

# PEDAGOGICAL & TECHNOLOGICAL KNOWLEDGE AND USE OF DIGITAL TECHNOLOGIES BY FACULTY BEFORE AND DURING PANDEMIC TIMES

Martín Omar Moreno Ruíz, José Luis Ramírez-Romero, & José Ángel Vera Noriega  
*Universidad de Sonora (Mexico)*

## Abstract

This paper describes the methodological design and main results of a research project whose main objective was to analyze the relationship between technological and pedagogical knowledge and the use of ICT by faculty at a public university before and during the pandemic. For data collection, an electronic questionnaire was applied to 250 faculty members, and frequencies, contrasts, and correlations of variables were analyzed. Among the main findings were the detection of a significant difference between both type of knowledge, with the later showing higher values in both periods, but the former experiencing a greater increase between periods. We also found significant differences before and during the pandemic in the use of ICT by faculty for planning, designing, and managing environments and experiences; for teaching, learning and curriculum development; and, for assessment and evaluation. However, the greater difference we detected was in the use of ICT for teaching, learning, and curriculum development. Finally, we also detected that technological knowledge is the factor that most strongly predicts ICT use by faculty. We can conclude that the success of universities in guaranteeing academic continuity in the face of similar contingencies necessarily requires a teaching staff competent in the knowledge and pedagogical use of existing and future digital technologies.

**Keywords:** *Pedagogical-technological knowledge, digital technologies, faculty, pandemic.*

---

## 1. Introduction

As a result of the pandemic caused by COVID-19, the World Health Organization (WHO, 2020a) recommended the closure of public and private institutions, affecting all fields of human endeavor. Educational institutions were one of the most affected.

In order to meet the needs of students and guarantee their learning, most countries implemented various measures to accomplish their goals (Dreeseni, et al., 2020; UNESCO, 2020). One of these strategies was remote teaching. This situation generated unscheduled changes, especially in higher education institutions (HEIs) such as the execution of strategies and actions related to the use of communication media such as newspapers, radio, television and other tools based on the use of the Internet such as videoconferences, MS Teams, Google's G suite, chats, streaming and online video, among other applications that work as a bridge to connect institutions, teaching staff and students (Fernández et al., 2020).

Remote teaching requires teachers to have a certain level of skill in the use of ICT, especially related to the use of digital technologies for remote monitoring, management and evaluation of learning (Ayciriet, 2020; Dussel et al., 2020; Kiekel et al., 2020; Zang, 2020). However, traditionally the use of digital technologies in teaching does not usually have a solid pedagogical basis. On the contrary, it is generally at the mercy of fading fads, which in turn causes that "the actual use of these technologies in teaching is not at the required level" (Ahmed et al, 2020, p. 59).

The objective of this work was to analyze the level of pedagogical and technological knowledge and the use of digital technologies by faculty of a Mexican public university, who faced the challenge of teaching remotely during the pandemic

## 2. Methods

This study was quantitative, descriptive, and correlational. A digital questionnaire (<http://encuestaunison.online>) with Likert scale responses was used for data collection. A non-probabilistic sample of 250 faculty from the University of Sonora (Mexico) belonging to different areas was used. The academics were selected by convenience using as a criterion that they had been teaching during the semesters in which classes were suspended due to the pandemic.

Of the faculty members who participated in the study, 50.8% were men and 49.2% were women, whose ages were between 27 and 80 years old. Half of the sample had an average of eleven years working at the university, while 10% had been working at the institution for more than two decades. Most of the subjects (85%) had a laptop while the rest had a personal computer or an electronic tablet.

To measure technological and pedagogical knowledge, the questionnaire of Ladrón et al. (2021) and the proposals of Mishra and Koehler (2006) and Zabalza (2003) were used as a reference. The questionnaire was contextualized to the population, so the components of the TPACK model were adapted in two dimensions: technological knowledge (items 11 to 23) and pedagogical knowledge (items 24 to 30), making a total of 20 questions.

Regarding the reliability and validation of the instrument, reliability was measured by calculating Cronbach's alpha. The value of the test was .95, which indicated a high consistency among the items that make up the measurement of the instrument. An exploratory factor analysis of maximum likelihood with oblique rotation was also performed, obtaining a value of .953 in the Kaiser-Meyer Olkin (KMO) measure, which indicates that the covariance matrix is sufficiently robust to allow assessment of the degree to which each of the variables is predictable by the others. In relation to the construct validation, the oblique rotation through the sedimentation plot allowed us to identify, as expected, a two-factor solution: 1= technological knowledge, 2= pedagogical knowledge. The percentage of variance explained by the scale was 67.24%, therefore, it was considered acceptable.

## 3. Results and discussion

This section presents findings on the technological and pedagogical knowledge of teachers at the University of Sonora, as well as the relationship of such knowledge with the use of ICT for teaching both before and during the health contingency caused by the COVID-19 pandemic.

### 3.1. Differences between technological and pedagogical knowledge by faculty before and during the COVID-19 pandemic

Results indicate that: (1) there is a significant difference between the technological and pedagogical knowledge of faculty before and during the pandemic with the later showing higher values in both periods, and (2) there is a slight increase in technological knowledge before and during the pandemic ( $T=-6.72$ ,  $d=-0.35$ ,  $p < .001$ ), while pedagogical knowledge did not change (See Table 1). This suggests as Schildkamp et al. (2020) argues, that due to the circumstances of the health contingency, technological knowledge was given higher priority to ensure the continuity of the classes.

*Table 1. Technological and pedagogical knowledge of faculty before and during the pandemic.*

	Before pandemic		During pandemic		T	p	d
	M	SD	M	SD			
Technological	3.43	.98	*3.75	.84	-6.72	< .001	-0.35**
Pedagogical	4.13	.75	4.13	.69	.023	.981	----

SD=Standard deviation

Prepared by the authors

\* Size of the effect between small and moderate

### 3.2. Use of ICT by faculty before and during the pandemic

As can be seen in Table 2, when comparing before and during the pandemic we found significant differences in the use of ICT for planning, designing, and managing environments and experiences ( $T= -10.15$ ,  $d=0.62$ ,  $p<.001$ ) for teaching, learning and curriculum development ( $T= -3.65$ ,  $d=-0.81$ ,  $p<.001$ ) and, for assessment and evaluation ( $T= -11.50$ ,  $d=0.20$ ,  $p<.001$ ).

Table 2. Type of ICT use before and during the COVID-19 pandemic.

	Before		During		T	P	d
	M	SD	M	SD			
Planning, designing and management of environments and experiences	3.50	1.01	4.07	.80	-10.15	< .001	-0.62**
Teaching, Learning & development of curriculum	2.42	1.16	3.37	1.16	-3.65	<.001	0.81***
Evaluation	2.28	.96	2.48	1.03	-11.50	<.001	-0.20*

SD=Standard Deviation

Prepared by the authors.

\*Small effect size; \*\* Moderate effect size; \*\*\* Large effect size

The greater difference we found in the use of ICT before and during the pandemic was in the use of ICT for teaching, learning, and curriculum development, which is consistent with the findings of Arras et al. (2021) with teachers at a public university who reported similar results. It should be noted that both before and during the pandemic, 86% of teachers almost always and always used digital presentations to teach. Thus, the use of this tool transcended the health contingency and is expected to be of greater importance in the immediate future.

The second category that experienced the greatest change was related to tools for planning, designing, and managing environments and experiences. It is worth noting that within this category the use of course management programs such as Moodle, Blackboard, Google Classroom, Schoology, and Microsoft Teams increased by 43% during the pandemic, which makes sense since classes were taught remotely.

Regarding the use of ICT for evaluation, it was the area where they have been less used ( $M < 2.48$ ), which coincides with the results of Jogezi et al. (2021) who also found that teachers made little use of technologies to evaluate their students.

### 3.3. Technological, pedagogical, and content knowledge as predictors of ICT use in teaching

The results on the weight of technological and pedagogical knowledge on the use of ICT in teaching practice are presented below. Table 3 reports information about the knowledge before the pandemic and Table 4 shows information on the same issue but during the time of the pandemic.

Table 3. Summary of the analysis of technological and pedagogical knowledge as predictors of ICT use in teaching before the pandemic.

Variable	B	SD B	B	T	P
Technological Knowledge	.514	.044	.619	11.650	$P < .001$
Pedagogical Knowledge	.011	.073	.010	.144	.858

Note.  $R^2 = .654$  (N=250,  $p < .001$ ), SD= Standard deviation

The results in Table 3 show that technological knowledge is positively associated with ICT use before the pandemic ( $r > 0$ ;  $P < .01$ ), and predicts its use with greater weight ( $B=.514$ ;  $P<.001$ ).

Table 4. Summary of the analysis of technological and pedagogical knowledge as predictors of ICT use in teaching during the pandemic.

Variable	B	SD B	B	T	P
Technological Knowledge	.419	.051	.504	8.180	$P < .001$
Pedagogical Knowledge	.096	.074	.095	1.301	.195

Nota.  $R^2 = .632$  (N=250,  $p < .001$ ), SD= Standard deviation

Table 4 shows how technological knowledge most strongly predicts ICT use ( $B=.419$ ;  $P<.001$ ). The results indicate that this knowledge has the strongest influence on the use of ICT in teaching. This finding can be understood as a positive association between the level of knowledge and the ability to use ICT by faculty, independently of the pandemic factor.

## 4. Conclusions

Summarizing, when comparing faculty members' ICT technical and pedagogical knowledge before and during the pandemic we detected that there is a significant difference between periods, with the later showing higher values in both periods. However, only the former experienced a significant increase between periods. We also found significant differences before and during the pandemic in the use of ICT by faculty for planning, designing, and managing environments and experiences; for teaching, learning and curriculum development; and, for assessment and evaluation. Nevertheless, the greater difference we detected was in the use of ICT for teaching, learning, and curriculum development. Finally, we also detected that technological knowledge is the factor that most strongly predicts ICT use by faculty.

Transforming teaching through technological and pedagogical knowledge, or a combination of both, is a complicated task, especially when faculty is forced to "improvise" in an unknown context, as in the case of the health contingency caused by the COVID-19 pandemic. From the findings of this study, it can be argued that updating, increasing and improving not only technological but also pedagogical knowledge of university professors facilitates their incorporation into different contexts, as is the case of remote emergency teaching, while helping to discover new work spaces that allow experimentation with different forms of teaching. Finally, we can conclude that the success of universities in guaranteeing academic continuity in the face of similar contingencies necessarily requires a teaching staff competent in the knowledge and pedagogical use of existing and future digital technologies.

## References

- Arras, A., Bordas, J.L., Porras, D., y Diez, M. (2021). Evolución en el uso de las tecnologías de la información y comunicación (TIC) y competencias de los docentes de la Universidad Autónoma de Chihuahua (México), durante la pandemia. *Formación universitaria*, 14(6), 183-192. <https://dx.doi.org/10.4067/S0718-50062021000600183>
- Ahmed, S., Qasem, B. & Pawar, S. (2020). Computer-Assisted Language Instruction in South Yemeni Context: A Study of Teachers' Attitudes, ICT Uses and Challenges. *International Journal of Language Education*, 4(2),59-73. Recuperado de <https://doi.org/10.26858/ijole.v4i2.10106>
- Ayciriet, F. [Canal de Federico Ayciriet] (2020). Los desafíos de enseñar en tiempos de pandemia: Humanizar la práctica docente mediada por tecnología. Recuperado de [https://www.youtube.com/watch?reload=9&v=\\_GujMK\\_qMvg](https://www.youtube.com/watch?reload=9&v=_GujMK_qMvg)
- Dreeseni, T., Akseeri, S., Brossardi, M., Dewanii P., Giraldoui, J. P., Kameii, A., Mizunoyaiiii, S. & Ortizi, J. (2020). Promising practices for equitable remote learning Emerging lessons from COVID-19 education responses in 127 countries. UNICEF. Innocenti Research Brief 2020-10. <https://www.unicef-irc.org/publications/pdf/IRB%202020-10%20CL.pdf>
- Dussel, I., Ferrante, P. y Pulfer, P. (2020). Nuevas ecuaciones entre educación, sociedad, tecnología y Estado. *Pensar la educación en tiempos de pandemia. Entre la emergencia, el compromiso y la espera* (pp. 351-368). Buenos Aires, Argentina: UNICEF: Editorial Universitaria. Recuperado de <https://es.calameo.com/read/006400294217347149015>
- Fernández, M., Gimenez, G. y Calero, J. (2020). Is the use of ICT in education leading to higher student outcomes? Analysis from the Spanish Autonomous Communities, *Computers & Education*, V157. <https://doi.org/10.1016/j.compedu.2020.103969>.
- Kiekel, J., Mczeal, W. & Flores, S. (2020). Teaching with a Non-Traditional Mindset: Lessons Learned from In-service Teachers. In: Ferdig, R.E., Baumgartner, E., Hartshorne, R., Kaplan-Rakowski, R. & Mouza, C. (Eds). *Teaching, Technology, and Teacher Education during the COVID-19 Pandemic: Stories from the Field* (pp. 568-574). Association for the Advancement of Computing in Education (AACE). Recuperado de <https://www.learnlib.org/p/216903/>
- Jogezai, N. A., Baloch, F. A., Jaffar, M., Shah, T., Khilji, G. K., y Bashir, S. (2021). Teachers' attitudes towards social media (SM) use in online learning amid the COVID-19 pandemic: the effects of SM use by teachers and religious scholars during physical distancing. *Heliyon*, 7(4), e06781. <https://doi.org/10.1016/j.heliyon.2021.e06781>
- Ladrón, L., Almagro, B. J. y Cabero, J. (2021). Cuestionario TPACK para docentes de Educación física. *Campus Virtuales*, 10(1). Recuperado de <http://http://uajournals.com/ojs/index.php/campusvirtuales/article/view/763/441>
- Mishra, P. y Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*. 108 (6), 1017–1054. Recuperado de [http://one2oneheights.pbworks.com/f/MISHRA\\_PUNYA.pdf](http://one2oneheights.pbworks.com/f/MISHRA_PUNYA.pdf)

- Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura (UNESCO) (2020). Serie de Seminarios Web para América Latina y el Caribe: No dejar a nadie atrás en tiempos de la pandemia del COVID-19. Recuperado de <https://es.unesco.org/fieldoffice/santiago/covid-19-education-alc/seminarios-web>.
- Organización Mundial de la Salud (OMS) (2020a). Palabras de apertura del Director General de la OMS en la conferencia de prensa sobre COVID-19-11 de marzo de 2020. <https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020>
- Schildkamp, K., Wopereis, I., Kat-De Jong, M., Peet, A. and Hoetjes, I. (2020). "Building blocks of instructor professional development for innovative ICT use during a pandemic", *Journal of Professional Capital and Community*, Vol. 5 No. 3/4, pp. 281-293. <https://doi.org/10.1108/JPC-06-2020-0034>
- Zabalza, M. A. (2003). *Competencias docentes del profesorado universitario. Calidad y desarrollo profesional*. Madrid, España: Narcea. Recuperado de <http://www.untumbes.edu.pe/vcs/biblioteca/document/variostlibros/Competencias%20docentes%20del%20profesorado%20universitario.%20Calidad%20y%20desarrollo%20profesional.pdf>
- Zhang, T. (2020). Learning from the Emergency Remote Teaching-Learning in China When Primary and Secondary Schools Were Disrupted by COVID-19 Pandemic. *Education Faculty Publications* 101. DOI: 10.21203/rs.3.rs-40889/v1