competence, numerous studies have determined that the perception of the students themselves of this is not very positive, although is true that there are other studies that indicate the opposite (Girón-Escudero, Cózar-Gutiérrez & González-Calero-Somoza, 2019; López-Meneses, Sirignano, Vázquez-Cano & Ramírez-Hurtado, 2020; Sánchez-Caballé, Gisbert-Cervera & Esteve-Mon, 2020). Generally speaking, in addition to this personal reflection about their competence, most research shows that the digital competence of teachers has a long way to go in order to reach a minimally acceptable level (Fernández & Fernández, 2016; Fernández, Tarabini & Lell, 2018; Gómez-Trigueros, Ruiz-Bañuls & Ortega-Sánchez, 2019; Llopis-Nebot et al., 2021; Mirete et al., 2020; Spante, Sofkova-Hashemi, Lundin & Algers, 2018; Zhao, Pinto Llorente & Sánchez Gómez, 2021). In this sense, beginning to develop this instructional competence as part of university training may be a good option, possibly even more so if we were to find an online context where digital tools would necessarily occupy a privileged position, as has been previously mentioned (Liesa-Orús, Vázquez-Toledo, & Lloret-Gazo, 2016; Moreno-Rodríguez, Gabarda-Méndez & Rodríguez-Martín, 2018; Prendes, Castañeda & Gutiérrez-Porlán, 2010; Spante et al., 2018; Zhao et al., 2021).

Even so, tools are not the same as digital competence, since tools only constitute part of said competence. This is reflected in the classifications of the digital competence of teachers by INTEF (2017) and the European Commission (Redecker & Punie, 2017), in which the tools occupy only part of the different dimensions included. This remains the trend in the recent review by the INTEF in 2022.

Taking into account the five dimensions proposed by the INTEF (2017), it can be seen that the majority of the tools are situated in areas 2 and 3, which refer to communication and collaboration and content creation. In the case of the European framework (Redecker & Punie, 2017), divided into six areas, digital resources are found primarily in areas 2, 3, 4, 5 and 6, which are related to digital contents, teaching and the learning, evaluation and feedback, the empowerment and the development of digital competence in students. While the European classification (Redecker & Punie, 2017) does not include separate sections dedicated to security or digital literacy, the INTEF (2017) does consider them. It can thus be said that these are two complementary classifications, with relevant aspects to take into account, because the two above-mentioned aspects, security and digital literacy, are essential for the proper development of digital competence in both teachers and students. In turn, the 2022 update (INTEF, 2022) comes closer to the division proposed by the European Commission (Redecker & Punie, 2017), considering the same six areas, and adding an important distinction between the professional competences of educators (related to areas 1 and 2), the instructional competences of the educators (related to areas 2, 3, 4 and 5) and the competences of students (related to areas 5 and 6) (INTEF, 2022).

Another interesting matter that should be evaluated is the significance of the latter areas included in the European framework (Cabero-Almenara, Gutiérrez-Castillo, Palacios-Rodríguez & Barroso-Osuna, 2020; INTEF, 2022; Redecker & Punie, 2017), areas 5 and the 6, dedicated to students and the role of the

teachers in the development of their digital competence. This becomes a much more relevant aspect if these students consist of future teachers, as in the case of the current study. These two areas mark the evolution from the concept of ICT (Information and Communication Technologies) to that of LKT (Learning and Knowledge Technologies), ending up with what seems to be reflected in these two aforementioned areas, which is the concept of PET (Participation and Empowerment Technologies) (Fernández et al., 2018; Gómez-Trigueros et al., 2019; Pinto-Santos, Cortés-Peña & Alfaro-Camargo, 2017).

Returning to the fact that reference is being made to an online context, it should be stressed that the future relevance of the use of digital tools should be focused not only on the development of certain dimensions of digital competence that have been presented, but also on other aspects that should be considered in a distance learning setting. In this manner, the fact that the resources can contribute to the autonomy of students, to creating a sense of group, to developing their self-regulation or motivation, will be some of the more positive aspects to consider when it comes to deciding to introduce the ICT in an online context (Azevedo, Cromley, Winters, Moos & Greene, 2006; Mosquera-Gende, 2022a; Peñalosa-Castro & Castañeda-Figueiras, 2021). It is therefore necessary to train teachers, both present and future, in the development of their digital competence (López-Meneses et al., 2020; Mosquera-Gende, 2021; Sánchez-Caballé et al., 2020).

When talking about self-regulation, autonomy or motivation, we are referring to certain characteristics that are often associated with active learning. Although it is a concept that is currently being used to encompass the so-called active methodologies, as early as 1995, Schwartz and Pollishuke spoke about active learning as that which allows students to make decisions and solve problems. Active learning implies a non-compartmentalized learning, based on real situations and involving experimentation, reflection, dialog and the development of a critical attitude. Another important characteristic of active learning is the quest for flexibility and personalization of learning, so that students can work at their own pace (Mosquera-Gende, 2022a; Peñalosa-Castro & Castañeda-Figueiras, 2021). The interaction also highlights the active learning on three levels: among the students themselves, with the instructors and with the contents. With regard to this last point, ICTs serve to facilitate the instructional dialog with the contents, allowing the students to create their own materials and follow personalized learning itineraries, as mentioned above, which contributes to their digital competence, their autonomy and their self-regulation skills (Mosquera-Gende, 2022a; 2022b; Murillo-Zamorano, López-Sánchez, Godoy-Caballero & Bueno-Muñoz, 2021; Peñalosa-Castro & Castañeda-Figueiras, 2021; Romero-García & Buzón-García, 2021).

Specifically, with regard to the university, the need is stressed for it to be self-regulated, situated and social learning, as well as active, emphasizing the relevance of the interactive and reflective component, making it applicable to the real world. All of this is connected to a constructivist approach and with a gradual acquisition of learning (Huber, 2008). This need to stagger the learning is related to the gradual introduction of digital tools in the educational context: first they are presented to the students; secondly, the students use them; and thirdly, the students create with them (Mosquera-Gende, 2021; Tourón, Martín, Navarro, Pradas & Íñigo, 2018). Related to this last point regarding the creation of material, many studies reveal good results in their implementation at the university level (De la Iglesia-Villasol, 2019; Itati-Mariño, Cardozo & Alfonzo, 2021; Mosquera-Gende, 2022a; Peñalosa-Castro & Castañeda-Figueiras, 2021). In this sense, numerous studies in higher education highlight the importance of the entertainment component and the good results of the cooperation among peers (González-Cabanach, Valle-Arias, Rodríguez-Martínez, García-Gerpe & Mendiri-Ruiz de Alda, 2007; Mosquera-Gende, 2022b; Murillo-Zamorano et al., 2021), aspects that also have a place in an active learning framework.

If we add to all of this the possibility that the use of digital tools and active learning can contribute to improving the academic performance of students, this option would be an even more complete proposal (González-Cabanach et al., 2007; Hartikainen, Rintala, Pylväs & Nokelainen, 2019). Both at the university

and the previous educational stages, we can find examples that link the use of the so-called active methodologies to an improvement in the academic results of the students, that is to say, in their performance (García-Peñalvo, Alarcón & Domínguez, 2019; Hartikainen et al., 2019). Numerous studies on the analysis of the student achievement reveal a relationship between study habits, the self-regulation of students and their academic results, with many also adding the relevance of social relations and interaction (Fernández-Lasarte, Ramos-Díaz & Axpe-Sáez, 2019; González-Cabanach et al., 2007). Likewise, in reference to certain aforementioned characteristics of active learning, there is also research that indicates that the promotion of student creativity, the support by the faculty, the development of their critical thinking and proper motivation represent the right ingredients to improve the performance of university students (Alquichire & Arrieta, 2018; Rincon-Flores & Santos-Guevara, 2021).

Consequently, in order for active learning to be successful at the university, contributing to improved academic achievement of the students, as well as their participation and involvement, instructors need to be trained in educational and instructional methods, as well as in their individual disciplines or in the knowledge and handling of digital tools (Huber, 2008).

Considering all the aspects covered, the overall objective of this research is to evaluate the influence that the use of digital tools has on the academic achievement of future English language teachers, as part of an active learning proposal in an online educational environment.

With this purpose in mind, two specific objectives are presented:

- To verify whether the use of digital tools, as part of an active learning proposal in an online educational environment, has an influence on the academic results of the students.
- To analyze, longitudinally, whether the relationship between the use of tools and the student performance varies over the different academic years that form part of this research.

2. Methodology

A total of 908 students participated in the study, of which 87% are women, who are the most represented in the degree programs studied. A large proportion are also Elementary Education degree students, accounting for approximately 61%. The rest were studying a master's degree in Compulsory Secondary Education and Baccalaureate Teacher Training, Vocational Training and Language Teaching. In all cases, we are talking about implementation in the corresponding subjects of English Language Instruction, within the framework of the two aforementioned degrees.

Academic year	Type of study	Gender	N	%
17/18	Primary	Male	16	1.76
		Female	106	11.67
18/19	Primary	Male	24	2.64
		Female	116	12.78
	Secondary	Male	23	2.53
		Female	194	21.37
19/20	Primary	Male	41	4.52
		Female	258	28.41
	Secondary	Male	12	1.32
		Female	118	13.00
Total			908	100

Table 1. Frequencies and percentages of participants by academic year, type of studies and gender

Considering the educational context where the experience takes place, it was considered essential to contribute to the development of the digital competence of the students, future teachers, as well as to

promote the creation of cooperative joint tasks that could foster greater participation in the courses and promote greater motivation with regard to them.

For this purpose, a specific forum was created, on which certain challenges were proposed that students needed to overcome jointly in order to obtain incentives (Mosquera-Gende, 2021; 2022a). The challenges gradually increased in complexity, in terms of both the number of students required to successfully pass them and the task involved, always related to the course content and the use of one or more free digital tools. Similarly, each challenge had a deadline for its resolution. In the proposed case, the rewards, always collective, meant access to an exam question pool, divided by issues, which were activated in the case of passing the proposed challenges. Some examples are presented below:

- Creation of a word cloud with terms referring to certain specific topics and the creation of an avatar, using it as the profile photo on the platform (this way, all students had a personalized image for forums participation; otherwise, everyone would have had a generic avatar). This was usually the first challenge for every course, following the aforementioned maxim that there is an increasing degree of complexity of the requested challenges.
- Development of self-correctable questionnaires related to the topics being studied (they remain available to the rest of their classmates and can be used by everyone to review).
- Creation of a video about a topic or part of a topic. This can be an animated video or a video accompanied by a presentation. As with any other activity, the results were made available to all students.

The completion of the challenges was evaluated according to the requested number of participants; the work by the students according to the criteria set for each challenge; and the meeting of the deadline set for each challenge. In addition, the instructor reviewed the students' creations in order to correct or comment on them, as necessary, if they were providing incorrect data or information to their classmates. Feedback was provided in this way on them. It can therefore be said that informal evaluation took place, but no grade was assigned.

The selected digital tools were always free, in order to permit access by all students. They were also easy to use, in order to avoid requiring excessive extra work, since this activity was voluntary. Another criterion used to select the tools referred to their educational possibilities for future teachers. In this sense , some of the tools that stood out were: Flipgrid (to develop audiovisual forums); Powtoon (to record animated videos); Loom (a screen recorder); Easel.ly (to create infographs); Kahoot, Quizizz, Quizbean and Topgrade (questionnaires); WordArt (to create word clouds); EzGIF (to create animated GIFs) and Twitter (the social network used for educational purposes), among others (Mosquera-Gende, 2022b; 2023).

For the evaluation of the effects of the educational intervention, a pre-experimental design without a control group was used. The purpose of this evaluation is to link the academic results to the use of digital tools in order to propose improvements in later implementations. As result variables, the grade on the practical activities, the final evaluation grade and the percentage of activities completed were used.

	17/18		**18/19**		**19/20**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Practical activity grade	2.806	1.175	3.309	1.108	3.348	1.024
Final score	6.768	2.984	7.799	2.743	7.437	3.291
% of activities completed	38.043	17.733	63.659	27.413	65.837	28.014

Table 2. Means and standard deviations of the result variables for the three academic years

The assumed normality of the distribution of scores was verified using the Kolgomorov-Smirnov statistic, as shown in the following table:

	17/18		18/19		19/20	
	K-S statistic	**P value**	**K-S statistic**	**P value**	**K-S statistic**	**P value**
Practical activity grade	0.155	0.074	0.307	0.00	0.307	0.00
Final score	0.241	0.001	0.253	0.00	0.283	0.00
% of activities completed	0.185	0.018	0.2	0.00	0.188	0.00

Table 3. Normality tests (Kolgomorov-Smirnov) for the dependent variables and the associated probability, according to the academic year

The test results indicate that normality is only met for the continuous evaluation grade in the academic year 17/18. Therefore, all variables will be considered to be non-normal, and as a result, non-parametric tests have been used for the statistical inference.

The comparison factors of these results are the number of digital tools used by the participants:

	17/18		18/19		19/20	
Tools	**N**	**%**	**N**	**%**	**N**	**%**
None	50	72.46	108	53.47	92	38.17
1 or 2	8	11.59	47	23.27	68	28.22
More than 2	11	15.94	47	23.27	81	33.61
Total	69	100.00	202	100.00	241	100.00

Table 4. Frequencies and percentages of the number of tools used by academic year

Regarding the data analysis plan, first of all, related to the first specific objective, we have compared the results of the three dependent variables (practical activity grade, final grade and percentage of activities performed) according to the number of digital tools used by means of a Kruskal-Wallis H test. This test analyzes the differences among the ranges of three or more groups and, in a complementary manner, a Mann-Whitney U test was used to analyze the differences between the results of each pair of groups. That is to say, the results of the group that did not use any tools was contrasted with those who used 1 or 2 tools, those who used none were compared to those who used more than 2 tools and those who used 1 or 2 tools were contrasted with those who used more than 2 tools.

Secondly, related to the second specific objective, the comparisons were carried out separately for each academic year. The analysis strategy is the same as in the previous step; first of all, the Kruskal-Wallis test was run to compare the results of the three tool use groups, and in a second step, each pair of groups was compared using the Mann-Whitney statistical U.

3. Results

The results of the comparison are shown below between the different groups formed according to number tools used (none, 1 or 2 and more than 2) for the entire sample. Table 5 shows the average ranges in each of the groups that are compared, together with the value of the Kruskal-Wallis statistic and the related probability (P value).

A range is a transformation of the original scale of the variables in the results (practical activity grade, final grade and % of activities), organizing the values from highest to lowest, in order to provide an ordinal distribution. For example, the student with the lowest score on the final grade was assigned the value of 1, the next was assigned 2, etc., and once in order, the average ranges of each group were compared. A higher average range therefore indicates a higher score in that group.

The Kruskal-Wallis test indicates differences in the three variables in the results, according to the number of tools used. If we focus on the average ranges, a higher level is observed for the group that uses more than 2 tools.

	Tools	N	Mean	Kruskal-Wallis H	df	P value
Practical activity grade	None	250	204.19	84.292	2	0.00
	1 or 2	123	273.44			
	More than 2	139	335.59			
	Total	512				
Final score	None	250	190.05	117.685	2	0.00
	1 or 2	123	277.85			
	More than 2	139	357.13			
	Total	512				
% activities	None	250	207.73	68.641	2	0.00
	1 or 2	123	266.03			
	More than 2	139	335.78			
	Total	512				

Table 5. Average ranges of the variables in the results, according to the number of used tools, the Kruskal-Wallis test and significance

The subsequent verifications performed with the Mann-Whitney U test (Table 6) indicate statistically significant differences among the three groups. Therefore, it is confirmed that the group of students that uses more than 2 tools earned better grades on the practical activities, on the final course grade and on the percentage of activities that they performed. It can also be stated, in the light of these results, that the group that earned the lowest scores is the one that did not use any tools.

	None vs. 1 or 2			None vs. more than 2			1 or 2 vs. more than 2		
	Grade on practical activities	Final grade	% Activities	Grade on practical activities	Final grade	% Activities	Grade on practical activities	Final grade	% Activities
M-W & U	11040.5	9926	11648.5	8632.5	6210.5	8910	6298	5726	5994
P value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6. Subsequent comparisons with the Mann-Whitney U test and the related probability

Table 7 shows that in the 17/18 academic year, the group that uses more than 2 tools has a higher average range for all three variables. This trend is repeated in the rest of the academic years. In addition, the Kruskal-Wallis test obtains significant values, and therefore it confirms the existence of differences in the results among the groups.

		Tools	N	Mean	Kruskal-Wallis H	df	P value
17/18	Practical activity grade	None	50	28.52	19.543	2	0.00
		1 or 2	8	49.88			
		More than 2	11	53.64			
		Total	69				
	Final score	None	50	27.72	24.065	2	0.00
		1 or 2	8	52.56			
		More than 2	11	55.32			
		Total	69				
	% activities	None	50	29.46	16.631	2	0.00
		1 or 2	8	42.38			
		More than 2	11	54.82			
		Total	69				

		Tools	N	Mean	Kruskal-Wallis H	df	P value
18/19	Practical activity grade	None	108	86.65	21.812	2	0.00
		1 or 2	47	107.94			
		More than 2	47	129.19			
		Total	202				
	Final score	None	108	74.84	52.087	2	0.00
		1 or 2	47	120.53			
		More than 2	47	143.72			
		Total	202				
	% activities	None	108	90.37	12.914	2	0.00
		1 or 2	47	102.01			
		More than 2	47	126.56			
		Total	202				
19/20	Practical activity grade	None	92	93.7	38.995	2	0.00
		1 or 2	68	118.68			
		More than 2	81	153.96			
		Total	241				
	Final score	None	92	92.26	43.567	2	0.00
		1 or 2	68	112.26			
		More than 2	81	160.98			
		Total	241				
	% activities	None	92	93.66	35.978	2	0.00
		1 or 2	68	116.86			
		More than 2	81	155.53			
		Total	241				

Table 7. Average ranges of the variables in the results, according to the number of used tools, the Kruskal-Wallis test and significance in each academic year

Table 8 includes the results of the comparisons of each pair of groups in terms of the tools used. In this way, the results of the Mann-Whitney U test indicate the existence of differences among the three variables between each pair of groups in the three academic years, except in the 17/18 and 18/19 academic years; in the percentage of activities performed by students who did not use tools and those who used 1 or 2 tools; and also in all three variables (practical activity grade, final grade and % of activities) between the groups that used 1 or 2 tools and those who use more than 2 in the 17/18 academic year.

		None vs. 1 or 2			None vs. more than 2			1 or 2 vs. more than 2		
		Practical activities grade	Final grade	% Activities	Practical activities grade	Final grade	% Activities	Practical activities grade	Final grade	% Activities
17/18	M-W U	76.5	51.5	121	74.5	59.5	77	39.5	36	24
	P value	0.005	0.001	0.066	0.00	0.00	0.00	0.668	0.508	0.056
18/19	M-W U	1995	1370	2220.5	1477	827	1653.5	864	831	811
	P value	0.025	0.00	0.211	0.00	0.00	0.00	0.024	0.038	0.024
19/20	M-W U	2416	2541.5	2473	1926.5	1668.5	1865.5	1884	1573.5	1817.5
	P value	0.010	0.042	0.021	0.00	0.00	0.00	0.00	0.00	0.00

Table 8. Subsequent comparisons with the Mann-Whitney U test and the probability associated with each academic year

4. Conclusions

With regard to the results obtained and the initially proposed objectives, it has been possible to demonstrate, according to the data analyzed in Table 5, that the mean ranges of the variables in the results present significant differences, according to the number of tools used, with the group that used more than 2 tools showing the highest level according to the Kruskal-Wallis test.

These results are also supported by the subsequent verifications made by the Mann-Whitney's U test, which once again indicates a clear and significant difference among the three groups. With this in mind, and continuing with the first objective of this work with regard to this study, it can be confirmed that students who have used 2 or more tools when completing the voluntary challenges proposed have obtained better academic results on both the practical activities and on the final course grade. On a similar note, these are also the students who perform the most continuous evaluation activities, which could likely have an effect on their motivation for this course. It should also be remembered that there are many other variables that can also have an influence, as will be mentioned below.

On the other hand, continuing with the analysis of these same data, it is detected that the students with the worst performance are those who do not use any tools and therefore, without being able to assess or investigate the reasons why, they are the ones who are the least involved in the voluntary active learning proposals offered in the course, either for personal or motivational reasons.

These same trends are repeated in all three courses analyzed, as is shown in Table 7, in which significant values are once again obtained for the Kruskal-Wallis test. These results are in agreement with those obtained in previous studies, such as that by Pardo-Cueva, Chamba-Rueda, Gómez and Jaramillo-Campoverde (2020), which investigated the specific use of the Padlet tool in a university context. In many of the studies analyzed, in addition to referring to the use of ICTs, emphasis is placed on some of the active learning characteristics indicated in the initial section of this article, and which are present in the proposal offered to the students in this intervention. This is the case of cooperation, interaction, participation, self-regulation and the role of the instructor, which are highlighted as key aspects for improving student performance (Pardo-Cueva et al., 2020; Fernández-Lasarte et al., 2019). However, we must not omit studies like that by Vásquez-Córdova (2021), which indicate that self-regulation is not a determining factor for improving performance at the university. It should be pointed out that in this case, it does not consider an online context, in which self-regulation can play a crucial role (Azevedo et al., 2006; Peñalosa-Castro & Castañeda-Figueiras, 2021).

The last table presented, Table 8, compares the results of all three academic years analyzed, thus fulfilling the second objective established for this work. While there are no significant differences with regard to continuous evaluation (% of activities) and the use of tools (number of tools used) in the 2017/18 and 2018/19 academic years, the results of the Mann-Whitney's U test indicate the difference among the three variables in each pair of groups in three academic years is more significant with the progression of the years. For this reason, it is believed that the modifications and improvements that are implemented in the proposal taking into account the students' results, their participation and their comments in forums, contribute to an improvement in their academic performance and their involvement and motivation towards the course, in turn promoting active learning, which coincides with the results of the study by Guillén-Gámez et al. (2022).

As mentioned earlier, in cannot be concluded that the use of tools necessarily leads to improved performance, since it is believed that there are many other variables that could have an influence and which are not being considered. Accordingly, it would be interesting to know the students' previous grades or those they have earned in other courses that they are studying at the same time in order to establish true causal relationships between the use of digital tools in an online context of active learning and the academic performance of the students (Cheng, Huang, Gribbins & Swan, 2018; Fernández-Lasarte et al., 2019). It would also be relevant to conduct a gender study related to performance and the use of digital tools within an active learning proposal, given that there are promising studies in this regard (Aguillon,

Siegmud, Petipas, Drake, Cotner & Ballen, 2020; Guillén-Gámez, Mayorga-Fernández & Del Moral, 2020; Jiménez-Cortés, Vico-Bosch & Rebollo-Catalán, 2017). Therefore, there are many aspects that remain to be studied in greater depth, but it is believed that the combination of an educational use based on digital tools and active learning strategies could be a good ally in order to improve student performance in the context of an online university.

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References

Aguillon, S.M., Siegmud, G.-F., Petipas, R.H., Drake, A.G., Cotner, S., & Ballen, C.J. (2020). Gender differences in student participation in an activel-learning classroom. *CBE Life Sciences Education,* 19(2). https://doi.org/10.1187/cbe.19-03-0048

Alquichire, S.L., & Arrieta, J.C. (2018). Competencias en TIC y rendimiento académico en la universidad: Diferencias por género. Voces y Silencios. *Revista Latinoamericana de Educación,* 9(1), 28-52. https://doi.org/10.18175/vys9.1.2018.03

Azevedo, R., Cromley, J., Winters, F., Moos, D., & Greene, J. (2006). Using computers as meta-cognitive tools to foster students' self-regulated learning. *Cognition and Learning*, 3, 97-10.

Cabero-Almenara, J., Gutiérrez-Castillo, J.J., Palacios-Rodríguez, A., & Barroso-Osuna, J., (2020). Development of the teacher digital competence validation of DigCompEdu check-in questionnaire in the university context of Andalusia (Spain). *Sustainability,* 12(15), 6094. https://doi.org/10.3390/su12156094

Cheng, Ch., Huang, Ch., Gribbins, M., & Swan, K. (2018). Gamify online courses with tools built into your learning management system (LMS) to enhance self-determined and active learning. *Online Learning,* 22(3). 41-54. https://doi.org/10.24059/olj.v22i3.1466

De la Iglesia-Villasol, M. C. (2019). Huellas de los estudiantes en las plataformas virtuales. Aplicación para evaluar una metodología de aprendizaje activo. *Revista Electrónica Interuniversitaria de Formación del Profesorado,* 22(3), 173-191. https://doi.org/10.6018/reifop.371341

Fernández, F.J., & Fernández, M.J. (2016). Los docentes de la Generación Z y sus competencias digitales. *Comunicar,* 24(46), 97-105. https://doi.org/10.3916/C46-2016-10

Fernández, G.E., Tarabini, N., & Lell, A. (2018). El tránsito de las tecnologías de la información a las tecnologías del empoderamiento y la participación en las aulas universitarias. Tecnología, Diseño e Innovación, 4(1). https://www.unae.edu.py/ojs/index.php/facat/article/view/99

Fernández-Lasarte, O., Ramos-Díaz, E., & Axpe-Sáez, I. (2019). Rendimiento académico, apoyo social percibido e inteligencia emocional en la universidad. E*uropean Journal of Investigation in Health, Psychology and Education,* 9(1), 39. https://doi.org/10.30552/ejihpe.v9i1.315

Ferrari, A. (2012). Digital competence in practice: An analysis of frameworks. *JRC Technical Reports.* Eupean Comission. Available at: https://ifap.ru/library/book522.pdf

García-Peñalvo, F.J., Alarcón, H., & Domínguez, Á. (2019). Active learning experiences in Engineering Education. *International Journal of Engineering Education,* 35(1B), 305-309. Available at: https://bit.ly/35v10Yn

Girón-Escudero, V., Cózar-Gutiérrez, R., & González-Calero-Somoza, J.A. (2019). Análisis de la autopercepción sobre el nivel de competencia digital docente en la formación inicial de maestros/as. *Revista Electrónica Interuniversitaria de Formación del Profesorado,* 22(3), 193-218. https://doi.org/10.6018/reifop.373421

Gómez-Trigueros, I.M., Ruiz-Bañuls, M., & Ortega-Sánchez, D. (2019). Digital literacy of teachers in training: Moving from ICTs (Information and Communication Technologies) to LKTs (Learning and Knowledge Technologies). *Educational Science,* 9(4), 274. https://doi.org/10.3390/educsci9040274

González-Cabanach, R., Valle-Arias, A., Rodríguez-Martínez, S., García-Gerpe, M., & Mendiri-Ruiz de Alda, P. (2007). Programa de intervención para mejorar la gestión de los recursos motivacionales en estudiantes universitarios. *Revista Española de Pedagogía,* 65(237), 237-256. Available at: https://dialnet.unirioja.es/descarga/articulo/2355442.pdf

Guillén-Gámez, F.D., Mayorga-Fernández, M.J., & Del Moral, M.T. (2020). Comparative research in the digital competence of the pre-service education teacher: Face-to-face vs blended education and gender. *Journal of E-Learning and Knowledge Society,* 16(3), 1-9. https://doi.org/10.20368/1971-8829/1135214

Guillén-Gámez, F.D., Cabero-Almenara, J., Llorente-Cejudo, C., & Palacios-Rodríguez, A. (2022). Differential analysis of the years of experience of higher education teachers, their digital competence and use of digital resources: Comparative research methods. *Technology, Knowledge and Learning*, 27, 1193-1213. https://doi.org/10.1007/s10758-021-09531-4

Hartikainen, S., Rintala, H., Pylväs, L., & Nokelainen, P. (2019). The concept of active learning and the measurement of learning outcomes: A review of research in engineering higher education. *Education Science,* 9(4), 276. https://doi.org/10.3390/educsci9040276

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The Difference Between Emergency Remote Teaching and Online Learning. *EDUCAUSE Review*, March 27. Available at: https://bit.ly/3qe93z2

Huber, G.L. (2008). Aprendizaje activo y metodologías educativas. *Revista de Educación*, extraordinary number 2008, 59-81. Available at: https://bit.ly/2UNu5cn

Instefjord, E.J., & Munthe, E. (2017). Educating digitally competent teachers: a study of integration of professional digital competence in teacher education. *Teaching and Teacher Education*, 67, 37-45. https://doi.org/10.1016/j.tate.2017.05.016

INTEF (2017). *Marco Común de Competencia Digital Docente*. Ministerio de Educación, Cultura y Deporte. Available at: https://bit.ly/2UHnsbn

INTEF (2022). *Marco de Referencia de la Competencia Digital Docente*. Ministerio de Educación, Cultura y Deporte. Available at: https://bit.ly/3rsEfMj

Itati-Mariño, S., Cardozo, G., & Alfonzo, P.L. (2021). Agilidad en el aprendizaje activo: propuesta en la asignatura modelos y simulación/Agility in active learning: proposal in the subject Models and Simulation. Mendive. *Revista de Educación,* 19(2), 542–554. Available at: https://bit.ly/36C896z

Jiménez-Cortés, R., Vico-Bosch, A., & Rebollo-Catalán, A. (2017). Female university student's ICT learning strategies and their influence on digital competence. *International Journal of Educational Technology in Higher Education,* 14(1), 2-12. https://doi.org/10.1186/s41239-017-0040-7

Kumar, A., & Kumar, G. (2018). The role of ICT in higher education for the 21st century: ICT as a change agent for education. *Multidisciplinary Higher Education. Research, Dynamics y Concepts,* 1(1), 76-83. Available at: https://bit.ly/2VDpnOA

Llopis-Nebot, M.A., Viñoles-Consentino, V., Esteve-Mon, F.M., & Adell-Segura, J. (2021). Diagnostic and educational self-assessment of the digital competence of university teachers. *Nordic Journal of Digital Literacy,* 16(3-4), 115-131. https://doi.org/10.18261/issn.1891-943x-2021-03-04-03

López-Meneses, E., Sirignano, F.M., Vázquez-Cano, E., & Ramírez-Hurtado, J.M. (2020). University students' digital competence in three areas of the DigCom 2.1 model: A comparative study at three European universities. *Australasian Journal of Educational Technology,* 36(3), 69-88. https://doi.org/10.14742/ajet.5583

Liesa-Orús, M., Vázquez-Toledo, S., & Lloret-Gazo, J. (2016). Identificación de las fortalezas y debilidades de la competencia digital en el uso de aplicaciones de internet del alumno de primer curso del Grado de Magisterio. *Revista Complutense de Educación,* 27(2). https://doi.org/10.5209/rev_rced.2016.v27.n2.48409

Maile-Cutri, R., & Mena, J. (2020). A critical reconceptualization of faculty readiness for online teaching. *Distance Education,* 41(3), 361-380. https://doi.org/10.1080/01587919.2020.1763167

Mattar, J. (Coord.) (2022). *Educação a Distância Pós-Pandemia*. Artesanato Educacional.

Mirete, A.B., Maquilón, J.J., Mirete, L., & Rodríguez, R.A. (2020). Digital competence and university teachers' conceptions about teaching. A structural causal model. *Sustainability,* 12(12), 4842. https://doi.org/10.3390/su12124842

Moreno-Rodríguez, M. D., Gabarda-Méndez, V., & Rodríguez-Martín, A.M.R.M. (2018). Alfabetización informacional y competencia digital en estudiantes de Magisterio. *Profesorado, Revista de Currículum y Formación del Profesorado,* 22(3). https://doi.org/10.30827/profesorado.v22i3.8001

Moreno-Guerrero, A.J., López-Belmonte, J., Pozo-Sánchez, S., & López-Núñez, J.A. (2020). Estado de la competencia digital docente en las distintas etapas educativas desde un alcance internacional. *Revista Espacios,* 41(16). Available at: http://www.revistaespacios.com/a20v41n16/a20v41n16p19.pdf

Mosquera-Gende, I. (2021). El desarrollo de la competencia digital de futuros docentes en una universidad en línea. *Bordón. Revista de Pedagogía,* 73(4), 121-143. https://doi.org/10.13042/Bordon.2021.89823

Mosquera-Gende, I. (2022a). Flexibilizar el proceso de enseñanza y aprendizaje en una universidad online. *Edutec. Revista Electrónica de Tecnología Educativa*, 79, 199-213. https://doi.org/10.21556/edutec.2022.79.2351

Mosquera-Gende, I. (2022b). Herramientas digitales colaborativas para la formación de futuros docentes en una universidad online. *REDU. Revista de Docencia Universitaria,* 20(1), 35-50. https://doi.org/10.4995/redu.2022.16806

Mosquera-Gende, I. (2023). *Aprendizaje informal en redes. Twitter y las #CharlasEducativas*. Octaedro. https://doi.org/10.36006/16414

Murillo-Zamorano, L.R., López-Sánchez, J.Á., Godoy-Caballero, A.L., & Bueno-Muñoz, C. (2021). Gamification and active learning in higher education: is it possible to match digital society, academia and students' interests? *International Journal of Educational Technology in Higher Education,* 18(15). https://doi.org/10.1186/s41239-021-00249-y

Pardo-Cueva, M., Chamba-Rueda, L.M., Gómez, Á.H., & Jaramillo-Campoverde, B.G. (2020). Las TIC y el rendimiento académico en la educación superior: una relación potenciada por el uso de Padlet. *Revista Ibérica de Sistemas e Tecnologias de Informação*, 28, 934-944.

Peñalosa-Castro, E., & Castañeda-Figueiras, S. (2021). Generación de conocimiento en la educación en línea: un modelo para el fomento de aprendizaje activo y autorregulado. *Revista Mexicana de Investigación Educativa,* 13(36), 249-281. Available at: https://bit.ly/3hIhdgG

Peters, M., Guitert-Catasús, M., & Romero, M. (2021). Student learning ecologies in online higher education: a model to support connected learning across contexts. *Higher Education Research & Development*. https://doi.org/10.1080/07294360.2021.2014408

Pinto-Santos, A.R., Cortés-Peña, O., & Alfaro-Camargo, C. (2017). Hacia la transformación de la práctica docente: modelo espiral de competencias TICTACTEP. *Pixel-Bit. Revista de Medios y Educación*, 51, 37-51. https://doi.org/10.12795/pixelbit.2017.i51.03

Prendes, M.P., Castañeda, L., & Gutiérrez-Porlán, I. (2010). Competencias para el uso de TIC de los futuros maestros. *Comunicar*, 35, 175-182. https://doi.org/10.3916/C35-2010-03-11

Prendes, M.P., Gutiérrez, I., & Martínez, F. (2018). Competencia digital: una necesidad del profesorado universitario en el siglo XXI. *RED. Revista de Educación a Distancia*, 56(7). https://doi.org/10.6018/red/56/7

Redecker, C., & Punie, Y. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu.* Publications Office of the European Union. Available at: https://bit.ly/3y263ch

Rincon-Flores, E.G., & Santos-Guevara, B.N. (2021). Gamification during Covid-19: Promoting active learning and motivation in higher education. *Australasian Journal of Educational Technology,* 37(5), 43-60. https://doi.org/10.14742/ajet.7157

Romero-García, C., Buzón-García, O., Sacristán-San-Cristóbal, M., & Navarro-Asencio, E. (2020). Evaluación de un programa para la mejora del aprendizaje y la competencia digital en futuros docentes empleando metodologías activas. *Estudios sobre Educación*, 39, 179-205. https://doi.org/10.15581/004.39.179-205

Romero-García, C., Buzón-García, O., & Touron, J. (2019). The flipped learning model in online based education for secondary teachers. *Journal of Technology and Science Education*, 9(2), 109-121. https://doi.org/10.3926/jotse.435

Romero-García, C., & Buzón-García, O. (2021). (Coords). *Metodologías activas con TIC en la educación del siglo XXI*. Dykinson. Available at: https://bit.ly/3i18VTB

Salinas, J., & de Benito, B. (2020). Competencia digital y apropiación de las TIC: claves para la inclusión digital. *Campus Virtuales,* 9(2), 99-111. Available at: https://bit.ly/36WmHy1

Sánchez-Cruzado, C., Santiago-Campión, R., & Sánchez-Compaña, M.T. (2021). Teacher Digital Literacy: The Indisputable Challenge after COVID-19. *Sustainability, 13*(4), 1858. https://doi.org/10.3390/su13041858

Sánchez-Caballé, A., Gisbert-Cervera, M., & Esteve-Mon, F. (2020). The digital competence of university students: a systematic literature review. *Aloma: Revista de Psicologia, Ciències de l'Educació i de l'Esport,* 38*(*1), 63-74. https://doi.org/10.51698/aloma.2020.38.1.63-74

Sangrà, A. (Coord.) (2020). *Decálogo para la mejora de la docencia online*. Editorial UOC. Available at: https://bit.ly/3PU5VoD

Schwartz, S., & Pollishuke, M. (1995). *Aprendizaje activo. Una organización de la clase centrada en el alumno*. Narcea.

Spante, M., Sofkova-Hashemi, S., Lundin, M., & Algers, A. (2018). Digital competence and digital literacy in higher education research: Systematic review of concept use. *Cogent Education, 5*(1). http://doi.org/10.1080/2331186X.2018.1519143

Tourón, J., Martín, D., Navarro, E., Pradas, S., & Íñigo, V. (2018). Validación de constructo de un instrumento para medir la competencia digital docente de los profesores (CDD). *Revista Española de Pedagogía,* 76(269), 25-54. https://doi.org/10.22550/REP76-1-2018-02

Vásquez-Córdova, Á.S. (2021). Estrategias de aprendizaje de estudiantes universitarios como predictores de su rendimiento académico. *Revista Complutense de Educación,* 32(2), 159-179. https://doi.org/10.5209/rced.68203

Vera, F., & García-Martínez, S. (2022). Creencias y prácticas de docentes universitarios respecto a la integración de tecnología digital para el desarrollo de competencias genéricas. *Revista Colombiana de Educación,* 1(84), 1-16. https://doi.org/10.17227/rce.num84-11582

Zhao, Y., Pinto Llorente, A.M., & Sánchez Gómez, M.C. (2021). Digital competence in higher education research: A systematic literature review. *Computers and Education*, 168, 104212. https://doi.org/10.1016/j.compedu.2021.104212

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