

UNIVERSIDAD DE GRANADA

FACULTAD DE CIENCIAS DE LA EDUCACIÓN Y DEL DEPORTE
Departamento de Didáctica y Organización Escolar



TESIS DOCTORAL

**POSIBILIDADES DE USO E INTEGRACIÓN DE TECNOLOGÍAS
EMERGENTES Y PROPUESTAS METODOLÓGICAS EN EDUCACIÓN
EN LA FORMACIÓN DEL PROFESORADO DE MELILLA**

PROGRAMA DE DOCTORADO EN CIENCIAS DE LA EDUCACIÓN

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Presentada por
JOSÉ MANUEL GARCÍA-VANDEWALLE GARCÍA

Para optar al Grado de Doctor Internacional por la Universidad de Granada

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DRA. MARINA GARCÍA CARMONA
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Melilla, 2022

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1. Introducción



1. Introducción

Vivimos en un mundo globalizado en el que las nuevas tecnologías paulatinamente van ocupando un lugar más importante en nuestras vidas. Han cambiado la forma en que trabajamos, nos comunicamos y nos divertimos (Cairns & Malloch, 2017; Cheng & Vongkulluksn, 2020). Son de vital importancia para el conjunto de la sociedad, debido a que contribuyen a su desarrollo económico (Park et al., 2015) y son esenciales para conseguir un empleo (Jones & Pal, 2015). Sin embargo, el uso de las nuevas tecnologías requiere de ciertos conocimientos y habilidades que conforman lo que se denomina como competencias digitales. Hay autores que incluso equiparan las competencias digitales con saber leer y escribir (Wilson et al., 2015), llegando a convertirse en una nueva alfabetización, la alfabetización digital (Cortina-Pérez et al., 2014).

La carencia de competencias digitales produce una barrera social, discriminando a quienes no disponen de ellas. Esa carencia en ocasiones impide el acceso al mercado laboral y dificulta las relaciones sociales, convirtiendo el dominio de las competencias digitales en un elemento fundamental para poder formar parte de la sociedad (Wu, et al., 2015a). Esto ha provocado que uno de los mayores problemas de nuestra era sea la desigualdad digital (Yu et al., 2017). Consciente de ello, la Unión Europea, mediante la Estrategia Europea 2020, otorga prioridad a la lucha contra las desigualdades para reiniciar la economía europea (Cruz-Jesus et al., 2016). Esta desigualdad se agrava en contextos socioeconómicamente desfavorecidos, teniendo en cuenta las dificultades y discriminación que ya poseen. Esto es en parte debido a que las personas que sufren la pobreza en mayor grado, son excluidas del acceso y uso de las nuevas tecnologías (Tamatea & Pramitasari, 2018).

Para adquirir las competencias digitales no basta con disponer de la tecnología (Akayogluet al., 2020; Pérez-Escoda et al., 2016). Es necesaria una formación práctica que nos permita hacer un correcto uso de las mismas. Para ello, se debe disponer de un profesorado bien formado para que sea capaz de desarrollar las competencias digitales de su estudiantado. Es fundamental que el profesorado, además de disponer de los conocimientos prácticos, sea capaz de transmitirlos mediante el empleo de metodologías eficaces y teniendo en cuenta el contexto (García-Carmona et al., 2021; Mooketsi & Chigona, 2016). Por ello, es igualmente importante la implantación de las nuevas tecnologías en educación para desarrollar las competencias digitales del alumnado y a su vez de la sociedad. Además, mediante un buen uso de las nuevas tecnologías se

puede mejorar el proceso de enseñanza-aprendizaje, consiguiendo que el alumnado obtenga mejores resultados que de forma tradicional (Kumbar et al., 2018). Estas facilitan la adquisición de conocimientos teóricos y prácticos mediante la resolución de problemas y el aprendizaje colaborativo (Baran, & Uygun, 2016; Siddiq et al., 2016). Además, según diferentes autores, el estudiantado prefiere aprender usando las nuevas tecnologías (Mendoza et al., 2015a) de manera que su utilización aumenta su motivación (Trujillo-Torres et al. 2020), convirtiéndoles en un estudiantado activo y positivo (Alshahrani & Ally, 2016; Trujillo, 2015). Asimismo, la TIC pueden contribuir a formar un alumnado crítico y reflexivo (García-Carmona, 2015). Por tanto, las nuevas tecnologías en educación son claves para la transformación educativa (Wogu et al., 2018), ayudando a romper barreras (Arshad & Saeed, 2015) y a superar límites en el aprendizaje (Alshahrani & Ally, 2016).

La Ciudad Autónoma de Melilla es una de las ciudades con mayor índice de fracaso y abandono escolar de Europa (MECD, 2017; MECD, 2019; PISA, 2018). En esta situación, el profesorado supone una figura importante al ser el encargado directo de instruir al estudiantado. La formación del profesorado es determinante para poder contar con buenos docentes. Por lo tanto, la mejora de la formación del profesorado de Melilla supondría mejorar a su vez la formación de su estudiantado. De esta forma, la formación del profesorado conllevaría la mejora de la situación educativa de Melilla (Bejaković & Mrnjavac, 2020; Comisión Europea, 2016; Koliouška & Andreopoulou, 2020; Quaglio et al., 2016; Valarezo et al., 2018), además de la social (Fang et al., 2019; García-Valcárcel et al., 2014; Reimers, 2020; Wu et al., 2015) y la económica (Cruz-Jesus et al., 2016; Reimers, 2020).

Es por ello que el objetivo principal de esta tesis doctoral consiste en estudiar las posibilidades de uso e integración de tecnologías emergentes y propuestas metodológicas en Educación en la formación del profesorado, en especial del que trabaja en contextos socioeconómicamente desfavorecidos como es el caso de Melilla. Se ha optado por una tesis por compendio de cinco publicaciones. La primera es un artículo de investigación que estudia la autopercepción de las competencias digitales del profesorado en formación de Melilla mediante un cuestionario. La segunda publicación, se centra en los elementos pedagógicos y metodológicos que son necesarios para hacer un correcto uso de las nuevas tecnologías en el aula. La tercera publicación, trata de cómo se ha de trabajar con las nuevas tecnologías en contextos desfavorecidos para

alcanzar una mejora educativa. El cuarto artículo, ahonda en cómo ha de ser la formación del profesorado con respecto a las nuevas tecnologías para conseguir un proceso educativo exitoso. Finalmente, con la intención de ofrecer un enfoque práctico, la quinta publicación que presentamos consiste en un capítulo de libro sobre un proyecto financiado por la Ciudad Autónoma de Melilla en el que se diseña una App móvil para favorecer la mejora de la situación educativa de la ciudad.

Cada una de las publicaciones incide en un aspecto clave que permite alcanzar el conjunto de objetivos planteados en la tesis. A continuación, señalamos más detalles sobre cada una de ellas:

- El primer artículo realiza un análisis de las competencias digitales del profesorado en formación de la Facultad de Ciencias de la Educación y del Deporte de la Ciudad Autónoma de Melilla. Con este primer artículo se busca conocer la autopercepción del profesorado en formación acerca de sus competencias digitales y sus carencias. Para ello se toma como base los ítems del Marco Común de Competencias Digitales Docentes establecidos por la Unión Europea. Este artículo nos permite conocer el estado de las competencias digitales del profesorado en formación de Melilla respecto al estándar marcado por la Unión Europea.
- El segundo artículo se centra en los aspectos pedagógicos y metodológicos que los docentes deben emplear en el uso de las nuevas tecnologías en el aula para alcanzar un proceso de enseñanza-aprendizaje eficaz. En esta publicación se indica la necesidad de incidir en la formación del profesorado y en la elección de las metodologías idóneas para conseguir la correcta implementación de las tecnologías emergentes. Los expertos indican cuáles son las metodologías y prácticas más efectivas para que el profesorado las utilice en sus aulas.
- El tercer artículo analiza la forma de implantar las tecnologías emergentes en contextos educativos socioeconómicamente desfavorecidos. La implementación de las nuevas tecnologías en la educación en estos contextos es posible y beneficiosa si se realiza correctamente. Además, su implantación permite paliar en parte su situación socioeconómica por las oportunidades laborales que genera y socialmente contribuye a su integración al facilitar la comunicación. En este artículo los expertos muestran la forma de utilizar las nuevas tecnologías en este tipo de contextos para mejorar la educación.

- El cuarto artículo se enfoca en la formación del profesorado por ser el elemento más importante en el cambio educativo tal y como indican diferentes autores reseñados en este trabajo. El profesorado se encarga de emplear las nuevas tecnologías en el aula y es la conexión directa con el estudiantado. Un profesorado con una buena formación, será capaz de transmitir eficazmente los contenidos y competencias pertinentes a su alumnado. Los expertos en este artículo señalan la mejor formación que puede obtener el profesorado para ejercer la docencia de forma eficaz.
- La quinta publicación se trata de un capítulo de libro que muestra una aplicación práctica del uso de las nuevas tecnologías en contextos educativos socioeconómicamente desfavorecidos. Concretamente en el caso de Melilla, en el que existe una barrera idiomática entre los centros escolares y las familias del alumnado y que puede influir en que la ciudad obtenga una de las puntuaciones más bajas de Europa en diversos informes educativos (MECD, 2017; MECD, 2019; PISA, 2018). Se ha creado una aplicación de mensajería instantánea financiada por la Ciudad Autónoma de Melilla que traduce y transcribe simultáneamente en una conversación entre interlocutores de distinta lengua independientemente de si saben escribir o no.

Para finalizar, se muestran las conclusiones de la investigación, acorde a los objetivos planteados y un decálogo en el que se resumen los elementos claves necesarios para alcanzar la correcta implantación de las tecnologías emergentes en contextos educativos socioeconómicamente desfavorecidos.

1. Introduction

We live in a globalised world where new technologies have come to occupy an increasingly important place in our lives. They have changed the way we work, communicate, and have fun (Cairns & Malloch, 2017; Cheng & Vongkulluksn, 2020). New technologies are of vital importance to society, as they contribute to economic development (Park et al., 2015) and are essential for employment (Jones & Pal, 2015). However, the use of these technologies requires certain knowledge and skills, what are known as digital competences. Some authors even equate digital competences with being able to read and write (Wilson et al., 2015) as a new form literacy: digital literacy (Cortina-Péreten et al., 2014).

The lack of digital competences creates a social barrier, discriminating against those who do not have them. This digital divide can prevent access to the labour market and hinder social relations, making the mastery of digital competences a fundamental element to be part of society (Wu et al., 2015a) and has led to one of the most pressing problems of our era: digital inequality (Yu et al., 2017). Aware of this, the European Union, through the European 2020 Strategy, has prioritised the fight against inequalities to restart the European economy (Cruz-Jesus et al., 2016). Such inequalities are more pronounced in socio-economically disadvantaged contexts, given the difficulties and discrimination they already suffer. This is partly because people who suffer greater poverty are excluded from accessing and using new technologies (Tamatea & Pramitasari, 2018).

To acquire digital competences, it is not enough to have the technology (Akayogluet al., 2020; Pérez-Escoda et al., 2016). Indeed, to use these technologies properly, practical training is also needed. To achieve this, teachers must be trained specifically to develop the digital competences of their students. In addition to having practical knowledge, it is essential that teachers be able to transmit that knowledge through effective methodologies and take into account the context (García-Carmona et al., 2021; Mooketsi & Chigona, 2016). Therefore, it is equally important to implement new technologies in education to develop the digital competences of students and, in turn, of society. Moreover, through the proper use of new technologies, the teaching-learning process can be improved, thus enabling students to achieve better learning outcomes than through traditional teaching methods (Kumbar et al., 2018). New technologies can also facilitate the acquisition of theoretical and practical knowledge through problem

solving and collaborative learning (Baran & Uygun, 2016; Siddiq et al., 2016). Furthermore, according to several authors, because students prefer to learn using new technologies (Mendoza et al., 2015a), thus increasing their motivation (Trujillo-Torres et al., 2020) and making them active and positive learners (Alshahrani & Ally, 2016; Trujillo, 2015). Information and communication technologies can also contribute to the development of critical and reflective learners (García-Carmona, 2015). In this regard, new technologies in education are key to educational transformation (Wogu et al., 2018) as they help to break down barriers (Arshad & Saeed, 2015) and overcome limits in learning (Alshahrani & Ally, 2016).

The Autonomous City of Melilla, Spain, has one of the highest school failure and dropout rates in Europe (Spanish Ministry of Education, Culture, and Sport [MECD], 2017; PISA, 2015). Teachers play a key role in this situation, as they are directly responsible for students' education. To have good teachers, however, it is essential that they receive the proper training. Improving teacher training in Melilla would not only improve the students' own training, but also the broader educational (Bejaković & Mrnjavac, 2020; European Commission, 2016; Koliouška & Andreopoulou, 2020; Quaglio et al., 2016; Valarezo et al., 2018), social (Fang et al., 2019; García-Valcárcel et al., 2014; Reimers, 2020; Wu et al., 2015), and economic (Cruz-Jesus et al., 2016; Reimers, 2020) situation of Melilla.

For these reasons, the main objective of this doctoral thesis is to examine the possibilities of using and integrating emerging technologies and methodological proposals in teacher training and education, especially for teachers working in socio-economically disadvantaged contexts such as Melilla. The thesis is a compendium of five publications. The first is a research article that analyses the self-perceived digital competences of trainee teachers in Melilla by means of a questionnaire. The second publication focuses on the pedagogical and methodological elements required to effectively use new technologies in the classroom. The third publication looks at ways to work with new technologies in disadvantaged contexts in order to achieve educational improvement. The fourth article addresses how to train teachers in the use of new technologies to ensure a successful educational process. Finally, with the intention of offering a practical approach, the fifth publication we present is a book chapter on a project financed by the Autonomous City of Melilla in which a mobile application has been developed to improve the educational situation in the city.

Each of the publications focuses on a key aspect with a view to achieving the objectives set out in the thesis. Each of the publications is described in greater detail in what follows:

- The first article analyses the digital competences of trainee teachers at the Faculty of Education and Sport of the Autonomous City of Melilla. The aim of this article is to determine the self-perceptions of trainee teaching staff regarding their digital competences and shortcomings. To this end, the items of the European Framework for the Digital Competence of Educators (DigCompEdu) established by the European Union are used as a basis. The article identifies the state of digital competences of trainee teachers in Melilla with respect to the standards set by the European Union.
- The second article focuses on pedagogical and methodological aspects that teachers should take into account when using new technologies in the classroom in order to achieve an effective teaching-learning process. This publication underlines the importance of teacher training and the choice of suitable methodologies to correctly implement emerging technologies. The experts indicate the most effective methodologies and practices teachers should use in their classrooms.
- The third article analyses how to implement emerging technologies in socio-economically disadvantaged educational contexts. The implementation of new technologies in education in these contexts is possible and beneficial if done correctly. Moreover, their implementation can help to alleviate such socio-economic situations through the creation of job opportunities and contribute to social integration by facilitating communication. In this article, experts show how new technologies can be used in these contexts to improve education.
- The fourth article focuses on teacher training as key element of educational change, as indicated by the authors reviewed in the study. Teachers are in charge of using new technologies in the classroom and are the direct link with students. Well-trained teachers will be able to effectively transmit the relevant content and competences to their students. The experts in this article suggest the best training that teachers can receive in order to teach effectively.

- This publication is a book chapter that presents a practical application of the use of new technologies in socio-economically disadvantaged educational contexts. Specifically, it looks at the case of Melilla, where there is a language barrier between schools and the students' families that may influence the city's poor ranking in various reports on education in Europe (MECD, 2017; PISA, 2015). An instant messaging application funded by the Autonomous City of Melilla has been created that simultaneously translates and transcribes a conversation between speakers of different languages, regardless of whether they can write or not.

Finally, the conclusions of the research are presented in relation to the established objectives, as well as ten guiding principles summarising the key aspects required to correctly implement emerging technologies in socio-economically disadvantaged educational contexts.

2. Contextualización de la Tesis Doctoral: Ciudad Autónoma de Melilla



2. El contexto de la Ciudad Autónoma de Melilla

La Ciudad Autónoma de Melilla es una pequeña ciudad española de unos 12km² situada en el norte de África. Se encuentra en el estrecho de Gibraltar y colinda con Marruecos. Tiene una población aproximada de unos 86.000 habitantes según el Instituto Nacional de Estadística (INE, 2017). Melilla es una de las fronteras de Europa con África, convirtiéndose en una ciudad de paso para muchos inmigrantes que quieren llegar a Europa. También se encuentra el Centro de Estancia Temporal de Inmigrantes (CETI) en el que conviven poblaciones cambiantes principalmente del África subsahariana, Argelia, Siria y otros países africanos (MECD, 2017; MECD, 2019).

En la actualidad, la ciudad cuenta con una población muy densa, por encima de la media de España y la Unión Europea (Ministerio de Educación y Formación Profesional, 2019). El origen de la mayoría de sus habitantes se encuentra en el norte de África y España, aunque también en otras naciones de la cuenca del Mediterráneo. Las comunidades mayoritarias son la cristiana y la musulmana, seguidas de la judía, hindú, romaní y china (Instituto de las Culturas de Melilla, 2019).

La comunidad musulmana abarca más del 50% de la población, es de origen bereber y su lengua es el tamazight. Son originarios del Rif, la región de Marruecos que colinda con Melilla. Melilla tiene la mayor concentración de jóvenes inmigrantes en escuelas públicas de España, además de ser la ciudad de España con mayor ratio alumno/profesor (Marmolejo & Montero-Alonso, 2009). De este alumnado, la mayor parte es musulmán, mientras que el estudiantado de cultura judía, hindú y romaní representa un porcentaje inferior al 2% (Instituto de las Culturas de Melilla, 2019).

La situación geográfica de Melilla (ver Figura 1) hace que reciba grandes cantidades de inmigrantes provenientes de África y Asia que buscan una vida mejor en España y el resto de Europa.

Figura 1

Situación geográfica de la Ciudad Autónoma de Melilla

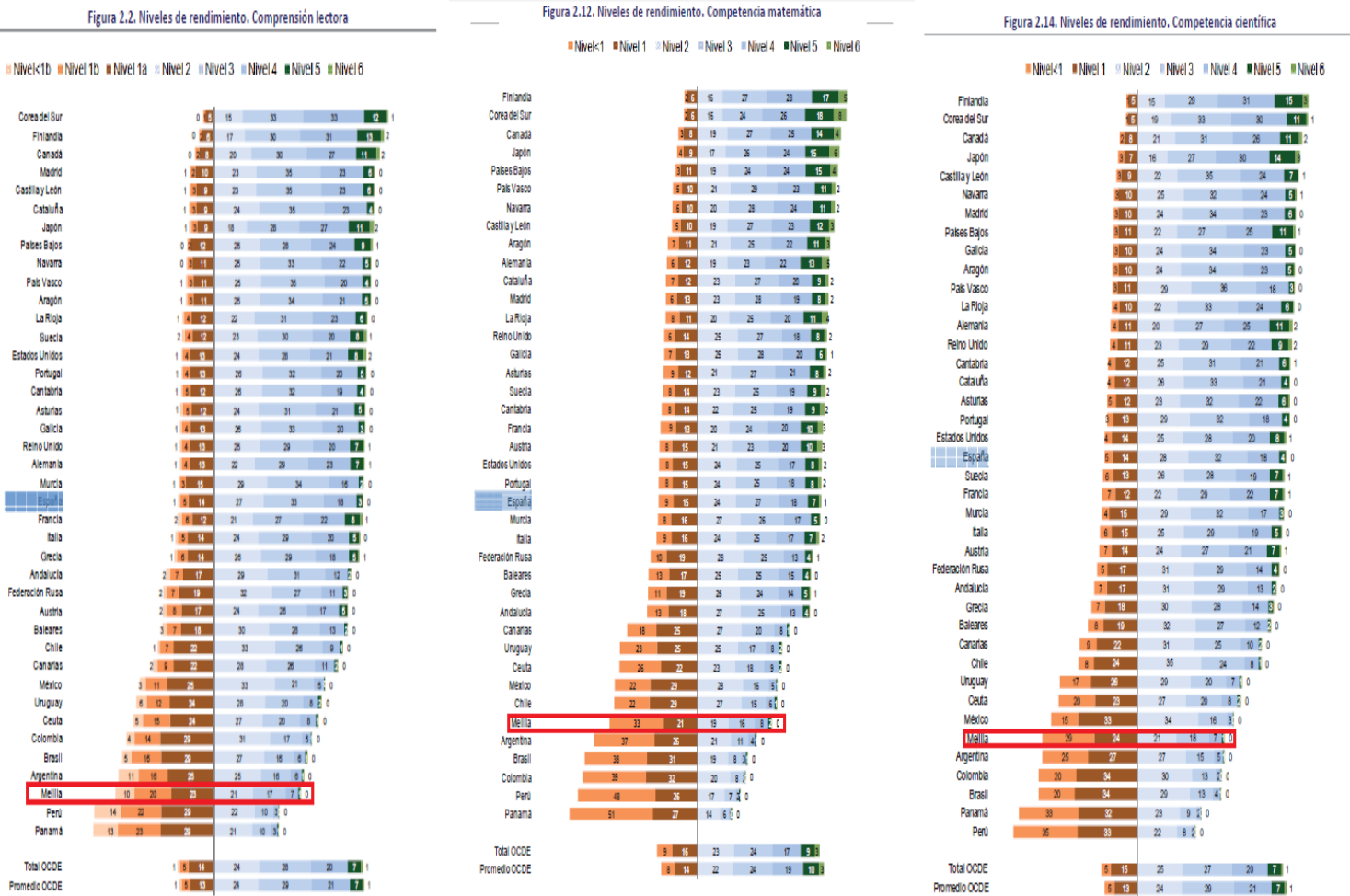


Fuente: Google Maps.

Esto ha dado lugar a una elevada concentración en las escuelas de Melilla de jóvenes desfavorecidos nacidos en el extranjero (MECD, 2017; MECD, 2019). Esta situación ha provocado que Melilla sea una de las ciudades con mayor índice de fracaso y abandono escolar de Europa (MECD, 2017; MECD, 2019) reflejado también en diversos informes educativos como PISA 2018. Debido a los bajos resultados obtenidos en PISA 2009 (Figura 2) tanto la Ciudad Autónoma de Melilla como Ceuta, otra ciudad española que se encuentra en una situación similar a la de Melilla, se dejaron fuera de los informes PISA 2012 y 2015 hasta su incorporación en PISA 2018.

Figura 2

Resultados de los niveles de rendimiento en el informe PISA 2009.



Nota. Niveles de rendimiento en comprensión lectora, competencia matemática y competencia científica de los estudiantes de Melilla en PISA 2009.

El cruce de fronteras nacionales requiere de un proceso gradual de educación intercultural en la resocialización de los niños migrantes y de sus familias para que no sufran exclusión social (García-Carmona et al., 2021). Todas estas peculiaridades hacen que la Ciudad Autónoma de Melilla presente un contexto educativo socioeconómicamente desfavorecido y complejo. Esto dificulta la implementación de las tecnologías emergentes en la educación para conseguir una mejora educativa y social.

3. Marco Teórico



3. Marco teórico

3.1. La implantación de las nuevas tecnologías en educación y las competencias digitales de los docentes

Se ha demostrado que la aplicación de las nuevas tecnologías en educación proporciona numerosos beneficios educativos (McGarr & Gavaldon, 2018). Entre sus múltiples posibilidades cabe destacar la facilitación del proceso de aprendizaje. Favorecen la colaboración, motivan al alumnado, les ayuda a ser más autónomos y se adapta a su nivel educativo, siendo especialmente útil en estudiantado con necesidades especiales (García-Valcarcel et al., 2014). Asimismo, permiten la integración de metodologías activas (Gámiz-Sánchez, 2017), las cuales se han demostrado ser muy efectivas al situar al estudiantado en el centro de su proceso de aprendizaje. Las nuevas tecnologías también permiten la enseñanza virtual, la cual ha sido determinante en la pandemia ocasionada por el COVID-19 (Martín et al., 2021). De la misma forma, el desarrollo de destrezas mediante el uso de las nuevas tecnologías genera beneficios que van más allá de la competencia digital (Hosseini-Mohand, 2021; van Laar, 2017). Por ejemplo, desarrolla las habilidades sociales, la responsabilidad, la capacidad de reflexión, la iniciativa, la autonomía y la resolución de problemas (García-Valcárcel et al., 2014). Todos estos beneficios repercuten en el conjunto de la población consiguiendo una mejora social (Fang et al., 2019; García-Valcárcel et al., 2014; Reimers, 2020; Wu et al., 2015). Por lo tanto, el desarrollo de las competencias digitales es especialmente recomendable en poblaciones socioeconómicamente desfavorecidas por su capacidad de facilitar la integración en la sociedad y en el mercado laboral (Cruz-Jesus et al., 2016; Reimers, 2020). En consecuencia, la mejoría de la situación educativa mediante el desarrollo de las competencias digitales del estudiantado y a su vez de su población, supondría una mejora del conjunto de la población de la ciudad.

Sin embargo, según recientes investigaciones, en general las universidades españolas no integran todo lo deseable el desarrollo de las competencias digitales en sus programas formativos (Guzmán-Simón et al., 2017). De hecho, cerca de la mitad del profesorado de educación superior opina que se debería promover más la innovación (Guzmán-Simón et al., 2017). Esta carencia ocasiona que la mayoría del estudiantado graduado considere que su formación es insuficiente para cumplir con las exigencias del mercado laboral (Fernández-Cruz & Fernández-Díaz, 2016; Guzmán-Simón et al., 2017).



En la formación de los futuros docentes sucede igual, con el agravante de que ellos serán a su vez los encargados de desarrollar las competencias digitales de su alumnado. Los docentes han de tener un conocimiento avanzado en competencia digital para que sean capaces de inculcarlo a su alumnado, no obstante, la mayoría de los docentes reconocen tener un nivel de usuario promedio con una baja capacidad de enseñar la competencia digital (Ramírez-Montoya et al., 2017). Es por ello que existe un desajuste entre las competencias digitales que necesitan los docentes para poder desarrollar las competencias digitales en su alumnado, y las competencias digitales que realmente tienen los docentes (Fernández-Cruz & Fernández-Díaz, 2016). Hasta ahora, los avances realizados en el desarrollo de sus propias competencias digitales han sido de forma individual ante el limitado apoyo de la administración académica (Falcó, 2017).

El marco TPACK (Koehler et al., 2014; Mishra & Koehler, 2006) nos muestra cómo no es suficiente que los docentes cuenten con las herramientas tecnológicas, sino que es necesario disponer de unos determinados conocimientos y habilidades para que el profesorado sea capaz de emplear eficientemente las nuevas tecnologías en el aula (Mishra & Warr, 2021). Como se ha mencionado anteriormente, la adquisición de dichas habilidades y conocimientos conforman lo que se denomina competencia digital (Spante et al., 2018). Es por ello que en la formación del profesorado es fundamental desarrollar sus competencias digitales para que sean capaces de emplear correctamente las nuevas tecnologías en el aula (Ramírez-Montoya et al., 2017). Por el contrario, la ausencia de habilidades y conocimientos en nuevas tecnologías, no solo perjudica al desarrollo de la competencia digital de su alumnado, sino que además impide en términos generales la enseñanza eficiente de los contenidos de otras materias (Cabero & Barroso, 2016). Para mejorar la competencia digital del estudiantado, debemos mejorar antes la de su profesorado, y para ello debemos desarrollar las competencias digitales que adquieren en su formación (Instefjord & Munthe, 2017; Sánchez-Prieto et al., 2021). Por lo tanto, es necesario elaborar un plan estratégico de formación docente (Gómez, 2015) el cual se debe comenzar por conocer el nivel de competencia digital de los futuros docentes (Guzmán-Simón et al., 2017).

Ante la necesidad de evaluar el nivel de competencia digital de los docentes, la Unión Europea ha elaborado el Marco Europeo para la Competencia Digital de los Educadores (DigCompEdu) (Redecker, 2017). La adaptación española del marco se denomina Marco Común de Competencia Digital Docente (INTEF, 2017) y ha sido el empleado

para medir la competencia digital del alumnado de los grados de Educación Primaria e Infantil y los del máster de formación de profesorado de la Facultad de Ciencias de la Educación y del Deporte de la Ciudad Autónoma de Melilla.

3.2. Los aspectos metodológicos-pedagógicos vinculados a la integración de las nuevas tecnologías en educación

Como hemos visto, el uso correcto de las nuevas tecnologías en educación es prometedor y aumenta las posibilidades de mejora tanto en contextos formales como informales (Mendoza et al., Fabregat, 2015b). Incluso, tecnologías como la realidad aumentada y realidad virtual, que ofrecen una mayor inmersión del alumnado en los contenidos trabajados, consiguen beneficios que van más allá de los contenidos. Por ejemplo, permiten reducir la ansiedad del alumnado (Begoli et al., 2018) ante determinadas situaciones y exponerles a experiencias virtuales que generan un aprendizaje similar a la experiencia real, pero sin la exposición a los peligros que dicha experiencia pueda conllevar en la realidad (Foronda et al., 2017). De este modo, las nuevas tecnologías son herramientas eficaces en la creación de contextos y materiales que permiten ofrecer al alumnado este tipo de experiencias (Alshahrani & Ally, 2016; Herrington & Oliver, 2000; Hinojo-Lucena et al., 2020).

Con este tipo de tecnología se ha llegado incluso a cambiar la perspectiva del alumnado y del profesorado sobre determinados aspectos del mundo y de la vida, al igual que sucede con experiencias reales (Amory, 2012). De esta forma es posible la creación de aulas inteligentes en las que la tecnología enriquezca y complemente la realidad, ofreciendo experiencias al alumnado que le permita aprender y mejorar su visión de la vida desde el aula (Alshahrani & Ally, 2016). Cuando se emplean las nuevas tecnologías en educación de forma eficaz, generan en el alumnado lo que se denomina aprendizaje auténtico (Bozalek et al., 2013), un tipo de aprendizaje que se basa en estudios exitosos (Brown et al., 1989). Las principales características del aprendizaje auténtico se recogen a continuación en la Tabla 1:



Tabla 1

Características del aprendizaje auténtico

Característica	Significado
1. Contexto auténtico.	Situaciones de un contexto real.
2. Tareas auténticas.	Problemas a los que se les aplica el conocimiento en el mundo real.
3. Acceso al pensamiento experto y modelado de procesos.	El alumnado y el profesorado pueden contribuir al aprendizaje con su experiencia.
4. Proporcionar múltiples roles y perspectivas.	Trabajo colaborativo en una tarea común.
5. Apoyar la construcción colaborativa del conocimiento.	Trabajo colaborativo en una tarea común.
6. Promover la reflexión para permitir la formación de abstracciones.	Al estudiantado se les favorece la reflexión y el intercambio de ideas.
7. Promover la articulación para hacer explícito el conocimiento tácito.	Al estudiantado se les facilita la posibilidad de comunicarse con profesionales sobre su aprendizaje.
8. Proporcionar entrenamiento y andamiaje por parte del maestro en momentos críticos.	El papel del profesorado no es dar conocimiento al alumnado, sino guiarles y ayudarles para que ellos lo encuentren.
9. Proporcionar una evaluación auténtica del aprendizaje dentro de las tareas.	La evaluación se integra con las tareas de aprendizaje.

Fuente: Elaboración propia a partir de Herrington, Reeves y Oliver (2010).

Esta modalidad de aprendizaje se centra en la exposición del alumnado a situaciones reales (Yin, Dooley, & Mu, 2019), haciendo que adquiera una mejor preparación para su futuro desempeño profesional (Bozalek et al., 2013). Por tanto, para que los docentes sean capaces de alcanzar tal grado de aprendizaje en su alumnado mediante el uso de las nuevas tecnologías, lo más importante es cómo los docentes integren la tecnología en sus enseñanzas (Geer et al., 2017; Gros, 2016). La enseñanza y el aprendizaje no dependen directamente de la tecnología (O'Flaherty & Phillips, 2015), sino del uso que el docente haga de las mismas en sus clases (Geer, et al., 2017; Gros, 2016). Por ello, este tipo de enseñanza requiere de un cambio de paradigma respecto a la forma tradicional de enseñar, la cual es pasiva para el alumnado y no fomenta su creatividad (Cochrane, et al., 2014; Judge et al., 2011). Sin un cambio en la pedagogía es improbable que exista un avance significativo en el aprendizaje del estudiantado, se requiere hacer un uso crítico de las tecnologías (Geer et al., 2017).

De este modo es fundamental la unión de la tecnología con pedagogía (Gros, 2016). Los avances en las nuevas tecnologías requieren de igual forma avances en las pedagogías

para poder ser empleadas con éxito en la enseñanza (Cairns & Malloch, 2017). Es necesario implementar la tecnología y la metodología de forma simultánea y progresiva, nunca la tecnología y posteriormente la metodología puesto que el alumnado asimilaría la tecnología sin ofrecer unos buenos resultados académicos (Hennessy et al., 2015). Los cambios en el alumnado comienzan a producirse cuando la pedagogía es activa y va evolucionando con el uso de la tecnología (Charbonneau-Gowdy, 2015). Para ello es necesario conseguir la unión de las nuevas tecnologías con pedagogías activas que sitúen al estudiantado en el centro de su aprendizaje, debido a que ofrecen nuevas oportunidades para el mismo (Goodwin, 2012; Shuler et al., 2012). Entre las metodologías activas más usadas se encuentran el aprendizaje basado en proyectos (ABP) y el aprendizaje basado en problemas (PBL) (Capacho, 2016).

No obstante, existe una brecha entre la tecnología y la pedagogía (Nasreen & Chaudhary, 2018) debido a que la enseñanza de nuevas tecnologías en la formación del profesorado suele limitarse a la enseñanza del dispositivo en sí, sin profundizar en los usos que se pueden hacer de ellas (Dong & Newman, 2016). El potencial de las nuevas tecnologías en mejorar la educación, depende de las habilidades del docente en aunar tecnología con pedagogía (Gros, 2016). Progresivamente los docentes deben ir cambiando las metodologías tradicionales por otras más transformadoras (Tarling & Ng'ambi, 2016). Se debe hacer un uso coherente de la tecnología como apoyo a las enseñanzas de los contenidos que el docente desee emplear con su alumnado. El empleo de la tecnología en educación solo tiene sentido cuando permite al profesorado y al alumnado hacer cosas que sin ella sería imposible (Murray & Olcese, 2011). En el caso de los docentes en formación, se deben integrar las nuevas tecnologías en su formación y en sus prácticas para que se puedan conseguir un cambio pedagógico posteriormente cuando ejerzan la labor docente (Nasreen & Chaudhary, 2018). Todo ello sin olvidar que el proceso de aprendizaje es un proceso que tiene lugar entre el profesorado y el alumnado en el que ambos aprenden (Kumbar et al., 2018). El profesor debe adaptar sus enseñanzas y metodologías a las capacidades y competencias del alumnado (Dong & Newman, 2016), consiguiendo de este modo un aprendizaje individualizado, al igual que a las necesidades y requerimientos de la sociedad actual para que su alumnado sea capaz de adaptarse a ella (Gros, 2016) y desenvolverse de una manera exitosa.



3.3. El impacto de las nuevas tecnologías en los contextos educativos socioeconómicamente desfavorecidos

El contexto socioeconómico del alumnado y de los centros escolares, presenta una fuerte influencia en el desempeño del estudiantado (OCDE, 2010a), llegando a determinar su éxito educativo (OCDE, 2010b). Entre otros factores se debe a la capacidad de acceso a los recursos (Claro et al., 2015; Erdogdu & Erdogdu, 2015). Así, la repercusión del entorno del estudiantado es muy alta, pudiendo superar la influencia recibida en el centro escolar (Munns et al., 2013).

La familia es uno de los factores que más condiciona al alumnado para su futura situación económica y social, al ser el entorno social más próximo (Claro et al., 2015). Uno de los elementos clave se encuentra en el nivel académico de los padres del estudiantado (Claro et al., 2015; Erdogdu & Erdogdu, 2015). En parte se debe a que personas con un mayor nivel académico suelen hacer un mejor uso de los recursos y de las nuevas tecnologías, al disponer de habilidades superiores (Hargittai & Dobransky, 2017). Las familias de contextos socioeconómicos desfavorecidos transmiten a sus hijos pensamientos autolimitantes como la desesperanza, impotencia y apatía, que no suelen llegar a superar (Tamatea & Pramitasari, 2018). Esto representa un gran obstáculo en su educación. Por otro lado, las familias de contextos socioeconómicos favorecidos, además de tener mayor acceso y exposición a los recursos como las nuevas tecnologías, cuentan con una mejor actitud hacia el uso de las mismas (Mooketsi & Chigona, 2014). Es por ello que la situación socioeconómica de las familias del estudiantado afecta a su rendimiento educativo (Munns et al., 2013) y no únicamente por su situación económica, sino por otros factores que derivan de la misma. Esta situación genera una brecha entre el estudiantado de diferente situación socioeconómica (Turner & Juntune, 2018). Por tanto, las escuelas y las universidades deben contribuir a eliminar esa y otras barreras sociales (Lineburg y Gearhart, 2013).

El impacto de las nuevas tecnologías en la educación de contextos socioeconómicos desfavorecidos, supone un impacto positivo para el estudiantado, tanto a nivel emocional como académico. La situación de desventaja del estudiantado perteneciente a contextos socioeconómicamente desfavorecidos, les ocasiona falta de autoconfianza y desánimo que habitualmente conlleva un abandono escolar temprano (Tamatea & Pramitasari, 2018). En este aspecto, las nuevas tecnologías les aportan beneficios emocionales como esperanza, confianza y satisfacción por el trabajo que realizan

(Hambira et al., 2017). Además, son herramientas que aumentan la motivación del alumnado, proporcionándole un mejor aprendizaje (Bolling et al., 2018; Nikolic et al., 2019) y haciendo que tenga un impacto en su desempeño educativo (Castillo-Merino & Serradell-López, 2014).

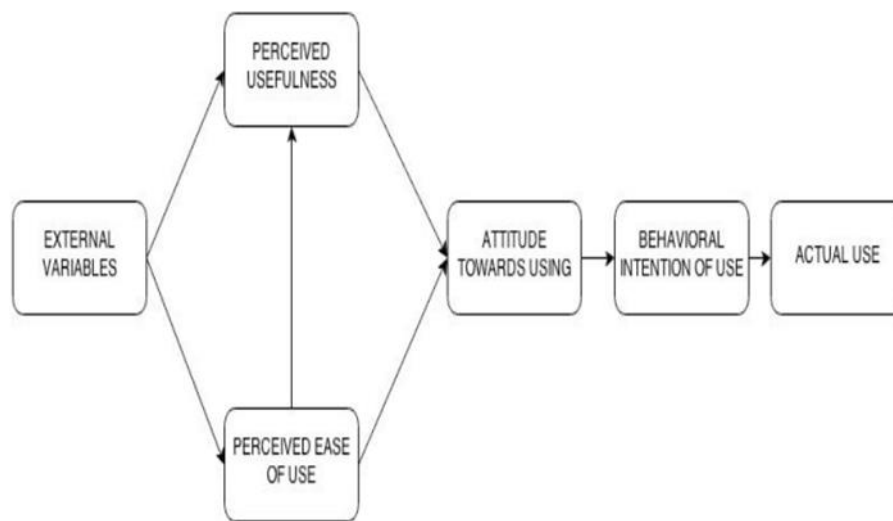
Por otro lado, la falta de acceso a la información y a las nuevas tecnologías dificulta el éxito educativo y laboral, teniendo una repercusión directa es su futura situación económica. Es por ello que el dominio de las nuevas tecnologías es fundamental para encontrar un empleo y poder desenvolverse en la sociedad actual (Broadbent & Papadopoulos, 2012). El problema ocasionado por esta brecha digital es más complejo que únicamente considerar que afecta al estudiantado pobre y al estudiantado rico (Claro et al., 2015). Según diversas investigaciones la brecha digital es uno de los mayores impedimentos para alcanzar la inclusión social y para la promoción de una economía fuerte y creativa (Fernández-de-Álava et al., 2017; Park, Choi, & Hong, 2015). Por lo tanto, la educación de personas socioeconómicamente desfavorecidas es esencial, no solo para ellas mismas, sino para el futuro de todos los países (Darling-Hammond, 2010).

Para conseguir un cambio educativo, los docentes, además de adaptar los contenidos que van a enseñar al nivel de su estudiantado, deben adaptarse al contexto educativo en el que ejercen (Alshahrani & Ally, 2016) y evaluar su impacto y consecuencias, especialmente en contextos desfavorecidos (Mooketsi & Chigona, 2014). Asimismo, deberán conocer, tal y como aludíamos en el apartado anterior, las nuevas tecnologías que deben emplear en cada situación en el aula (Bai et al., 2016b). Todo ello depende en gran medida del grado de aceptación de las nuevas tecnologías de la comunidad educativa como se puede observar en el Modelo de Aceptación de Tecnología (TAM) (Davis, 1989). Podemos observar en la siguiente representación del modelo TAM (Figura 3), cómo es determinante que los docentes aprecien la utilidad de las nuevas tecnologías para que finalmente se decidan a usarlas.



Figura 3

Modelo de aceptación de tecnología (TAM)



No obstante, como hemos mencionado anteriormente, la principal barrera se encuentra en la falta de conocimiento de los docentes sobre las nuevas tecnologías (Nikolic et al., 2019). Su carencia se debe en parte a que consideran que requiere demasiado tiempo y les distrae del plan de estudio (Hennessy et al., 2015). Estos aspectos se hacen aún más palpables al hablar de contextos socioeconómicamente desfavorecidos ya que suelen suponer una dedicación superior de tiempo por parte del profesorado que atiende, no solo a cuestiones académicas, sino a un compendio de diferentes problemáticas sociales de la comunidad educativa en la que se inserta. Por todo ello, una vez más se evidencia que la figura del profesor es clave en el cambio educativo (Prieto et al., 2014; Tabata et al., 2008).

3.4. La importancia de la formación del profesorado

Como ya hemos visto, alcanzar el éxito educativo depende en buena parte del profesor (Nikolopoulou & Gialamas, 2015a), por lo que supone un elemento fundamental en la integración de las nuevas tecnologías en el aula para conseguir un cambio educativo (Geer et al., 2017). Al desempeñar el profesorado su labor docente de forma eficaz, consigue un mayor impacto en la educación (Munns et al., 2013). Un impacto que se ve acrecentado cuando además hacen uso de las nuevas tecnologías (Durães et al., 2016).

No obstante, los docentes se encuentran con obstáculos para integrar las nuevas tecnologías en sus clases a pesar de que la mayoría presenta una predisposición positiva hacia su uso (Bingimlas, 2009). Estas dificultades son las que finalmente provocan que los docentes se muestren reacios a emplear las nuevas tecnologías en el aula (Van Acker et al., 2013), llevándolos a hacer un uso escaso de las nuevas tecnologías en la docencia y dificultando su integración (Marcelo et al., 2015). Algunas investigaciones señalan como uno de los principales motivos, la falta de dispositivos digitales en los centros educativos (Pelgrum, 2001). Coincide con la percepción del profesorado sobre la existencia de una carencia de recursos y de las condiciones necesarias en el aula, además de una falta de apoyo y confianza en sus aptitudes (Nikolopoulou & Gialamas, 2015a). Al menos España, cuenta con una amplia infraestructura, pero se hace un escaso uso de la misma (Gil-Flores et al., 2017), evidenciando que la tecnología por sí misma no puede cambiar los entornos de aprendizaje (Marcelo et al., 2015).

Al margen de la disponibilidad de recursos, se encuentra también el factor humano, que es el encargado de hacer un uso correcto y eficiente de los medios. En este sentido, otro de los obstáculos es la falta de conocimientos y habilidades del profesorado sobre las nuevas tecnologías, además del tiempo y esfuerzo que requieren para adquirirlos (Tallvid, 2016). La falta de conocimientos lleva en ocasiones al profesorado a emplear recursos tecnológicos con metodologías tradicionales (Brun & Hinostroza, 2014), integrando las nuevas tecnologías que más se adecuan a su labor docente (Espigares-Pinazo et al., 2022; Marcelo et al., 2015). El profesorado es consciente de su carencia de competencias digitales y esto a veces le genera ansiedad y falta de confianza (Van Acker et al., 2013) provocada por la posibilidad de que su alumnado tenga mayores conocimientos sobre las TIC y no sea capaz de resolver sus dudas (Wang et al., 2014). De hecho, en numerosas ocasiones el estudiantado suele tener mayores conocimientos de nuevas tecnologías que su profesorado (Cairns & Malloch, 2017; Wang et al., 2014). Este desajuste entre las competencias digitales del profesorado y del alumnado representa un grave problema debido a que el profesorado no puede desarrollar las competencias del estudiantado si ellos no las tienen (Fernández-Cruz & Fernández-Díaz, 2016). Dentro de sus limitaciones, los docentes disponen de mayor conocimiento técnico que pedagógico sobre las nuevas tecnologías (Roig-Vila et al., 2015). El factor más importante para poder desarrollar la competencia digital del estudiantado se encuentra en las habilidades digitales y pedagógicas del profesorado (Fernández-Cruz &

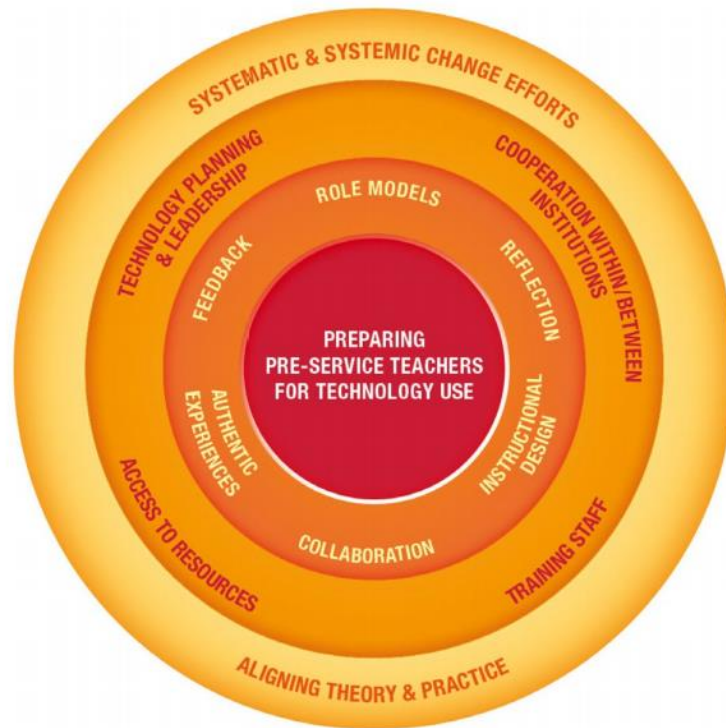


Fernández-Díaz, 2016). La competencia digital del profesorado es esencial para conseguir una mejora en los procesos de enseñanza y aprendizaje (Trujillo et al., 2020), para ello se debe medir su nivel de competencia en base a un marco en el que estén definidas (Almerich et al., 2016). También es necesario mejorar las competencias digitales de los directores de los centros escolares para conseguir acelerar el cambio educativo (Tondeur et al., 2008).

Los factores más decisivos en la formación del profesorado son las horas de formación y apoyo que reciben los docentes (Charbonneau-Gowdy, 2015; Hsu & Kuan, 2013). También es importante que realicen un trabajo colaborativo (Van Acker et al., 2013). En la formación del profesorado se ha de considerar la compatibilidad de la formación con su trabajo, debido a que habitualmente esa incompatibilidad es lo que le impide realizarla (Cuban et al., 2001). Además, según algunas investigaciones, en la formación de los futuros docentes no hay una buena conexión entre la teoría y la práctica (Brun & Hinostroza, 2014), debido, en ocasiones, a la carencia de experiencias docentes en las que se integren las nuevas tecnologías con metodologías innovadoras de una forma práctica (Barak, 2014). Como resultado, sus experiencias con las nuevas tecnologías no son significativas (Valtonen et al., 2015). Esto supone un problema debido a que su futura práctica docente se verá condicionada por las experiencias previas (Koh et al., 2013). Sin embargo, cuando las experiencias con el uso de las nuevas tecnologías son buenas, se consigue cambiar la visión sobre la integración de las nuevas tecnologías en educación y vuelve a los docentes más comprometidos hacia su uso (Bozalek et al., 2013). No obstante, para los centros de formación del profesorado es complejo integrar las nuevas tecnologías en la práctica docente de su alumnado (Tondeur et al., 2016). Por ello la función de los formadores de docentes es crucial (Garba & Yusuf, 2016). Los formadores de docentes que hacen un uso innovador de las tecnologías son aquellos que se relacionan con otros educadores y con expertos en este ámbito para posteriormente enseñar lo aprendido a su estudiantado mediante un enfoque pedagógico centrado en el alumno (Drent & Meelissen, 2008). También se emplean otras estrategias como reflexionar sobre los beneficios de las nuevas tecnologías en educación, la colaboración entre docentes, prácticas supervisadas y retroalimentación continua (Tondeur et al., 2019). En la Figura 4 se puede observar el modelo para preparar a los futuros docentes para el uso de la tecnología (Tondeur et al., 2012), en el que se muestran los elementos repartidos en diferentes niveles:

Figura 4

Modelo SQD para preparar al profesorado de pre-servicio para el uso de la tecnología



Fuente: Tondeur et al. (2012) [La figura en color se puede ver en wileyonlinelibrary.com].

Por tanto, la formación en competencia digital consiste en una búsqueda cognitiva de conocimiento, actividad y práctica (Chen et al., 2019). Se busca dotar de un conocimiento pedagógico que les permita emplear correctamente la tecnología, un conocimiento sobre la tecnología en sí y las competencias necesarias para emplearlas (Aslan & Zhu, 2017). Una vez cuentan con esa base, los docentes necesitarán seguir una serie de pasos para implantar el uso de las nuevas tecnologías en sus clases de manera eficaz. En primer lugar, fijar unos objetivos, a continuación, anticiparse a los resultados del aprendizaje, describir el propósito de la actividad, seleccionar las herramientas adecuadas, que el estudiantado realice un proyecto y que reflexionen acerca de su proceso de aprendizaje (Ng'Ambi, 2013). Se debe emplear siempre metodologías activas (Markus & Mentzer, 2014) como el aprendizaje basado en proyectos o el aprendizaje-servicio que permiten al alumnado poner en práctica sus conocimientos (Salam et al., 2019). El último paso sería conseguir el aprendizaje a lo largo de la vida puesto que siempre se ha de ir adecuando a los nuevos avances y hacerlo de forma



autodidacta, ya que las nuevas tecnologías lo permiten, sin embargo, pocos son capaces de conseguirlo (Gogh & Kovari, 2019).

Finalmente, la implementación de las nuevas tecnologías en educación se verá condicionada por su utilidad, disponibilidad, el acceso que tengan los docentes a las tecnologías fuera del aula, además de sus experiencias previas y el apoyo que reciban durante el proceso (Van Den Beemt & Diepstraten, 2016). En función del uso que se haga de las nuevas tecnologías el aula, esta obtendrá la consideración de aula tradicional, emergente o innovadora (Bocconi et al., 2013).

3.5. Ejemplo de aplicación de las nuevas tecnologías en la Ciudad Autónoma de Melilla.

La diversidad lingüística de la Ciudad Autónoma de Melilla causa algunos problemas de comunicación que acaban afectando a la situación educativa. En la ciudad existen muchas familias en las que ninguno de sus miembros posee unos mínimos conocimientos de lengua española, siendo la lengua vehicular de los centros educativos de Melilla. Cuando este estudiantado alcanza un nivel suficiente de español, que les permite seguir las clases, presentan un desajuste académico que les impide finalizar con éxito sus estudios. Este es uno de los principales factores que ha hecho que Melilla sea una de las ciudades con mayor tasa de fracaso y abandono escolar de Europa (MECD, 2017; MECD, 2019). Esta barrera idiomática afecta también a la comunicación entre los centros escolares y las familias del estudiantado (García-Carmona, 2014).

Los centros escolares deben poner medios para facilitar la comunicación con las familias del estudiantado para que puedan ser partícipes de la educación de sus hijos e hijas (Chuang, 2005). Para conseguir un proceso de enseñanza-aprendizaje exitoso es esencial la implicación de las familias del alumnado en la escuela (García-Carmona, 2014; García-Carmona et al., 2020; Henderson & Mapp, 2002; National PTA, 1998, 2000, 2007, 2010; Henderson & Berla, 1994; Olivos, 2010).

Los teléfonos móviles, internet y las redes sociales se han convertido en herramientas tecnológicas de uso cotidiano (Bas & Pérez, 2010). El hecho de que sean herramientas de comunicación al alcance de la mayoría de la población las hace idóneas para ser empleadas en contextos socioeconómicamente desfavorecidos. Este tipo de tecnología

ofrece múltiples opciones de comunicación efectivas y rápidas. Las nuevas tecnologías pueden ofrecer una comunicación alternativa entre las familias y los centros escolares que potencie y desarrolle las relaciones presenciales (Trujillo, et al., 2012).

Para que una tecnología sea utilizada adecuadamente en contextos educativos, los usuarios deben disponer del conocimiento necesario y acceso a las mismas (Sáenz, 2007 citado en Aguilar & Leiva, 2012). En el caso de la tecnología empleada en este estudio realizado en Melilla, únicamente se requiere de dispositivos móviles y de una aplicación de mensajería instantánea. La mayoría de la población conoce el funcionamiento de las aplicaciones de smartphones y las emplea habitualmente, por lo que puede aprender el uso de una aplicación nueva en poco tiempo. En cuanto al teléfono móvil, es un dispositivo de uso generalizado en la sociedad actual por lo que la mayoría de la gente ya dispone de él. En el caso de aquellas personas que no dispongan de uno, es un dispositivo muy accesible debido a que se puede conseguir con una mínima inversión por la alta oferta de dispositivos que existen en el mercado. Además, los bajos requisitos de las aplicaciones de mensajería instantánea como la que se desarrolló en el proyecto permiten que se pueda utilizar en dispositivos antiguos y de baja gama.

La herramienta de tecnológica creada para facilitar la comunicación evitando la barrera idiomática y reforzar las relaciones entre los centros escolares y las familias, se espera que consiga lo siguiente (Chuang, 2005):

- Adaptarse a las nuevas tendencias sociales y a las necesidades de la familia.
- Ampliar el uso de internet en el centro de enseñanza.
- Abrir nuevos cauces de información y comunicación entre el centro educativo y la familia.
- Ofrecer a la familia un medio de comunicación eficaz.
- Facilitar la difusión de información (proyectos, noticias, avisos...).
- Promover la interacción entre el centro educativo y la familia.

Abordando las competencias digitales de los docentes en formación y los campos relativos a cómo ha de ser la formación del profesorado, las metodologías a emplear y la forma de trabajar en contextos desfavorecidos, se pretende obtener una visión amplia y completa del fenómeno. Además, con el proyecto de la aplicación de idiomas se procura poner en práctica el uso de las nuevas tecnologías en entornos educativos socioeconómicamente desfavorecidos.



4. Justificación



4. Justificación

La línea de investigación de la presente tesis doctoral nace de la actual necesidad de disponer de competencias digitales que nos permitan hacer un buen uso de las nuevas tecnologías para conseguir la integración social y el acceso al mercado laboral. Este aspecto es algo especialmente sensible e importante en contextos socioeconómicamente desfavorecidos. Además, los perjuicios ocasionados por la ausencia de competencias digitales en la población de dichos contextos, no se circunscribe a los mismos, sino que afecta al desarrollo social y económico de todo el país. La importancia y relevancia de la investigación queda patente ante la gran cantidad de organizaciones internacionales, entre las que se encuentran la Unión Europea y la UNESCO, que conscientes de ello, vienen realizando iniciativas destinadas a paliar esta situación como en el informe sobre la iniciativa emblemática de Europa 2020 "Una agenda digital para Europa" de la Comisión Europea (Comisión Europea, 2013). Además, a pesar de su importancia, en la realización de este estudio hemos podido comprobar que existe poca literatura sobre la temática. El presente trabajo pretende contribuir a cubrir ese vacío aportando conocimiento que pueda ser expandido en futuras líneas de investigación.

En la tesis se presentan propuestas para alcanzar un cambio mediante la educación, formando a la población en competencias digitales. Esto se produce con la mejora de las competencias digitales de los docentes para que sean capaces de desarrollar las competencias digitales en sus alumnos. En primer lugar, esto repercute en una mejora de la situación educativa de la ciudad (Bejaković & Mrnjavac, 2020; Comisión Europea, 2013; Koliousska & Andreopoulou, 2020; Quaglio et al., 2016; Valarezo et al., 2018) y posteriormente en una mejora del conjunto de la sociedad (Fang et al., 2019; Garcia-Valcarcel et al., 2014; Reimers, 2020; Wu et al., 2015) y de su economía (Cruz-Jesus et al., 2016; Reimers, 2020). Es fundamental alcanzar una correcta implantación de las nuevas tecnologías en la educación formal y ello dependerá en gran medida de las competencias digitales de los docentes. El profesorado ha de disponer de un nivel avanzado de competencias digitales para poder desarrollar las competencias digitales de su alumnado. De este modo, debe ser capaz de emplear las nuevas tecnologías eficazmente en sus enseñanzas, adaptándose al contexto educativo en el que desempeñen su labor y a las necesidades de su alumnado.

La investigación se centra en la implantación de las nuevas tecnologías en contextos educativos socioeconómicamente desfavorecidos y, por ello, parte del trabajo de campo



de la investigación se realiza en la Ciudad Autónoma de Melilla, ya que es una de las ciudades europeas con mayor índice de fracaso y abandono escolar según diversos informes educativos (MECD, 2017; MECD, 2019; PISA, 2018). No obstante, las conclusiones del estudio pueden ser extrapolables a contextos similares o de menor complejidad, contribuyendo así a ofrecer una serie de medidas aplicables a otros contextos educativos socioeconómicamente desfavorecidos.

Esta tesis doctoral pretende contribuir a solucionar la problemática presentada, mediante el análisis de la formación del profesorado de Melilla y la consulta a expertos internacionales sobre la correcta implantación de las tecnologías emergentes en contextos educativos socioeconómicamente desfavorecidos para mejorar la situación educativa y social de la ciudad. Estos expertos pertenecen a diferentes ámbitos educativos como Universidades, centros de investigación, escuelas, etc., con el fin de ofrecer una visión más completa del fenómeno objeto de estudio. De esta forma se busca encontrar los puntos clave que permitan mejorar la situación educativa y con ella la social. También se ha realizado un proyecto en la Ciudad Autónoma de Melilla como ejemplo del uso de nuevas tecnologías en este tipo de contextos para mejorar su situación educativa. Consiste en la creación de una herramienta que contribuye a salvar una de las principales barreras que impide el desarrollo educativo de la ciudad, la barrera idiomática.

La pregunta de investigación, por tanto, sería: ¿Cómo implantar las nuevas tecnologías en educación para mejorar la situación educativa de contextos socioeconómicos desfavorecidos? Esta cuestión se concreta en los siguientes interrogantes:

- ¿Cuáles son las carencias y/o fortalezas en las competencias digitales del profesorado en formación de la Ciudad Autónoma de Melilla?
- ¿Cómo debe ser la formación del profesorado para que sea capaz de implementar las nuevas tecnologías con éxito y desarrollar las competencias digitales de su alumnado?
- ¿Cuáles son los puntos clave que permiten mejorar la educación en estos contextos?

Partiendo de las cuestiones planteadas, establecemos el objetivo general de la tesis doctoral que consiste en “Analizar las posibilidades de implantación de tecnologías emergentes y metodologías activas en la formación inicial del profesorado de Melilla”. Se pone el foco en los contextos educativos socioeconómicamente desfavorecidos y por ello parte de la investigación se realiza en la ciudad de Melilla (MECD, 2017; MECD, 2019; PISA, 2018). Del objetivo general se derivan los objetivos específicos (OE) que han marcado la línea de la presente investigación:

- OE1. Conocer la percepción del profesorado en formación de Melilla sobre las carencias en su competencia digital.
- OE2. Encontrar las metodologías y pedagogías idóneas que permitan emplear eficazmente las nuevas tecnologías en el proceso de enseñanza-aprendizaje.
- OE3. Averiguar la mejor forma de implantar las nuevas tecnologías en contextos socioeconómicos desfavorecidos.
- OE4. Descubrir cómo ha de ser la formación de los docentes para que cuenten con una avanzada competencia digital que les permita desarrollar las competencias digitales de su alumnado.
- OE5. Emplear las nuevas tecnologías para mejorar la situación educativa de la ciudad de Melilla.
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5. Metodología



5. Metodología

Para la realización de la investigación se empleó un método mixto (Johnson & Onwuegbuzie, 2004) en el que los análisis cualitativos se han complementado con cuantitativos para obtener mayor objetividad y reforzar los datos obtenidos. El método mixto es una de las metodologías que más se emplean en investigación educativa (Cáceres et al., 2007; Pereira, 2011). Asimismo, la estrategia empleada ha sido el método deductivo (Dávila, 2006) para la consecución de los objetivos planteados (Tabla 2).

Tabla 2

Estrategia metodológica aplicada en la consecución de los objetivos específicos.

Objetivo	Método
OE1. Conocer la percepción del profesorado en formación de Melilla sobre las carencias en su competencia digital.	Cuantitativo
OE2. Encontrar las metodologías y pedagogías idóneas que permitan emplear eficazmente las nuevas tecnologías en el proceso de enseñanza-aprendizaje.	Mixto
OE3. Averiguar la mejor forma de implantar las nuevas tecnologías en contextos socioeconómicos desfavorecidos.	Mixto
OE4. Descubrir cómo ha de ser la formación de los docentes para que cuenten con una avanzada competencia digital que les permita desarrollar las competencias digitales de su alumnado.	Mixto
OE5. Emplear las nuevas tecnologías para mejorar la situación educativa de la ciudad de Melilla.	-----

Como puede observarse, se han utilizado diferentes estrategias metodológicas en función de la información que se necesitaba recabar en cada caso. La metodología empleada en la tesis se puede dividir en tres partes:

Primera parte. Método cuantitativo. Es el empleado en el primer artículo (competencias digitales del profesorado), donde se analizaron los datos obtenidos de los cuestionarios sobre los ítems del Marco Común para la Competencia Digital de los Docentes (Gabarda et al., 2017; INTEF, 2017). Para ello se utilizaron un conjunto de pruebas cuantitativas (D'ancona & Ángeles, 1999) que se detallan más adelante.



Segunda parte. Método mixto utilizado para analizar las entrevistas semiestructuradas (Kvale, 2012) realizadas a los 8 expertos internacionales en educación para los artículos segundo (aspectos metodológicos), tercero (contextos desfavorecidos) y cuarto (formación del profesorado). El análisis consta de dos partes, una parte cualitativa en la que se analizan las transcripciones de las entrevistas en busca de información relevante para la investigación mediante el análisis de contenido y otra parte cuantitativa en la que se analizan las transcripciones mediante un análisis de sentimientos que nos permite identificar las emociones de los informantes ante las diferentes cuestiones planteadas. El análisis de sentimientos permite complementar y reforzar la información recogida en las respuestas, ofreciendo una visión más objetiva del fenómeno estudiado.

Tercera parte. En la quinta publicación (App de idiomas) se ha realizado una revisión de la literatura existente sobre la situación educativa de la ciudad. La revisión de la literatura, junto con el conocimiento y experiencia de los investigadores, permitió detectar las carencias existentes en el contexto educativo de la Ciudad Autónoma de Melilla. Partiendo de dichas carencias, se pudo diseñar un software personalizado que se adaptase a las necesidades reales de la ciudad, ofreciendo una herramienta eficaz para su uso diario.

5.1. Selección y tamaño de la muestra

5.1.1. Primera publicación (competencias digitales del profesorado).

En esta investigación se contó con el alumnado del Grado en educación Infantil, Grado en Educación Primaria y Máster de profesorado de la Facultad de Ciencias de la Educación y del Deporte de Melilla. El alumnado en formación de los dos grados y de la maestría representan casi la totalidad de los docentes en formación de la ciudad de Melilla. Se les ha ofrecido participar a los cuatro cursos académicos que componen cada una de las dos titulaciones de grado en educación y al curso académico de la maestría. Fueron invitados a participar un total de 266 informantes (Grado en Educación Infantil 68, Grado en Educación Primaria 154 y máster 44) y aceptaron 176 (Grado en Educación Infantil 46, Grado en Educación Primaria 110 y máster 20). De los 176 participantes, 154 respuestas se recogieron de forma presencial en las aulas y 22 mediante cuestionarios online (Grado en Educación Infantil 5, Grado en Educación Primaria 10 y máster 7). La media de edad de los participantes fue de 21 años.

5.1.2. Segunda (aspectos metodológicos), tercera (contextos desfavorecidos) y cuarta publicación (formación del profesorado).

Para las entrevistas se recurrió a un tipo de muestreo intencional o por conveniencia (Hurtado, 2006) para seleccionar expertos internacionales en educación de diferentes ámbitos que permitiesen ofrecer una visión más completa de la realidad investigada. A continuación, se presentan los 8 expertos internacionales y algunos datos destacables de su trayectoria profesional. Para conservar el anonimato de los participantes, se les ha identificado con la palabra “Informante” seguida de un número:

Informante 1. Exdirector de uno de los centros escolares ATLSchool situado en Silicon Valley (California, USA). Es uno de los centros educativos más innovadores del mundo que se nutre de los expertos en tecnología de Silicon Valley, que es donde se crea y desarrolla la mayor parte de la tecnología a nivel mundial. Empresas como Google, Apple, Uber, Airbnb, etc. se encuentran ubicadas allí. Actualmente es director de un centro educativo Montessori.

Informante 2. Profesor de educación en la Universidad de Stanford e investigador especializado en la aplicación de las nuevas tecnologías en diferentes contextos educativos entre los que se encuentran los contextos socioeconómicos desfavorecidos.

Informante 3. Profesor principal de los grados de educación de la Universidad de Stanford y director de Learning Design and Technology (LDT). Estudia entre otros temas la implantación de la tecnología en la docencia y la creación de herramientas digitales efectivas.

Informante 4. Profesor emérito en Ciencias de la Educación en la Universidad de Stanford. Fue galardonado por su impacto en la educación científica con el premio NARST. Es un premio a las contribuciones distinguidas a la educación científica realizadas a través de la investigación. Fue presidente del grupo de expertos en ciencias de PISA de la OCDE.

Informante 5. Vicepresidente ejecutivo de la Singularity University, una universidad dedicada a pronosticar el impacto de las nuevas tecnologías en el futuro. Ayudan a líderes a conocer cómo emplear la tecnología para mejorar la



sociedad. La universidad está financiada por Google y la NASA y se encuentra ubicada dentro de las instalaciones de la NASA en California (EEUU).

Informante 6. Vice-Rector de enseñanza, aprendizaje y educación digital, y director de enseñanza de calidad e innovación en el aprendizaje de University College London (UK). Es el líder académico para la educación digital y en línea en toda la universidad.

Informante 7. Profesor y galardonado autor de varios *best seller* sobre educación de la editorial de Harvard University Press. Uno de ellos se encuentra entre los libros más vendidos sobre enseñanza y aprendizaje, traducido a doce idiomas. Ha sido asesor de varios gobiernos entre los que se encuentra la Unión Europea y otras instituciones por todo el mundo. También fue Rector y vicepresidente de Asuntos Académicos de la Universidad del Distrito de Columbia.

Informante 8. Referente internacional en educación y gran orador. Autor de varios *best sellers* internacionales. Fue asesor de educación del Reino Unido y ha sido nombrado orador empresarial del año en Reino Unido en varias ocasiones. Ha trabajado con una gran variedad de personas distinguidas, incluido el expresidente estadounidense Barack Obama, el Dalai Lama, el príncipe Carlos y el cofundador de Apple, Steve Wozniak. Actualmente trabaja con organizaciones a la vanguardia de la innovación y la excelencia global como Microsoft, Deloitte o Google.

La experiencia de los 8 expertos en educación permite ofrecer una visión completa y objetiva de la realidad educativa estudiada en la presente tesis doctoral.

5.1.3. Quinta publicación (App de idiomas).

En este estudio no existe una muestra puesto que el análisis sobre las carencias del sistema educativo de la Ciudad Autónoma de Melilla se ha realizado mediante revisión bibliográfica de estudios nacionales e internacionales de la ciudad. La aplicación está dirigida a las AMPA, los CEIP, Institutos y a cualquier otra entidad educativa que requiera de su uso, como los centros de adultos, el CETI, etc.

Se ha seleccionado la Ciudad Autónoma de Melilla para este estudio por su situación educativa. Al igual que para el artículo primero, Melilla ofree un contexto educativo complejo y representa un buen ejemplo del tipo de contextos en el que pretendemos implantar las nuevas tecnologías para alcanzar una mejora educativa y social.

5.2. Instrumentos de recogida de datos

5.2.1. Primera publicación (competencias digitales del profesorado).

En el estudio de las competencias digitales de los futuros docentes de Melilla, se empleó un cuestionario en el que se recogen los 91 ítems de las cinco áreas que componen la competencia digital del Marco Común para la Competencia Digital de los Docentes (Gabarda et al., 2017; INTEF, 2017).

- Área de competencia 1: Alfabetización informacional y de datos (16 ítems)
- Área de competencia 2: Comunicación y colaboración (31 ítems)
- Área de competencia 3: Creación de contenidos digitales (16 ítems)
- Área de competencia 4: Seguridad (13 ítems)
- Área de competencia 5: Resolución de problemas (15 ítems)

Las respuestas para cada uno de los ítems anteriores es una escala tipo Likert de 4 opciones en la que los informantes expresaban el grado de conocimiento correspondiente a cada uno de los ítems. Las 4 opciones son: 1«Totalmente en desacuerdo», 2«En desacuerdo», 3«De acuerdo» y 4«Totalmente de acuerdo». Las respuestas hacen alusión ha si cuentan con el conocimiento contenido en el ítem por lo que la opción 1 sería el mayor grado de conocimiento y la opción 4, sería el mínimo o inexistente.

5.2.2. Segunda (aspectos metodológicos), tercera (contextos desfavorecidos) y cuarta publicación (formación del profesorado).

Para las entrevistas, se ha realizado una revisión bibliográfica en busca de preguntas validadas que se hayan realizado a expertos en educación educativa. Las preguntas se han extraído del libro de entrevistas a expertos en educación y tecnología “Educación y tecnología las voces de los expertos” (Gvirtz, 2012). En el libro se realizan preguntas a



una gran cantidad de expertos y sobre múltiples aspectos relacionados con la educación y la tecnología. Para la investigación se han seleccionado aquellas preguntas que inciden en los aspectos concretos objeto del presente estudio. Las preguntas han sido agrupadas por dimensiones y el número de preguntas varía en función de la temática investigada:

- Aspectos metodológicos, 9 preguntas divididas en dos dimensiones: tecnologías emergentes (4 preguntas) y aspectos docentes-pedagógicos vinculados a la integración de las TIC (5 preguntas).
- Contextos desfavorecidos, 9 preguntas divididas en dos dimensiones: la integración de las TIC en contextos desfavorecidos y el Uso crítico de las TIC y el origen del cambio educativo.
- Formación del profesorado, son las pertenecientes a la dimensión: formación del profesorado que consta de 5 preguntas.

5.2.3. Quinta publicación (App de idiomas).

Para este estudio se ha realizado una revisión bibliográfica de la literatura existente sobre la situación educativa de la Ciudad Autónoma de Melilla tanto a nivel nacional con informes del Ministerio de Educación Cultura y Deporte español, como informes internacionales de reconocido prestigio como PISA (PISA, 2018). También se han consultado otros realizados por la propia ciudad en el Instituto de las Culturas (Instituto de las Culturas de Melilla, 2019). Todo ello, unido a la experiencia de los investigadores que se encuentran en la ciudad y conocen el contexto educativo de la misma es lo que ha permitido detectar las carencias existentes en el sistema educativo de la ciudad. En base a dichas carencias, se ha seleccionado el tipo de tecnología idónea y las características que debía tener, teniendo en cuenta la financiación obtenida y los plazos para realizar el proyecto.

5.3. Proceso de recogida de datos

5.3.1. Primera publicación (competencias digitales del profesorado).

Para el estudio de las competencias digitales, se contactó de manera telemática por correo electrónico con profesorado de diferentes asignaturas de los dos grados y la maestría objetos del presente estudio. Se les solicitó permiso para para pasar el cuestionario a su alumnado durante sus clases. Al existir asignaturas optativas, grupos de prácticas etc, se contactó con profesorado en cuyas asignaturas se encontraba el grupo completo de estudiantado. Una vez en el aula, en primer lugar, se dio las indicaciones pertinentes respecto al cuestionario y se informó respecto a los objetivos de la investigación y el Marco Común de Competencias Digitales Docentes. A continuación, se resolvieron las dudas al estudiantado que había aceptado voluntariamente participar y firmado un documento de consentimiento informado. Finalmente, se procedió a facilitarle a cada uno una copia del cuestionario en papel para que la cumplimentaran. También se realizó una versión digital del cuestionario en un formulario de Google Form que se le envió por correo electrónico a aquel estudiantado que no se encontraba en clase los días que se pasaron los cuestionarios de forma presencial.

5.3.2. Segunda (aspectos metodológicos), tercera (contextos desfavorecidos) y cuarta publicación (formación del profesorado).

Las entrevistas se llevaron a cabo 4 de forma presencial en California (EEUU), 3 de mediante videoconferencia utilizando la herramienta Skype y 1 por correo electrónico. Se contactó con los informantes por correo electrónico para solicitarles la entrevista. En el correo se les informaba del contenido y objetivos de la misma. Ante la dificultad de concertar una cita con los expertos, las entrevistas presenciales y por videoconferencia se llevaron a cabo por dos personas para garantizar la correcta realización y recogida de muestras. Un nativo de habla inglesa realizaba las preguntas de la entrevista y se centraba en la interacción con el informante. El otro investigador se centraba en que la entrevista quedase correctamente registrada para su posterior análisis y anotar aquellos datos relevantes que tuvieran lugar durante las entrevistas como por ejemplo anotaciones en una pizarra. Se buscaron nativos que hablasen el mismo tipo de inglés que el informante para facilitar lo máximo posible la comunicación y aumentar la



cercanía con el informante. Se empleó inglés británico con los informantes de origen británico e inglés americano con los informantes de origen estadounidense. En las entrevistas presenciales se ha empleado una grabadora manual y en las videoconferencias se empleó Skype. En ambos casos se anotaban los tiempos de las preguntas y otros datos relevantes en un cuaderno de campo.

Todas las entrevistas tienen una duración aproximada de una hora y cuentan con el consentimiento de los informantes. La información personal de los informantes ha sido eliminada en los artículos, se les asignó un código para garantizar la protección de datos.

5.3.3. Quinta publicación (App de idiomas).

Como se comentó en el punto anterior relativo a la muestra, para este estudio se realizó una revisión bibliográfica por lo que no se ha requerido de una recogida de datos sobre el terreno ni recabarlos de unos determinados informantes. Se ha partido del análisis de estudios anteriores sobre la situación educativa de la ciudad. El análisis permitió detectar carencias educativas de la ciudad que fueron tomadas como referencia para el diseño del producto tecnológico que mejor se adaptara a ellas.

5.4. Proceso de análisis de datos

5.4.1. Primera publicación (competencias digitales del profesorado).

El análisis de los datos recogidos mediante los cuestionarios cuenta de varias etapas:

1. Se crea un indicador específico para cada una de las áreas de competencia. Mediante la utilización de influencias de factores de ítem derivadas de un análisis factorial exploratorio (Hair et al., 2009; Härdle & Simar, 2012).
2. Se realiza un análisis descriptivo de los indicadores utilizando la estadística descriptiva principal y posteriormente se crean gráficas de caja. Se utiliza la inferencia estadística para probar si hubo diferencias entre los grupos propuestos en la segunda etapa. Para ello, se comprueba previamente el supuesto de normalidad utilizando la prueba de Kolmogorov-Smirnov con la corrección de Lilliefors (1967). En este caso, si se cumple la suposición, utilizamos la prueba t ,

y si no, aplicamos la alternativa no paramétrica de la prueba de Mann-Whitney-Wilcoxon.

3. Se crea un modelo de regresión lineal múltiple utilizando mínimos cuadrados ordinarios (OLS) con la finalidad de encontrar la relación existente entre los indicadores y las variables independientes de interés como el género, el año académico o el grado que se está cursando (Gujarati et al., 2012; Wooldridge, 2016).

Los pasos realizados permiten a los investigadores describir la situación actual (Best, 1970) y facilitan la explicación del tema (Verma & Mallick, 1999). Es un estudio no experimental, en el que se encontraron resultados y posteriormente fueron analizados para responder a las cuestiones planteadas.

5.4.2. Segunda (aspectos metodológicos), tercera (contextos desfavorecidos) y cuarta publicación (formación del profesorado).

Para las entrevistas se ha empleado un enfoque mixto como se ha comentado anteriormente. La parte cualitativa consiste en el análisis de las transcripciones para extraer la información de mayor relevancia en cada una de las cuestiones planteadas a los expertos. Un análisis del contenido que consiste en categorizar, distribuir el y analizar su contenido (Bardin, 1996; Miles & Huberman, 1994). En la parte cuantitativa se emplea el conteo de palabras y el análisis de sentimientos. Para ambas pruebas se ha utilizado el lenguaje informático de estadística avanzada R mediante la herramienta Rstudio.

Para el conteo de palabras se ha empleado la nube de palabras en la que el tamaño de las palabras guarda relación con el número de veces que se repite. Cuanto mayor es el número de veces que se repite una palabra en el texto, mayor será su tamaño. Se han eliminado del conteo palabras irrelevantes como los artículos puesto que no aportaban información relevante para el estudio. En resumen, esta herramienta nos permite identificar las palabras más frecuentes de forma visual.

Por otro lado, la minería de texto para extraer información objetiva a través del Procesamiento del Lenguaje Natural (PLN) de las transcripciones de las entrevistas con el paquete de R, Tidy text. Se ha utilizado el análisis de sentimientos en las respuestas



de los informantes. El análisis detecta 8 sentimientos (ira, anticipación, asco, miedo, alegría, tristeza, sorpresa y confianza) y dos valores (negativo y positivo), seleccionadas en el diccionario NRC Word-Emotion Association Lexicon de Saif M. Mohammad (Mohammad & Turney, 2010).

5.4.3. Quinta publicación (App de idiomas).

Finalmente, el proyecto en el que se empleó las nuevas tecnologías para mejorar la situación educativa de Melilla. La creación y desarrollo del software para smartphone se realizó una revisión bibliográfica de los informes educativos realizados anteriormente tanto a nivel nacional como PISA como otros nacionales realizados por el Ministerio de Educación Cultura y Deporte español (MECD, 2017; MECD, 2019) sobre la situación educativa de la Ciudad Autónoma de Melilla. La revisión bibliográfica permitió detectar las carencias principales que provocaban que la ciudad cuente con elevados índices de fracaso abandono escolar. En primer lugar, se detectó el problema de la comunicación, permitiéndonos seleccionar el tipo de tecnología apropiada. La mayoría de la población de la ciudad dispone de dispositivo móvil y está familiarizada con su uso. Además, actualmente los móviles tienen funcionalidades avanzadas y permiten el uso de aplicaciones de software como la mensajería instantánea por sus bajos requisitos. A continuación, se analizó el perfil del usuario y del contexto para concretar las especificaciones y características que debía disponer la aplicación. Se observó que parte de los usuarios proceden de entornos rurales por lo que no tienen un conocimiento elevado de las nuevas tecnologías. Para ello, la aplicación cuenta con un diseño claro, sencillo e intuitivo para facilitar lo máximo posible su uso. Además, se proporciona un manual y se ofrece asistencia y orientación desde el centro escolar en el que le ayudarán con la instalación y le enseñarán a usarla. También encontramos que entre los usuarios hay personas que no saben leer ni escribir por lo que se le añadió la funcionalidad de transcribir los mensajes y de reproducirlos en audio. De esta forma una persona puede recibir en audio los mensajes escritos y responder igualmente mediante un audio. El programa transcribe el audio, lo traduce a la lengua del receptor y se lo entrega por escrito o en audio dependiendo de lo que haya escogido (Figura 5).

Figura 5

Funcionamiento de la aplicación



Fuente: elaboración propia.

La aplicación resultante pretendió contar con las siguientes características básicas:

- Versátil: La aplicación será compatible con los sistemas operativos Android que abarcan casi la totalidad del mercado.
- Pocos requisitos: Para que pueda ser empleada en la mayoría de dispositivos.
- Intuitiva: Cualquier persona sin conocimientos informáticos ha de ser capaz de usarla. Debe tener una interface clara y sencilla.
- Facilitadora de la comunicación:
 - Traductora: La aplicación traducirá los mensajes de forma instantánea para facilitar la comunicación entre personas de diferente lengua.
 - Transcripción: Las personas que no sepan leer ni escribir, podrán personalizar la aplicación para que lea los mensajes y contestarlos mediante audio.
- Canal instantáneo: La comunicación se realizará de forma instantánea mediante mensajes como WhatsApp o alertas de móvil.

Con las funcionalidades anteriores, un conjunto de personas de diferente lengua puede comunicarse instantáneamente al margen de su lengua y si sabe escribir o no. A todo lo anterior ha habido que añadir la dificultad de desarrollar el software dentro de la financiación obtenida.

El proyecto fue seleccionado para el programa internacional de emprendimiento Telefónica Open Future en el que se continuó desarrollando. También se va a realizar



una segunda fase del proyecto en el que se consultará a las asociaciones de madres y padres AMPA sobre las funcionalidades que mejorarían la utilidad de la herramienta. Así conseguiríamos adaptarla aún más a las necesidades reales de los centros educativos de la ciudad y conseguir una herramienta práctica que contribuya a la mejora de la situación educativa de la Ciudad Autónoma de Melilla.

5.5. Ética de la investigación

En la primera publicación se solicitó el consentimiento previo a la facultad, al profesorado y al alumnado. La presente investigación cumple con las directrices marcadas por la Asociación americana de Investigación Educativa para la realización de investigaciones en el ámbito de la educación (AERA, 2011). Es importante respetar un código ético que respete los derechos de los participantes y garantice la fiabilidad de los datos (Buendía & Berrocal, 2001).

En la primera publicación se solicitó el consentimiento previo del alumnado y del profesorado que ha participado en la investigación. Todos los participantes fueron previamente informados y se resolvieron todas sus dudas antes de que participaran. En las publicaciones dos, tres y cuatro, se solicitó el consentimiento previo para la realización de la entrevista y para su grabación y posterior análisis. Además, para guardar su privacidad, se omitió vincular la aportación con cada informante, identificándolos en las publicaciones con el nombre “informante” seguido de un número. Para la quinta publicación no ha sido necesario solicitar permisos debido a que se tomó la información de documentos públicos y en ningún momento se ha empleado información sensible.

6. Resultados



6. Resultados

6.1. Competencias digitales de los futuros docentes de Melilla

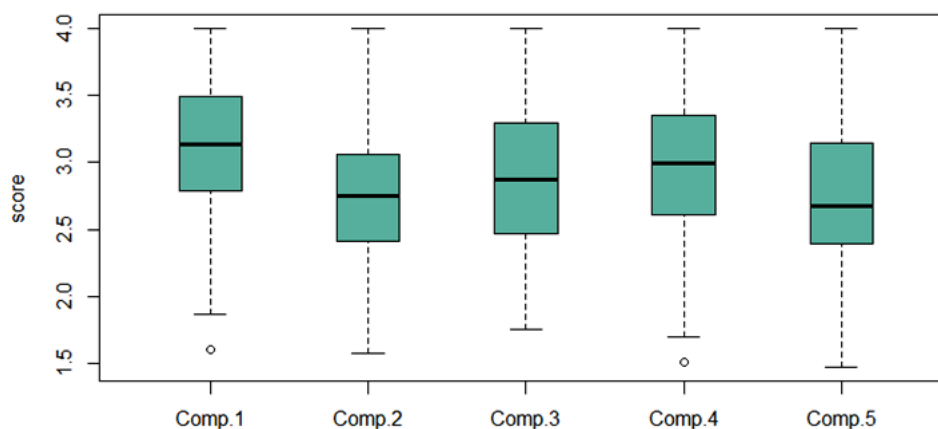
Resultados del cuestionario de autoevaluación sobre las cinco competencias del CDCFT:

En primer lugar, se definió un indicador del nivel de autoevaluación del alumnado docente para cada área de competencia a partir de la evaluación de los ítems. Los indicadores fueron construidos como promedio ponderado utilizando la carga factorial del ítem en su área de competencia para determinar el peso. Las influencias de los factores se calcularon utilizando el método de extracción de componentes principales (Hair et al., 2009; Härdle & Simar, 2012). Los indicadores fueron construidos de esta manera con el fin de asignar un valor a cada ítem de acuerdo a su contribución a la competencia.

En segundo lugar, se realizó un análisis descriptivo de los indicadores. No se observaron variaciones significativas en la media y la desviación estándar entre los indicadores. Los coeficientes de asimetría y curtosis son cercanos a cero en todos los casos, lo que indica que la distribución del área de competencia es casi simétrica. En relación a la fiabilidad de los indicadores, obtenemos altas puntuaciones alfa de Cronbach (Cronbach, 1951). Se puede observar en la Figura 6 todos los indicadores tienen una distribución casi simétrica con valores que van de 1,6 a 4.

Figura 6

Diagrama de cuadros de indicadores por área de competencia





En tercer lugar, se contrastaron las diferencias de medias y se incluyeron pruebas de normalidad para verificar el supuesto inicial antes de aplicar la prueba t. Si la suposición no es satisfactoria, entonces se muestra la alternativa no paramétrica Mann-Whitney-Wilcoxon. La prueba de normalidad es significativa sólo en el área de Competencia 5 para el grupo de grado. En general, se observó que las diferencias son significativas entre los grupos a excepción de la competencia del área 4.

En los resultados de las regresiones realizadas, las variables 'grado' y ' año académico' son significativas. En casi el total de los casos, la variable 'año académico' se correlaciona positivamente con el indicador del área de competencia correspondiente. Muestran mayor puntuación en las diferentes competencias cuanto mayor es el tiempo de formación. Por ello el estudiantado de master obtuvieron la mejor puntuación, seguidos del grado en Educación y Primaria y posteriormente el Grado de Educación Infantil que ha obtenido la menor puntuación de los tres grupos analizados.

6.2. Resultados cualitativos de las entrevistas

En este apartado se resumen principales resultados obtenidos a partir de las opiniones de los informantes clave en las diferentes áreas:

6.2.1. Aspectos metodológicos-pedagógicos

6.2.1.1. El uso de tecnologías emergentes en el ámbito educativo

El profesorado es el elemento más importante, la tecnología es solo una herramienta que facilita el aprendizaje de los contenidos. No obstante, las funcionalidades más utilizadas de las nuevas tecnologías son las de facilitar la comunicación y el feedback además de permitir el aprendizaje autónomo fuera de las aulas. Deben utilizarse siguiendo un plan y unos objetivos. Si se emplean correctamente son muy beneficiosas, sin embargo, si se emplean mal pueden ser muy perjudiciales. El impacto de la tecnología en la educación depende de la confianza del profesorado para integrarlas en su docencia. La confianza, habilidad y conocimiento del docente indican el éxito del aprendizaje en el aula. La tecnología transformará el proceso de enseñanza y aprendizaje, lo hará interesante y emocionante para el alumnado. La tecnología hará que la escuela no sea el principal lugar en el que aprendan. Sin embargo, la tecnología no acabará sustituyendo al

profesorado debido a la necesaria interacción humana del docente y la empatía hacia su alumnado.

6.2.1.2. Los aspectos metodológicos-pedagógicos vinculados a la integración de las nuevas tecnologías en educación

Se debe utilizar la tecnología teniendo unos objetivos adecuados y un currículo contextualizado. En base a los objetivos se selecciona la tecnología idónea que nos permitirá alcanzarlos. Se requiere una mezcla de metodologías que fomenten la experiencia como el aprendizaje basado en proyectos. La mayoría del estudiantado aprende mejor cuando la enseñanza es rica en contexto, experiencia y dinámica. Es importante educar en competencias y promover el uso de la tecnología a los jóvenes para su futuro laboral.

El uso de tecnologías emergentes en las aulas puede influir en aspectos condicionantes del aprendizaje como la autorregulación, la concentración y la motivación. Sin embargo, mal empleadas pueden distraer y desconcentrar al estudiantado. La tecnología puede amplificar cualquier tipo de enseñanza, por lo que hay que permitir que la tecnología se fusione con el sistema. No obstante, la tecnología no debe definir la educación, debe apoyarla. Además, hay una disyuntiva entre lo que la tecnología puede hacer y lo que la educación realmente necesita. Se debe empezar por sustituir las herramientas tradicionales por las tecnológicas modernas de forma paulatina. Es fundamental crear interés porque es el impulsor de la motivación debido a que es beneficioso que el alumnado, siguiendo su interés, construya algún elemento de aprendizaje empleando la tecnología. Hay que familiarizar al estudiantado con la tecnología y facilitarles el acceso a ellas. El alumnado y el profesorado pueden aprender a través de otras comunidades que hagan actividades similares.

6.2.2. Contextos educativos socioeconómicamente desfavorecidos

6.2.2.1. Uso de las nuevas tecnologías en contextos desfavorecidos

Existe una gran ignorancia sobre la situación real de las personas desfavorecidas. Esto genera estereotipos que condicionan la forma en que son tratadas por otras personas y por sí mismas. La tecnología les ayuda dotándoles de confianza y facilitándoles un canal



en el que expresar y mostrar sus desigualdades. El uso de la tecnología no es la prioridad, aunque puede ser transformadora. Las nuevas tecnologías empleadas por docentes con buena formación, contribuyen a mejorar su situación educativa y social, ayudando en su integración en la sociedad. El conocimiento y dominio de la tecnología facilita la integración laboral, además de motivar al estudiantado y fomentar la colaboración a través de las fronteras económicas.

Lo principal es una buena formación docente seguida de un plan de estudios que prepare al estudiantado para enfrentarse a la sociedad y a sus familias. Es importante incidir en las familias por ser uno de los pilares fundamentales en la educación del estudiantado.

Es necesario emplear una buena pedagogía y presentar los contenidos de diferentes formas. Fomentar el trabajo en grupo además del acceso a la información y la comunicación laboral, para facilitar el intercambio de ideas entre los diferentes países. También es aconsejable trabajar la competencia cultural y contratar profesorado de diversos orígenes.

Los docentes no deben diseñar lecciones para la clase alta porque aumentan la brecha digital. Deben realizar la programación de sus clases teniendo en cuenta el contexto y aprovechando la tecnología que se encuentre a su disposición.

Es muy importante el entorno del estudiantado. Crear un ambiente en el que se sientan incluidos, comunicando sus propias ideas a los demás y de esta forma puedan ayudarles a crecer y permitirles vivir experiencias diferentes. También es fundamental contar con ellos en la implementación de las tecnologías en el aula. No obstante, el trabajo que se puede hacer fuera de la escuela es increíble, facilitando la comunicación y favoreciendo las relaciones humanas a distancia.

Se deben aumentar los fondos en educación para financiar la tecnología y dar tiempo suficiente para que se aprecien los resultados. La equidad entre el alumnado es esencial en la implementación de las nuevas tecnologías en la educación. Asimismo, es imprescindible proporcionar las herramientas y los conocimientos necesarios para utilizarlos. La brecha digital afecta dañando al aprendizaje de la misma forma, por ausencia de uso de tecnología que por un uso excesivo de la misma.

6.2.2.2. El uso crítico de las nuevas tecnologías y el origen del cambio educativo

El acceso a las nuevas tecnologías, la confianza depositada en ellas y la formación, no parecen ser las más idóneas. Esto ha producido que en general no se integren, sino que se consideren especiales y a veces, una amenaza o una distracción. Sin embargo, cuando la tecnología es utilizada correctamente, su impacto puede ser profundo. La situación está mejorando gradualmente en las escuelas públicas debido a la formación de los docentes.

Las nuevas tecnologías permiten promover cualquier tipo de aprendizaje mediante un buen currículo, un enfoque pedagógico que fomente el pensamiento crítico y el uso efectivo de la tecnología con herramientas como la Taxonomía de Bloom. Después, lo más importante será cómo diseñar un proyecto.

Las nuevas tecnologías pueden ser la clave para alcanzar un nivel más profundo de pensamiento. Proporcionan retroalimentación y ofrecen formas creativas de obtener comentarios del estudiantado. Se debe trabajar la empatía, es clave para que el estudiantado desarrolle conocimientos y la voluntad de aceptar nuevos conocimientos o nuevas personas en un grupo. También la curiosidad, por ser la base del pensamiento crítico y reflexivo. El pensamiento crítico requiere del uso de argumentos o razonamientos. La tecnología refuerza esto permitiendo la creación de simulaciones y experiencias para el alumnado.

El cambio educativo requiere de la participación de toda la comunidad educativa. La implementación tiene que ir desde arriba hacia abajo y se debe hacerse de manera crítica y reflexiva. El gobierno está a cargo de la educación, la gestiona y la financia, proporcionando los recursos y la estructura necesarios. Pueden dar independencia a las escuelas o incluso desarrollar un plan de estudios nacional. Las universidades pueden contribuir a la mejora de la situación educativa mediante la investigación de nuevas técnicas y metodologías que faciliten el proceso de enseñanza-aprendizaje. También, ofreciendo una formación del profesorado de calidad basada en la práctica y el pragmatismo, debido a que existe un desajuste entre los planes de estudio de los docentes y lo que necesitan las escuelas. Por último, los docentes deben formarse y esforzarse por emplear correctamente lo aprendido.

La clave es el profesorado por ser quien usa la tecnología y conoce el contexto. Otro elemento fundamental es el estudiantado. Las escuelas también son responsables del



cambio educativo, a través del desarrollo de planes de estudio. Estos deben diseñarse a 10 o a 15 años vista, y así ayudar al estudiantado a ser ciudadanos más productivos, valiosos y pacíficos.

6.2.3. Formación del profesorado

Existen muchos docentes que no saben emplear correctamente las nuevas tecnologías en el aula por carencias en su formación. Se le dedica poco tiempo y centrado principalmente en ver las características de la tecnología, no a cómo emplearlas para apoyar el aprendizaje. El profesorado adquiere una formación inicial y luego no se vuelve a capacitar. Necesita actualizar continuamente sus habilidades, conocimientos y experiencia además de contextualizar lo que ha aprendido y aplicarlo en entornos específicos del mundo real. Hay que mejorar la formación del profesorado, porque el profesorado no puede transferir conocimientos y habilidades que no tiene. La formación debe ser pragmática y permitirle adaptarse a cualquier contexto educativo. Son los docentes los que cambiarán la forma en que se utiliza la tecnología, no las universidades. Invertir en los docentes es invertir en la sociedad porque su trabajo es beneficioso para el conjunto de la sociedad. Es esencial que la formación y la certificación sean obligatorias para todo el profesorado. Para garantizar que los docentes posean un mínimo de conocimientos, es necesario establecer estándares. Es la mejor manera de lograr resultados efectivos en términos de productividad.

Los docentes deben ser conscientes de los beneficios del uso de las nuevas tecnologías en la educación y reconocer la necesidad de mejorar. Deben actualizar y renovar constantemente sus prácticas de enseñanza. Como se ha mencionado, la formación debe basarse en la práctica, para que los futuros docentes puedan integrar e implementar las nuevas tecnologías en su escuela y en la sociedad. Para lograrlo, el profesorado debe tener no solo conocimientos suficientes, sino también la predisposición a utilizarlos. Los docentes en ocasiones se sienten intimidados por la posibilidad de no utilizar adecuadamente las nuevas tecnologías. Es necesario apoyarlos para que se sientan cómodos y valoren el uso de las herramientas tecnológicas.

El profesorado debe someterse a un aprendizaje permanente. Es importante que conozcan las herramientas que están disponibles actualmente. También, es fundamental que recibían una retroalimentación constante de otros maestros que supervisen su

trabajo. La colaboración entre pares es una de las mejores maneras de formar a los futuros docentes. Asimismo se deben establecer metas con resultados específicos que puedan ser monitoreados y vinculados al desarrollo profesional. Los mejores programas de formación docente son aquellos que trabajan con un profesor veterano en el aula y en una variedad de entornos.

Fomentar la curiosidad y la necesidad de saber para seguir aprendiendo (aprendizaje permanente). La creación de estudiantado de por vida debe ser uno de los objetivos principales de cualquier tipo de educación, incluida la del profesorado.

Por último es necesario involucrar al estudiantado en el proceso de formación de los docentes, haciendo que copartan su conocimiento sobre nuevas tecnologías. De esta forma, el alumnado se siente valorado porque colabora con el profesorado. Sin embargo, esto puede ocasionar problemas debido a que algunos docentes son reacios a ser enseñados o corregidos.

6.3. Resultados cuantitativos de las entrevistas

El análisis realizado a las respuestas de los informantes se compone de dos partes. Una que consiste en un recuento de palabras mediante una nube de palabras para identificar los conceptos que se repiten con mayor frecuencia. La otra parte es un análisis de sentimientos en base al diccionario "nrc" (Mohammad & Turney, 2010) de las respuestas recogidas. Este diccionario clasifica 14182 unigramas en ocho emociones básicas (ira, anticipación, asco, miedo, alegría, tristeza, sorpresa y confianza) y dos sentimientos (positivo y negativo).

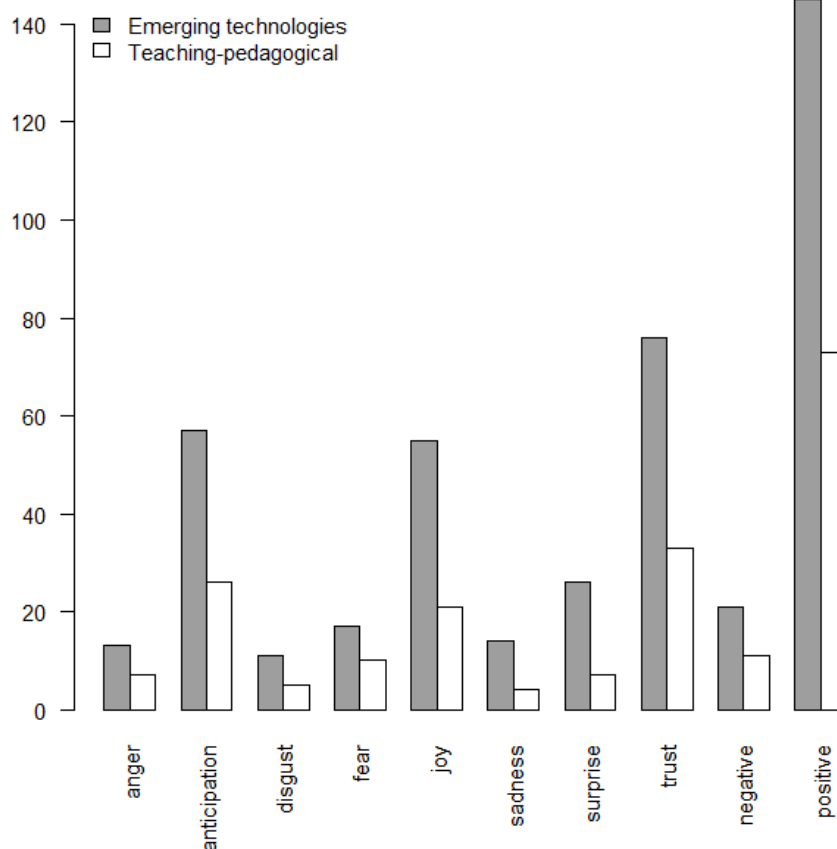
6.3.1. Aspectos docentes-pedagógicos

En el conteo de palabras aparecen con mayor frecuencia en la dimensión "Tecnología emergente" la palabra "technology" seguida de "students" y "teachers". En la dimensión "docente-pedagógica" aparece la palabra "students" como la más frecuente, seguida de "learning" y "technology" con una frecuencia similar. En ambas dimensiones las emociones y sentimientos positivos aparecen con mayor frecuencia que los negativos. Las emociones más presentes son "trust", "anticipation" y "joy"; mientras que las menos presentes son "anger", "disgust" y "sadness".



Figura 7

Análisis de las emociones basado en el diccionario nrc por dimensión.



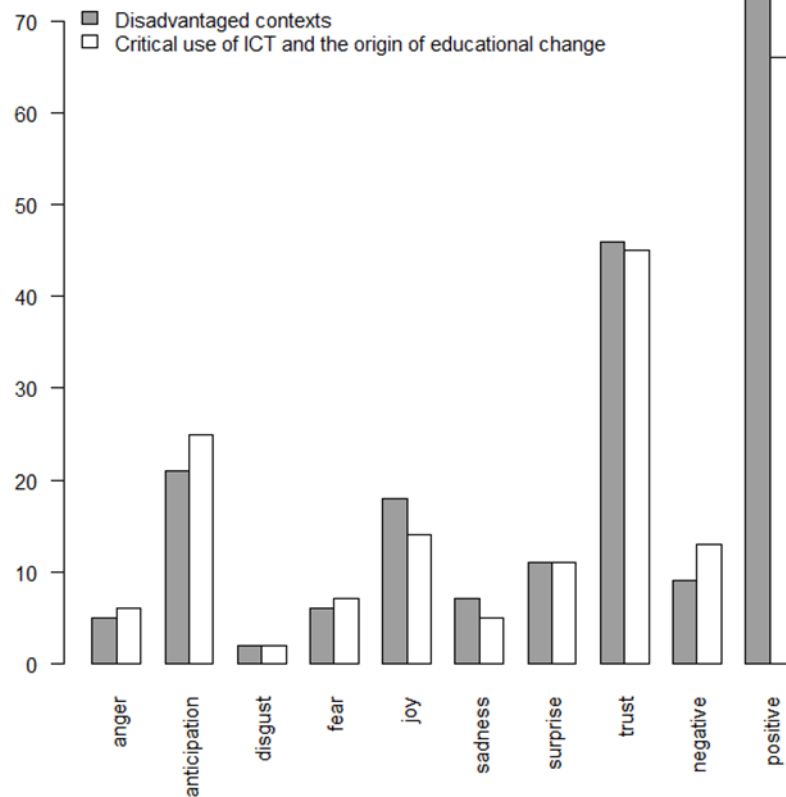
6.3.2. Contextos educativos socioeconómicamente desfavorecidos.

En ambas dimensiones, la de tecnologías emergentes y la didáctico-pedagógico, la palabra más usada ha sido "like". Otras palabras con tamaños relativamente grandes que coinciden en las dos dimensiones son "students" o "technology". En la dimensión "Uso de las TIC en contextos desfavorecidos", además observamos otras palabras como "different" o "access". En la nube de palabras de la dimensión "Uso crítico de las TIC y el origen del cambio educativo", destacan palabras como "use", "crítico", "currículum" o "way".

En cuanto a los sentimientos, destaca el gran número de sentimientos positivos identificados en contraste con los negativos. Destacan las emociones "trust", "anticipation" y con un poco menos de frecuencia "joy".

Figura 8

Análisis de emociones basado en el diccionario NRC por dimensión.



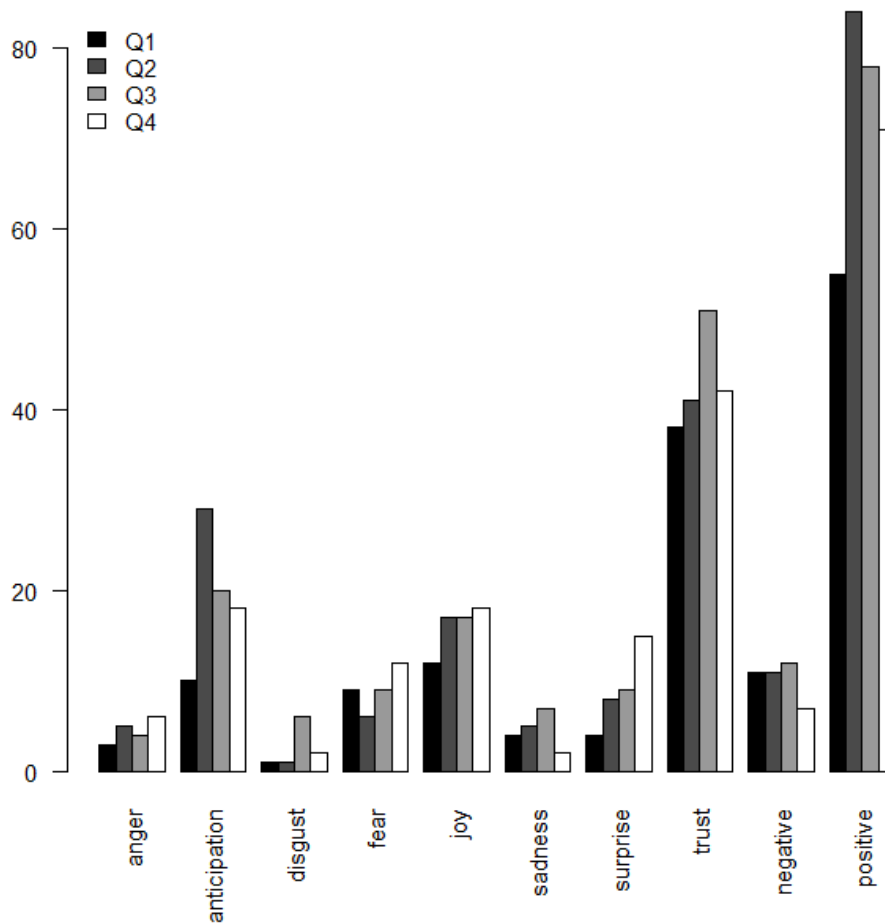
6.3.3. Formación del profesorado

Las palabras con mayor tamaño en la nube de palabras son "teacher", "technology", "students", "can", "learning" y "like". Estos fueron los conceptos más repetidos, particularmente "teacher" y "teachers". Otras palabras como "can" y "like" también aparecen con más frecuencia ya que son dos verbos de uso común en inglés. Los sentimientos positivos superan ampliamente a los negativos. Las emociones predominantes son la "trust" y "anticipation".



Figura 9

Análisis de las emociones basado en el léxico del NRC por pregunta



6.4. Aplicación de las nuevas tecnologías en la Ciudad Autónoma de Melilla

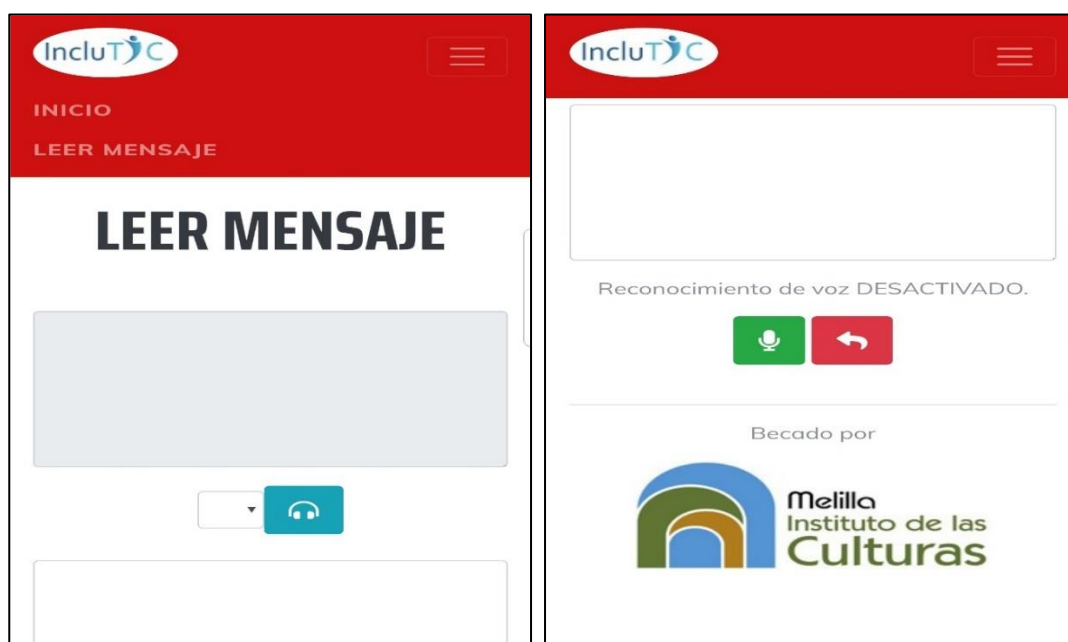
El proyecto concluyó con la creación de la aplicación de software que reúne las características básicas necesarias descritas en el marco teórico. La aplicación es funcional y permite solventar el problema de comunicación para el que fue creado. Sin embargo, no ha sido posible incorporar otras funcionalidades adicionales debido a las limitaciones de la financiación obtenida para el proyecto y a los altos costes de desarrollo de este tipo de herramientas digitales. A la versión final se le ha dado el nombre de “Inclutic” por su función principal que es la inclusión de las diferentes culturas de la Ciudad Autónoma de Melilla. Al iniciar la aplicación, se solicita un código que será facilitado por el centro educativo a las familias. De esta forma se pretende que solo los pertenecientes a la comunidad educativa puedan acceder a las comunicaciones y solo a aquellas que les correspondan dependiendo del curso

académico en el que estudien sus hijos o las necesidades del centro.. Con ello se pretende que puedan hacer un uso de la aplicación garantizando la protección de datos. Una vez que el usuario haya desbloqueado la aplicación con el código facilitado por el centro educativo, solo deberá introducir su nombre y seleccionar la lengua en la que desea comunicarse.

La aplicación cuenta con una interface sencilla e intuitiva y con caracteres grandes para facilitar su uso a personas adultas, que son las principales destinatarias de la aplicación. Tanto el idioma de la interface como los mensajes enviados y recibidos estarán en la lengua que hayan seleccionado. Podrán oír el mensaje recibido pulsando el botón azul en el que aparecen unos auriculares.

Figura 10

Interface de comunicación



Fuente: elaboración propia.

Para responder en forma de audio, pulsarán el botón verde en el que aparece un micrófono. De esta forma la aplicación hará la transcripción del audio, lo enviará y traducirá, entregándoselo al receptor en la lengua que haya asignado.



7. Agrupación de artículos



7. Agrupación de artículos científicos relacionados con los objetivos de la tesis

El compendio se compone de los siguientes trabajos:

1. García-Vandewalle García, J. M., García-Carmona, M., Trujillo Torres, J. M. Moya Fernández P. (2021). Analysis of digital competence of educators (DigCompEdu) in teacher trainees: the context of Melilla, Spain. *Technology, Knowledge and Learning*. <https://doi.org/10.1007/s10758-021-09546-x>
2. García-Vandewalle García, J. M., García-Carmona, M., Trujillo Torres, J. M., & Moya-Fernández, P. (2022). The integration of emerging technologies insocioeconomically disadvantaged educational contexts. Theview of international experts. *Journal of Computer AssistedLearning*,1–13. <https://doi.org/10.1111/jcal.12677>
3. El artículo titulado “Teaching-pedagogical aspects regarding the integration of Emerging technologies. The view of international experts” aún no ha sido publicado. Se encuentra enviado a una revista catalogada Q2 en SCOPUS desde hace varios meses.
4. García-Vandewalle García, J. M., García-Carmona, M., Trujillo Torres, J. M., & Moya-Fernández, P. (2022). Teacher Training for Educational Change: The View of International Experts. *Contemporary Educational Technology*, 14(1), ep330. <https://doi.org/10.30935/cedtech/11367>
5. García-Vandewalle García, J. M., & García-Carmona, M. (2020). Creando lazos interculturales entre las familias y los centros educativos de Melilla: la comunicación mediada por TIC como herramienta facilitadora de la inclusión educativa de las diferentes culturas. En XXX (Coords.) *Teoría y práctica en investigación educativa: una perspectiva internacional* (pp. 2186-2197). [Dykinson](#). ISBN 978-84-1377-174-8,.

A continuación, se muestran los trabajos de forma individual:



7.1. Analysis Of Digital Competence Of Educators (Digcompedu) In Teacher Trainees: The Context Of Melilla, Spain

Highlights

- Master's students have a more positive self-assessment of their digital competence
- Years of education increase positive self-assessment of digital competence except in safety
- Undergraduates and postgraduates' self-assessment of digital competence differs
- Implementation of the Digital Competence of Educators should be explored further

Abstract

Melilla is one of the cities in Europe with the highest rate of school failure and dropout, so improving students' digital competence would improve the educational situation in the city. In order to do this, teachers must have digital skills and be able to teach them. The Common Framework for Digital Competence of Educators was used to analyse the digital competence of teachers in training at the Faculty of Education and Sports Sciences of Melilla, Spain, applying several quantitative techniques to analyse the data collected from a questionnaire based on the items within the framework. Indicators are set for each competence using factor analysis, contrasting differences between groups of undergraduate and graduate students. Similarly, links between some of the students' characteristics and the competences are searched for by adjusting a regression through the MCO method. The results show the self-assessed level of digital competence in different areas and the differences between the bachelor's and master's programs. Digital competence gaps were also detected in teacher training, especially in security. The conclusions revolve around improving the area of digital security, enabling a higher level of digital skills according to the framework. Indeed, more hours of training in digital competence are needed while taking into account the educational context as well as technological knowledge, the pedagogy to teach it and the content to be taught. Likewise, the necessary skills must be developed by educators for them to be able to transmit digital competence to their students and support them in educational centres.

Keywords: educational technology, educational innovation, training, learning processes, teacher education, teaching skills

1. Introduction

The research analyses the deficiencies and training needs in relation to the digital teaching competence of educators in training in the city of Melilla. As such, it is based on the parameters established by the European Union in the Common Digital Competence Framework for teachers (CDCFT) (Gabarda et al., 2017; INTEF, 2017). By improving on training in digital skills of future teachers, we ensure that their students acquire digital skills, the influence of which will improve the educational situation of the city of Melilla (Bejaković & Mrnjavac, 2020; Comisión Europea, 2013; Koliouška & Andreopoulou, 2020; Quaglio et al., 2016; Valarezo et al., 2018) and consequently social (Fang et al., 2019; Garcia-Valcarcel et al., 2014; Reimers, 2020; Wu et al., 2015) and economic (Cruz-Jesus et al., 2016; Reimers, 2020) status. The study of the situation in Melilla could be extrapolated to educational contexts of similar or lesser educational complexity.

Similar studies are being carried out in different contexts (Escudero et al., 2019; Ortega-Sánchez et al., 2020; Rojo-Ramos et al., 2020) to learn about the digital competence of teachers. The present study is carried out in a complex educational context with one of the lowest scores in Europe according to the PISA2015 report and other educational reports (MECD, 2017). The city located in North Africa has a different social and educational context from other parts of Spain.

Technology has become a major part of our daily personal and professional lives, and has notably improved communications and job performance, among many other aspects (Mendoza et al., 2015; Monllau & Ávila, 2015). However, the use of information and communications technologies (ICT) has also given rise to a new type of social inequality between those who have access to and knowledge of technology and those who do not (i.e. the digital divide), which further deepens existing social inequalities (Blank, 2017; Philip et al. 2017; Ragnedda, 2017; Šuminas, A et al., 2018; van Deursen, & van Dijk, 2019). This new type of inequality is primarily based on economic and educational factors.



Social inequalities related to economic factors can be mitigated by using low-cost devices and opting for the growing trend known as “Bring your own device” (BYOD), which makes the inclusion of technology in the classroom more affordable and sustainable by using devices already available to students (Attewell, 2015; Gkamas et al., 2017; Maher & Twining, 2017). Almost every student has a smartphone, which they can use to reproduce audio-visual material, work on assignments and access emerging technologies such as augmented and virtual reality without incurring extra costs or using additional devices. For example, without the use of Google cardboard, you can play virtual reality content on your smartphone, selecting the full screen option for mobile phones instead of splitting it for and holding the phone in front of your eyes with separate visuals for each eye. A lot of free content can be found on internet sites like YouTube VR. Within this scheme, schools should be able to provide a limited number of devices to disadvantaged students to use for educational purposes. Moreover, educational measures and policies are currently promoting the use of ICT in the classroom (Chen et al., 2019; Mahi et al., 2019; Plaza-De La Hoz, 2018; Tairab et al., 2016). Allowing students to use their smartphones via the BYOD initiative, increases their motivation to work on assignments and makes it easier for them to access information on the internet and applications (Laxman & Holt, 2017; Maher & Twining, 2017). Consequently, programmes have been devised to help make new technologies available to everyone, regardless of their academic or economic status, thus potentially contributing to bridging the digital divide and inequalities (Pérez-Castro et al., 2021).

Other factors concerning education have also created a new type of inequality i.e., digital illiteracy between those who possess the knowledge and skills needed to use new technologies and those who do not (Cortina-Pérez et al., 2014). Digital illiteracy limits professional development and access to the labour market. To address this phenomenon, the European Union (EU) has underlined the vital role of education in promoting new technologies. This is so as to strengthen human capital, employability and competitiveness, given that the lack of digital competence increases the risk of unemployment, poverty and social exclusion (Bejaković & Mrnjavac, 2020; Koliouška & Andreopoulou, 2020; Quaglio et al., 2016; Valarezo et al., 2018). To this end, the EU has created a framework of the digital competences (DigComp) citizens need to acquire in order to increase digital literacy across the board (Carretero et al., 2017; Pérez-Escoda & Fernández-Villavicencio, 2016; Kerkhoff & Cloud, 2020). The objective of

digital literacy is to facilitate inclusion in the information society, enjoy a fuller and more participatory life, and use essential tools to enhance active citizen engagement (Abad, 2014). The Digicomp framework is based on the analysis of other frameworks carried out by Ferrari 2012, to develop 21st century skills.

Education policies around the world are currently seeking ways to reduce the digital divide among students. Indeed, ICT is considered a paramount and wide-ranging issue and is included in the objectives of the Horizon 2020 programme (Centre for the Development of Industrial Technology (CDTI & European Office, 2014) & European Office, 2014). The United Nations Literacy Decade (UNLD) and the United Nations Decade of Education for Sustainable Development (UNDESD) both aim to reduce poverty and improve health and quality of life. The two initiatives view education as making an important contribution to the achievement of these goals and are founded on the belief that technologies can help in the process. Moreover, many countries are redefining their education systems to provide twenty-first century skills to support social and economic development (Reimers, 2020).

This study seeks to identify the shortcomings of Melilla's teacher trainees in digital competence to improve the educational situation of the city. The city of Melilla has one of the most complex educational contexts in Europe PISA 2015 and this context is a determining factor for the execution of ICT projects (Mooketsi & Chigona, 2016). Despite the benefits that ICTs bring to society (Fang et al., 2019), people from disadvantaged contexts are excluded from access to them and their use (Tamatea & Pramitasari, 2018). In addition to the deficiencies in the educational situation, the lack of digital competence prevents people from being part of society (Wu et al., 2015). So much so that Europe in its "European Strategy 2020" plan focuses on the fight against digital inequalities as an attempt to restart Europe's economy (Cruz-Jesus et al., 2016). The need to improve Melilla's digital competence goes beyond its educational situation and, due to the complexity of its context, needs to be studied.

This study is based on the standards set by international organisations such as the European Commission and UNESCO (UNESCO, 2008), as well as the Spanish Ministry of Education. The structure and items in the questionnaire have been defined in accordance with Spanish education legislation namely the Ley Orgánica 3/2020, de 29 de diciembre, por la que se modifica la Ley Orgánica 2/2006, de 3 de mayo, de Educación and INTEF guidelines (INTEF, 2017). The items are the same as those used



officially to assess the digital competence of teachers. The difference is in the way of evaluating them because it is assessed by the direct response of students on a Likert scale of 4, instead of having to present evidence for each of the items. This makes the responses collected dependent on each person's self-concept. The study analyses the level of self-perception (Fernández, 2010; Nuere & Díaz-Obregón, 2018) of digital competence in teacher trainees pursuing Bachelor's Degrees in Early Childhood Education, Primary Education and the Master's Degree in Secondary Education at the Faculty of Education and Sports Sciences at the University of Granada Campus in Melilla based on the CDCFT, the Spanish adaptation of the DigCompEdu (Escudero et al., 2019; Ortega-Sánchez et al., 2020; Rojo-Ramos et al., 2020). Given that this is the only teacher training faculty in Melilla, the study focuses exclusively on the digital competences of a group of teacher trainees in the university of that city. The aim of the study was to determine the strengths and weaknesses of teacher training and identify the competence areas in the CDCFT framework that need to be strengthened (Gimeno & Gallego, 2007). The overall aim is to promote the integration of the latest technological advances into Melilla's classrooms in order to improve the quality of education and bridge the digital divide (Cruz-Jesus et al., 2016).

2. Training teachers in digital competence

Digital competence is based on digital literacy (Martin & Grudziecki, 2006) and digital literacy is formed by a set of skills and knowledge (Spante et al., 2018). According to the EU communication "Supporting growth and jobs – an agenda for the modernisation of Europe's higher education systems", more than two thirds of students and graduates consider that there is a mismatch between their training and the skills demanded by the labour market (Fernández-Cruz & Fernández-Díaz, 2016; Guzmán-Simón et al., 2017). Almost half of higher education teachers share the same opinion and believe it is necessary to promote innovation (Guzmán-Simón et al., 2017). Nonetheless, even though these teachers recognise the importance of ICT, most state that they only have average personal user skills and below-average digital teaching skills (Falcó, 2017).

There is a gap between digital competence developed in informal learning contexts and that acquired in formal learning contexts such as universities. In general, Spanish universities do not integrate the use of ICT and digital literacy in their training modules (Guzmán-Simón et al., 2017). Some degree programmes, such as education, offer

specific courses on ICT, but this is not the case for all degree programmes, despite the fact that new technologies are used in all fields. In turn, support from the education administration is perceived as limited and most progress is made on an individual basis (Falcó, 2017). This issue is of particular importance given the potential influence that workplace support has on the integration of digital competence (Instefjord & Munthe, 2017). Poor ICT use can also hinder the professional development of teacher trainees, which, once they graduate, can become a source of difficulties in their professional practice as teachers (Guzman-Simon et al., 2017). Teacher training is therefore of vital importance for successfully introducing new technologies in the classroom (Ramírez-Montoya et al., 2017).

There is also a mismatch between the skills teachers require to develop the digital competence of their students and own their actual skills (Fernández-Cruz & Fernández-Díaz, 2016). Teachers are unable to develop their students' digital competence if they do not have an advanced command of those skills themselves (Ramírez-Montoya et al., 2017). Neither will they be able to efficiently teach a subject by overcoming isolated pockets of knowledge in technology, content, or education without mastering ICT skills (Cabero & Barroso, 2016). This can be seen in the TPACK framework (Koehler, et al., 2014; Mishra, & Koehler, 2006) which collects the knowledge that teachers should have about Content (CK), Pedagogy (PK), and Technology (TK): Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK). The TPACK framework has proven its effectiveness (Atun, & Usta, 2019) giving more attention to the kinds of knowledge, skills, and attitudes (KSA) (Mishra, & Warr, 2021). El marco TPACK ha sido estudiado en un elevado número de Investigaciones en el área de educación y actualmente ese número de investigaciones va en aumento (Soler-Costa et al, 2021).

Digital competence gaps in teacher training originate from the very same gaps experienced by the educators who train teachers (Instefjord & Munthe, 2017). If teacher trainees do not recognise their educators as role models in the use of new technologies in education, it is highly unlikely that they will be inspired by them to implement technology in the classroom (Falcó, 2017). Changes in education must therefore involve changes in the methodology used, which requires, among other things, a strategic teacher training plan (Gómez, 2015; Trujillo, 2015). This is where online training of



teacher trainees can be used (Perry & Jan, 2017) to focus on the confident, critical and creative use of ICT (Fernández-de-Álava et al., 2017; Liang & Fung, 2020). So as to design such a plan, the teacher trainees' level of digital competence must first be determined (Guzmán-Simón et al., 2017).

The benefits of teaching digital competence

Throughout the article the terms "competences" and "skills" are used, referring to different terms. Skills are often necessary requirements to achieve competences. In this section, we discuss some of the reasons why teachers' digital competence needs to be developed and outline some of the associated benefits. First, it has already been demonstrated that the application of ICT in education provides many educational benefits (McGarr & Gavaldon, 2018). ICT is currently being used in child and adult education, thus resulting in the on-going development of training tools and programmes (Hinojo-Lucena et al., 2020). ICT facilitates the learning process for students, it motivates and helps them become more autonomous. Furthermore, ICT can be adapted to their level, which is especially beneficial for special needs students (García-Valcarcel et al., 2014).

In turn, the use of ICT allows the integration of active methodologies (Gámiz-Sánchez, 2017). Currently, due to the global pandemic caused by COVID-19, the use of active methodologies has increased due to the virtual condition of teaching (Martín et al., 2021). Active methodologies put the student in focus within the teaching-learning process (Jiménez et al., 2020). Innovative methodologies have a long history of excellent results in many educational settings (Fatikhova & Sayfutdiyeva, 2017). Some of the most notable methodologies include flipped classroom learning (Sáez-López & Cózar-Gutiérrez, 2017) and project-based learning (Fatikhova & Sayfutdiyeva, 2017), which is regarded as the "superstar" of methodologies due to its success (Ramírez & Gómez, 2016).

Moreover, ICT is a very powerful motivator that helps students develop responsibility towards others and learning, and also affords the possibility of integrating special needs students (García-Valcarcel et al., 2014). In the acquisition of digital competence, motivation is one of the most important factors due to it being the driving force explaining online students' achievements (Castillo-Merino & Serradell-López, 2014).

The use of ICT also facilitates collaborative learning and the development of 21st-century skills which have a broader scope than digital competence (van Laar, 2017). This enables the acquisition of social skills and problem-solving skills, as well as greater autonomy, responsibility and capacity for reflection and initiative (Garcia-Valcarcel et al., 2014), among others.

Furthermore, the latest technological and methodological innovations represent an advance in education (Bejaković & Mrnjavac, 2020; Comisión Europea, 2016; Koliouška & Andreopoulou, 2020; Quaglio et al., 2016; Valarezo et al., 2018) that should be used for making improvements in the most disadvantaged socioeconomic contexts. Therefore, an improvement in education and digital skills of the population would mean a social improvement (Fang et al., 2019; Garcia-Valcarcel et al., 2014; Reimers, 2020; Wu et al., 2015) by facilitating integration in society and in the labour and economic market (Cruz-Jesus et al., 2016; Reimers, 2020) because digital competence allows access to jobs with higher salaries and to new professions, some of them online and even self-employment. The autonomous city of Melilla, Spain, which is located on the north coast of Africa, is one of the cities with the highest school failure and dropout rates in Europe (Spanish Ministry of Education, Culture and Sport [MECD], 2017) according to recent educational reports, including PISA 2015. In order to successfully implement the latest developments in education, it is essential to improve teachers' digital competence.

3. Common Digital Competence Framework for Teachers (CDCFT)

The need to establish a body of knowledge that defines digital competence in education has led various international organisations to develop reference guidelines. For instance, the Computer and information literacy (CIL) which was established in ICILS 2013 and maintained in ICILS 2018 (Fraillon et al., 2019). In the same way, another framework was created in 2008, the UNESCO developed the ICT Competency Standards for Teachers (UNESCO, 2008) and has recently disseminated a framework of ICT skills and standards for teacher training in partnership with the Pontificia Universidad Javeriana de Cali (Valencia-Molina et al., 2016). The Common Framework for the Digital Competence of Teachers (hereinafter CDCFT) is the Spanish adaptation of the EU's European Framework for the Digital Competence of Educators, DigCompEdu (Redecker, 2017), which was created to measure and verify the level of educators'



digital competence. In turn, this framework is based on the Common European Framework of Reference for Languages, which classifies language mastery from A1 to C2 levels. Spain implemented the framework through the National Institute of Educational Technologies and Teacher Training (INTEF, 2017) and divided it into five areas:

Area 1. Information and data literacy

Locate and retrieve relevant information on the internet and know how to store, organise and analyse such information for its possible applications in teaching. Examples include the creation of teaching materials, presentations, and others.

Area 2. Communication and collaboration

Share community-created resources and experiences through online tools, allowing feedback between teachers. Belong to teaching communities in social networks. This will enable the dissemination of good practices and the creation of a validated resources bank.

Area 3. Digital content creation

Create and edit own teaching materials and audio-visual productions, while understanding how copyright and licences are to be applied. In order to provide personalized learning to students, teachers must be able to create their own resources.

Area 4. Safety

Protect personal data, digital content and use technology in a responsible and safe manner. Problems such as identity theft or cyberbullying may occur if new technologies are not used properly.

Area 5. Problem solving

Identify needs and know how to choose digital resources for resolving problems. Decide which are the most appropriate tools and use them properly, particularly with regard to active methodologies.

The implementation of the DigCompEdu in Europe has meant that the level of educators' digital competence can be measured for the very first time (INTEF, 2017). Using the Spanish adaptation, recent studies have been performed to determine the level

of digital competence of teacher trainees in Spain (Escoda & Conde, 2016). Results of self-assessment tests carried out by the informants in this research indicate that digital competence is currently lacking in the field of education (Guzmán-Simón et al., 2017). Moreover, teachers' expectations and beliefs about their own ability have a significant influence on the integration of new technologies (Korthagen, 2017).

The publication of the CDCFT has given rise to various studies aimed at determining the level of teachers' digital competence in order to address ICT shortcomings (Gabarda et al., 2017). However, practical applications have not yet been implemented in schools (Deumal & Guitert, 2015). Several studies have indicated the need for greater emphasis on ICT training to support teaching practices in educational institutions (Ramirez-Montoya et al., 2017). The same can be seen in many international publications such as the *Digital Agenda for Europe* (European Commission, 2013), the *TALIS* (OECD, 2014) and the *ICSL* reports (Valle et al., 2015).

So as to achieve the implementation of the framework in the classroom by teachers, it is essential to take into account other factors in addition to that of technology. This can be seen in the TPACK model (Koehler, et al., 2014; Mishra, & Koehler, 2006) and in the "Will, Skill, Tool (WST) model of technology integration (Knezek et al., 2000) which communicates that will (positive attitudes), skill (technology competency), and tool (access to technology tools) are necessary for a teacher to effectively integrate information technology into classroom practices (Agyei & Voogt, 2011).

4. Methodology

A set of quantitative methods were used to analyse the data collected from a questionnaire based on the items in the CDCFT published by the INTEF. En el análisis se han tenido en cuenta todos los ítems de las 5 áreas de competencia del Marco Común de Competencias Digitales Docentes que se detalla en el anexo. Our analysis consists of several stages. In the first stage, we construct an indicator for each competence area using the item loadings factor derived from an exploratory factor analysis (Hair et al., 2009; Härdle & Simar, 2012). In the second stage, we perform a descriptive analysis of the indicators using the main descriptive statistics and create several boxplots for the indicators. Next, we use statistical inference techniques in order to test whether there are differences between the groups proposed in the second stage. For this, we check



beforehand the assumption of normality using the Kolmogorov-Smirnov test with the correction of Lilliefors (1967). If the assumption is fulfilled, we use the t-test. Otherwise, we apply the nonparametric alternative Mann – Whitney – Wilcoxon. Finally, in the fourth stage, a multiple linear regression model was estimated using ordinary least squares (OLS) to determine the association between the indicators and the independent variables of interest such as the degree being studied, the academic year or the trainee teacher's gender (Gujarati et al., 2012; Wooldridge, 2016). This array of techniques enables researchers to describe the current situation (Best, 1970) and makes it easier to explain the subject matter (Verma & Mallick, 1999). This is a non-experimental study, in which the results were observed and then analysed in order to respond to the issues raised.

4.1. Objective

The aim of the study was to determine the level of digital competence of teacher trainees in the Bachelor's Degree in Early Childhood Education, the Bachelor's Degree in Primary Education and the Master's Degree in Secondary Education at the Faculty of Education and Sports Sciences at the University of Granada Campus in Melilla. To achieve this objective, the level of self-assessed competences in response to the items in the CDCFT was analysed.

Hypothesis:

By improving the training in digital skills of future teachers, we will ensure that their students acquire digital skills, the influence of which will improve the educational situation of the city of Melilla and consequently both its social and economic situations as well.

Objective:

Analyse the training needs and gaps in relation to the teaching staff in training's digital teaching competence the city of Melilla.

4.2. Sample

266 students (Early Childhood Education 68, Primary Education 154 And Master 44) have been invited to participate in the study and 176 have accepted (Early Childhood Education 46, Primary Education 110 And Master 20). The invited sample has an average age of 21. The number of samples is 176, of which 154 are face-to-face responses and 22 online responses, 5 Degree in Early Childhood Education, 10 Degree in Primary Education and 7 from the Master's Degree in Teacher Training for Compulsory Secondary Education, Baccalaureate, Professional Training and Teaching of languages. The entire student body consisted of the three degree-programmes mentioned above (two bachelor's degrees and one master's degree in education). In order to ensure the sample was representative of the population, it covered four years and included students from the three degree-programmes. The accepting sample is shown in the following table for each of the academic years and degrees.

Table 1 shows the main descriptive statistics of the explanatory variables. As it can be observed, of the 176 teacher trainees that comprise the total sample, 62.5% were enrolled in a Bachelor degree in Primary Education, 11.36% in a Master degree in Secondary Education and 26.14 % in a Bachelor's degree in Early Childhood Education. Additionally, 76% of the sample was female (the variable of "gender" takes the value of 1 if female and 0 otherwise) and the average age was 22.28 years old. Finally, it should be noted that 39.21% of those surveyed were in their first academic year, 24.43% in their second year, 23.86 in their third year and 12.5% in their fourth year.

Table 1

Descriptive statistics: explanatory variables

Variable	Mean	SD	Min	Max
Gender	0.7614	0.428	-	-
Degree_1	0.625	0.486	-	-
Degree_2	0.1136	0.3182	-	-
Year	2.097	1.062	1	4
Age	22.28	3.903	18	40



Note. Degree_1 refers to a bachelor’s programme in primary education, while Degree_2 refers to a master’s programme.

4.3. Instrument

For this study, we used a questionnaire that measures the teacher trainees’ level of digital competence based on the CDCFT. The questionnaire is divided into the five areas within the aforementioned framework and contains 91 items distributed over these five areas:

- Competence area 1: Information and data literacy (16 items)
- Competence area 2: Communication and collaboration (31 items)
- Competence area 3: Digital content creation (16 items)
- Competence area 4: Safety (13 items)
- Competence area 5: Problem solving (15 items)

Table 2

Items on the questionnaire used for the data collection by competence area

QUESTIONNAIRE ITEMS BY AREA	
Area 1	1.1. Browsing, searching and filtering data, information and digital content
	1.2. Evaluating data, information and digital content
	1.3. Managing data, information and digital content
Area 2	2.1. Interacting through digital technologies
	2.2. Sharing through digital technologies
	2.3. Engaging in citizenship through digital technologies
	2.4. Collaborating through digital technologies
	2.5. Netiquette
	2.6. Managing digital identity
Area 3	3.1. Developing digital content
	3.2. Integrating and re-elaborating digital content
	3.3. Copyright and licences
	3.4. Programming

Area 4	4.1. Protecting devices
	4.2. Protecting personal data and privacy
	4.3. Protecting health and well-being
	4.4. Protecting the environment

Area 5	5.1. Solving technical problems
	5.2. Identifying needs and technological responses
	5.3. Creatively using digital technologies
	5.4. Identifying digital competence gaps

A 4-point Likert-type scale was used to measure the responses. Respondents assigned a score to various statements concerning the use of a variety of technological aspects according to their knowledge: 1 “Strongly disagree”, 2 “Disagree”, 3 “Agree” and 4 “Strongly agree”.

All statements refer to the mastery of different aspects of technology. Consequently, the more respondents agree with a statement, the greater their mastery of that aspect of technology, while the less they agree, the lower their overall competence is.

4.4. Procedure

Permission was sought from the teachers of the early childhood education and primary education degrees, the master’s degree and the faculty to perform the survey. The questionnaire was administered in the classrooms of the teacher trainees in their respective subjects. First, a brief explanation was given to the respondents regarding the objectives of the research, as well as on the CDCFT. Any doubts were then resolved before giving the questionnaire to the teacher trainees who had previously agreed to participate in the survey voluntarily and after signing an informed consent.

In order to ensure participation in the study by the greatest possible proportion of teacher trainees, an online version of the questionnaire was also made available by e-mail. This allowed the trainees who were absent on the day of the survey to participate.

Once the data was collected, it was processed using the RStudio 1.4.1106, R 4.0.3 and the packages car, lmtest and nortest.



5. Results

In what follows, we discuss the results of the respondents' self-assessment of their level of digital competence as measured in the questionnaire about each of the five CDCFT competences.

First, an indicator for the teacher trainees' level of self-assessment was defined for each competence area based on the assessment of the items. The indicators were constructed as a weighted average using the factor loading of the item in its competence area to determine the weight. The factor loadings were calculated using the principal component extraction method (Hair et al., 2009; Härdle & Simar, 2012). The indicators were constructed this way in order to assign a value to each item according to its contribution to the competence. The factor loadings for each indicator are shown in detail in the appendix.

In the second stage, we carry out a descriptive analysis of the indicators. The main descriptive statistics for the indicators are shown in Table 3. No significant variations were observed in the mean and the standard deviation between the indicators. Specifically, the mean for the indicators ranged from 2.75 to 3.10, while the standard deviation ranged from 0.48 to 0.55.

The coefficients of skewness and kurtosis are close to zero in all cases, which indicates that the distributions of the competence area are approximately symmetric and mesokurtic. In relation to the reliability of the indicators, we obtain high Cronbach's alphas. All the indicators have values greater than 0.8, which is considered good, with the exception of competence area 4, which is greater than 0.7 and is considered acceptable (Cronbach, 1951).

Table 3

Descriptive statistics of the indicators

Indicator	Mean	SD	Min	Max	Skewness	Kurtosis	Cronbach's alpha
Competence area 1: Information and data literacy	3.098	0.482	1.610	4	-0.416	-0.291	0.870

Competence area 2: Communication and collaboration	2.745	0.484	1.579	4	0.026	-0.356	0.900
Competence area 3: Digital content creation	2.873	0.511	1.758	4	0.006	-0.811	0.854
Competence area 4: Safety	2.943	0.551	1.508	4	-0.254	-0.400	0.723
Competence area 5: Problem solving	2.749	0.527	1.469	4	0.201	-0.461	0.830

Figures 1 and 2 show the distribution of the indicators. As can be observed in Figure 1, there are no major variations between competence areas. In other words, all the indicators have an almost symmetrical distribution with values ranging from 1.6 to 4. It is worthy noting the indicator for Competence Area 1, which shows a greater degree of skewness. Specifically, 25% of the trainees who obtained the highest values for the indicator are in the range 3.5 and 4, while the 25% who obtained the lowest values are in the range 1.6 and 2.8. The indicator for Competence Area 4 shows a similar distribution, although it is less accentuated. The 25% of trainees with the highest values for the indicator are in the range of 3.35 to 4, while the 25% with the lowest values are in the 1.5 to 2.6 range. Moreover, the middle 50% of values for the indicator of Competence Area 5 are not distributed homogeneously and there is a greater distance between the median (2.7) and third quartile (3.2) compared to the first quartile (2.4). Two outliers with particularly low values can also be observed for Competence Areas 1 and 4.

Figure 1

Boxplot of indicators by competence area.

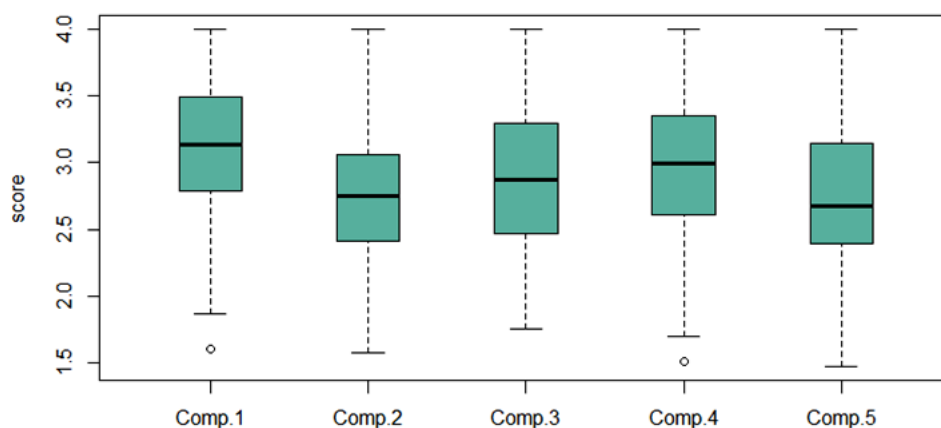




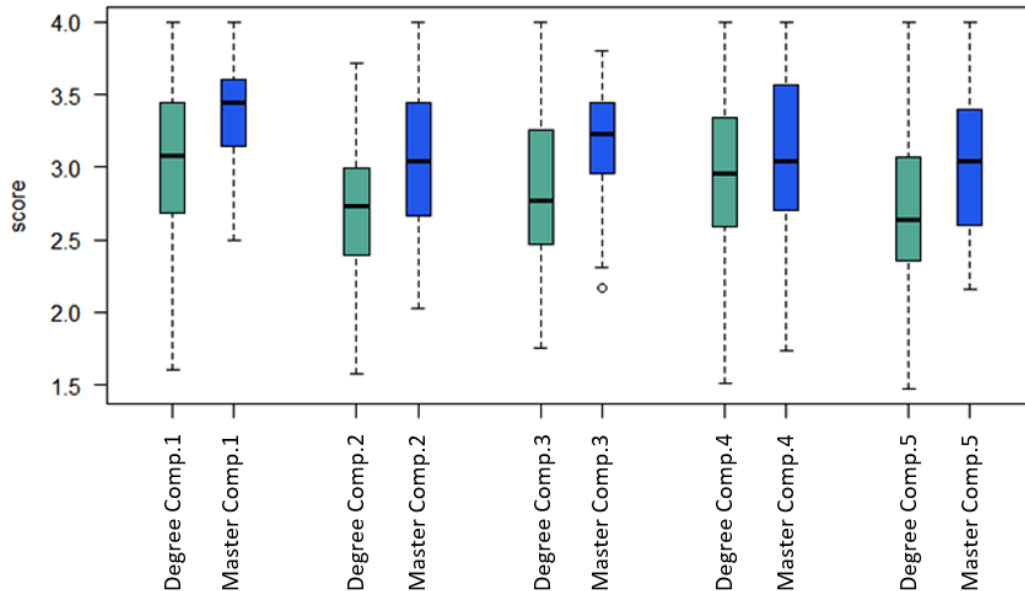
Figure 2 shows the box and whisker plot for the indicators grouped by type of degree (i.e. bachelor's or master's). As can be observed, students studying for their master's degree have higher skill acquisition values and a higher median value in all the indicators, while the undergraduates show a lower minimum value. For example, in the distribution of the indicator for Competence Area 3 (Digital content creation), the values of the master's degree students in comparison with the undergraduates' values are more concentrated, although the maximum value is higher for the undergraduate students.

The relationship between degree programme and academic year is analysed below for the indicators of the competence areas. Specifically, OLS was used to fit a regression line between each indicator, the explained variable and the explanatory variables degree and academic year. The variables age and gender were also included. The fit method was chosen because of the advantages it presents with respect to other methods, namely the easy and intuitive interpretation of the regression coefficients.

As mentioned, the sample comprised students from two undergraduate degree programmes and one postgraduate degree programme: A Bachelor's Degree in Early Childhood Education, a Bachelor's Degree in Primary Education and a Master's Degree in Secondary Education. In order to include this information in the model, two dummy variables were used: Degree_1 and Degree_2. These variables take the value 1 if the respondent was a primary education student or if the respondent was a master's degree student, respectively, and 0 if otherwise. When both variables take the value 0, it means that the respondent is an early childhood education student.

Figure 2

Boxplot of indicators by competence area grouped according to undergraduate and postgraduate degrees



In the third stage of our analysis, we contrast the differences in means of the groups set in the previous stage. Table 4 shows the results of the test of discrepancies on the averages. Additionally, normality tests are included to verify the initial assumption so as to apply the t-test. In case the assumption is not satisfactory, the nonparametric alternative Mann – Whitney – Wilcoxon is shown. The normality test is significant only in competence 5 for the degree group. In general, it is observed that the differences are significant between groups. The exception is that of competency 4.

Table 4

Analysis of discrepancy of means in undergraduate and master students

	K-S group Degree	K-S group Master	Test de diferencias
Comp. 1	0.062 (0.1756)	0.110 (0.7544)	-3.9402 (0.0004)
Comp. 2	0.045 (0.6234)	0.125 (0.5693)	-2.8181 (0.0097)
Comp. 3	0.086 (0.2117)	0.150 (0.2825)	-2.5923 (0.0157)
Comp. 4	0.043 (0.7138)	0.142 (0.3604)	-0.9772 (0.3384)
Comp. 5	0.075 (0.0333)	0.104 (0.8297)	1027.5* (0.0172)

Contrast statistic and p-value between parenthesis *test Mann–Whitney–Wilcoxon.



Table 5 shows the results of the regressions performed on each indicator. It should be noted that the objective of the regressions was to establish relationships between some of the trainees' characteristics and the perceived acquisition of skills. In general, the variables "degree" and "academic year" were found to be significant in the models, while the variables "age" and "gender" were not significant for any of the indicators.

Specifically, a positive relationship was found between being a master's student and the value of the indicator for the competence area. For example, in Competence Area 1 (Information and data literacy), the mean value of the indicator for the master's students was 0.603, which is higher than the score of the bachelor's students in early childhood education. Similar results were also observed for the rest of the indicators. With regards to Competence Area 2 (Communication and collaboration), significant differences were also found among the students in the different degrees. In particular, the primary education students obtained a mean value of 0.167, which was higher than the early childhood education students.

In almost all cases, academic year is positively correlated with the indicator of the corresponding competence area. The effect of being in a later academic year has a positive influence on the indicator of the competence area. Competence Area 5 (Problem solving) presents the greatest variation with an increase of 0.115 per academic year-

Table 5

Results of the regressions

	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5
(Intercept)	2.997*	2.462*	2.747*	2.700*	2.663*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Degree_1	0.094	0.167*	0.015	0.195	0.145
	(0.265)	(0.049)	(0.871)	(0.056)	(0.122)
Degree_2	0.603*	0.610*	0.453*	0.348*	0.614*

	(0.000)	(0.000)	(0.005)	(0.0472)	(0.000)
Age	-0.014	-0.008	-0.006	-0.003	-0.014
	(0.214)	(0.509)	(0.645)	(0.811)	(0.271)
Gender	0.079	0.046	-0.032	0.034	-0.012
	(0.369)	(0.595)	(0.731)	(0.748)	(0.905)
Year	0.108*	0.114*	0.102*	0.061	0.115**
	(0.008)	(0.005)	(0.019)	(0.205)	(0.010)
R ²	0.111	0.122	0.072	0.041	0.095
Num. obs.	168	172	175	168	172
RMSE	0.4601	0.4602	0.4995	0.5491	0.5106

Note. Degree_1 refers to the bachelor's programme in primary education, while Degree_2 refers to the master's programme. * $p < 0.05$. The p -values are shown in parentheses.

6. Discussion and conclusions

In general, teacher trainees perceive a progressive improvement in their digital competence throughout their study programmes. In other words, the higher the level of education they receive, the more positive their self-assessment is (Gómez, 2015; Trujillo, 2015). The results for the master's degree students are higher those of students in their fourth year of the early childhood education and primary education degrees. This indicates that from the time the students complete the bachelor's degree to the time they complete the master's degree, there is an increase in the ICT skills acquired. This improvement in ICT skills may also be due to the students' own experience or self-training during this same period of time (Instefjord & Munthe, 2017). Therefore, the higher the academic level of the respondent, the higher the level of self-assessed digital competence.

On the other hand, the early childhood education students obtained the lowest scores. More specifically, statistically significant differences were found between these students and the primary education students on their digital competence score. This could be due



to the fact that the study programmes provide teacher trainees at higher educational levels with more training in digital competencies than those at lower levels and that lower levels require a lower level of digital competence to perform their job functions (Ramírez-Montoya et al., 2017). These differences might also be explained by the fact that teacher trainees who will be teaching at higher educational levels are more concerned about acquiring better digital competence (Falcó, 2017).

In general, the learning outcomes were positive, given that the values for the acquisition of competences increase as students advance in their degree. The exception to this is Competence Area 4 related to safety (INTEF, 2017), since the value does not increase as the students progress through the years (Gómez, 2015). However, the value remains quite high throughout the years, which might suggest that the teacher trainees already possess this knowledge and are not provided new content to add to what they already know (Guzmán-Simón et al., 2017). Nonetheless, it is essential that teachers be made aware of the importance of using new technologies in a critical and responsible way that respects both the health and safety of users and the environment (Redecker, 2017; Simandl et al 2017).

As mentioned above, teachers must have a minimum level of digital competence in order to use technologies and methodologies in an appropriate manner when teaching specific content and also to adapt to the educational context and resources at their disposal (Cabero & Barroso, 2016; Guzmán-Simón et al., 2017). In addition to technical knowledge (TK) about technology, it is necessary to have knowledge of the content (CK) to be taught and pedagogical knowledge (PK) to be able to teach it correctly (TPACK model) (Atun, & Usta, 2019) and have the necessary skills and attitudes (KSA) (Mishra, & Warr, 2021). This is of particular importance in complex educational settings, such as socioeconomically disadvantaged situations (Blank, 2017; Philip et al. 2017; Ragnedda, 2017; Šuminas, A et al., 2018; van Deursen, & van Dijk, 2019) and ones characterised by high academic failure and dropout rates where teaching is more difficult, such as in Melilla (MECD, 2017).

Despite the fact that technological resources should be used in all teacher training courses and although there is a specific compulsory subject on ICT learning in the third year of the early childhood education degree and in the second year of the primary education degree, the master's degree does not offer a specific course on the use of ICT in education. However, ICT training may be insufficient (Guzmán-Simón et al., 2017) if

the teachers themselves who provide it do not continue to be trained (Redecker, 2017). It creates a mismatch between training and the skills demanded by the labour market (Fernández-Cruz & Fernández-Díaz, 2016; Guzmán-Simón et al., 2017). Therefore, the acquisition of digital competence is a lifelong learning task (Redecker, 2017) so that teachers can be up to date. To make ICT training more flexible and accessible, it could be provided online (Perry & Jan, 2017). This would put the focus on the training universities educating the teacher trainees and the skills of the teacher who train them, thus providing workplace support (Instefjord & Munthe, 2017). The principal factor in achieving educational change in the classroom is the teacher and in order to educate digitally competent teachers, the focus must be on those who train them (Instefjord & Munthe, 2017).

In conclusion, this study analysed the level of teacher trainees' digital competence based on the items in the CDCFT (Gabarda et al., 2017; INTEF, 2017). According to the analyses, the most relevant results are as follows. As the number of years in higher education increases, teacher trainees' positive self-assessment of their digital competence also increases in all areas except Competence Area 4, safety (INTEF, 2017). This highlights the progressive training of students in new technologies throughout their education (Gómez, 2015). Master's degree students have a more positive self-assessment of their digital competence in all areas than students in the early childhood and primary education degrees. Again, this demonstrates that the higher the level of education, the higher the level of digital competence according to the students' self-assessment (Redecker, 2017). Experience should also be taken into account in the case of master's degree students. Many of them had completed their degree and were working, having received some additional training.

The results point to the need for greater training in digital competence (Escudero et al., 2019; Ortega-Sánchez et al., 2020; Rojo-Ramos et al., 2020). Regarding the context of Melilla, digital competence can be worked on in socio-economically disadvantaged contexts because the cost of technology is not a problem if you know how to use it (Attewell, 2015; Gkamas et al., 2017; Maher & Twining, 2017). So, it depends on the training of teachers (Gómez, 2015). For this, trainers must take into account the context (Mooketsi & Chigona, 2016), pedagogical and technical knowledge and the content to be taught (Koehler, et al., 2014; Mishra, & Koehler, 2006). All this in addition to promoting knowledge as in the skills and attitudes that teachers must have (Agyei &



Voogt, 2011; Mishra, & Warr, 2021; Knezek et al., 2000; Korthagen, 2017). In order for teachers to stay up-to-date, training must be ongoing throughout their careers (Redecker, 2017), in person or online (Perry & Jan, 2017) to facilitate training as is currently being done with the pandemic global COVID19 (Martín et al., 2021). It is essential to apply it also to university professors, so that they are trained in the same way to then train future professors (Instefjord & Munthe, 2017).

It is also important to reinforce training in the field of digital security (Redecker, 2017; Simandl et al 2017) because to reach a level of digital competence set by the CDCFT framework, a certain score must be reached in all areas (INTEF, 2017). For example, if they have a C2 level in all areas except security in which they have an A2, their digital proficiency level is A2 because it is the level at which they master all areas. Currently, the level of digital competence of the study's teachers in training is hampered by digital security. By improving their competence in this area, they will be able to obtain a higher level of digital competence (INTEF, 2017).

With these measures and their implementation in schools (Instefjord & Munthe, 2017), it would be possible to improve, on the one hand, the digital competence of teachers in training in Melilla and alleviate their deficiencies when transmitting them to their students (Falcó, 2017; Fernández-Cruz & Fernández-Díaz, 2016) and on the other hand, the shortcomings of education universities in the training of future teachers' digital competence would also improve (Guzmán-Simón et al., 2017). With these measures, it is likely that future teachers will be able to correctly train their students in digital competence when teaching classes in schools, thus improving the digital competence of the population of Melilla. In this way, by improving the digital competence of Melilla's inhabitants, the development of the city would improve (Bejaković & Mrnjavac, 2020; Koliouška & Andreopoulou, 2020; Quaglio et al., 2016; Valarezo et al., 2018; van Laar, 2017), not only the educational sphere (Cabero & Barroso, 2016; McGarr & Gavaldon, 2018; Ramírez-Montoya et al., 2017), but also on economic (Cruz-Jesus et al., 2016; Reimers, 2020) and social levels (Fang et al., 2019; Garcia-Valcarcel et al., 2014; Reimers, 2020; Wu et al., 2015).

The recent implementation of the Common Framework for Digital Competence for Teachers (INTEF, 2017) also shows that more research is needed in this field, specifically focusing on the specific strategies that need to be implemented (Deumal & Guitert, 2015). This process of change should be based on the confident, critical and

creative use of ICT for the acquisition of digital competence (Redecker, 2017; Simandl et al 2017).

7. Limitations and future research

This study has several limitations. First, although the data collected in the questionnaire indicate a high level of digital competence among the respondents in the three degree-programmes, they refer to the respondents' self-assessment, so their level of perceived digital competence may not coincide with their actual level (Korthagen, 2017). This is one of the problems of self-evaluation, the subjectivity of each informant regarding their knowledge or the level of mastery over it. However, self-evaluation is a valuable tool to know the student's judgment of their own learning (Fernández, 2010; Nuere & Díaz-Obregón, 2018), allowing us to detect their strengths and weaknesses (Gimeno & Gallego, 2007). Second, the CDCFT items do not measure the respondents' knowledge of methodologies, which is a fundamental factor for teaching new technologies (Cabero & Barroso, 2016). Technology on its own is merely a tool and must be combined with the appropriate methodology if it is to be used successfully in the classroom (O'Flaherty & Phillips, 2015). Third, the study does not measure the real capacity of teacher trainees to apply their knowledge in practice; a factor that is especially important in difficult educational contexts, such as the case of Melilla. This would involve, among other things, adapting the technology to make it affordable to overcome one of the main obstacles of the digital divide (Wu et al., 2015).

Future research should therefore examine teacher trainees' educational digital competence to determine the gap between their self-assessed and actual competences. Teachers should be analysed in real educational situations to check if they are capable of applying their knowledge. It would also allow us to compare each's level of self-perception of their knowledge from this study, with their actual knowledge. Research could also be carried out on the use of active methodologies and new technologies in a practical and contextualised way to obtain more precise results on the real possibilities of implementing ICT in Melilla and in other educational contexts.



8. Implications of the Study

Los resultados del estudio aportan conocimiento sobre las carencias detectadas en un tipo de contexto educativo peculiar y complejo, y ofrece alternativas sobre cómo abordar la problemática. Además, permite que nuevas investigaciones continúen profundizando en el mismo tema mediante nuevos experimentos o generando conocimiento a través de la comparación con estudios similares. Es decir, contribuye a la base teórica de futuras investigaciones.

La implicación práctica más inmediata es la aplicación de las conclusiones del estudio para la mejora de la situación educativa y social de la Ciudad de Melilla. De la misma forma, los conocimientos obtenidos pueden ser aplicados a otros contextos de similar complejidad o menor. La aplicación práctica puede dar lugar a nuevas investigaciones que analicen detalladamente la evolución de contextos educativos y sociales similares desde la mejora de su situación educativa y los factores que difieren del resto de contextos.

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APPENDIX A

Table 6 shows the factor loadings for each of the items in relation to their corresponding competence. The factor loadings were calculated by principal components extraction and used to construct the indicators for the five competence areas.

Table 6

Item factor loadings

Item	Comp. 1	Item	Comp. 2	Item	Comp. 3	Item	Comp. 4	Item	Comp. 5
A111	0.473	A211	0.486	A311	0.547	A411	0.644	A511	0.580
A112	0.599	A212	0.392	A312	0.584	A412	0.674	A512	0.645
A113	0.584	A213	0.400	A313	0.528	A413	0.626	A513	0.698
A114	0.620	A214	0.560	A321	0.638	A421	0.629	A521	0.268
A115	0.659	A215	0.628	A322	0.556	A422	0.632	A522	0.554
A121	0.572	A221	0.647	A323	0.586	A423	0.116	A523	0.515
A122	0.633	A222	0.616	A324	0.582	A431	0.562	A531	0.482
A123	0.557	A223	0.512	A325	0.578	A432	0.672	A532	0.637
A124	0.520	A224	0.394	A331	0.561	A433	0.547	A533	0.627
A125	0.515	A225	0.517	A332	0.634	A434	0.541	A534	0.602
A126	0.633	A226	0.597	A333	0.490	A441	0.669	A541	0.175
A131	0.652	A231	0.567	A334	0.504	A442	0.674	A542	0.581
A132	0.601	A232	0.571	A341	0.559	A443	0.653	A543	0.413
A133	0.583	A233	0.580	A342	0.657			A544	0.673

A134	0.605	A234	0.669	A343	0.406	A545	0.532
A135	0.582	A241	0.594	A344	0.635		
		A242	0.594				
		A243	0.584				
		A244	0.694				
		A245	0.597				
		A251	0.531				
		A252	0.417				
		A253	0.454				
		A254	0.415				
		A255	0.301				
		A261	0.480				
		A262	0.196				
		A263	0.171				
		A264	0.348				
		A265	0.281				
		A266	0.466				

APPENDIX B

QUESTIONNAIRE ITEMS

1. COMPETENCE AREA 1: Information and data literacy

1.1. Browsing, searching and filtering data, information and digital content

1.1.1.	I search the internet to find information and resources for educational purposes.
1.1.2.	I select and adapt the different types of digital resources and information I find on the internet to my training needs.
1.1.3.	I analyse the information and resources I find on the internet and filter them according to my training needs.
1.1.4.	I am able to manage the information flows I access (HR, subscriptions, etc.) for my teacher training and share the information with my colleagues.
1.1.5.	I use keywords and specific vocabulary, sometimes in English, to find the information I need.



1.2. Evaluating data, information and digital content

1.2.1.	I assess the suitability and quality of the resources and information I find on the internet for my training.
1.2.2.	I critically evaluate the resources and information I find on the internet and use in my training.
1.2.3.	I analyse the reliability of several sources of information before using them.
1.2.4.	I use strategies to evaluate the usefulness and accuracy of the resources and information I find on the internet in order to optimize the time spent searching for them.
1.2.5.	I am aware of digital media copyrights and licences and evaluate them before using them in my training.
1.2.6.	I develop and use advanced search strategies to find information and resources on the internet and share them with my colleagues.

1.3. Managing data, information and digital content

1.3.1.	I am familiar with and use the existing storage systems on different devices.
1.3.2.	I use both local and online storage strategies (applications and browser extensions) to save files related to my training.
1.3.3.	I update resources and information related to my training, create copies of them and store those I do not use.
1.3.4.	I have cloud or external storage devices where I store and share resources and files that may be of interest.
1.3.5.	I am able to compress files and create backup copies of the materials I use to optimize the storage space I have on my devices.

2. COMPETENCE AREA 2: Communication and collaboration

2.1. Interacting through digital technologies

2.1.1.	I am aware of the number of existing online applications and communication tools and use them to help me achieve my training objectives.
2.1.2.	I communicate with my colleagues and teachers through various online communication services where I exchange information on my teacher training.
2.1.3.	I am able to create and manage communication networks between my colleagues where we communicate and share files related to our training.

2.1.4.	I am aware of the existence of educational social networks and I actively collaborate and participate in them.
2.1.5.	I design and use different communication and file transfer strategies depending on the audience and the activity.

2.2. Sharing through digital technologies

2.2.1.	I analyse and critically evaluate the digital educational information I have access to, share it and encourage my peers to do the same.
2.2.2.	I interact for educational purposes through my applications and web spaces with students in my degree and with teachers by publishing news and information on education.
2.2.3.	I regularly redistribute and publish educational information that I consider relevant to our training.
2.2.4.	I keep a critical and tolerant attitude in social spaces for online communication and I am aware of the cultural diversity that exists in them.
2.2.5.	I collaborate and cooperate via internet with members of the educational community and use ICTs in a responsible and effective manner.
2.2.6.	I use online spaces to share educational content I consider relevant for my community of followers and provide feedback and recommendations.

2.3. Engaging in citizenship through digital technologies

2.3.1.	I participate in online spaces where I search and read documents to improve teaching practice and I publish opinions about the topic.
2.3.2.	I have a digital signature and use the digital environments provided by public services.
2.3.3.	I frequently use my digital devices to do educational administrative procedures online.
2.3.4.	I participate and do procedures in virtual spaces related to digital citizenship that are useful for my future teaching profession.

2.4. Collaborating through digital technologies

2.4.1.	It is easy for me to access and participate in online spaces or share documents online.
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2.4.2.	I feel confident in using online applications and collaborative spaces for my future work as a teacher.
2.4.3.	I create, share and comment on online documents with educational content that can help my colleagues.
2.4.4.	I access and participate in online spaces to which I have been invited and where I create and share educational documents with other participants.
2.4.5.	I participate in online discussions about education, as I believe it is important to foster the development of intercultural awareness and values when working in shared digital spaces.

2.5. Netiquette

2.5.1.	I am aware of the existence of norms and conventions for online writing and communication (netiquette) and use them consciously.
2.5.2.	I write messages and use the various forms of online communication in a respectful and non-offensive manner.
2.5.3.	I am aware of the main risks to students of using the internet (cyberbullying) and have information on how to detect and act upon such risks in the event they occur.
2.5.4.	I have information on the risks and inappropriate uses of the internet and am training to address problems of this type that may arise in my educational practice.
2.5.5.	I believe it is essential to develop intercultural awareness and respect among students and promote the use of netiquette by them.

2.6. Managing digital identity

2.6.1.	I know about and understand the concepts of digital identity and digital reputation and I care about and value them in my networks.
2.6.2.	I care about and protect the image I project in networks by avoiding posting images or videos that could damage my personal reputation.
2.6.3.	I provide my personal data only on secure network sites and easily identify deceptive messages and/or scams.
2.6.4.	I create secure keys or passwords that I regularly change as a protection protocol.

2.6.5.	I am aware of the importance of managing my digital identity as a future teacher.
2.6.6.	I can easily manage my accounts from any device at any time and know what cookies are and how to manage them.

3. COMPETENCE AREA 3: Digital content creation

3.1. Developing digital content

3.1.1.	I use online tutorials to learn how to use applications for creating digital educational content.
3.1.2.	I am familiar with and use word processing and presentation software on my digital devices during my training.
3.1.3.	I use image, video and audio editing software to adapt audiovisual material to my training needs.

3.2. Integrating and re-elaborating digital content

3.2.1.	I search for and use materials and programs that could be useful educational resources for me.
3.2.2.	I edit, adapt and/or collaboratively create digital educational resources for my students.
3.2.3.	I have a public or private space where I store digital educational resources or materials.
3.2.4.	I store resources or files in an organized way in my devices that can be useful for my future teaching practice.
3.2.5.	I am able to plan teaching activities using digital resources and adapt them to my needs.

3.3. Copyright and licences

3.3.1.	I know the difference between the various types of licences and I correctly cite the source of all the digital content I use.
3.3.2.	I am aware of, respect and use different types of licences in my teaching practice.



3.3.3.	I search for information about how to properly cite copyrighted content to ensure it is used correctly.
3.3.4.	I promote and support that educational institutions provide free access to knowledge.

3.4. Programming

3.4.1.	I know how the internet and some programming software for certain digital applications work.
3.4.2.	I update my computer and technology knowledge regularly and I am aware of the potential of artificial intelligence in education.
3.4.3.	I am able to create and program simple educational video games using various tools.
3.4.4.	I search for solutions to various problems that may arise in computer and educational technology processes in an autonomous way.

4. COMPETENCE AREA 4: Safety

4.1. Protecting devices

4.1.1.	I understand the risks for my digital devices when accessing certain websites and try to avoid such risks using different strategies.
4.1.2.	I avoid risks associated with using cloud-based tools and accessing certain websites by using and changing my passwords on those sites.
4.1.3.	I use advanced and updated protection software (antivirus, etc.) in all my devices.

4.2. Protecting personal data and privacy

4.2.1.	I am aware of the risks of using the internet and I apply personal data protection strategies (e.g., never repeat the same passwords).
4.2.2.	I safely store and retrieve different access data to my accounts.
4.2.3.	I encourage the responsible use of technology, as well the respect and protection of personal digital data using the appropriate privacy settings according to my objectives.

4.3. Protecting health and well-being

4.3.1.	I am aware of the physical and psychological risks derived from the incorrect use of technology and I apply prevention strategies by managing my emotions when certain problems arise.
4.3.2.	I develop intervention patterns to be executed daily in order to avoid cyberbullying and reinforce safety on the internet.
4.3.3.	I monitor the time spent working online and apply the correct ergonomic postures to avoid any physical harm.
4.3.4.	I am aware of the intervention protocols in cases of addiction to technology.

4.4. Protecting the environment

4.4.1.	I apply energy saving measures to limit the impact of technologies on the environment.
4.4.2.	I use technologies in a sustainable manner by promoting the recycling and reuse of disused equipment.
4.4.3.	I apply recommendations to reduce consumption of supplies (hardware, ink, paper) in order to lessen the carbon footprint.

5. COMPETENCE AREA 5: Problem solving

5.1. Solving technical problems

5.1.1.	I try to individually solve common technical problems related with my digital devices with the support of tutorials.
5.1.2.	I have sometimes solved technical problems related with my digital devices through online communication.
5.1.3.	I solve less common technical issues related with digital devices and environments that I use in my training.

5.2. Identifying needs and technological responses

5.2.1.	I know some tasks that can be done by using technologies for the improvement of teaching and learning.
5.2.2.	I take online courses and participate in virtual training spaces of different sorts that promote autonomous learning.
5.2.3.	I search and use digital tools and applications to solve problems and needs in my training.



5.3. Creatively using digital technologies

5.3.1.	I create and use different means of digital expression (blogs, posters, websites, etc.).
5.3.2.	I attend online social events to share educational experiences or search for innovative solutions to various problems related to education.
5.3.3.	I have participated in some innovative digital projects.
5.3.4.	I plan and participate on virtual environments in the creation of digital educational content.

5.4. Identifying digital competence gaps

5.4.1.	I am aware that I have to improve my digital competence and know my limitations in this area.
5.4.2.	I know the latest improvements related to digital competence and try to keep myself up-to-date in an autonomous way.
5.4.3.	I mainly use the internet to develop my digital competence.
5.4.4.	I am able to identify gaps in digital competence and find solutions for them.
5.4.5.	I am able to do simple activities through ICTs.

7.2. Teaching-pedagogical aspects regarding the integration of Emerging technologies. The view of international experts

Abstract

Technology is essential in our society and must be integrated into educational centres. In order to find the best way to do so, this article studies interviews with eight international experts in education and technology. A mix of methodologies have been used, qualitative through the analysis of the interviews and quantitative with the analysis of the transcripts using R statistics software. The results indicate that the most important element is the teacher, followed by the learning objectives and the curriculum, using an active methodology. Technology in itself does not contribute anything, it all depends on the teachers' training.

Keywords

ICT, Teaching-Learning, Teaching innovation, teacher training, active methodologies, emerging technologies

Introduction

The appearance of computers and other electronic devices has changed the way we communicate, work and have fun, creating expectations about their use in education (Cheng, S. & Vongkulluksn, V. 2020; Habibi, F., & Zabardast, M., 2020; Cairns & Malloch, 2017). According to Goodchild (2018), new technologies in education represent an innovation in the way teachers deliver content to students, helping to improve the quality of the teaching-learning process through an active procedure of transition to real life (Kumbar, Bidnurkar, Tamhane, & Kumbar, 2018), being key to educational transformation (Yeo, Y., & Lee, J. 2020; Wogu, Asogwa, Ezenwaji, & Ibenegbu, 2018). They also help to break down many barriers found in learning (Arshad & Saeed, 2015) and to overcome their limitations. (Alshahrani & Ally, 2016).

Educators hope that the implementation of new technologies in the classroom will improve students' critical thinking, problem solving, collaborative work, communicative



competence and creativity. (Neira, Salinas, & Crosetti, 2017). Most teachers use ICT to support the prescriptive learning which they have traditionally taught, while only a few use it to achieve transformative learning (Sánchez-Cabrero, et al. 2019; Ng'Ambi, 2013). According to Arshad and Saeed (2015), the most relevant benefits related to emerging technologies are: efficiency (they are faster, more precise and can be used at any time), safety (they help prevent accidents), and environmental care (many emerging technologies are geared towards conserving the environment).

Students are also favourable towards the use of new technologies in the classroom. Various studies indicate that the majority of students are very interested in the use of emerging technologies in their training and wish to continue working with them (Mendoza, Baldiris, & Fabregat, 2015a). These learners prefer learning using types of ICT with which they obtain better results, compared to the traditional forms of teaching (Kumbar et al., 2018). New technologies have also been shown to help turn students into active and positive learners (Alshahrani & Ally, 2016).

Among the main barriers that hinder the integration of new technologies in the classroom, the lack of financial resources and the lack of time for teacher training stand out (Arshad & Saeed, 2015; Prinsloo & Van Deventer, 2017; Rogers, 2000). On the other hand, the high cost of technology has encouraged the use of pirated software (Wogu et al., 2018) and in the classroom, free software, specifically in academic environments, increasing in turn the use of web 2.0 (Saeed, Yang, & Sinnappan, 2009). Furthermore, although the ubiquity of ICT can achieve better grades from students (Ng'Ambi, 2013), the absence of social interaction can create feelings of isolation in the student assembly (Goosen & Mukasa-Lwanga, 2017).

1. The use of emerging technologies in teaching to achieve authentic learning

(Neira et al., 2017), emerging technology is considered one that meets the following 13 characteristics: it is contextual (it depends on the context), it is continuously evolving, it involves alteration (it has the ability to modify the educational context, it manages to change or update the teaching-learning process), It adapts to context (facilitating the use of strategies that allow the integration of technology in the classroom), it is ubiquitous (it is present everywhere, overcoming space-time limitations), it is innovative (it contains functions not previously seen), it has a degree of uncertainty regarding its use,

it is complementary (it allows its incorporation with other technologies and methodologies), it is accessible, functional, easy to use, interactive and complex.

The use of emerging technologies such as augmented reality and virtual reality in education is promising in formal and informal contexts, expanding opportunities to improve education, offering alternatives to personalize, localize and contextualize learning (Mendoza, Baldiris, & Fabregat, 2015b), to make it more attractive and meaningful (Foronda et al., 2017) as well as to increase the rates of students who pass (Goosen & Mukasa-Lwanga, 2017). They are also used successfully with pupils with special learning needs to develop competencies and reduce anxiety in different situations (Begoli, DeFalco, & Ogle, 2018).

Certain studies show a high level of correlation between the use of emerging technologies and authentic learning (Bozalek et al., 2013). The bases of authentic learning are found in the theory of situated cognition (Brown, Collins, & Duguid, 1989) which was based on the study of very successful learning. The elements of authentic learning better prepare students for their professional lives (Bozalek et al., 2013). This is achieved by focusing learning towards its use in real situations (Yin, Dooley, & Mu, 2019). Emerging technologies facilitate the acquisition of authentic learning by being the most effective in creating contexts and materials (Alshahrani & Ally, 2016; Herrington & Oliver, 2000). There are nine elements that constitute authentic learning (Herrington, Reeves, & Oliver, 2010):

Table 1.

Characteristics of authentic learning

Characteristics	Meaning
1. Authentic context	Situations from a real context.
2. Authentic tasks.	Problems to which knowledge is applied in the real world.
3. Access to expert thinking and process modelling.	Students and teachers can contribute to learning with their experience.
4. Provide multiple roles and perspectives.	Collaborative work on a common task.
5. Support the collaborative construction	Collaborative work on a common task.



of knowledge.	
6. Promote reflection to allow the formation of abstractions.	Students are encouraged to reflect and share ideas.
7. Promote articulation to make tacit knowledge explicit.	Students are given the opportunity to communicate with professionals about their learning.
8. Provide training and scaffolding by the teacher at critical times.	The role of the teacher is not to give knowledge to the students, but to guide and help them to find it.

Source: Own source based on Herrington, Reeves, and Oliver (2010).

An example of this is the study carried out with emerging technologies to promote authentic learning by Amory (2012) which succeeded in changing the students' perspective about the world, and the interest and commitment of teachers to continue using educational technologies in their classrooms. Emerging technologies also allow for the creation of smart classrooms, generating a context for learning with technology enhanced by the environment (Alshahrani & Ally, 2016).

2. Didactic-pedagogical aspects linked to the integration of ICT

We know that teaching and learning are not directly linked to technology (O'Flaherty & Phillips, 2015). No technology has an impact on its own, learning occurs through the way in which teachers integrate it into their teachings (Geer, White, Zeegers, Au, & Barnes, 2017; Gros, 2016). The critical use of emerging technologies in the classroom requires the modification of current pedagogical approaches (Geer et al., 2017). The traditional educational system, focused on the distribution of content and learning measured by exams, does not inspire creativity (Cochrane, Antonczak, Keegan, & Narayan, 2014) and it is the teachers who are responsible for most of the teaching process while the students most of the time listen passively (Judge, Osman, & Yassin, 2011). Without a change in pedagogy, it is unlikely that there will be a significant impact on students' learning (Geer et al., 2017). Therefore, advances in ICT also require advances in pedagogies (Cairns & Malloch, 2017). Changes in students begin to occur when pedagogical approaches are more active and evolve with the increased use of technology (Charbonneau-Gowdy, 2015). Introducing technology first and then

pedagogy is counterproductive, it is necessary to introduce them simultaneously from the start and in a studied and structured way, otherwise students will assimilate technology without obtaining good results (Hennessy, Haßler, & Hofmann, 2015). The combination of emerging technologies with student-centred pedagogies and authentic learning offer new opportunities for learning (Goodwin, 2012; Shuler, Levine, & Ree, 2012). Therefore, the union of technology and pedagogy is absolutely necessary (Gros, 2016).

Despite the effort to integrate technology into teacher training, there continues to be a gap between technology and pedagogy (Nasreen & Chaudhary, 2018). On many occasions, teaching with ICT is limited to teaching the use of the electronic device itself (Dong & Newman, 2016). The use of technologies makes sense when it allows teachers and students to do things that could not be done without them (Murray & Olcese, 2011). The potential of ICT in the learning process, therefore, depends on the teacher's abilities to design activities that align pedagogy and technology for the benefit of the student (Gros, 2016). There are teachers who lack effective pedagogies that allow the integration of ICT in early learning and development (Dong & Newman, 2016). However, teachers are gradually changing their traditional pedagogies, while education students are opting for transformative pedagogies (Tarling & Ng'ambi, 2016). This is because the use of different pedagogies and the creation of learning experiences have become a motivation for educators (Cairns & Malloch, 2017). In the case of teachers in training, they must know how to integrate ICT as tools to achieve pedagogical change (Dogan, et al., 2021; Nasreen & Chaudhary, 2018). For this, it is essential that in their training they have ICT-based practices and methodologies that promote meaningful learning (Nasreen & Chaudhary, 2018).

On the other hand, active methodologies consolidate the four main points that teachers and students highlight in relation to educational change in pedagogy: collaboration, communication, autonomy and authenticity (Geer et al., 2017). Practical and collaborative work with the integrated use of technology allows the building of a deeper (or authentic) learning and keeps students active and motivated (Hennessy et al., 2015). For this, teachers must adjust their pedagogies to the students' level of competence (Dong & Newman, 2016) and take into account the needs of a modern and changing society (Gros, 2016). In this way, the learning process is a joint work between the teacher and the students in which both learn (Kumbar et al., 2018), so the use of



discussion and dialogue becomes fundamental for the pedagogical strategy (Barnes & Kennewell, 2017).

Among the most used active methodologies are project-based learning and / or problem-based learning (PBL). The problem-solving methodology can be used in virtual environments (Capacho, 2016) accessible from mobile technologies, which are motivating for teachers and students (Hennessy et al., 2015) and educational platforms such as Moodle that are effective because they favour cooperative learning (Manca & Ranieri, 2013). Students who learn through the PBL methodology and ICT, obtain significantly better results than only with the PBL methodology (Judge et al., 2011). Content, internet information and interactions between students and teachers, in addition to learning management systems (LMS), social networks and blogs, are essential for the efficient application of innovative learning methodologies (Zuo et al., 2021; Kavitha & Anitha, 2017).

4. Methodology

Design and sample selection

This study explores the experiences of 8 international educational technology experts from leading educational institutions on the integration of emerging technologies in the classroom. Participants were chosen based on their vast experience in educational technology. The selected key informants were: the director of one of the most innovative schools in the world, ATLSchool located in Silicon Valley (California, USA), the place where technology is born worldwide (companies such as Google, Apple, Uber, Airbnb, etc. were created there), three professors from the department of education at Stanford University (USA), a professor at Singularity University (USA), the director of teaching innovation at University College London (UK) and the president of The Best Teachers Institute (USA) and author of the *best seller* “What the Best College Teachers Do”, an education benchmark and former UK education advisor. The diversity of informants gives us a complete vision of the phenomenon from different perspectives, encompassing schools, the university context and teacher training.

The selection of the sample was carried out using an intentional sampling method (Tójar, 2006) to achieve a complete view of the entire educational plan. With the aim of obtaining quality information, the informants belong to different educational levels related to technology of recognized international prestige. In this way, the points of view of recognized experts from different educational perspectives are collected.

Interviews and procedure

To learn about the main pedagogical aspects of the critical use of emerging technologies in the classroom, a mixed approach has been used. On the one hand, qualitative, through semi-structured interviews in order to achieve a better understanding of the data collected and increase the informants' participation. On the other hand, quantitative, through data processing with the word count technique and sentiment analysis using text mining, or more specifically opinion mining, to extract objective information about the informants' feelings and perceptions in relation to the proposed topics. It is carried out by applying Natural Language Processing (NLP) to the transcripts of the interviews carried out with the R programming language and the Tidy text package.

The interview consists of 9 questions divided into two sections: Emerging technologies (4 questions) and Teaching-pedagogical aspects linked to the integration of ICT (5 questions).

Data collection was carried out through different means. Four of the interviews were in person in California (USA), and the other four interviews were conducted by telematic means, responding to the needs and circumstances of each person interviewed.

All interviews have been carried out with the informants' prior consent. An informal style has been used to create a more comfortable environment for the informant. The interviews lasted approximately one hour. All personal information that could identify the person has been deleted, and each transcript has been assigned a code that guaranteed anonymity. All interviews were then recorded and professionally transcribed.



Data analysis

In order to process the interview transcripts, we used a classical content analysis method conducted by earlier scholars (Bardin, 1996; Miles & Huberman, 1994) for our analytical scheme. This method includes phases of categorisation, text distribution and content analysis. The first step of the analysis was identifying the different categories that emerged from the meta-category (the overarching category), learning the opinion of the aforementioned international experts in educational technology on how to implement emerging technologies in the classroom. We identify two subcategories that involve the objective, as follows: a) Use of emerging technologies in education; b) Didactic and pedagogical aspects related to the integration of ICT in the classroom. The second step of the analysis was prompted by the following questions: a) How are emerging technologies used in education? And b) What methodological aspects should be taken into consideration for their integration into the classroom? This step involved scrutinizing the text passages within each category (for example, integration proposals). The third step complemented the analysis of linking the categories with the objectives of the paper to address the general two-folded question leading this study. It involved going back and forth between the original transcript passages to ensure that no relevant aspect had been omitted through paraphrasing and summarising of the interviewees' narratives. These categories were distributed around the two objectives, and subsequently used to organise the findings.

Moreover, the processing of the obtained data was carried out using the RStudio program. This software is well known and widely used in teaching and research due to being free as well as a multiplatform software, and it has allowed us to provide relevant data from advanced statistical analysis. For the word count, a word cloud has been created that shows the most repeated words. Their size correlates to the number of repetitions. Before counting, a text treatment is carried out to eliminate irrelevant words such as articles, etc. For the sentiment analysis, a series of words that represent feelings (anger, anticipation, disgust, fear, joy, sadness, surprise and trust) and two values (negative and positive) have been taken into account, selected in the NRC Word-Emotion Association Lexicon dictionary by Saif M. Mohammad (Mohammad & Turney, 2010).

5. Results

5.1. Qualitative results

This section presents an overview of the experiences and perceptions of international experts in education, regarding the implementation and correct use of emerging technologies in the classroom.

The use of emerging technologies in education

The informants agree that the teaching staff are the most important element to properly implement the use of both emerging technologies and more traditional technologies. Technology is only a tool that facilitates the learning of content.

"In my opinion the most important technology is teachers, who teach well, so if you have good teachers you can get most of the way with old technologies, analogy technologies, paper and pencils and all the non-digital technologies."

(Informant 1)

They emphasize that emerging technologies are highly motivating for students. The most used functions are to facilitate communication and feedback between students and teachers, besides allowing autonomous learning outside the classroom. An example they make is the use of virtual reality simulations, which allow students to be taken to impossible places and make them experience the same things that other people feel in different contexts. However, they emphasize that currently there are not many educational resources based on this. In addition, they indicate as a negative aspect that technologies slow down teaching due to the time it takes to learn and fine-tune it in the classroom, in addition to the permanent obsolescence of new technologies. When teachers are trained and familiar with a technology, another appears to replace it.

Regarding the impact of the use of emerging technologies in educational centres, they highlight that it is very relevant to how teachers use them. If the teacher uses technology to create a natural critical learning environment, it will be very beneficial, but simply repeating old and ineffective approaches can be very damaging, even distracting. They must be used with a suitable plan and following objectives. Therefore, it is important to learn to use new technologies because they occupy an important place in our society,



but it is equally important to teach and educate students about the correct use of technology.

“I think looking at the problem at the scene through the lens of technology as a tool is necessarily the right way of doing things”. (Informant 7)

“I think that all emerging technologies are significant in education because they are in life”. (Informant 6)

“It depends on how they are used by teachers by educators it will guide how students use them and if they are used to create what we call a natural critical learning environment then they can be quite powerful and can help how people learn more deeply”. (Informant 8)

On the other hand, the impact that technology has depends on the confidence of teachers to integrate it and explore its potential. Sometimes educators are unprepared or feel insecure when using new technologies and the problems that these can cause. Teacher training is a critical factor in this regard. Their confidence, skill, and knowledge define how successful classroom learning will be. Therefore, the impact will depend on the quality of the training that the teacher has had.

“The critical thing as you know is teacher training but you have to make it fun for the teachers right you have to like engage their own interest and passion and not tell them they have to do it because I have to do it”. (Informant 2)

“I think one particular challenge is the readiness of teachers and the degree of confidence teachers have in using the technologies, emotional development necessarily has to be a particular feature that needs to be plugged into any implementation of this technology very carefully”. (Informant 7)

Participants' perceptions of the future indicate that technology will transform teaching and learning processes, making them interesting and exciting for students. Schools will not be the main place in which they learn, they will promote autonomous learning, adapt to the students, and each person will be in charge of their own learning based on their interest and commitment.

“New technology will transform teaching and learning you will make it in interesting exciting the kids will all be desperate to come to school again unhappy to leave”. (Informant 5)

“The biggest thing that I see is that school is not going to be the primary place that people learn, it never has been really but with technologies, I think that learning is gonna be more and more distributed across places”. (Informant 2)

However, those interviewed point out that technology will not end up replacing teachers due to the necessary human interaction they offer and the empathy towards their students. Students prefer dealing with people because education is a type of social act that cannot be replaced by artificial intelligence, especially in the case of young children who need human interaction.

“There is a there's a human condition element that is underlying that causes people to think that they will become irrelevant that they will no longer be needed in the interactions between student and teachers”. (Informant 4)

Teaching-pedagogical aspects linked to the integration of ICT

Participants indicate that if technology is used with appropriate learning objectives and a contextualized curriculum in mind, it is very productive, otherwise it is a waste of time and a distraction. The first priority must be the learning objectives, then the ICTs that help to achieve them can be selected. New ways of teaching are based on the functioning of the human brain, such as the use of active methodologies that allow students to build their own learning-based experiences. These help democratize education and develop students' autonomy based on personalized education.

“It democratizes education; through access to content, quality of interaction and experiences”. (Informant 6)

“These technologies lead to more personalized education paths especially if it's based on student interest, in that case, the whole system gets flipped around it's no longer a teacher pushing the student to learn something it's the student pulling as much information as they can get because they're interested in a topic”. (Informant 4)

“It can simulate things that we can't otherwise access let us play with molecules it can let us blow up explosive dangerous gases it can let us manipulate stars right it can change all sorts of things”. (Informant 1)



Likewise, the informants emphasize that the context in which the active methodologies are used will be a determining factor, but ideally there'd be a mixture of methodologies, including everything that is experimental such as project-based learning or problem-based learning, which allow students to investigate a problem and reach an agreement with others on some kind of solution.

“Some teachers are so amazing at project-based learning and they're just everything is experiential”. (Informant 3)

They also highlight that technology can amplify any type of teaching, so technology must be permitted to merge with the system. There are many resources, the most interesting according to the informants, are those that contribute to digital literacy, online resources and those that favour computational thinking that allow a five-year-old child to start programming her own robot. Yet, technology should not define learning, it should support it. Students must be familiarized with technology and given access to it.

“We build the learning environments around big intriguing fascinating important questions and we give people an opportunity to try to answer those questions or solve those problems”. (Informant 8)

“They are designing all of these technologies so the big ideas around computational thinking can be introduced at a very young age”. (Informant 2)

In regards to the order to follow for the use of emerging technologies in the classroom, it is emphasized that the most important thing is to have an objective, if it is not an artificial exercise. Next, you should start by replacing traditional tools with modern technology without any significant functional change, to gradually increase the uses of the new technology to take advantage of its full potential.

They also highlight the importance of communication technologies, to create spaces where students can tackle problems and collaborate from different parts of the world, where the creation of simulations can be enormously useful. They emphasize that it is more powerful for children to build their own interests and opinions by creating gadgets using technology for any topic or subject. This is also applicable to teachers, for educators to share their best practices and learn from the success stories of others.

“Without a goal without purpose it's just an artificial exercise in some senses”. (Informant 5)

“Should probably start by looking at the substitution using technological tools as a direct substitute of more traditional ways”. (Informant 7)

“We can use them for communication we can use them to create spaces where students can tackle problems”. (Informant 8)

All participants agree that the use of emerging technologies favours collaborative work. Communication and collaboration are integral parts of new technologies, which oppose traditional ways of learning. They allow students to access people from all over the world to work and learn alongside them.

“You have to set up projects so that children know that they can collaborate and you want them to and it's easier like if you have a bigger screen but it helps to collaborate because everyone has different perspectives to bring having said that collaboration is not always easy”. (Informant 2)

Furthermore, the integration of emerging technologies in the classroom can influence aspects that determine learning such as self-regulation, concentration and motivation. In this regard, the informants emphasize that self-regulation is a challenge, since multitasking distracts students and hinders their learning. It depends on the students, the designed study plan and the technology used. The transition between reinforcements and technology, allow for the autonomy of the student. But many students are not ready for self-regulation and an assessment is necessary to control their autonomous work.

“Children can only learn to self-regulate and self-manage if they are given opportunity to do so and the very democratic nature of tech promotes that”. (Informant 6)

Likewise, they point out that the use of technology offers feedback to students on their work and helps them improve. Technology has the potential to dissolve the walls of the classroom. The problem is that it can be terribly distracting and can undermine concentration. Furthermore, there is a trade-off between what technology can do and what education truly needs.

The informants agree that most students learn best when teaching is rich in context, experience, and dynamics. Then technology can have a hugely positive impact. Learning is more engaging if you work with data relevant to the students' lives. This has an impact on academic performance, which depends on how the teaching and



motivation of students develops. It is essential to create interest because it is the driver of motivation. We do not know what future employment will require, so it is important to educate in skills and promote the use of technology to young people for their future work.

“Motivation and interest to me are very aligned right and interest is a driver of motivation and said the more that I feel connected to an activity or a topic the more time I'm going to spend”. (Informant 2)

“In terms of educational performance, if we remember that most students learn best when teaching is rich in context, experience and dynamic then tech can have a hugely positive impact”. (Informant 6)

“They can be engaging if your exercise involves working with a data set that is more relevant to your life”. (Informant 5)

5.2. Quantitative results

An analysis of the participants' responses is then carried out. The analysis consists of two parts. In the first part, a word count is done. Later, a word cloud is made for each dimension. This technique consists of representing the most used words in a text in a graph with a font size proportional to the frequency with which they were used. In the second part, a sentiment analysis is carried out on the participants' answers using the “nrc” lexicon (Mohammad & Turney, 2010). This lexicon classifies 14182 unigrams into eight basic emotions and two feelings. The emotions are anger, anticipation, disgust, fear, joy, sadness, surprise and trust; while the feelings are positive and negative. In order to carry out a more exhaustive analysis, the results are broken down by dimension and by question.

Figure 1 includes the word clouds for each dimension. It is observed that some words appear in both clouds in a large size, which indicates that they were frequently used in the answers. Some stand out such as technology, can, and students. Indeed, both dimensions focus on technologies, skills and the students themselves. There are also some words that are represented in the graph in a larger relative size in one of the dimensions. For example, in the dimension “Emerging technologies” the word “teachers” is kept, which highlights that technologies are a reality in classrooms and the

leading role of teachers in this sense. For its part, in the “Teaching-pedagogical” dimension, words such as “learning” are kept, which highlights the student's learning as a central issue.

Figure 1.

Word clouds by dimension.



Figure 2 shows the emotions identified in the responses of the experts in each of the dimensions analysed. First of all, it is important to emphasize that in both dimensions optimistic emotions and positive feelings appear more frequently than negative emotions and feelings. This fact can be interpreted as the experts interviewed seeing the incorporation of technology into teaching as positive and desirable. Regarding the distribution of emotions, we can observe that it is similar in the two dimensions. The most present emotions are "trust", "anticipation" and "joy"; while the least present are "anger", "disgust" and "sadness". This indicates that the informants have a positive predisposition to the issues raised, something very hopeful as they are the greatest experts in their respective areas with full knowledge of the objective of this study. It also denotes the positive and realistic attitude that the interviewees have about a critical and real integration of technology in the classroom based on its potentialities.

Figure 2.

Analysis of emotions based on the NRC lexicon by dimension.

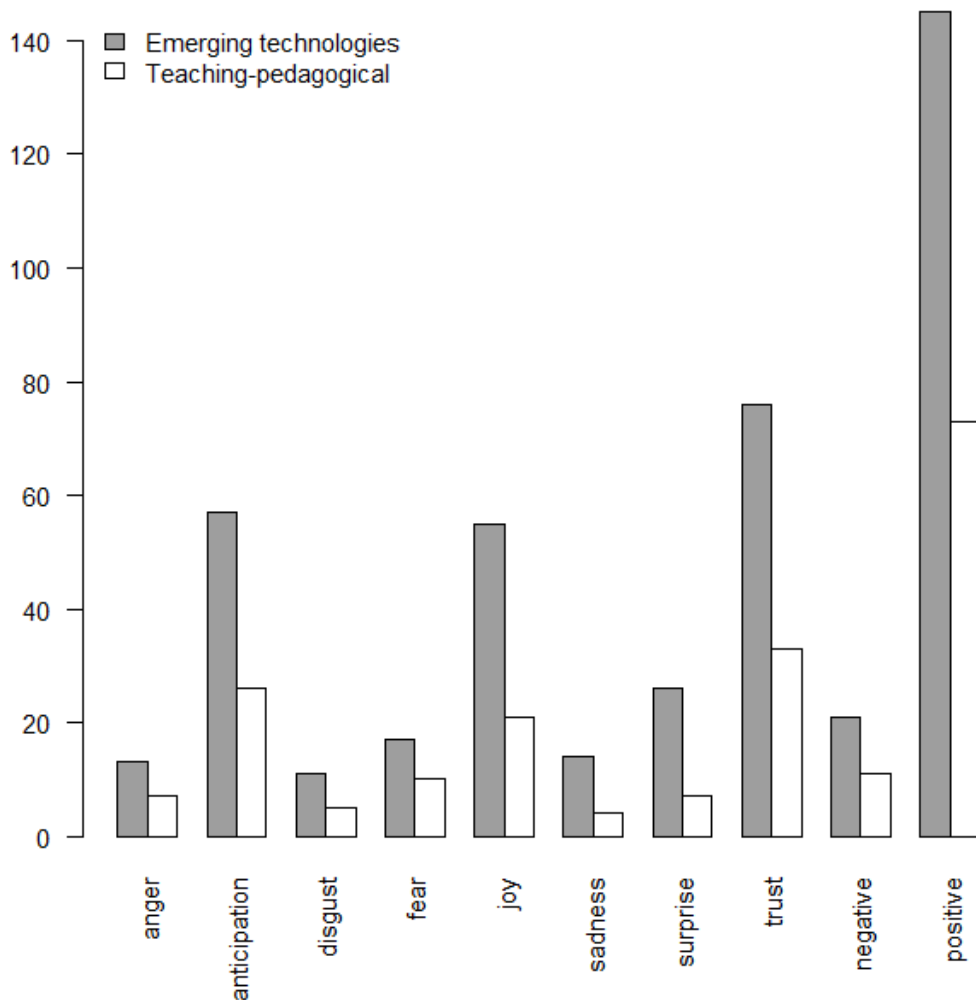


Figure 3 represents the emotions, positive or negative, in relative terms identified in the experts' responses to each question. A high proportion of positive feelings is observed in all the answers to each of the questions. Said proportion of positive feelings is between 87.13% for question 1 and 71.25% for question 2. Consequently, the proportion of negative feelings is between 12.87% and 28.75% for the previous questions respectively.

Figure 3.

Analysis of feelings (positive and negative) based on the NRC lexicon per question.

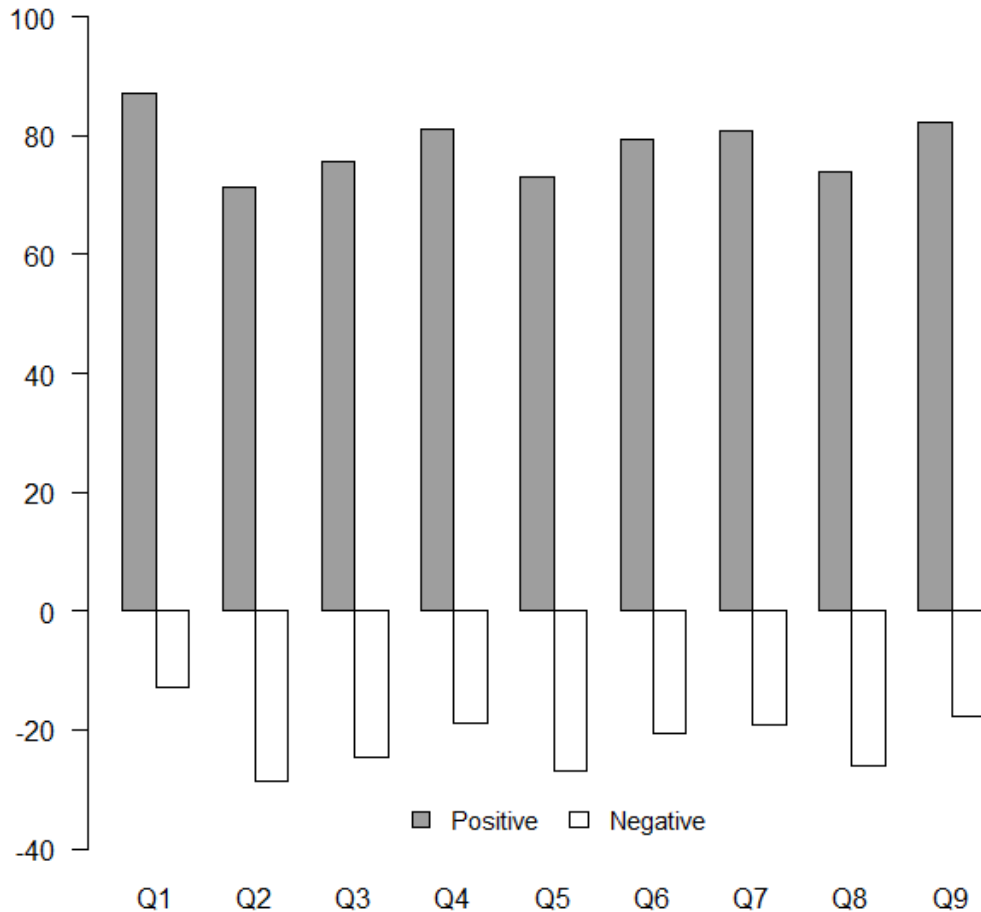


Table 2.

Percentages per question

%	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Positive	87.12	71.25	75.53	81	73.03	79.38	80.95	74	82.18
Negative	12.87	28.75	24.47	19	26.97	20.62	19.05	26	17.82

The average of the positive percentages of all responses is close to 80%. One question stands out above the rest with almost 90%. It is question 1 that refers to emerging technologies that may be most useful in education. The average percentage of negative responses is around 21%. As with the positive responses, there is one that is above



average with 28.75%. It is question 2 that deals with how they think emerging technologies will affect schools. These two questions that are above the average of the positive and negative percentages belong to the “Emerging Technologies” dimension, which indicates that this dimension is where there is the greatest contrast of opinions. In general, table 2 reflects a high proportion of positive feelings when talking about the integration of emerging technologies in the classroom.

Discussion and Conclusions

Regarding the use of emerging technologies in education, it is important to point out that learning technology is fundamental because we live in a computerized society (Cairns & Malloch, 2017). It is necessary to know its uses to come together socially and to be able to work (digital literacy), causing situations of social exclusion (digital divide) among those who are not adequately trained (Klaassen et al., 2017) thus conditioning their future.

One of the most important functions that has allowed new technologies to improve education are the new ways in which we can communicate using it (Wogu et al., 2018), as we can now interface and learn like never before (Adi & Scotte, 2015). This has favoured collaborative work and ubiquitous learning (Luppicini and Haghi 2013) without eliminating the necessary social interaction of face-to-face classes (Goosen & Mukasa-Lwanga, 2017). One of the most prominent emerging technologies in this research is virtual reality. This is due to its ability to simulate situations and contexts that allow students to live experiences that would otherwise be impossible (Mendoza et al., 2015b).

However, this research highlights the lack of teacher training as one of the main problems in the implementation of emerging technologies (Dong & Newman, 2016). On many occasions, teachers are unable to use new technologies in their classes and solve the problems that may arise from them (Nasreen & Chaudhary, 2018). This shows the importance of teacher training so that they can cope with and adapt to changing times (Foronda et al., 2017). The training of new teachers will progressively influence the classrooms and their veteran colleagues. Therefore, it is important that their training is carried out using ICT (Nasreen & Chaudhary, 2018).

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The integration of new technologies in the classroom can begin with the use of technologies at their most basic functions and progressively increase their complexity until reaching their full potential, carrying out strategies that facilitate their integration in the classroom (Foronda et al., 2017). The key, however, is not to overcomplicate our view of the emerging methodology. There are too many “new ideas” and “methodologies” that confuse schools and teachers, and we need to have greater confidence in allowing emerging technology to merge into the system. “We must be strong and secure enough to ensure that technology does not define education, but rather supports it”. (Informant 6)

Through the word counting technique, our research shows that in the Emerging Technologies dimension, technology is closely linked the teacher’s profile. It also highlights learning, which is an essential element in achieving the correct implementation of emerging technologies in education. The sentiment analysis shows the confidence and positive vision that informants have regarding the integration of emerging technologies in the classroom.

Regarding the didactic and pedagogical aspects that stand out as fundamental to achieve the integration of ICT in the classroom, all informants agree that the methodology is more important than technology, and that the most important element to achieve the correct implementation of new technologies in the classroom, is the teacher (Gros, 2016). A well-trained teacher is able to use any tool or technology successfully to teach their students (Geer et al., 2017; Gros, 2016). It is also necessary to generate a natural critical learning environment (Neira et al., 2017), which has an important effect on the teaching-learning process (Rogers, 2000) by improving the quality of education (Kumbar et al., 2018). However, there are few teachers who use new technologies to offer authentic and transformative learning (Sánchez-Cabrero et al. 2019; Ng'Ambi,



2013), with the majority being new teachers who try the most (Tarling & Ng'ambi, 2016). Without a change in pedagogy, a significant change in student learning is unlikely to take place (Geer et al., 2017). It is therefore important to influence teacher training (Nasreen & Chaudhary, 2018) to achieve the necessary union between pedagogy and technology (Gros, 2016).

It is also necessary to have well-defined learning objectives as well as a contextualized curriculum. Technology is just a tool that facilitates learning and when well used can significantly improve the teaching-learning process. Technology must support the learning process, not be the its center since it is incapable of promoting learning by itself (O'Flaherty & Phillips, 2015). Likewise, this study points out that the use of technology in class is highly motivating for students and teachers (Cairns & Malloch, 2017), but if not used correctly it becomes a distraction. Therefore, it is important not to introduce technology before pedagogy because it would be counterproductive (Hennessy et al., 2015).

Students are being trained to perform jobs that do not yet exist, which is why they must be coached mainly in competencies (Klaassen et al., 2017). Active methodologies are a good tool for this as they prioritize the teaching of skills over content and allow a more personalized learning adapted to their interests, thus stimulating their curiosity and motivation. The most recommended active methodologies for the integration of emerging technologies in the classroom are project-based learning and problem-based learning. Working with real and close problems to stimulate students and get them involved. However, it is important to adapt the methodologies to the students' context (Koehler & Mishra, 2009) and to their level of competences (Dong & Newman, 2016).

In the word count of the pedagogical dimension, the words that appear the most are technology, students and can. It is interesting to compare this with the previous dimension that focuses on emerging technologies. Instead of students, there is teacher. It seems that when we talk about integrating technology in the classroom it is focused on technology and the teacher, but when it comes to pedagogy and learning, the focus is on students and technology. Also, as in the other dimension, the word learning is repeated. When it comes to the sentiment analysis, it again shows that the informants are aware of the situation and are confident and optimistic about the integration of emerging technologies in education, which is very encouraging.

We can conclude, therefore, that the most important thing for the implementation of new technologies in education is the teacher. Quality training must be provided to future teachers so that they know how to successfully use new technologies in the classroom. These teachers will give more importance to pedagogical and didactic aspects over technology itself in order to achieve authentic learning in students. Selecting appropriate learning objectives and a contextualized curriculum are two key factors to this process. The use of active methodologies such as project-based learning or problem-based learning, allow the development of students' competences based on stimulating and relevant questions, as well as promoting collaborative work. Above all, the context and educational level of the students must be taken into account. Based on all the above, the technology that best allows them to achieve the proposed objectives must be carefully selected and thus achieve a personalized and motivating teaching-learning process.

Compliance with Ethical Standards

- The authors declare that they have no conflict of interest.
- This research does not involve human participants and/or animals.
- The research has the informed consent of all the people who participate in it.

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x



7.3. The integration of emerging technologies in socioeconomically disadvantaged educational contexts. The view of international experts

Abstract

Background

The development of students' digital skills is essential to access the labour market and interact with society, being especially important in disadvantaged socioeconomic contexts affected by the digital divide.

Objectives

The investigation has two objectives. On the one hand, to study the integration of ICT in disadvantaged contexts and, on the other, to know the critical use that is made of them in schools as a source of educational change.

Methods

In this research, eight international experts in education are interviewed on what they consider to be the best way of implementing new technologies in disadvantaged contexts to achieve educational improvement. A mixed methodology has been used, qualitative through semi-structured interviews and quantitative through a text mining analysis of the interviews' transcripts with the R programming language.

Results and Conclusions

The results show that the teaching staff is the key element. The curriculum, objectives and school director's help are also highlighted, as well as the collaboration of the students who have to be provided with the necessary digital resources. At the state level, greater funding and support from universities are needed to support research and the quality of teacher training.

Keywords

Contexts Effect, Educational Change, Educational Technology, Educational Innovation, Equal Education, Educational Discrimination

Introduction

Computers and technology have changed the nature of the current generation of citizens (Espigares-Pinazo et al., 2020; Wang, Hsu, Campbell, Coster, & Longhurst, 2014a). In disadvantaged countries, obtaining a degree in ICT allows people to alleviate employment discrimination, providing them with powerful tools that allow them to combat social inequalities (Jones & Pal, 2015). However, one of the most critical problems in this age of information is digital inequality (Yu, Lin, & Liao, 2017). Despite the fact that ICTs support the economy's development assuming there's opportunity for an economic income, the poorest and most disadvantaged people are normally excluded from its access and usage (Tamatea & Pramitasari, 2018). These people are especially affected by the widespread use of ICT in our society, which causes them to be forced to use technology to become members of society (Wu, Damnée, Kerhervé, Ware, & Rigaud, 2015a). An example is found in the 2020 European Strategy, which prioritizes the fight against digital inequalities to make the most of ICTs as a measure of restarting Europe's economy (Cruz-Jesus, Vicente, Bacao, & Oliveira, 2016).

Many countries are making significant investments in ICT and including them in their development policies to favor economic growth and be more competitive internationally (Fernández-de-Álava et al., 2017; Kozma & Vota, 2014). In the same way, impoverished countries must create the necessary policies that allow for the positive impact of ICTs (Wogu, Asogwa, Ezenwaji, & Ibenegbu, 2018). Therefore, it is important to increase active participation in digital society due to the benefits that the use of new technologies offer (Fang et al., 2019).

To accomplish the implementation of ICT from the classroom, a pedagogy that implies the contextualization of the teachers' practices must be used (García-Carmona, 2015; Munns, Sawyer, & Cole, 2013). Contextual factors affect the execution of ICT projects (Mooketsi & Chigona, 2016). This fact can be observed in the TPACK model of ICT integration (Koehler & Mishra, 2009). However, the integration of ICT in teaching works in a similar way with students regardless of their initial level (Bai, Mo, Zhang, Boswell, & Rozelle, 2016). That is why it is necessary to take into account how ICTs are used in disadvantaged contexts, as well as how to make vital use of them and know the source of the educational change that the implementation of ICTs in a reflective way allows. Hence, the research has two objectives. On the one hand, to study the



integration of ICT in disadvantaged contexts and, on the other, to learn about the critical use made of them in schools as a source of educational change.

Despite the importance of new technologies, there are gaps in the literature on how they can be implemented in socio-economically disadvantaged contexts to improve education. The present research contributes to filling these existing gaps by offering a practical approach based on the experience of experts (Müller-Bloch & Kranz, 2015). This contribution can serve as a basis for future lines of research to improve the situation in these educational settings and reduce existing inequalities.

1. Use of ICT in disadvantaged contexts

The environment surrounding students may have a greater effect on them than the school (Munns et al., 2013). Similarly, family context is more influential than any other factor in the students' performance in the fact that it is the initial restriction to their economic and social situation (education and occupation of the parents) (Claro, Cabello, San Martín, & Nussbaum, 2015). Therefore, the socio-economic background of students and schools has a powerful influence on their performance (Organisation for Economic Co-operation and Development [OECD], 2010a) and conditions educational success (OECD 2010 b). For this reason, the students' home environment is a key element in their future academic performance, requiring the families' support, the environment and the school to achieve this (Turner & Juntune, 2018). According to data obtained in PISA 2012, family environment has a vital impact on the integration of ICT in the training of the students and schools, in addition to being so in their academic performance. This is influenced by the resources available at both locations, besides their parents' academic (Claro et al., 2015; Erdogdu & Erdogdu, 2015). This can be observed in aspects such as when people with a higher level of education make greater use of the internet and have superior skills (Hargittai & Dobransky, 2017).

Likewise, research conducted by Tamatea & Pramitasari (2018) notes that children from underprivileged socio-economic contexts also inherited forms of self-limiting thinking that they probably never overcome, and often have a sense of hopelessness, helplessness and apathy. On the other hand, rich students have more exposure and experience in the use of new technologies and better attitude towards the use of computers in opposition with poor students (Mooketsi & Chigona, 2014) who have less access to computers at

home (Hohlfeld et al., 2008). That is why poverty affects the learning outcomes of students (Munns et al., 2013). This creates a gap in academic achievement between students raised in impoverished environments and their counterparts (Turner & Juntune, 2018). Schools and universities need to help remove these barriers as well as other existing social barriers in education and mistrust among middle-class educators and poor families produced by cultural and social differences (Lineburg & Gearhart, 2013). This makes disadvantaged students require more support to meet their shortcomings such as a structured plan to meet their needs to achieve success (Hambira, Lim & Tan, 2017). In addition to their families academic support from an early plan age (Turner & Juntune, 2018).

Educational interventions in disadvantaged socioeconomic contexts are initiated from the outside with little participation from those affected (Thapa & Sæbø, 2016). This occurs because students start out with few or no long-term goals and without self-confidence. Sometimes they are easily discouraged and drop out of school (Tamatea & Pramitasari, 2018). In this regard, the impact of ICT is positive on students from disadvantaged backgrounds (Hambira et al., 2017) because it brings them emotional benefits (Hambira et al., 2017): it increases the student's enjoyment of the class, their level of hope increases, students take pride in their work, it alleviates students' anxieties, reduces fear of using technology and helps them overcome boredom in class.

The digital gap

The digital divide is one of the main obstacles for social inclusion and for the promotion of a strong and creative economy (Fernández-de-Álava et al., 2017; Park, Choi, & Hong, 2015). In disadvantaged contexts, lack of access to information and technologies seriously hinders success in education, employment and economic prospects. For this reason, mastering technology is essential in education to get a good job and function in today's society (Broadbent & Papadopoulos, 2012). A reflection of this is the job search websites that demand a large number of people with ICT skills (Tamatea & Pramitasari, 2018).

There are three levels of digital divide (Hohlfeld et al., 2008): the first is financial, access to technology, the second is cognitive, cultural and social, (OECD, 2010) which refers to how technology is used (Claro et al., 2015) and third is their usage (Mérida-



López & Extremera, 2017). That is why the digital divide is more complex than simply rich versus poor (Claro et al., 2015). There are also other factors that favor the digital gap such as remoteness and age. Remoteness occurs mainly in rural areas (Park, 2017) and age wise in people over 65 years of age, called the “grey gap” (Friemel, 2016; Wu, Damnée, Kerhervé, Ware, & Rigaud, 2015b). To lessen this gap, the education of the most disadvantaged is essential, not only for them but for the entire country, determining the future of that country based on what happens with these people’s schooling (Darling-Hammond, 2010).

2. Critical use of ICT and the origin of educational change

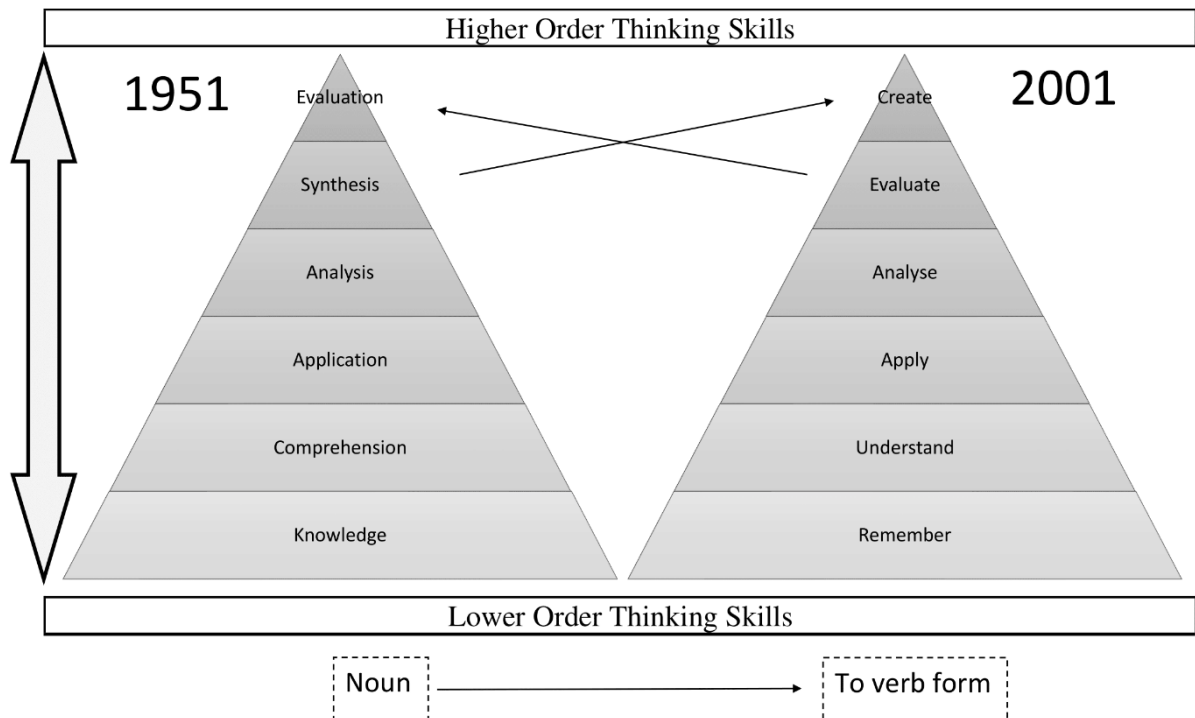
To achieve critical use of ICT, it is necessary to develop critical thinking. Critical thinking in the words of Paul R. and Elder L. (2003) consists of *“developing capacities to identify or formulate problems and solve them, evaluate information and use it, test ideas based on relevant criteria, recognize one’s own judgments and put them to use testing of new arguments, communicating effectively with others ”*(p. 4).

The development of critical thinking (Paul & Elder, 2003) begins with the person who is unaware of problems and therefore does not think about them. This person is called a thoughtless thinker. Next, we find the challenged thinker, who is aware of problems, but does not face them. Later, the beginner thinker who tries to improve, but without practice. Then he will become the practicing thinker, who recognizes the need to practice regularly. With Practice and experience they transform into the forward thinker, advancing as they practice. It ends with the master thinker, for whom good thinking habits become second nature.

To develop students’ critical thinking in the classroom, Bloom’s taxonomy can be used for designing lesson plans as proposed by Sadker and Sadker (2014, as cited in Organization of American States [OAS], 2015). However, the new version of Bloom’s taxonomy revised by Anderson and Krathwohl (2001) should be used for this purpose, as they have adapted Bloom’s taxonomy to the digital age. One of the most important changes is that the highest level is no longer evaluation but creation.

Figure 1

Illustration showing the difference between Bloom's original taxonomy and the revised version.



Own elaboration based on Diagram 1.1, Wilson, Leslie O. 2001.

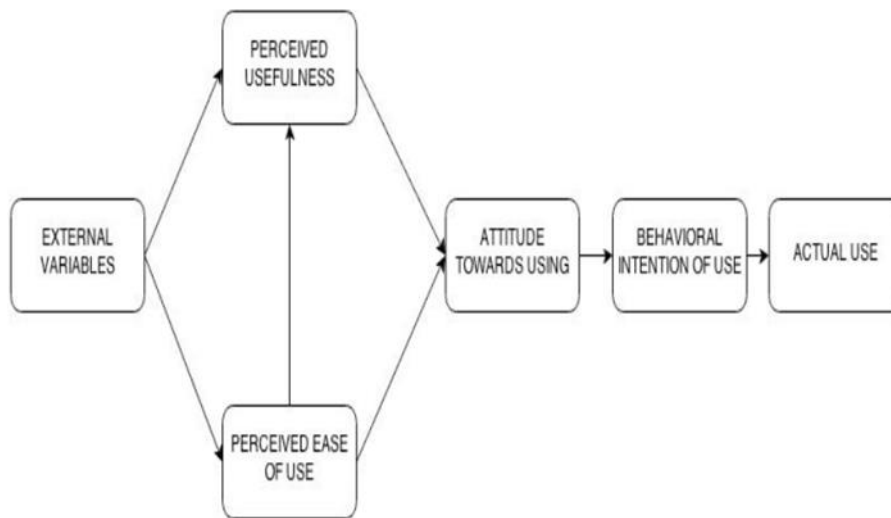
As for educational change, ICT and communication are key because they allow interaction and feedback between people around the world, providing access to education at any time and from anywhere (Wogu et al., 2018). The integration of ICT would be superfluous if it did not involve an improvement in the quality of teaching (Nikolic, Petkovic, Denic, Milovancevic, & Gavrilovic, 2019). However, not all ICT resources are appropriate for all situations in the classroom (Bai, Mo, Zhang, Boswell, & Rozelle, 2016). To make critical use of ICT, teachers must focus on content rather than the ICTs themselves, focus on the problem and then seek the appropriate means, formed in pedagogies and innovative approaches, and adapt to the context (Alshahrani & Ally, 2016). Therefore, the figure of the teacher is key and is studying their attitude



towards new technological tools (García-Carmona, 2015; Prieto, Migueláñez, & García-Peñalvo, 2014). It is also essential to understand and evaluate the educational community's degree of acceptance of new technologies to improve and implement the integration of ICT. This can be determined by the Technology Acceptance Model (TAM) (Davis, 1989), showing how users come to accept and use technology:

Figure 2

Technology Acceptance Model (TAM)



However, the biggest obstacle to the integration of ICT is teachers' lack of knowledge in regards to the use of ICT in teaching (Nikolic et al., 2019). The essential elements in the integration of technology in the school are ICT resources, training, time and technical assistance (Bingimlas, 2009), but teachers feel that the integration of ICT and new pedagogies requires too much time and that they distract them from their study plan (Hennessy, Haßler, & Hofmann, 2015). Another aspect to take into account in studies on ICT integration is its context and consequences, mainly in disadvantaged areas (Mooketsi & Chigona, 2014).

For their part, students want greater use of ICT because it motivates them and provides them with better learning (Bølling et al., 2018; Nikolic et al., 2019), which has an impact on their educational performance (Castillo-Merino & Serradell-López, 2014). This can also be observed in young people from impoverished countries who show the same level of interest in technology as young people from the rest of the world (Fisher, Yefimova, & Yafi, 2016). In many cases, if students do not use new technologies in their classroom, it is not because of the age or abilities of the teacher, but rather because

of the shortage of opportunities that they have to use them in school (Wang, Hsu, Campbell, Coster, & Longhurst, 2014b). In this sense, it is important to take into account that in order to achieve the correct use of ICT we need pedagogical innovations to be based on learning objectives, teachers, students, ICT, connectivity and multiple learning outcomes (Bocconi, Kamylyis, & Punie, 2013).

3. Methodology

Design and sample selection

The present investigation has two objectives. On the one hand, to study the integration of ICT in disadvantaged contexts and, on the other, to know the critical use that is made of them in schools as a source of educational change. For this, it has the participation of 8 international experts in education who are interviewed on how to implement new technologies in disadvantaged socioeconomic contexts to improve the educational situation.

For the selection of key informants, international experts in educational technology with great experience and experience have been sought out to guarantee the quality of the data obtained. It has also been taken into account that they belong to different educational levels in order to obtain a more complete view of the phenomenon. For this reason, the selection of the sample was through an intentional sampling method (Tójar-Hurtado 2006), leading to the choice of the following key informants: the director of teaching innovation at University College London, three professors from the department of education at Stanford University, a professor at the University of the Singularity, the principal of one of the most innovative schools in the world, ATLSchool located in Silicon Valley, California (USA), the president of the Best teacher Institute and author of the book “What do the best university teachers do? an Education Guru and former UK Education Advisor.

Interviews and procedures

The research uses a mixed approach to obtain more accurate results through the triangulation method. It has a qualitative part, which consists of semi-structured interviews lasting one hour, using informal language to create a comfortable



environment with the informant. And another quantitative part, through a text mining analysis with the R programming language, to provide greater objectivity in the analysis.

The interview consists of 9 questions divided into two dimensions: the integration of ICT in disadvantaged contexts and the Critical use of ICT and the origin of educational change. The interviews were conducted through different channels: 3 by video conference using Skype, 4 in person in California (USA) and one by email, responding to the needs and circumstances of each person interviewed. All interviews have been carried out with the prior consent of the informants. All personal information that could identify the person was deleted, and each transcript was assigned a code that guaranteed anonymity. All interviews were then recorded and professionally transcribed.

Data analysis

Phase 1

We applied a classical content analysis method on the interview transcripts conducted by earlier scholars (Bardin, 1996; Miles & Huberman, 1994) for our analytical scheme. This method is structured in phases of categorization, text distribution and content analysis. The first step of analysis was identifying the different categories that emerged from the meta-category (the overarching category), to know the international education experts' opinions on how to implement emerging technologies in socio-economically disadvantaged educational contexts. We identify two subcategories: a) Integration of ICT in disadvantaged contexts; b) Critical use of ICT and the origin of educational change. The second step of the analysis was prompted by the following questions: How can technology be integrated in disadvantaged contexts? And where is the origin of educational change? This step involved scrutinizing the text passages within each category. The third step complemented the analysis of linking the categories with the objectives of the paper to address the general two-folded question leading this study. It involved going back and forth between the original transcript passages to ensure that no relevant aspect had been omitted through paraphrasing and summarizing of the interviewees' narratives. These categories were distributed around the two objectives (integration of ICT in disadvantaged contexts and the Critical use of ICT and the origin of educational change), and subsequently used to organize the findings.

Phase 2

The data obtained from the interviews with the RStudio statistics program have been processed. It is a free and multiplatform software, well known and used in teaching and research because it allows advanced statistical analysis. The use of this software has allowed us to provide relevant data that have complemented those obtained in the qualitative analysis.

The word count has been carried out by means of a word cloud in which the most repeated words are highlighted, their size being proportional to the number of times it appears. However, prior to performing the count, the text has been processed to eliminate irrelevant words such as articles, taglines and auxiliary verbs. For the sentiment analysis, a set of words representing feelings (anger, anticipation, disgust, fear, joy, sadness, surprise and trust) and two values (negative and positive) were used, selected from the NRC Word-Emotion dictionary Association Lexicon by Saif M. Mohammad (Mohammad & Turney, 2010).

5. Results**5.1. Qualitative results**

This section provides an overview of the perception of international experts in education based on their experience, on the integration of ICT in disadvantaged contexts and the Critical use of ICT and the origin of educational change.

Use of ICT in disadvantaged contexts

The informants point out that, although emerging technology is not the priority in disadvantaged contexts, it can be transformative because it maximizes access to high-quality knowledge and experiences. Furthermore, emerging technology encourages collaboration across socioeconomic boundaries and is inherently motivating for students.

“It can be transformative as it maximises the access to high-quality knowledge and experiences, it allows opportunity for collaboration across socioeconomic boundaries and raises the sense of value and purpose for students”. (informant

6)



The informants indicate that there is much ignorance about the real situation of disadvantaged people. However, one of the core challenges in these contexts is the economic capacity to acquire the technology. Therefore, it is all-important that we provide them with the tools and knowledge necessary to use it.

Another fundamental factor that the people interviewed shared with us is that teachers should not design lessons only for the upper class because they would be actively widening the digital gap. They have to use technology that makes sense in their context and pay attention to the technology ecosystem in order to design the experience. For example, mobile phones are widely used in disadvantaged countries. An old mobile allows connection to the internet and the search for information by giving people resources in their own environments.

“They should have been utilized it actually the emerging technologies give people the resources in their own environments”. (informant 4)

To attain this, teachers must be taught how to teach people in disadvantaged communities with few resources. In other words, to achieve the integration of emerging technologies in underprivileged contexts we need to ensure that we have expert and well-trained teachers.

“I think a lot of the time we need to address the teaching and make sure that we have expert well-trained teachers to be able to help those students”. (informant 1)

The experts also highlight the importance of the students' environment. An environment must be created where students feel included, communicating their own ideas to those of others that can help them grow and allow them to live different experiences. It is also essential to count in the students in the implementation of emerging technology in disadvantaged contexts. For this, they need to collaborate with teachers, being in charge of emerging technology with each student having a different role.

“Technologies will create an environment where all students feel included”. (informant 8)

The informants also emphasize that the work that can be done outside of school is incredible, facilitating communication and favouring human relationships over distances. ICTs also service labour relations, as the use of computers is required in any

job or to carry out administrative procedures. Additionally, having digital skills allows one to obtain a higher salary. They even point out its effectiveness with students with special educational needs:

“Technologies have tended to be particularly effective in the context of what in the UK we might call special educational needs education”. (informant 7)

Another foundational aspect that the informants tell us is to have proper pedagogy. We have to use good pedagogy in disadvantaged contexts and with people with learning difficulties, presenting the same material, in very different ways to facilitate understanding.

“Pedagogy, in general, is also good pedagogy for those disadvantaged contexts and people with learning difficulties or additional needs”. (informant 7)

In the same way, it is important to encourage access to information and work communication to facilitate the exchange of ideas between different countries. Also designing teamwork projects to counterbalance one of the negative aspects of new technologies which is that students tend to isolate themselves. Another way for students to be in contact with other cultures is by working on cultural competence and by hiring teachers from diverse backgrounds.

“Communication to facilitate exchange of ideas to facilitate simulation to facilitate going to places you've never been”. (informant 8)

The informants emphasize the importance of taking into account the resources that the educational community possess. Teachers, for their part, must take into consideration the technology available to their students to be able to send them homework. On the other hand, in educational centres, the use of new technologies is hinged upon its costs and by the maintenance of the structures. In the case of students, we have to provide them with ICT tools which we allow some of them to take home, although it may pose some security problems. The backing of families, the communication plan with them and what to do with the old devices is plays a strong and fundamental role.

“What's at home should be taken into account at school so teachers should know what the students have access to at home how they spend their time” (informant 2)



So as to make the implementation of emerging technologies in disadvantaged contexts a reality, the informants agree that the first thing to address is the training of teachers to offer good teaching. Then a good curriculum that prepares students to participate in society as adults productively and have jobs to support themselves and their families. It is also essential to teach families about ethics, citizenship and harassment (digital citizenship), as parents represent one of the fundamental pillars in their education.

“Teacher training should be supportive right at the pre-service level as well so right before is the teacher going through their own training”. (informant 2)

Another essential aspect that informants show us is financing. More funding must be allocated for education, most of it for technology, and given enough time to see the results. We have to offer students the same resources so that they all have the same starting point. You cannot have some students with access to a technology and others not. Equity is essential in the implementation of new technologies in education. However, the digital divide is a problem if the use of technology is based on financial affordability. In addition, the digital gap affects in two ways, either having an excessive amount of technology, or no access to it at all. Both cases can damage learning. Regarding the measures that must be taken so that students have access to ICTs and can be trained in them, avoiding the digital divide, they highlight:

“Full and free access to high-speed internet and high-quality equipment and teaching”. (informant 6)

“It would clearly be beneficial to make available to young people the same set of resources in students to give them an equal starting point “. (informant 7)

“It is about making better use of resources that people do in that kind of way”. (informant 5)

Likewise, the informants underline that new technologies connect people in a meaningful way, showing inequalities and giving voice to students who are not represented, allowing them to defend their ideas. For example, through virtual reality, experiences could be created that allow students to understand what refugees have gone through. And yet, although it is good that the community that welcomes them knows what they have been through, there is nothing to be done about it.

“Connecting people in meaningful ways also perhaps showing the inequities more perhaps well ideally also giving students who are underrepresented more of a voice ideally”. (informant 3)

There are other risk factors that informants highlight, such as the threat stereotypes pose, both because of how people treat others and how one may feel about themselves. This creates anxiety, which can lead people to end up complying with stereotypes. In this regard, technology can help by making people believe in themselves and their ability to grow. However, technology cannot solve existing inequalities in society by itself.

“Stereotype threat is extraordinarily important stereotype threat is the idea that if you are a member of the group about which there is a very widespread negative social stereotype about your group the mere existence of that negative stereotype can and often does adversely affect your performance and even your conception of yourself “. (informant 8)

We can conclude that new technologies can contribute to improving the situation of disadvantaged contexts both on an educational level and in other aspects such as social and labour integration. Although for this to occur, they must be used correctly by well-trained teachers.

Critical use of ICT and the origin of educational change

The informants agree that overall CTs are not being used sensibly. Access to new technologies, the trust placed in them and training, is not universally good. This has led to ICTs not being integrated, but considered special and sometimes a threat or a distraction. On the contrary, when ICTs are used well, their impact can be profound, but this is not yet the norm.

“Where ICT is used well, it is having a profound impact but that is still not the norm” (informant 6)

However, informants also note that we cannot generalize because there are many inspiring teachers who use technology in a meaningful way yet also many classrooms where technology has not worked well. This situation is gradually improving in public schools with the training of teachers.



“I think it is improving in public schools with teacher training and teacher review”. (informant 3).

Another key factor detected in the research is that implementation has to go from the top down. Technology can be used critically and thoughtfully, but teachers are sometimes told what to do. Although principals usually don't have the time to help teachers as they should, there are plenty of online resources where they can get feedback on how to improve their students' learning. For example, teaching our students what information is reliable among all the fake news that online.

“I think that we have in there are ways that we can improve how they're being used today”. (informant 4)

Regarding pedagogy, the results of the research indicate that any type of learning can be promoted, just as they simultaneously show us the limits of what can be done with new technologies in the classroom. It is a matter of general pedagogy that requires a good curriculum, a pedagogical approach that encourages critical thinking and the effective use of technology with tools such as Bloom's Taxonomy. Once we have all of the above, the most important thing will be how the projects are designed.

“Is it's a question of the general pedagogy if you have a curriculum if you have a pedagogical approach that fosters critical thinking and analysis technology can be used really effectively”. (informant 7)

The informants underscore that new technologies can be the key to reaching a deeper level of thinking. Among its qualities, the characteristic of making the invisible visible stands out, providing the audience with feedback. Plus, they offer creative ways to get feedback from students. Students can act using technology; it is not limited to teachers. The most important thing is to help students develop ideas, encouraging them to change or improve something. For this, empathy is key, so that students develop knowledge and the willingness to accept new knowledge or new people in a group.

Another key aspect that we must instil in students is curiosity, as it is the basis for critical and reflective thinking. It is essential because even though we are born critical and reflective thinkers, the classroom has never been the best setting to nurture these behaviours. To this end, new technologies are a very adept catalyst as they offer a

highly interactive and personalized experience that produces self-directed learning. In this regard, one of the informants points out:

“Curiosity is the foundation of critical and reflective thinking. ICT is a fantastic catalyst for that”. (informant 6)

On the other hand, critical thinking has to be supported by making use of argument or reasoning and this is achieved through collaborative sites that permit students to work together. It can be done without technology, but technology reinforces this process. Using technology as a means of communication between people and with other devices, in a way that enables us to create simulations and experiences for students.

“A lot of this is about the curriculum and how your design projects right and so if you give inquiry kinds of projects where you ask for reflection and you ask for synthesis and the production of new knowledge then it's gonna be more likely that you're going to generate that capacity”. (informant 2)

The informants agree that those responsible for carrying out educational change are the entirety educational community. The government is in charge of education, it is also the one who initiates the process and who can offer financing. At a state level, they must use our resources effectively as well as at the local level because they can give schools independence or even develop a national curriculum.

“It's all about we've got to get governments in democratic societies involved in sponsoring these kinds of things in our country” (informant 8)

On the other hand, there are the universities because they empirically investigate the most effective teaching practices and play an important role in teacher training. Educators must be trained for professional performance in any type of social context and through the use of new technologies, or the problem of the digital divide will remain in the new generation of teachers.

“I don't think you can expect the university to do everything but that they should but the university should right have that be part of the teacher education”. (informant 2)

Schools are also responsible for educational change, through the development of study plans and the teachers who finally integrate them into their classes.



Other informants believe that the key to integrating new technologies lies mainly in teachers because they are the ones who are going to use said technology and know the context. Teachers have to be rooted in the classroom. Volunteer teachers must be recruited to use new technologies in the classroom and empower them. These will guide the other teachers and motivate them.

“Really has to be the teachers because the teachers are going to use it or no but then they need models about how to use it so it's a kind of back and forth between practice and reflection” (informant 5)

“Having the teachers train other teachers so one way I think is teachers who are interested in empowering them than to take that on and lead others and to show how it's working” (informant 3)

The fundamental element is students, who actively contribute to the integration of new technologies if they are allowed to use their technologies and methodologies at school.

“Students! Allow them to use their technologies and methodologies in school... we can learn from them as much as the other way round”. (informant 6)

The informants emphasize that education is an investment in the future and must be designed so that within 10 to 15 years, it will aid students to be more productive, valuable and peaceful citizens. Besides financing, educational policy has to provide the necessary resources and structure, and obtain the best answers and arguments for its use.

Additionally, they emphasize that it is essential to solve the problem of teacher training in the use of new technologies. The curricula for teacher education have to be modified, because there is a mismatch between the curricula and what the schools need.

“In policy has to be set by people who are interested in the big goal that is of learning that they're interested in fostering learning and I say that because often policy is set by people who have something to sell”. (informant 8)

“There's a fundamental mismatch between what school curricula expect and what is being assessed in schools”. (informant 7)

“I think education policy does play a role but that the so there's a balance to be had between designing a learning experience on a local and extremely local level in a classroom”. (informant 1)

We can conclude that we ought to align the strong points of all elements of the educational to achieve the effective integration of emerging technologies in disadvantaged contexts. Among them, the figure of the teacher and their training stand out, which should allow them to take fully benefit from the technologies available in their school and through the use of a pedagogy adapted to the context.

5.2. Quantitative results

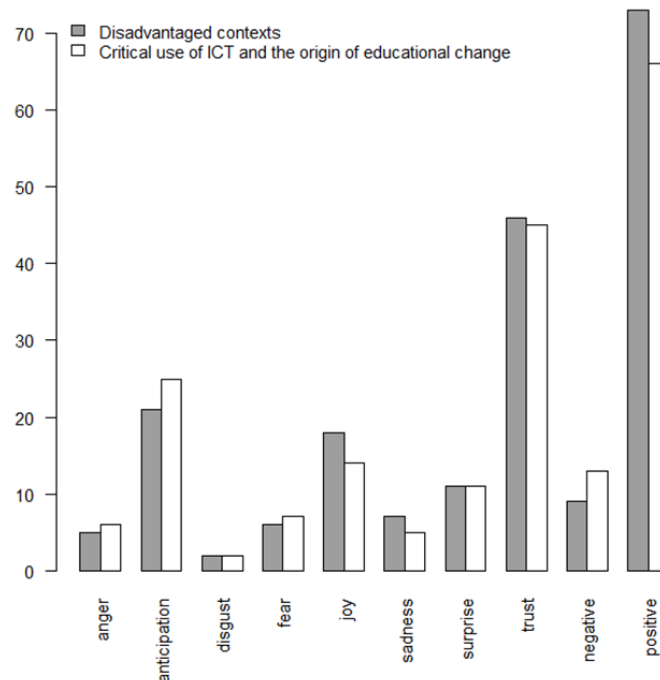
In this section, an analysis of the responses given by the experts regarding the different dimensions (Integration of ICT in disadvantaged contexts and Critical use of ICT and the origin of educational change) is carried out. On the one hand, a count of the most used words in their answers is made and a word cloud is made for each dimension. This graph is well known and used in the context of qualitative analysis. It consists of representing words used in the answers in a size proportionate to the frequency in which they are observed. In this way, it is possible to analyse which ideas or concepts are those that motivate the studied dimensions.

On the other hand, a sentiment analysis has been carried out using the “NRC” dictionary. This dictionary, which is proposed by Mohammad & Turney (2010), contains a collection of unigrams that identify basic emotions and feelings. Specifically, there are 14182 unigrams classified into 8 emotions (anger, anticipation, disgust, fear, joy, sadness, surprise and trust) and two feelings (positive and negative).

In figure 3 the word clouds for each dimension are observed. It should be noted that in both dimensions the word with the largest size, that is, the one most used in the responses, is “can”. This fact could be justified by the nature of the verb being frequently used in the English language. Other words with relatively large sizes that coincide in the two dimensions are "students" or "technology", which is a reflection of the central theme of the research. If we focus on the “Use of ICT in disadvantaged contexts” dimension, we observe some words with relatively large sizes, such as “like”, “different” or “access”. The frequent use of these words in the responses shows that the variation in access to new technologies is a prominent problem that must be addressed. For its part, in the word cloud of the dimension "Critical use of ICT and the origin of educational change", words such as "use", "critical", "curriculum" or "way" stand out, which can be explained by important role that ICT plays in the training of students.

Figure 4

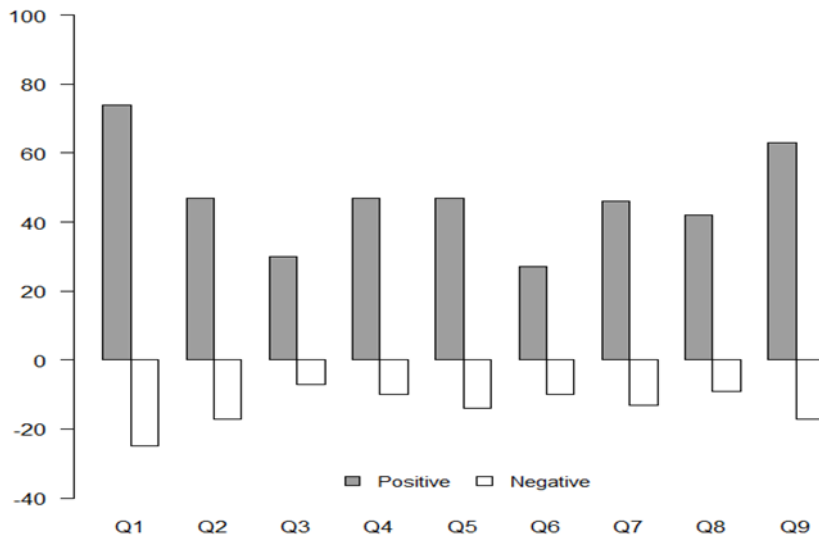
Analysis of emotions based on the NRC dictionary by dimension.



In Figure 5, the feelings count for each question have been broken down into relative terms. Questions 1-5 correspond to the dimension “Integration of ICT in disadvantaged contexts”, while questions 6-9 correspond to the dimension “Critical use of ICT and the origin of educational change”. It is observed that all the answers present a ratio of positive feelings of between 75% - 85%, with questions 3, 4 and 8 standing out as those with the highest percentages. These questions refer to the aspects of ICT that must be taken into account when integrating them in schools in disadvantaged context and to allow students to train and have access to ICT while avoiding the digital divide, including those responsible for starting the effective integration of new technologies in education. On the contrary, questions 2 and 5 have the lowest rates of positive feelings. These questions refer to how ICT can help the inclusion of students and how it could reduce social inequalities beyond the digital divide. This fact shows that on both questions they are somewhat less optimistic.

Figure 5

Analysis of feelings (positive and negative) based on the NRC dictionary per question.



6. Discussion and Conclusions

With regards to the implementation of emerging technologies in disadvantaged contexts, it is highlighted that new technologies improve communication favouring inclusion (Wogu et al., 2018). In the same way, they also promote inclusion by facilitating collaboration across socioeconomic boundaries, giving voice to students who are not represented and allowing them to spread their ideas around the world. The same occurs with students with special educational needs (Midgley, 1993). New technologies also champion inclusion as they are necessary to apply for work and / or to qualify for higher salaries (Jones & Pal, 2015). Another benefit of emerging technologies in disadvantaged contexts is promoting curiosity, which is the foundation for critical and reflective thinking.

Nonetheless, the informants warn that there is a lot of ignorance when it comes to the real situation of disadvantaged people. One of its main problems is the threat stereotypes that society often has about certain people or groups pose. These stereotypes affect how said groups are treated by society and even by themselves.

As the experts have indicated, the fact that the use of technology cannot be based only on financial affordability must also be taken into consideration, as costs limit the use of new technologies (OECD, 2010). For this reason, teachers have to use technology that makes sense in the context in which they teach (Alshahrani & Ally, 2016), taking into account the electronic devices available to their students when planning their classes. In addition, the informants emphasize that there must be equity between the resources that the students have and for this, they must be provided with the technology and given confidence about its usage they will make of it despite the risk it may represent. The greater the access that students have to learning resources, the greater their chances of learning are (Van Den Beemt & Diepstraten, 2016).

The informants are in favour of the use of emerging technologies, provided they are used appropriately. They believe that, although the possibilities offered by new technologies outside the classroom are extraordinary, a balance is needed in their use (Claro et al., 2015). For example, there are teachers who end up burning out due to difficulty disconnecting from work due to incoming emails, WhatsApp groups, etc. This is on account of the excessive use of technology. It is equally detrimental to teachers and students, and the digital divide affects in the same way by an excessive use of technology that ends up damaging learning (Hohlfeld et al., 2008; Mérida-López & Extremera, 2017).

The word count of this dimension “Integration of ICT in disadvantaged contexts” using the word cloud, shows several of the elements treated in this dimension. For example, it highlights the role of the students on whom the informants focus their attention. The feelings are collected are positive throughout all the questions, rating much higher than the negative feelings. Among the positive feelings, the one regarding the integration of emerging technologies in disadvantaged contexts stands out, which is very significant as it is the main axis of this research. However, they are somewhat less positive about how technology can help the social inclusion of students and also on how it can battle social inequalities. The question that obtained the lowest positive score is the one that refers to the aspects of emerging technologies that can be integrated into schools in disadvantaged contexts. In the responses, the informants exhibited the incorrect use of ICT in educational centres. Despite being the question with the lowest score in positive feelings, as with the rest of the questions, the score has much more positive than negative points. Regarding the analysis of feelings, it reinforces what was collected



above, the majority of feelings are positive, especially highlighting that they feel confident and aware of the situation and gladly face it.

Regarding the critical use of ICT and the origin of educational change, the experts underline that the implementation has to be critical and reflective, supported by higher educational organizations (Robertson, 2017). For this, one of the key aspects is to correctly use pedagogy (Alshahrani & Ally, 2016; Markus & Mentzer, 2014). We begin by asking students a question to peak their interest, which may be one of the proposals by Myra Sadker and David Sadker (2014) (cited in OEA, 2015) to continue overcoming the steps of the development of critical thinking (Paul & Elder, 2003) that will allow the evaluative use of ICT in the classroom.

Another of the fundamental aspects to which the professionals allude to in the process of implementing new technologies is that students must be taken into account and not only the teacher (Prieto et al., 2014). Students are vital in this process (Bocconi et al., 2013) and have to be a central part in it and always be treated with empathy. Due to the complexity of all this, the implementation of new technologies is limited due to time shortage, this being one of its main problems. However, in some aspects it can be partially remedied through the use of online resources (Laurillard, 2016).

Other essential aspects that allow reflective and critical learning are motivation, curiosity and communication (Wogu et al., 2018). ICTs favour these capacities, and have many resources to foster curiosity in students and tools to promote communication and group work. Yet, the informants highlight that ICTs are not being used properly, which means that the expected results are not obtained when they are provided to educational centres. This sometimes causes uncertainty and mistrust towards new technologies (Erdogdu & Erdogdu, 2015). Still, in many cases the exemplary use of new technologies in education is observed thanks to the exceptional teachers who have dedicated enough time and effort to master them (Bingimlas, 2009). This allowed them to make meaningful and inspiring use of new technologies favouring deep learning (Nikolic et al., 2019).

The experts say that to achieve educational change, the entire educational community must participate. Educators and students from the classroom, universities from teacher training and research on the best ways to teach. On the other hand, governments can also contribute by providing more funding for education (Kozma & Vota, 2014) and

also by creating a good curriculum for schools besides granting them independence to develop their own. In the same way, it is important to wait long enough for the results to be appreciated (Bingimlas, 2009). It is essential that teachers plan for a society 10 to 20 years from now by giving great importance to digital literacy (Wilson, Scalise, & Gochyyev, 2015) because the current educational policy and curriculum will be out of date by the time students finish their studies. (Wilson et al., 2015).

Moreover, the professionals interviewed call attention to the importance of digital literacy, a society that increasingly uses new technologies is fundamental due to the benefits they offer (Fang et al., 2019). The teaching of new technologies has to pivot around the development of competencies and skills over and above the theoretical content. Critical thinking must be fostered to allow students to navigate the uncertain future they will encounter when they finish their studies.

The analysis carried out through the word count on the "Critical use of ICT and the origin of educational change" dimension reflects some of the essential elements (teachers, students and technology) necessary to achieve the critical use of ICT. We can also observe positive verbs, coinciding with the results obtained in the sentiment analysis. Positive feelings rates are far superior to negative ones in all the questions, although it is observed that standing out is the question about the role of educational policy. The one that is least positive is the one related to the critical use of ICT in schools, paralleling the informants' responses. The encompassing feelings indicate the knowledge and faith that the informants have in the questions raised.

Statistical analyses complement the qualitatively obtained data in the interviews. This reinforces the information analysed from the informants' transcripts. From all this, we can deduce that the informants are aware of the educational problems presented during the interview and confront them with faith and optimism. In summary, the results of the research show a hopeful future when it comes to the implementation of new technologies in education in disadvantaged contexts and identify the key points that must developed in order to achieve with critical perfectionism. We cannot innovate for a few, ignoring those who have the most difficulties because they need it most. Technological and pedagogical advances must be within everyone's reach if we want to improve on education and thereby create a better world.



7. Contributions and implications:

The results of the study are applicable to disadvantaged socio-economic contexts as they indicate key elements for the implementation of new technologies in these settings. Knowledge of these key elements may not only contribute to improving the educational situation but can also be used as a basis for new lines of research. In this regard, our study highlights the need for the entire educational community to participate in educational change and how to do so, where the most important elements of change are the teacher followed by the students. The study also provides indications for teachers to perform more successfully in these contexts. Among other actions in this regard, the technology should be adapted to the specific context and all students should be provided the devices to ensure equity among them and boost their confidence. However, this whole process requires time, trust and support. Indeed, the main challenges detected in this research are the lack of time to implement new technologies and the fact that the excessive or inappropriate use of new technologies can be as harmful as the absence of them, as well as cause uncertainty and mistrust towards them. A suitable pedagogy is also needed, such as beginning classes with a question to arouse students' curiosity. The above points developed in the article allow us to detect shortcomings both in the implementation of new technologies and in the critical use that is made of them in schools. Our findings could be extrapolated to other types of educational settings as disadvantaged socio-economic contexts imply a high level of complexity and require specific attention. It is also clear from the study that the experts are optimistic about the possibility of implementing technology in these contexts, but less so about the ability of technology to combat social inequalities. In sum, by providing a broad overview of this phenomenon, the study contributes to filling a gap in the existing literature on the implementation of new technologies in disadvantaged socio-economic contexts and opens the door to new lines of research that can deepen and expand on our knowledge of the topic.

Conflict of interest

The authors declare no conflict of interest.

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7.4. Teacher training for educational change: the view of international experts

Introduction

Today, knowledge is fundamental for economic development (Mendonça et al., 2015). In knowledge-based societies, digital literacy is essential to equip learners with the necessary skills to ensure professional and personal success in the 21st century (Hohlfeld et al., 2008). Digital literacy is a core concept in education, not only with regard to the acquisition of theoretical knowledge, but also practical experience through problem solving or collaborative work (Baran, & Uygun, 2016; Siddiq et al., 2016), with some authors even supporting the idea that it is as important as being able to read and write (Wilson et al., 2015).

Information and communications technologies (ICTs) are of critical importance to society because they contribute to economic development (Park et al., 2015) and ICT skills are essential for getting a job (Jones & Pal, 2015). Despite being digital natives, however, the digital competence level of Generation Z (people born from the mid-1990s to the mid-2000s) is low, since mere exposure to these technologies is insufficient and digital literacy depends on how ICTs are used (Pérez-Escoda et al., 2016). In this regard, ICTs can be defined based on three dimensions of use: access to assets (devices), basic skills (knowledge of how the tools work), and complex capabilities (higher-level knowledge, digital literacy) (Mendonça et al., 2015). Yet digital literacy is not simply a question of using technology (Akayoglu et al., 2020; Pérez-Escoda et al., 2016); it requires specific training for the acquisition of complex skills and competencies. For this reason, it is necessary to teach students advanced digital skills with a view to their future labour market insertion.

To this end, it is essential to promote ICT use among students and integrate these technologies in the classroom (Thieman & Cevallos, 2017). The use of ICTs in the classroom also improves students' academic performance, thus making teaching more effective and boosting the quality of education (Hambira, Lim, & Tan, 2017). ICTs also facilitate students' work, give them more autonomy, motivate them, and can be adapted to each student's level regardless of their difficulties (García-Valcárcel et al., 2014).

For instance, ICT training works well for learners with special educational needs and is one of the most useful forms of vocational rehabilitation for people with disabilities (Midgley, 1993), to such an extent that the British government recognised the

importance and benefits of ICT use for people with special educational needs (Williams et al., 2006). Moreover, thanks to the Internet, ICTs are a powerful resource that can foster intercultural interaction by supporting different languages and cultures as never before (Resta & Laferrière, 2015). A direct relationship has also been found between people with access to the Internet and health literacy (Estacio et al., 2017). Additionally, the widespread use of ICTs has had an increasing impact on society and on relations between institutions and citizens (Eger & Maggipinto, 2010) and does so in an inclusive way because technology enables the full participation in society of people with visual impairments and problems of mobility (Jones & Pal, 2015).

Emerging technologies will continue to influence our society and are expected to affect education more deeply than ever before (Klaassen et al., 2017). For this reason, it is important that teachers be aware of technological innovations that will improve the future professional performance of their students (Foronda et al., 2017) by helping them to develop vital innovative and creative skills (Klaassen et al., 2017). In doing so, the skills acquired by students will in turn be passed on to society, in addition to encouraging the involvement of parents and family members in the use of technologies (Manzoor, 2016). To ensure the proper integration of ICT in the classroom, it should be viewed as a mode of learning and included in the curriculum (Nikolopoulou & Gialamas, 2015b).

Therefore, it is essential that teachers be properly trained in order to effectively develop the digital knowledge and skills of their students. The aim of this research is to determine the key elements of teacher training in the use of innovative technologies and methodologies in order to improve the educational process.

Teacher training

Teachers are a key element for the integration of technology in the classroom (Geer et al., 2017) because educational success depends largely on them (Nikolopoulou & Gialamas, 2015a). Exemplary schools and teachers can make a difference (Munns et al., 2013) and when they also use ICTs properly, multiple benefits can be gained, such as greater teacher availability, fewer time constraints, and more personalised learning (Durães et al., 2016). However, many teachers are reluctant to implement ICTs in their classrooms (Van Acker et al., 2013) and use technology very infrequently, resulting in



the poor integration of ICTs in the classroom (Marcelo et al., 2015). Normally, when ICTs are employed for teaching purposes, only a limited number of resources are used based on traditional methods (Brun & Hinostroza, 2014) because teachers integrate the technologies that best suit their teaching practices (Marcelo et al., 2015).

Although teachers generally perceive the integration of ICTs in their classrooms in a positive light, they often encounter barriers that prevent them from doing so (Bingimlas, 2009). According to Pelgrum (2001), 40% of teachers believe that the main obstacle to using ICTs is the lack of digital devices. In Spain, ICT use in the classroom is low, despite the extensive ICT infrastructure in schools (Gil-Flores et al., 2017). In addition to insufficient material, the limited use of ICTs is due to teachers' lack of technical competence, mastery of the technology, and the excessive time and effort involved (Tallvid, 2016). Nikolopoulou and Gialamas (2015a) found that teachers perceive four barriers to ICT use: lack of support, lack of confidence, lack of equipment, and class conditions. Anxiety about using ICTs is one of the main barriers due to teachers' lack of confidence and negative attitudes (Van Acker et al., 2013). Anxiety also occurs because teachers worry that they know less than their students and do not have enough knowledge to solve their doubts (Wang et al., 2014). This happens with new technologies because teachers are sometimes less digitally literate than their students (Cairns & Malloch, 2017; Wang et al., 2014).

The key to developing students' digital competence is determined by teachers' own digital and pedagogical skills (Fernández-Cruz & Fernández-Díaz, 2016). Indeed, teachers cannot develop their students' digital competencies if they do not have them themselves (Fernández-Cruz & Fernández-Díaz, 2016). Because teachers have more pedagogical than technical knowledge—which implies that they have little knowledge to integrate ICTs and develop their students' digital competencies—they need to change their mindset and become digitally literate (Roig-Vila et al., 2015). The digital competence of teachers is essential for the integration of ICTs in the teaching-learning process and these competencies need to be defined in a common framework (Almerich et al., 2016). Therefore, teachers must be properly trained in the use of ICTs, as technologies alone cannot change learning environments (Marcelo et al., 2015).

The most important factors in teacher education are hours of training and support for teachers (Charbonneau-Gowdy, 2015; Hsu & Kuan, 2013). Continuous teacher training combined with collaborative work with colleagues fosters a positive attitude towards

ICT use (Van Acker et al., 2013). However, it is necessary to offer training schemes at times that teachers can attend, as training is often incompatible with their work at school (Cuban et al., 2001).

In the training of future teachers, it is important to instruct them in how to integrate ICTs into the teaching and learning process (Brun & Hinostroza, 2014) as there is a gap in teacher education between theory and practice due to a lack of experience with innovative methodologies (Barak, 2014). Currently, pre-service teachers have learning experiences with ICT but they are not significant (Valtonen et al., 2015), partly because it is very difficult for teacher training institutions to assist prospective teachers in designing and integrating ICT into their teaching practice (Tondeur et al., 2016). This is a problem because trainee teachers' perceptions of the use of new technologies are conditioned by their previous experiences (Koh et al., 2013). However, when training experiences with ICT are good, teachers succeed in transforming students' worldviews and are more committed to using technology in their classrooms to build collective knowledge (Bozalek et al., 2013). ICT training for heads of schools is also important and should be a priority as it hastens the pace of technology integration in schools (Tondeur et al., 2008).

In terms of support, teachers need to be provided continuous accompaniment and follow-up until they become proficient in the use of technology (Archer et al., 2014), as it is a fundamental aspect of their professional development (Quintana & Zambrano, 2014). Moreover, given that teacher motivation is one of the most important factors in the integration of ICTs in the classroom (Uluyol & Sahin, 2016), teachers need to be encouraged to be more open to innovation and use these technologies both inside and outside the classroom (Van Den Beemt & Diepstraten, 2016).

The role of teacher educators is also crucial to building a solid knowledge base and developing 21st-century skills in teachers (Garba & Yusuf, 2016). Teacher educators who use ICTs in innovative ways (Drent & Meelissen, 2008) maintain contacts with educators and ICT experts, observe and experience the benefits of ICTs, use a learner-oriented pedagogical approach, and have a level of digital competence commensurate with their pedagogical expertise. Recent studies conducted with university professors have shown that teacher training has shifted from a teaching paradigm to a learning paradigm (Guillén-Guerrero & Molina, 2019). Differences have also been found between new teachers who have received training and accompaniment (Kozanitis et al.,

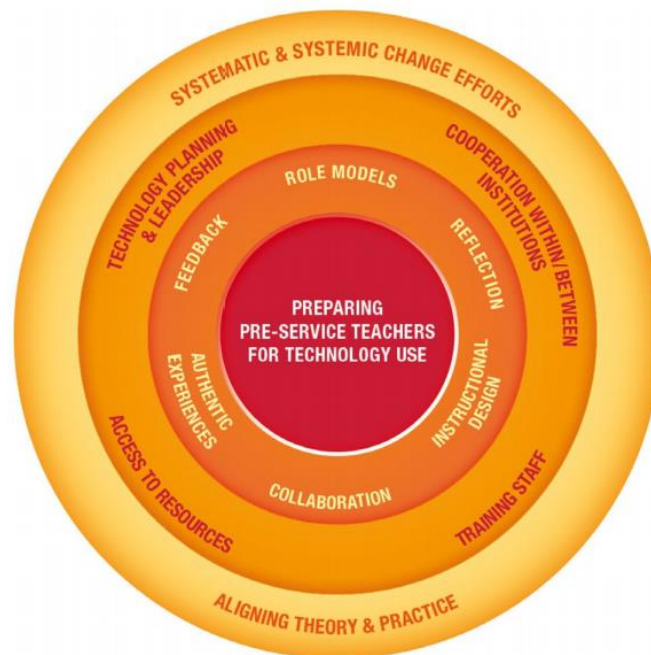


2018) and those who have undergone a longer training process with respect to those who have not (Postareff et al., 2007). In general, previous research has established a positive relationship between the length of training (45 hours) and the evolution of teaching conceptions and approaches (Kozanitis et al., 2018). Similarly, other studies have shown that building a climate of mutual respect and trust among teachers helps to improve their professional competencies and that participation in a learning community reinforces their professional identity (Nemiña, 2018).

Many of the traditional teacher education models are technocentric (Harris et al., 2009). For this reason, the Technological Pedagogical Content Knowledge (TPACK) model is now recommended to ensure that teachers are qualified to meet the requirements of 21st-century learning (Drajati et al., 2021). TPACK can be taught effectively through training courses (Zimmermann, 2021) that can be blended (Guillén-Guerrero & Molina, 2019). Instruments are also needed to assess TPACK in pre-service teachers (Schmidt et al., 2009). In this line, some studies are presenting very valid ways of assessing the model (Wahyuni et al., 2021). Other strategies have also been employed to prepare pre-service teachers, such as the Synthesis of Qualitative Data (SQD) model (Tondeur et al., 2019), which considers teacher educators as role models, encourages reflections on the role of technology in education, technology use, collaboration with other teachers, supervised experience, and continuous feedback.

Figure 1.

SQD model to prepare pre-service teachers for technology use



Source: Tondeur et al. (2012) [Colour figure can be viewed at wileyonlinelibrary.com].

Pre-service teacher training in ICT competence occurs in three stages (Chen et al., 2017): cognitive search, activity, and practice. In turn, the factors that enable the integration of ICT in the training of future teachers are (Aslan & Zhu, 2017) pedagogical knowledge, pre-service ICT training, and ICT competence. As regards pedagogical knowledge, for the use of emerging technologies to be effective, the following phases should be implemented (Ng'Ambi, 2013): a) set an educational goal; b) anticipate learning outcomes; c) describe the purpose of the activity; d) select the appropriate tools; e) the students create an artefact (i.e., a project); and f) the students reflect on their learning process. In addition, various ICT resources need to be integrated with each other and with innovative methodologies (Markus & Mentzer, 2014). Service learning, which provides real-world experience while providing a service to the community, can be useful for this purpose (Salam et al., 2019). Ideally, the conditions will be created for self-directed and, ultimately, lifelong learning, although few students are actually capable of doing so (Gogh & Kovari, 2019).

Teachers' digital competence can also facilitate the educational use of ICTs in the classroom depending on the following five factors (Van Den Beemt & Diepstraten,



2016): ICT usefulness, support received, previous experience, and ICT availability and access outside the classroom. In addition, the teacher's role, the ICT used, the learning objectives, the involvement of people outside the school, the involvement of the students, and the learning outcomes achieved will determine the type of innovation fostered in the classroom, which can either be traditional classrooms where teaching practices are conventional, emerging classrooms in which teaching practices are halfway between more traditional and more innovative ones, or fully innovative classrooms (Bocconi et al., 2013).

The main premise of this article is to improve teacher training to improve education. To this end, we intend to identify the key elements needed to improve both pre-service and in-service teacher education. The study seeks to answer the following question: What are the key elements of teacher education that ensure the successful use of technology and innovative methodologies in the classroom? Through various analyses of interviews with experts with broad experience in different fields of education, the most important points will be identified. These points will be the key elements for improving teacher training.

Methods

Design and sample selection

The aim of this study is to identify key elements of teacher training related to the use of innovative technologies and methodologies with a view to improving the educational process. More specifically, it attempts to determine how education can be improved through teacher training. In this regard, teachers must be able to adapt to different contexts and settings using the methodologies and technologies available to them in order to provide their students the best possible education. To this end, eight international experts in education participated in this study. The experts were interviewed about training teachers in how to integrate new technologies in their teaching practice.

To ensure the quality of the data obtained and gain a more comprehensive view of the phenomenon, the informants were selected using a purposive sampling method (Tójar, 2006). The selected informants are all international experts in education with extensive experience who come from different educational backgrounds. Specifically, the sample

includes the head of digital education and professor of education at University College London; three professors from the Graduate School of Education at Stanford University; a professor from Singularity University; the head of AltSchool based in Silicon Valley, California, USA, and one of the most innovative schools in the world; the president of the Best Teachers Institute and author of the book *What the Best College Teachers Do*; and an education guru and former education advisor from the UK.

Interviews and procedure

A mixed research approach was used to obtain more precise results by the triangulation of methods. In a first phase, a qualitative method was used based on one-hour, semi-structured interviews. In a second phase, a quantitative method was employed to analyse the information in a more subjective manner. To this end, the transcriptions of the interviews with the informants were analysed using text mining and the R programming language. The data were then processed using RStudio statistical software and the “tm” (Feinerer & Hornik, 2020), “wordcloud” (Fellows, 2018), and “syuzhet” packages (Jockers, 2015). RStudio is a well-known and widely used application in teaching and research since it is a free multiplatform software that provides relevant data for advanced statistical analyses.

The interviews were conducted through different channels: three by videoconference using the Skype platform, four face-to-face interviews in California, and one by email. For the interview conducted via email, the same open-ended questions used in the other interviews were sent to the informant, who responded to them in writing. All interviews were recorded and subsequently transcribed for the analysis with the prior consent of the informants. Any personal information that could identify the informants was deleted, and each transcript was assigned a code to guarantee their anonymity. All interviews were then recorded and professionally transcribed.

Data analysis

Qualitative analysis

To analyse the interview transcripts, a classical content analysis method was used (Bardin, 1996). The method was structured into phases of categorisation, text distribution, and content analysis. The first step of the analysis involved identifying the different categories that emerged from the meta-category (the overarching category) and



identifying the key elements for training teachers in the use of innovative technologies and methodologies to improve the educational process. The second step of the analysis was structured around the following questions:

1. What do you think about the development of standards to regulate the digital competence of teachers?
2. What role does initial teacher training at universities play in this educational change?
3. What importance do you attach to the permanent education of teachers?
4. What is the teacher's main challenge in this context of change?
5. What knowledge or practices should be modified and integrated?

The third step complemented the analysis linking the categories with the study objective in order to address the general question guiding the research. It consisted of thoroughly reviewing the passages of the original transcript to ensure that no relevant aspect had been omitted when paraphrasing and summarising the informants' narratives. The categories were distributed in accordance with the study objective and will be used below to structure the presentation of the results.

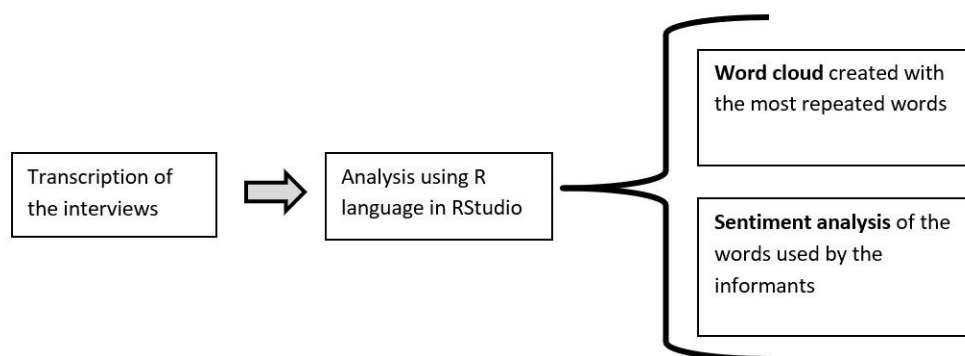
Quantitative analysis

The data drawn from the interviews were analysed using the RStudio statistics program, as mentioned above. This is a highly versatile program, making it suitable for use in a large number of fields, including education. The software was used to analyse the interview transcripts and obtain relevant data to complement the qualitative data. The words used in the transcripts are represented in a word cloud (Heimerl et al., 2014; Lohmann et al., 2015). This process consisted in plotting the words in the transcripts and displaying them in a size proportional to the frequency with which they appear in the responses, thus indicating the elements of greatest importance to the informants. Thus, the most frequent words in the experts' responses are the largest in the chart. The chart enables detecting keywords that help to identify the main ideas behind the responses. Prior to the analysis, irrelevant words, such as fillers, tags, articles, and auxiliary verbs that appear in large numbers in the transcripts and did not provide relevant data for the research, were eliminated from the count. A sentiment analysis of the interviews was also conducted to complement the data obtained through the qualitative analysis. Sentiment analysis consists of searching for a series of words

associated with certain feelings to identify the emotions produced in the informants in response to the questions. The analysis is done using the NRC Word-Emotion Association lexicon developed by Saif M. Mohammad (Mohammad & Turney, 2010). The NRC is a list of English words associated with eight basic emotions (anger, anticipation, disgust, fear, joy, sadness, surprise, and trust) and two sentiments (positive and negative) in the experts' responses. This type of analysis is frequently used in research (Liu, 2012; Patra et al., 2015; Parmar et al., 2018; Martinez & Mateus, 2019; Sasangohar et al., 2020).

Figure 2.

Sequence of the qualitative analysis



Results

Qualitative results

This section provides an overview of international experts in education based on their own experience in training teachers in the use of innovative technologies and methodologies to improve the educational process.

Teacher training

The informants highlighted that many teachers do not currently know how to use technology in the classroom because teacher training curricula are often just one year in length and cover a large amount of content but leave little room for learning about new technologies. Moreover, training is often limited to learning about the characteristics and potential of technology, rather than how to actually use it to support learning. In this regard, teacher training in ICTs needs to cover aspects such as learning management systems, applications, and collaborative tools, as well as the pedagogical methods to use



them. In addition, teachers are permanent novices because new technologies are always emerging.

“Many of our teacher candidates come in and have not been taught using new technologies and part of this is technology is always changing.” (Informant 1)

As the experts pointed out, this may also be due to the fact that teachers acquire initial training and then never retrain. Although initial training provides them with basic skills, there is nothing to demonstrate advanced competence. Teachers need to continually update their skills, knowledge, and experience because many of the tools and competencies they require are constantly changing. In this regard, professional development is important as it enables future teachers to contextualise what they have learned and apply it in specific, real-world settings. This is a fundamental aspect of teacher training because education is about preparing students for the challenges that lay ahead.

“Vital! Teachers should always be, first and foremost, lead learners. If education is about helping to prepare our students for the challenges of their future then we need to ensure that our teachers are kept aware of that future. In order to do that, their own skills, knowledge and experiences need to be constantly refreshed.” (Informant 6)

In order for teachers to adapt to these changes, the experts stress the importance of teachers being aware of the benefits of using new technologies in education. Teachers need to know how new technologies work and why they work so that they can make the necessary modifications and changes to enable them to effectively implement technology in different educational settings. They also need to embrace ongoing action research and have the commitment and confidence to constantly refresh and renew their teaching practices. However, the focus should not only be on teachers, but also the heads of schools because they have a significant impact on their educational institutions.

“We can’t keep focusing just on teachers because principals are so important like the people at the top so in some of the schools that I think are doing the most exciting things.” (Informant 2)

The informants also underlined the importance of challenging the beliefs of future teachers arising from their own education. Training must be practice-based, so that future teachers can integrate and implement new technologies in their school and in society. Indeed, the new generation of teachers requires training that enables them to apply what they have learned in any context. To achieve this, teachers must have not only sufficient knowledge, but also the predisposition to use it.

“We need to remember though that most young people who are wanting to train as teachers have increasingly high levels of digital competence which means that we need to develop programs about how tech supports learning, not about how to use tech. We need also to understand that it will be that generation of teachers who will evolve how we use tech in education, it will not be universities. We need to ensure that training is based on pragmatism and not prescription.” (Informant 6)

As the interviews revealed, teachers should undergo lifelong learning, because what they are teaching, how they are teaching it, who they are teaching it to, and the tools they are using are constantly changing. It is important to know what tools are currently available, even if they are changing. However, to get people to change, they have to learn to change, and that means recognising the need to improve, which is not always pleasant. According to one of the informants, this fails to meet the four C’s of learning: “competence, control, confidence, and comfort.” Another aspect reported by the informants is that teachers are intimidated by the possibility of not using new technologies properly, which makes them feel stupid. It is therefore very important to support teachers in ICT use.

“Just the intimidation and feeling stupid [for] not knowing technology and also time for when it comes to using it with students, teachers have to understand it themselves.” (Informant 3)

The experts also underline the importance of permanent training that cannot be limited solely to attending a few workshops. Moreover, teacher trainees need to receive constant feedback from other teachers who supervise their work. Indeed, collaboration between peers is one of the best ways to train future teachers: since both teach the same things, they both get feedback. In addition, goals should be set with specific outcomes that can be monitored and linked to professional development. A good example of this is the Japanese model, where a group of teachers prepare a lesson and test it with



different groups of students until they are satisfied that effective learning has been achieved, and then publish the lesson for other teachers to see. If the use of new technologies were also incorporated, the system would be a very powerful. For this to happen, part of the budget needs to be earmarked for investment in this process by both the education authorities and schools:

“Permanent education of teachers, it’s absolutely necessary and so that’s another thing that I think has to be in all schools’ budgets.” (Informant 3)

In this regard, the informants emphasise that the best teacher education programmes are those that work with a veteran teacher in the classroom and in a variety of settings. One informant stated that future teachers need to be made to think about what it means to learn by answering four questions. The first question is what people must do intellectually and emotionally to achieve learning; the second, what can go wrong as a stereotype threat; the third, how to create a critical environment where learning is more likely to occur (not simply deliver information), and the fourth, how we as teachers and our students can come to understand our learning progress (assessment).

Another aspect of teachers’ learning is to foster curiosity and the need to know, which also provides teachers the necessary tools and skills to continue learning for the rest of their lives (lifelong learning). Creating lifetime learners must be one of the primary goals of any type of education, including that of teachers, who should always be learners. Teachers need to be comfortable with and value the use of technological tools in order to reach students in a different way, and they need to get excited about and learn how to use the tools so that they can then help their students to do the same. The constant development of new technologies facilitates lifelong learning through online tools and resources such as teacher communities on Facebook, Twitter, Pinterest, and other platforms where teachers can learn from each other.

“A lifetime learner, that has to be one of the goals of any education, how you create a lifetime learner [who’s] going to continue to grow and continue to try new kinds of things.” (Informant 8)

In addition, the informants underscored the importance of involving students in the teacher training process. In this regard, students can help teachers by teaching them about new technologies, although this idea is not always looked well upon by teachers as they often view themselves as the single source of knowledge and are reluctant to be

taught or corrected by their students. However, if teachers are receptive to accepting student input, it can transform the traditional passive teaching dynamic into a more active one. In addition, students feel valued because they collaborate with the teacher regardless of age or cultural differences.

“Students can be involved in helping to teach the teachers so it’s a different model because sometimes teachers like to be the house of knowledge that impart their knowledge to all of their students.” (Informant 4)

According to the informants, it is essential that training and certification be compulsory for all teachers. Teachers must demonstrate that they possess the minimum competencies to be able to teach. Moreover, their teaching skills should be assessed on the basis of research on how human beings learn, so that they are able to use any tool to construct a natural and critical learning environment that facilitates deep learning. Investing in teachers is investing in society because their work is beneficial to society.

“You should be able to show that you've got a minimum competence. I think it is like a driving test, you know you should be able to show that you’ve got a minimum competence, okay I mean, I, I think if you want to call yourself a professional teacher you shouldn’t know the repertoire of tools that are available. [That] doesn’t mean you have to use them, okay, but you should know that, well, I could use this tool for doing this particular . . . support this kind of learning, this tool for this particular learning.” (Informant 5)

In order to ensure that teachers possess a minimum of knowledge, one of the most important aspects that the informants mentioned is the need to set standards. This would also mean that teachers would know how to use the latest and most up-to-date tools and feel confident, although the informants acknowledged that this is difficult to put into practice. The complexity of using ICT effectively in the classroom is a challenge because it is not simply a question of teaching with technology. We start by choosing the technology we are going to use and then it has to be mixed in with other more traditional tools. Likewise, the teacher training curriculum should be standards-based, because according to the informants this is the best way to achieve effective results in terms of productivity.

“The standards-based teacher education curriculum is really the best way of achieving effective outcomes in terms of productivity [...] However I don’t



think standards are necessarily a panacea. In the UK, a IC standards was used for a few years at the late 1990s, early 2000s, and I think there were about 107 standards and the whole thing became so . . . and it lead to evidence and the standards [went] from demon level describing the basic functionality of core technologies all the way through to sophisticated pedagogical routines. They've made them very, very difficult to use in an operational [way].” (Informant 7)

Such standards should be grounded in the educational ethos and aims of the school. Moreover, they should be part of teacher development and competence to ensure that teachers receive the same training in the use of new technologies.

The informants indicated that new teachers have increasingly higher levels of digital competence and that it is the teachers who will change the way technology is used, not the universities. It is therefore necessary to work towards lifelong learning for teachers and inspire them to be leaders.

“It is critical. I don't know that students can respect or feel confident about the implementation of new technologies in their school and also in all of society if the teachers don't have the base knowledge.” (Informant 4)

In short, many teachers lack the necessary digital skills due to gaps in their training. For this reason, teacher training must be improved because teachers cannot transfer knowledge and skills they do not have. Training needs to be pragmatic and enable teachers to adapt to any educational context. In addition, permanent training is necessary to ensure that teachers keep up to date. In the process, teachers can count on students for help, as students often have better knowledge of the use of new technologies than teachers. Teaching competencies must also be evaluated to determine teachers' ability to teach and minimum standards should be set to ensure effective teaching practices, which are best measured by pedagogy-based standards.

Based on the above analysis, the following key elements related to teacher training have been identified:

- Teachers require digital skills to be able to transmit them to their students.
- Teacher training must be pragmatic.
- Teachers must be able to adapt to a diversity of educational contexts.
- Teachers must receive ongoing training to ensure that they keep up to date.

- It is important that teachers are supported by their students.
- Teachers' competencies should be assessed based on standards.
- Pedagogy-based standards should be set.

Quantitative results

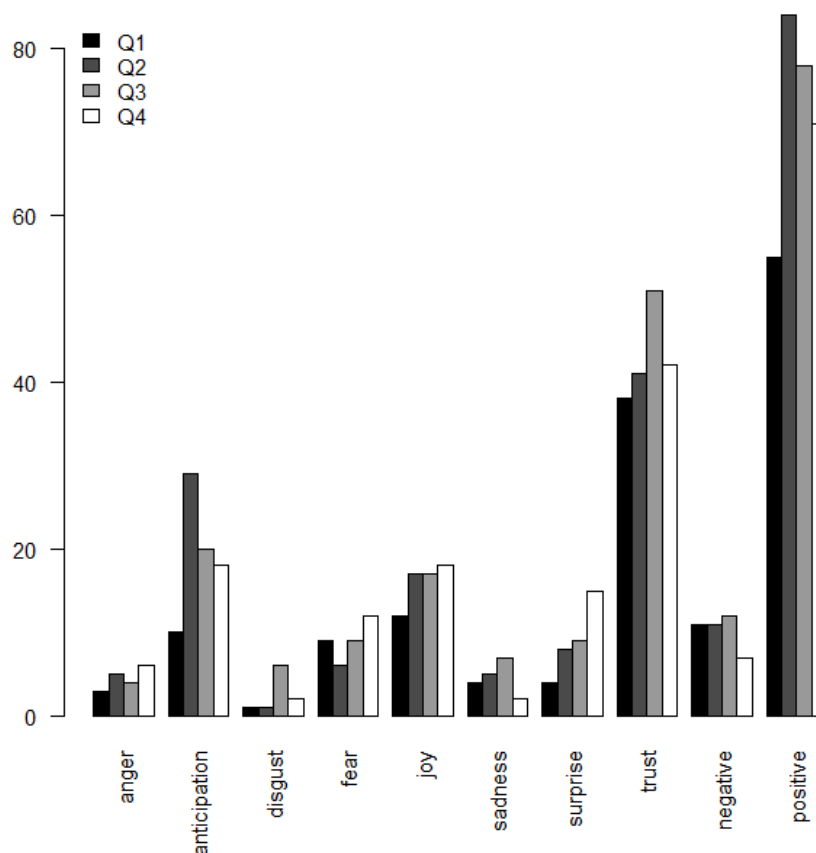
In this section, a quantitative analysis is carried out of the experts' responses to the questions on teacher training. First, a word cloud was created using the transcripts of all the interviews. This was followed by a sentiment analysis developed by Mohammad & Turney (2010) in the informants' responses using 14182 unigrams.

Figure 3 shows the word cloud based on the informants' responses. As can be seen, the words with the largest size are "teacher", "technology", "students", "can", "learning", and "like". These were the most frequently repeated words, particularly "teacher" and "teachers", since they were the main topic of the interviews. Other words such as "can" and "like" also appear more frequently since they are two commonly used verbs in English. However, "teacher", "student", and "technology" are among the words that occur together most frequently, thus highlighting the importance of these three aspects in teacher training.

digital competence, even though this is a relevant issue in their discourse. In contrast, Question 3, which refers to the importance of permanent training, elicited more negative sentiments and the highest frequency of the emotions “sadness” and “disgust” than in the rest of the questions. This might suggest that the experts believe that permanent teacher training is more complex or difficult to achieve. Although Question 3 showed the highest scores in terms of negative sentiment and negative emotions, negative feelings are still much lower than the positive ones in this question.

Figure 4.

Analysis of emotions based on the NRC lexicon by question



The results of the sentiment analysis identified the following key elements of teacher training:

- The need to improve teacher training.
- The difficulty of implementing permanent training.
- Standards and norms are not the most important elements of teacher training.



Discussion

As our study has shown, the most important factor to achieve educational change is teacher training (Geer et al., 2017), followed by curricula that engage students not only in their own learning, but in society as a whole (Broadbent & Papadopoulos, 2012). The figure of the teacher appears as a key element in educational change both in the interviews with the experts and the quantitative analyses of their transcripts. Consequently, special emphasis must be placed on teacher training, which is decisive for their future performance in the classroom. However, teacher training is currently inadequate (Fernández-Cruz & Fernández-Díaz, 2016), as teachers are often not trained in new technologies. One of the main findings of our research points to the importance of teachers being taught how to use technologies in a practical way (Pérez-Escoda et al., 2016) and to support their teaching practice. The experts highlight the importance of using real-life experiences in teacher training with the support of veteran teachers. According to previous research, teachers are still only taught about the properties and characteristics of technology (Barak, 2014). This means that new technologies are often not used appropriately in schools, thus explaining why both the informants and previous studies speak of the need for pre-service teachers to certify minimum digital competencies in order to become teachers (Aslan & Zhu, 2017). Equally, certified standards would make it possible to verify teachers' advanced competencies by recognising their work.

The informants agreed that although initial teacher training entails the mastery of basic competencies required for teaching practice, the mastery of advanced competencies must also be certified. However, as initial teacher training is lacking, the level of initial competencies acquired during training is insufficient and not a guarantee that teachers have, in fact, acquired basic skills. Therefore, the use of standards could also be included in their training to confirm that trained teachers have the necessary skills to be successful in their profession. Standards-based curricula would be the most effective way to achieve this (Almerich et al., 2016) so that all teachers receive the same level of training and those who obtain an advanced level are given due recognition. From the study it is clear that standards should be based on each school's pedagogical approach and goals. However, it is important to note that establishing a large number of standards is also counterproductive due to the difficulty of applying them in practice. This difficulty may have influenced the low level of optimism reflected by the experts in the

qualitative analysis on the implementation of standards to measure teaching staff skills. As mentioned, the informants highlight that teacher training requires a pragmatic not a theoretical approach (Siddiq et al., 2016). Therefore, training future teachers with a veteran teacher in the classroom in a variety of settings is the best option (Van Acker et al., 2013). In addition, lifelong learning and supporting and even inspiring teachers to be leaders is paramount to their success. Nonetheless, the informants highlighted the complexity involved in doing this, because teachers are permanent novices since new technologies are constantly emerging and changing the way they work. At the same time, however, ICTs can facilitate lifelong learning since teachers can train online (Laurillard, 2016) and provide feedback to each other in online communities (Tondeur et al., 2019). However, in order to do so, teachers must have a minimum knowledge of new technologies to successfully carry out online training and keep up to date independently on a permanent basis. Minimum skills must be acquired during initial training to ensure teachers can perform their functions autonomously. This is particularly important in cases where teachers are teaching in rural or isolated areas with limited peer support and material resources. They need to use the internet to create resources, interact with other teachers, participate in online training, and keep up to date. Heads of schools also play an important role in coordinating teachers, as a teacher who works alone in his or her classroom will not be able to bring about educational change (Tondeur et al., 2008). The experts stress the importance of supporting and motivating teachers.

An additional finding of the study is that some teachers are intimidated by new technologies in the classroom out of the fear that their students will know more than they do (Cairns & Malloch, 2017). Sometimes this insecurity makes them feel awkward in front of their students (Wang et al., 2014) and teachers need to feel confident (Archer et al., 2014) and valued (Drossel et al., 2017). Therefore, the lack of adequate training for future teachers leads to the lack of skills, which ultimately leads to insecurity when it comes to implementing and experimenting with new technologies in the classroom. This means that even if technological devices are available, improvements in education will not be achieved. In this regard, another important factor the informants mentioned is the collaboration of students in the implementation of new technologies in the classroom (Thieman & Cevallos, 2017), as students often have more knowledge of new technologies than teachers (Cairns & Malloch, 2017; Wang et al., 2014). Students need



to be involved, assigned a role, and given responsibility, and empathy is essential for students to develop knowledge. Teamwork also prevents them from isolating themselves when using new technologies. The role of parents and collaboration with families is equally important in the regard. External help, especially from students, could boost the implementation of new technologies in the classroom. This would enable teachers to see students as helping them to use classroom technologies rather than as evaluators who question their work. The feedback between teachers and students in the implementation of new technologies takes pressure off teachers and enables them to feel more at ease. It also gives students a greater role in their own learning process. Moreover, student participation would facilitate teachers' continuous learning, as students are, in general, highly proficient in new technologies (Cairns & Malloch, 2017; Wang et al., 2014). In turn, it would also change the traditional role of the teacher from that of transferer of knowledge to that of guide who accompanies students in their learning process. This role is endorsed in the most innovative methodologies and is referred to as active learning methodologies, which includes project-based learning. The importance of students in the learning process is reflected in both the international experts' responses and the analysis of the words used.

Additionally, the word count revealed that the informants are concerned about two key aspects of teacher training, namely the importance of using technology in the classroom and taking students into account in the learning process. These data coincide with those collected in the interviews. Currently, much importance is attached to student-centred learning processes (Author, (2015) and students as collaborators in the implementation of new technologies in the classroom (Author, (2020). Moreover, the sentiment analysis of the responses to the questions showed higher scores for positive feelings than for negative ones, thus indicating the positive attitude and confidence of the experts regarding the issues raised. The question on initial teacher training showed the highest positive score, while the question on standards for regulating teachers' digital competence showed the lowest, although the score remained high. This question obtained the lowest score for positive sentiment and the emotions of confidence and anticipation, coinciding with the opinion expressed by the experts on the difficulty of implementing standards. This could indicate that the experts believe it would be easier to improve teacher competencies in initial teacher training than to assess their competencies through standards because of the complexities involved.

Conclusions

The data obtained in the quantitative analysis coincide with and support the data of the qualitative analysis. The study shows that teachers are the most important element for educational change to occur and must therefore receive pragmatic training to be able to adapt to any educational context or setting. Training needs to be ongoing because the conditions in which teachers work (i.e. students, technology, the classroom, etc.) are constantly changing and they need to keep up to date to provide their students a quality education. To achieve this, however, teachers require support and must be motivated. Much of this support can come from the students themselves if they are given an active role in their learning process, are motivated, and made to feel useful. The support of heads of schools is also essential so that the changes involve the whole school and are not limited to a single classroom. As mentioned above, in order to determine whether teachers are up to date and really have digital teaching skills, standards must be set. In short, teachers are a key element in the teaching-learning process and play an essential role in the proper integration of ICTs in the classroom. Therefore, to benefit their students and the rest of society, they must be provided quality training focused on teaching practice. Several of the above elements coincide with those of the SQD model (Tondeur et al., 2019).

Limitations and future research

This study has some limitations. The main limitation was the impossibility of conducting all the interviews face-to-face, as interviews of this type are usually conducted in a more relaxed atmosphere and informants tend to provide more information. The interviews conducted by videoconference, although similar to face-to-face interviews, are actually somewhat colder and more direct. Finally, the interview conducted by email was the most restrained and the responses were collected directly in writing. Had the interview been carried out in person, it would have been possible to obtain a greater amount of information. Nonetheless, thanks to digital media, we have been able to interview leading professionals who have contributed their knowledge and experience to this study.



Future research could focus on the degree to which each of the key elements impacts on different educational contexts. This would allow us to observe whether some elements are more relevant in certain contexts and need to be improved. A specific educational context could also be evaluated and key elements could be reinforced to ascertain the degree of educational improvement. In summary, with the aim of facilitating educational change, further research could be carried out from a more practical approach to expand on the findings presented in this study.

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7.5. Creando lazos interculturales entre las familias y los centros educativos de Melilla. la comunicación mediada por tic como herramienta facilitadora de la inclusión educativa de las diferentes culturas

1. Introducción

Melilla es una ciudad multicultural en la que conviven personas con diferentes costumbres y religiones enriqueciendo el patrimonio histórico de la ciudad. No obstante, la diversidad lingüística en ocasiones supone un obstáculo que dificulta la comunicación. Hay familias que desconocen el español, la lengua vehicular de los centros educativos de la ciudad, y cuando sus hijos e hijas comienzan a ir a la escuela, es el único lugar en el que tienen contacto con ella. En muchas ocasiones, cuando este alumnado consigue un nivel lingüístico de español suficiente para seguir las clases, tiene un desnivel académico que le imposibilita finalizar con éxito sus estudios. Este ha sido uno de los principales factores que ha provocado que Melilla tenga una alta tasa de abandono y fracaso escolar según recientes informes (MECD, 2017) entre los que se encuentra PISA 2015. La barrera idiomática también afecta a la comunicación entre los centros educativos y las familias del estudiantado. La participación de las familias en la educación de los niños es fundamental y para ello deben de trabajar conjuntamente con los centros escolares (García-Carmona, 2014).

Con el fin de mejorar esta situación, se ha desarrollado una app para dispositivos móviles que facilita la comunicación entre los centros escolares y las familias del estudiantado salvando las barreras idiomáticas. Se aprovecha que hoy en día la mayor parte de la población dispone de un *smartphone*, un dispositivo inteligente que porta en todo momento y que permanece conectado a la red, para utilizarlo como canal de comunicación. La app permite al centro escolar enviar un mensaje instantáneo tipo *WhatsApp* en español a las familias del estudiantado y que estas reciban el mensaje en una lengua diferente (la elegida por las mismas). Las familias responden en su propia lengua y los centros escolares reciben la respuesta en español. De esta forma se crea un canal directo e instantáneo entre los centros escolares y las familias que reduce las barreras idiomáticas existentes. La app también permite la opción de leer los mensajes que llegan de los centros escolares en la lengua seleccionada por las familias y permite la respuesta oral. La app transcribe la respuesta oral, la traduce y la envía en español al centro educativo. Así se consigue facilitar también la comunicación entre aquellas personas de diferente lengua que no saben leer ni escribir. De esta forma se espera que



la comunicación y trabajo conjunto entre centros escolares y las familias del alumnado, contribuya a mejorar la situación educativa de la ciudad.

2. Marco teórico

El centro educativo ha de desarrollar un plan global de acción para poder escuchar a los padres y madres y darles tiempo y espacio para que se comuniquen y participen de forma personal en actividades informativas, formativas, culturales y sociales (Chuang, 2005). El papel de las madres y padres es fundamental en la escuela (Henderson & Mapp, 2002; National PTA, 1998, 2000, 2007, 2010; Henderson & Berla, 1994; Olivos, 2010) y es necesario que estén bien informados de todo lo que acontece en el colegio de sus hijos/as. Para ello se pueden usar diversas vías o canales de comunicación y participación.

Los avances de las tecnologías han marcado el desarrollo de las últimas décadas. Internet y el uso de las redes sociales (Tuenti, Facebook, Twitter, LinkedIn, YouTube...) se han convertido en una pieza clave en la vida de la familia influyendo de forma consciente o inconsciente en su desarrollo (Bas Peña & Pérez de Guzmán, 2010). En consonancia con estos hechos, las familias necesitan que las escuelas proporcionen nuevos escenarios de participación mediante las Tecnologías de la Información y la Comunicación (TIC) además de los ya existentes presenciales. Las TIC abren un inmenso abanico de posibilidades de comunicación que favorece y facilita la participación de las familias en la educación de sus hijos y en el centro escolar y a su vez promueven una vía de relación intercultural de la comunidad educativa. Asimismo, la destrucción de la barrera de los horarios mediante las TIC, que en muchas ocasiones impiden una mayor relación de las familias con el centro educativo, genera infinidad de posibilidades de comunicación efectivas y rápidas.

Las actividades que realizan los tutores y tutoras de clase, el centro y las asociaciones de madres y padres de alumnado (AMPA), así como la información relevante sobre el funcionamiento de los centros educativos son asuntos clave para compartir con el resto de la comunidad escolar y conseguir así que los padres y madres se involucren más. Para ello las tecnologías de la información junto a internet y la comunicación se convierten en herramientas muy versátiles y adecuadas que nos permiten dar a conocer la información que necesitamos a las personas que queramos con la dedicación de poco

tiempo y espacio. Sin lugar a dudas, la integración de las TIC para la mejora del diálogo y la reflexión relacional entre familia y escuela, “es una oportunidad de participación comprometida y favorecimiento de una relación alternativa que potencie y desarrolle las relaciones directas cooperativas que puedan darse en el contexto presencial” (Trujillo, et al., 2012, p.1215).

Las posibilidades educativas de las TIC han de ser consideradas en dos aspectos: conocimiento y uso (Sáenz, 2007 citado en Aguilar Ramos & Leiva Olivencia, 2012). En el caso de la participación de las familias, para que éstas se mantengan en contacto a través de las TIC, debemos cerciorarnos de que saben manejar las tecnologías en cuestión. Si este no fuese el caso, el centro educativo podría ofrecer talleres de formación para estos padres y madres como medida de fomento de la participación de la familia en la escuela. Además, también hay que tener en cuenta que estas familias puedan tener acceso a las tecnologías ya que existen casos que las condiciones económicas lo impiden. En estos casos la escuela debería proporcionar un lugar equipado para ello donde los padres pudiesen disfrutar de estos servicios o proveer los recursos tecnológicos necesarios.

Una vez que se tiene el conocimiento de las herramientas de trabajo, la comunidad educativa se dispondrá a utilizarlas de manera apropiada. En esta etapa el centro educativo también debería formar a los padres y madres que lo necesiten. El uso de estos canales de comunicación para la comunicación familia-colegio, equipo directivo-AMPA -resto de padres y madres, etc., deberá estar sujeto a unas normas de participación basadas en todo momento en el respeto mutuo.

La app de internet y, en concreto de una app dedicada a la comunicación de las familias y los centros educativos, se encamina hacia unas finalidades como las siguientes (Chuang, 2005):

- Adaptarse a las nuevas tendencias sociales y a las necesidades de la familia.
- Ampliar el uso de internet en el centro de enseñanza.
- Abrir nuevos cauces de información y comunicación entre el centro educativo y la familia.
- Ofrecer a la familia un medio de comunicación eficaz.
- Facilitar la difusión de información (proyectos, noticias, avisos...).
- Promover la interacción entre el centro educativo y la familia.



Asimismo, las TIC como herramientas facilitadoras de la participación y comunicación de las familias de diversas culturas en los centros educativos pretenden:

- Eliminar la barrera idiomática que separa a algunas familias de los centros educativos.
- Mantener a las familias al día sobre todos los aspectos relacionados con el desarrollo y educación de sus hijos.
- Fomentar la relación entre el centro educativo y la familia, estableciendo un nuevo modo de comunicación entre profesorado, familias y alumnado.
- Usar internet como canal de comunicación entre los padres de manera que se fomente el espíritu de comunidad escolar.
- Fomento de la participación y conocimiento de todas las culturas que estén presentes en el centro educativo.
- Etc.

3. El método

3.1. El contexto de Melilla

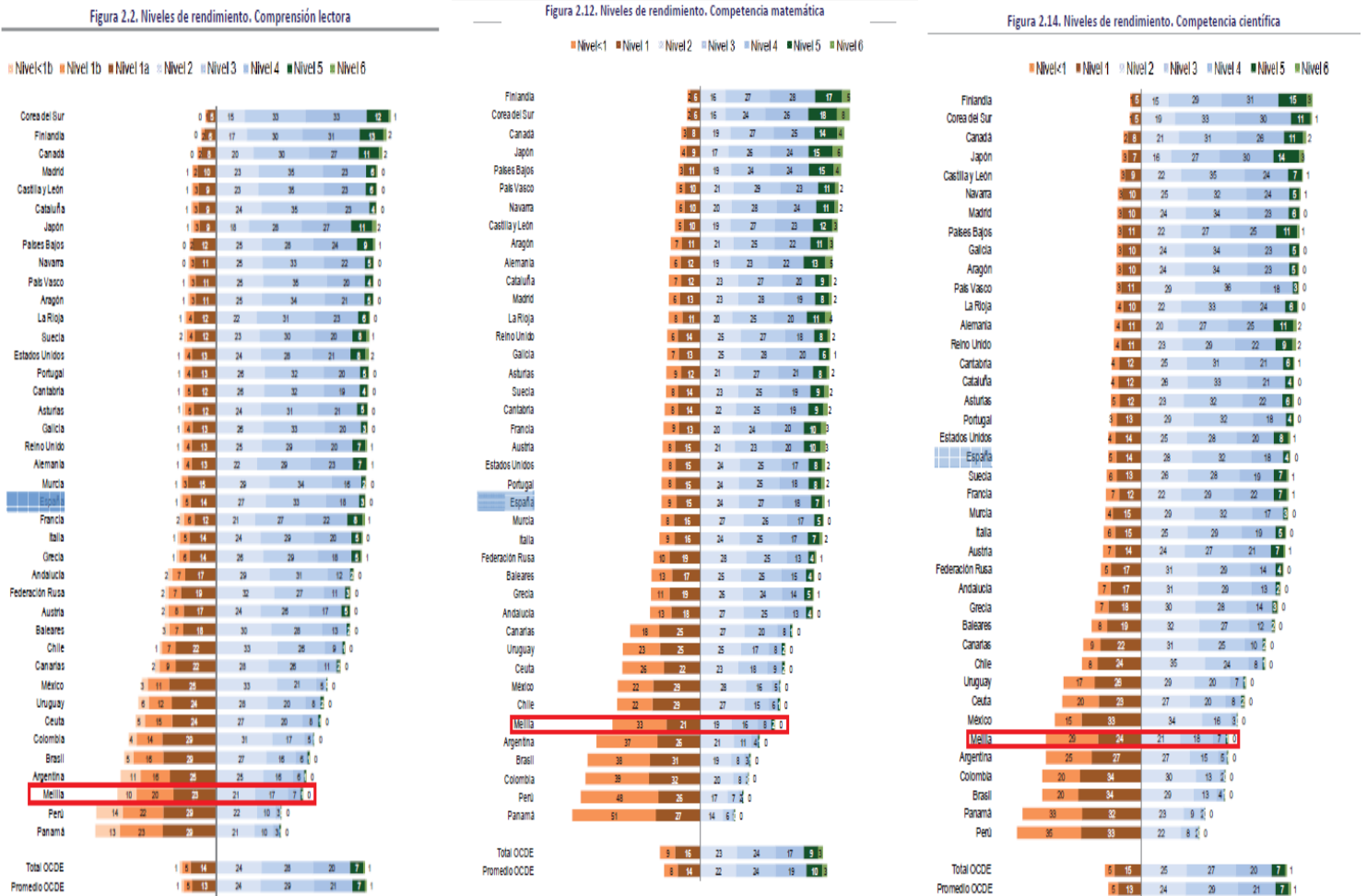
Melilla es una ciudad española de 12km cuadrados situada en África junto a la frontera norte de Marruecos. En ella hay 86.487 habitantes, algo más de la mitad son musulmanes, de los cuales la mayoría son autóctonos de la zona del Rif, la parte de Marruecos colindante con Melilla. Su lengua materna es el tamazight, una variante del tarifit proveniente de las tribus bereberes que poblaban el norte de África, la cual no tiene raíces con el árabe ni ningún dialecto que provenga del mismo. Además, en Melilla existen pequeñas comunidades de origen judío, hindú, romaní y chino. Por otra parte, en los Centros de Estancia Temporal de Inmigrantes (CETI) podemos encontrar poblaciones cambiantes principalmente del África subsahariana, Argelia, Siria y otros países africanos (MECD, 2017; MECD, 2019).

En la actualidad, Melilla es un contexto que avanza desde la multiculturalidad a la interculturalidad (Ruiz-Montero, et al., 2019). No obstante, esta diversidad de lenguas en ocasiones genera barreras en la comunicación. La situación se ve agravada en los casos de familias que no saben leer ni escribir procedentes de contextos socioeconómicos más desfavorecidos. Uno de los mayores problemas generados a raíz de este hecho se da en educación. Como se ha mencionado

anteriormente, la Ciudad Autónoma de Melilla es la ciudad con mayor índice de abandono y fracaso escolar de Europa según diversos informes entre los que se encuentra PISA 2015. A continuación, se pueden observar los resultados obtenidos en el informe PISA 2015 en tres de las materias más importantes:

Figura 1

Resultados de los niveles de rendimiento en el informe PISA 2009.



Nota. Niveles de rendimiento en comprensión lectora, competencia matemática y competencia científica del estudiantado de Melilla en PISA 2009.

En las gráficas anteriores podemos observar el lugar que ocupa España en la clasificación del informe PISA en comprensión lectora, competencia matemática y competencia científica. El informe compara la media nacional con las provincias y con otros países que obtuvieron una puntuación similar. En el recuadro marcado en cada una de las tres gráficas podemos observar la posición que ocupa Melilla, siendo la provincia española de menor puntuación. Las gráficas pertenecen al informe PISA



2009 debido a que en los últimos informes PISA 2012 y 2015 no se incluyó a la Ciudad Autónoma de Melilla.

3.2. Inlucic

La familia es uno de los pilares más importantes en el proceso educativo. Es por ello que el trabajo conjunto entre escuela y familias es fundamental. Con este propósito surge la necesidad de crear una app que facilite y aumente la comunicación fluida entre todas las familias (con independencia de la lengua materna que utilicen) y el centro educativo. La app, por tanto, nace con el objetivo de facilitar la necesaria cooperación entre los centros escolares y las familias del estudiantado.

En base a los resultados obtenidos en el análisis realizado sobre el contexto de Melilla, se determinaron las características que debía tener la app. Para ello la app se basó en tres principios: pocos requisitos tecnológicos para que sea accesible económicamente, sencilla de usar para que no requiera de conocimientos o competencias previas, y práctica para que sea una herramienta útil que solucione sus problemas reales. De esta forma se conseguiría llegar al mayor número de personas posible. Sus principales características son:

- **Versátil:** Una de las características más importantes de la app es que sirve para todos los centros, pudiendo ser personalizada fácilmente para el centro y curso que se desee utilizar. La app es compatible con los sistemas operativos Android y IOS para abarcar casi la totalidad del mercado.
- **Pocos requisitos:** Para que pueda ser empleada en la mayoría de dispositivos.
- **Intuitiva:** Cualquier persona sin conocimientos informáticos ha de ser capaz de usarla.
- **Facilitadora de la comunicación:**
 - **Traductora:** La app traduce los mensajes de forma instantánea para facilitar la comunicación entre personas de diferente lengua.
 - **Transcripción:** Las personas que no sepan leer ni escribir, pueden personalizar la app para que le lea los mensajes y contestarlos mediante audio.
- **Canal instantáneo:** La comunicación se establece directamente entre los centros y las familias de forma instantánea como mensajes de WhatsApp o

alertas de móvil. El receptor puede responder igualmente de forma instantánea permitiendo al centro recabar datos de los padres y madres que han visto en mensaje.

De esta forma se busca crear una herramienta intuitiva, versátil y accesible a todo el mundo que facilite la comunicación entre los centros educativos y las familias del estudiantado. Incidiendo en las familias del estudiantado como uno de los pilares fundamentales de la educación junto con el contexto y el centro educativo, se pretende reforzar la cooperación entre los centros escolares y las familias del estudiantado para mejorar la educación del estudiantado y disminuir los elevados índices de abandono y fracaso escolar que actualmente existen en la Ciudad Autónoma de Melilla.

3.3. Fases de elaboración e implementación de la App

Como se ha mencionado anteriormente, el objetivo general de la investigación es facilitar la comunicación entre las familias de las diferentes culturas de Melilla y los centros educativos salvando las barreras idiomáticas para favorecer la interculturalidad. Esto se pretende conseguir mediante la creación de una app intuitiva para *smartphone*/Tablet que facilite la comunicación entre las familias de diferentes culturas con los centros educativos.

Las fases de elaboración e implementación de este proyecto son dos:

En la primera, la creación de la app con las funcionalidades básicas. La app ha sido realizada mediante una empresa externa siguiendo nuestras indicaciones basadas en estudios anteriores recogidos en el marco teórico y el estado de la cuestión. Una vez finalizada la app, se dará difusión en los centros escolares de la Ciudad Autónoma de Melilla de forma telemática para fomentar su uso y solucionar cualquier duda sobre la misma. En caso de que algún centro lo requiera, se presentará en el mismo para facilitar y orientar sobre el uso y características de la app.

En la segunda, se está realizando un diagnóstico de las dificultades en la comunicación entre las familias y los centros escolares consultando directamente con representantes de las AMPA y los órganos directivos de los centros escolares. Esto se lleva a cabo mediante un cuestionario semiestructurado sobre las necesidades y aspectos concretos



para facilitar la comunicación familias-centro. El cuestionario se ha elaborado en un formulario de Google Docs que se les ha hecho llegar mediante la Federación de Asociaciones de Madres y Padres de Alumnos (FAMPA) de Melilla.

La información recogida sobre las necesidades y la experiencia de los centros educativos de Melilla en su conjunto, será analizada para proponer futuros avances y modificaciones de la app que permitan mejorar la comunicación entre familias y centros escolares, solventando la barrera idiomática y empleando un canal intuitivo y accesible. El estudio incluirá todas las características posibles de entre las recogidas en el análisis, respetando siempre los principios de un uso intuitivo y que requiera de poco hardware para ser empleado en la mayoría de dispositivos posibles. Este punto es especialmente importante para acceder a aquellas familias de contextos socioeconómicos desfavorecidos con las que se pretende estrechar lazos en pro de una mejor educación e integración. Otro de los apartados a añadir a la app será la creación de un “rincón intercultural” en el que se ofrezca información sobre las diferentes culturas del centro y de la ciudad y a la vez se puedan anunciar actividades destinadas a la interacción y el encuentro de las diferentes comunidades.

3. Resultados

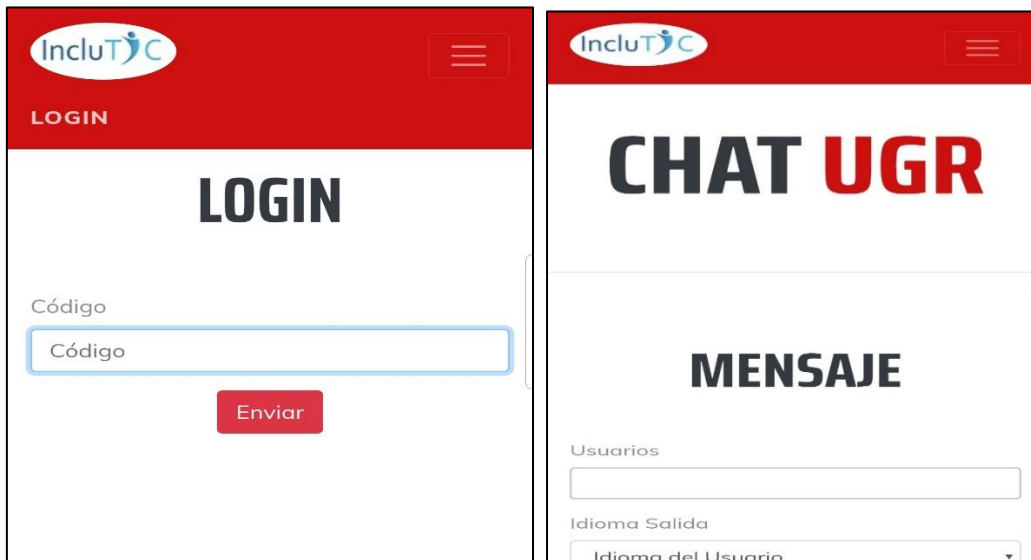
La investigación finalmente culminó con la creación del software de app adaptado al contexto de Melilla en base al análisis que se realizó sobre el mismo.

La app cumple con todas las funcionalidades básicas que permiten solventar el problema de comunicación entre los centros escolares y las familias del estudiantado. No ha sido posible incorporar otras funcionalidades avanzadas basadas en las necesidades de cada centro escolar de Melilla debido al presupuesto del que disponíamos.

A la app resultante se le ha dado nombre de “Inclutic”, haciendo referencia a su principal función que es la inclusión de las diferentes culturas de la ciudad mediante las TIC. La app al iniciarse solicita un código a los usuarios que será facilitado por el centro educativo para garantizar la protección de la comunicación entre los centros educativos y las familias respetando la privacidad. Una vez que accedamos a la app, el usuario introducirá su nombre y escogerá la lengua con la que desea comunicarse con el centro educativo.

Figura 2

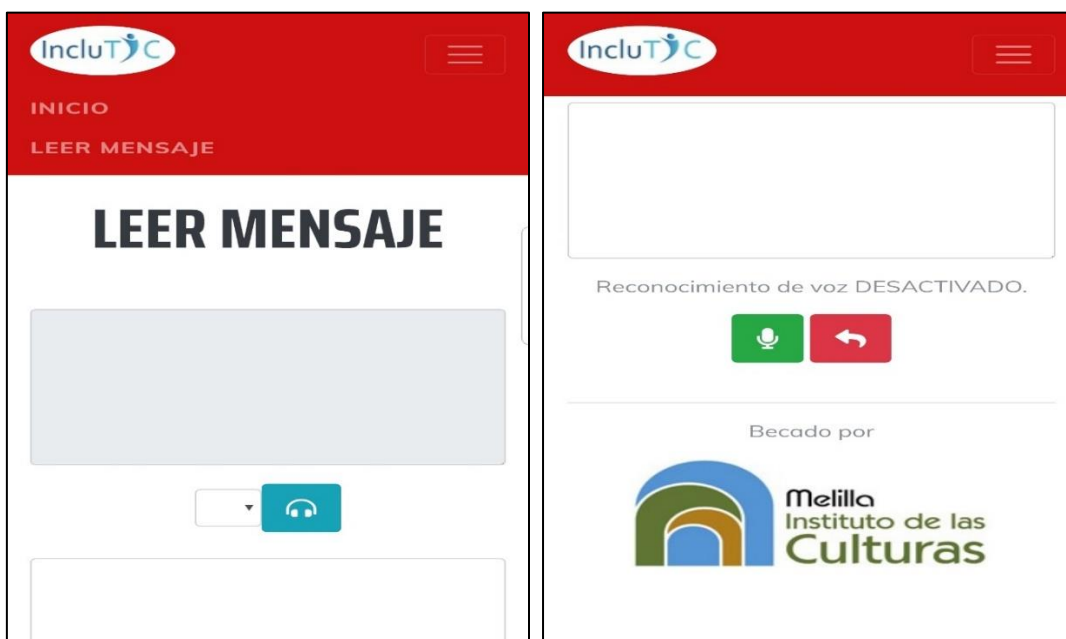
Configuración inicial de la app.



Como se puede observar, se ha optado por una interface sencilla y clara, con letra grande para facilitar su uso a personas adultas que serán las principales usuarias de la app. El mensaje le aparecerá en la lengua que hayan seleccionado y podrán leerlo o escucharlo si pulsan el botón azul que tiene el dibujo de unos auriculares.

Figura 3

Interface de comunicación.





Para contestar al mensaje, escribirá en su lengua, que previamente habrán seleccionado, o de forma oral pulsando el botón verde en el que aparece un micrófono. La app realizará la transcripción del mensaje de audio y al enviarlo lo traducirá llegando al centro educativo en español.

4. Discusión y conclusiones

La app resultante del presente estudio cumple satisfactoriamente con los objetivos propuestos. Es capaz de realizar transcripciones y traducciones de forma simultánea posibilitando la comunicación entre un conjunto de personas que emplean diferentes lenguas de forma oral o escrita. Por tanto, mejora la comunicación entre los centros escolares y las familias del estudiantado (Trujillo, et al., 2012) permitiéndoles involucrarse de forma más activa con el centro escolar (Henderson & Mapp, 2002; National PTA, 1998, 2000, 2007, 2010; Henderson & Berla, 1994; Olivos, 2010). La app se ha realizado con financiación limitada por lo que no se ha podido crear una app nativa desde cero, y se ha creado empleando diversas funcionalidades de otras aplicaciones.

Actualmente, se está realizando la segunda parte de la investigación en los centros educativos de Melilla sobre las funcionalidades y características que dichos centros consideran de utilidad incluir en la app. Esto nos proporcionará información valiosa que nos permitirá personalizar aún más la app a las necesidades de los centros educativos de Melilla (Ruiz-Montero, et al., 2019). De esta forma se adaptaría con mayor detalle el software a las necesidades reales del contexto de la Ciudad Autónoma de Melilla aumentando la influencia del centro educativo (Chuang, 2005) y de las familias del estudiantado (Bas Peña & Pérez de Guzmán, 2010) sobre el alumnado para reforzar estos dos pilares fundamentales de su educación.

En un futuro se pretende añadir a la app todas las nuevas funcionalidades que se recojan del estudio que se está llevando a cabo en los centros escolares. Incluso la creación de una app totalmente nativa sin contar con las funcionalidades de otras aplicaciones. Todo ello dependerá de la financiación que se obtenga para realizar la segunda fase de la app. El presupuesto asignado anteriormente para el proyecto únicamente ha permitido la creación de la app con las funcionalidades básicas, en un futuro se pretende realizar un

nuevo proyecto que mejore la app con las nuevas funcionalidades propuestas por los centros. Finalmente, lo que se busca es que la app tenga un uso práctico y real (Sáenz, 2007 citado en Aguilar Ramos y & Leiva Olivencia, 2012) que mejore la situación educativa de la ciudad y facilitar la creación de lazos interculturales entre la población.

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8. Indicios de calidad



8. Indicios de calidad de los artículos publicados

Las publicaciones que componen la tesis han sido aceptadas por revistas que cumplen los indicios de calidad y requisitos valorados por el programa de Ciencias de la Educación B22.56.1 (RD.99/2011) de la Universidad de Granada. De la misma forma se cumple con el mínimo de 3 artículos publicados o aceptados en revistas de impacto.

A continuación, se procede a especificar los indicios de calidad para cada una de las publicaciones presentadas.

8.1. Analysis of digital competence of educators (DigCompEdu) in teacher trainees: the context of Melilla, Spain

El artículo fue publicado el 14 de julio de 2021 en la revista “Technology, Knowledge and Learning” (ISSN: 22111662, 22111670) <https://doi.org/10.1007/s10758-021-09546-x>

Es una revista editada en Estados Unidos. Se encuentra indexada en la base de datos Scopus desde 2011. Presenta índice de impacto en SJR 0.969 en las áreas Mathematics: Mathematics (miscellaneous), Social Sciences: Education, Computer Science: Computer Science Applications y Computer Science: Human-Computer Interaction. Se encuentra en el cuartil Q1 de esta base de datos.

Technology, Knowledge and Learning

Scopus coverage years: from 2011 to Present

Publisher: Springer Nature

ISSN: 2211-1662 E-ISSN: 2211-1670

Subject area: [Mathematics: Mathematics \(miscellaneous\)](#) [Social Sciences: Education](#) [Computer Science: Computer Science Applications](#)

[Computer Science: Human-Computer Interaction](#)

Source type: Journal

CiteScore 2020

4.0

SJR 2020

0.969

SNIP 2020

1.709

8.2. Teaching-pedagogical aspects regarding the integration of Emerging technologies. The view of international experts.

El artículo aún no ha sido publicado. Se ha enviado a una revista que pertenece a la categoría Q2 en la base de datos de Scopus hace varios meses..



8.3. The integration of emerging technologies in socioeconomically disadvantaged educational contexts. The view of international experts.

El artículo ha sido publicado online el 18 de abril del 2022 la revista “Journal Of Computer Assisted Learning” 1–13 <https://doi.org/10.1111/jcal.12677>.

Esta revista está editada en Reino Unido. Se encuentra en indexada en la base de datos de Scopus desde 1985. Presenta índice de impacto en SJR 1.583 en las áreas de Social Sciences: Education y Computer Science: Computer Science Applications. Pertenece al cuartil Q1 de esta base de datos.

Journal of Computer Assisted Learning
Scopus coverage years: from 1985 to Present
Publisher: Wiley-Blackwell
ISSN: 0266-4909 E-ISSN: 1365-2729
Subject area: [Social Sciences: Education](#) [Computer Science: Computer Science Applications](#)
Source type: Journal

[View all documents >](#) [Set document alert](#) [Save to source list](#) [Source Homepage](#)

CiteScore 2020	5.9
SJR 2020	1.583
SNIP 2020	2.212

La revista es también Q1 en JCR, Journal Citation Reports (Clarivate Analytics): 46/265 (Education & Educational Research).

JCR YEAR
2020

JOURNAL OF COMPUTER ASSISTED LEARNING

ISSN
0266-4909

EISSN
1365-2729

JCR ABBREVIATION
J COMPUT ASSIST LEAR

ISO ABBREVIATION
J. Comput. Assist. Learn.

Journal information

EDITION
Social Sciences Citation Index (SSCI)

CATEGORY
EDUCATION & EDUCATIONAL RESEARCH - SSCI

LANGUAGES	REGION	1ST ELECTRONIC JCR YEAR
English	ENGLAND	1997

Publisher information

PUBLISHER	ADDRESS	PUBLICATION FREQUENCY
WILEY	111 RIVER ST, HOBOKEN 07030-5774, NJ	6 issues/year

2020 JOURNAL IMPACT FACTOR

3.862

JOURNAL IMPACT FACTOR WITHOUT SELF CITATIONS

3.539

8.4. Teacher training for educational change: the view of international experts

El artículo fue publicado en CONT ED TECHNOLOGY, Volume 14, Issue 1, Article No: ep330. Fue publicado Online el 26 noviembre de 2021 en la revista “Contemporary Educational Technology” (ISSN: 1309-517X) <https://doi.org/10.30935/cedtech/11367>

La revista está editada en Turquía. Se encuentra indexada en la base de datos Scopus desde 2011. Presenta índice de impacto en SJR 0,439 en las áreas Social Sciences: Education y Business, Management and Accounting: Management of Technology and Innovation. Se encuentra en el cuartil Q2 de esta base de datos.

Contemporary Educational Technology
 Scopus coverage years: from 2018 to Present
 Publisher: Anadolu University, Faculty of Communication Sciences
 E-ISSN: 1309-517X
 Subject area: [Social Sciences: Education](#) [Business, Management and Accounting: Management of Technology and Innovation](#)
 Source type: Journal

[View all documents >](#) [Set document alert](#) [Save to source list](#) [Source Homepage](#)

CiteScore 2020	2.1
SJR 2020	0.439
SNIP 2020	1.328

8.5. Creando lazos interculturales entre las familias y los centros educativos de Melilla. La comunicación mediada por TIC como herramienta facilitadora de la inclusión educativa de las diferentes culturas.

El capítulo fue publicado en el libro Teoría y práctica en investigación educativa: una perspectiva internacional, coordinado por Gerardo Gómez García, Magdalena Ramos Navas-Parejo, Carmen Rodríguez Jiménez, Juan Carlos de la Cruz Campos, 2020, ISBN 978-84-1377-174-8, págs. 2186-2197

El capítulo ha sido editado en España por la editorial Dykinson. Editorial independiente, con más de 40 años de experiencia. La editorial Dykinson ha sido evaluada como editorial de prestigio por el Grupo de Evaluación de la Ciencia y la Comunicación Científica Grupo EC3 (Universidad de Granada y Universidad de Navarra). Recientemente, y para acreditar que los trabajos editados han superado un proceso de evaluación y calidad, se ha establecido el proceso anónimo de revisión por pares. Cuentan con un Consejo Asesor de la editorial, que se encarga de la evaluación anónima de aquellos trabajos que se ofrecen a Dykinson para su posible publicación compuesto por catedráticos, profesionales y profesorado de reconocido prestigio.



En el índice de excelencia editorial SPI (Scholarly Publishers Indicators) obtiene las siguientes métricas en la categoría general y en educación:

General (504 editoriales) ICEE 20.763 Posición 14 de 272 (cuartil 1).

Educación (156 editoriales) ICEE 0.954 Posición 16 de 94 (cuartil 1).

9. Conclusiones



9. Conclusiones

9.1. Objetivo general: encontrar la forma de mejorar la situación educativa de contextos socioeconómicos desfavorecidos mediante la implantación de las nuevas tecnologías en educación para desarrollar su competencia digital.

El sondeo de la percepción de las competencias digitales de los docentes en formación de Melilla nos permite conocer mejor al elemento educativo principal en el cambio educativo en la ciudad de Melilla. A continuación, la información recogida de los docentes en formación de Melilla y de los expertos internacionales nos muestra los factores importantes en cuanto a la metodología que se debe emplear, la forma de implantar las nuevas tecnologías en contextos socioeconómicamente desfavorecidos y en cómo ha de ser la formación del profesorado. Finalmente se muestra un ejemplo del uso práctico de las nuevas tecnologías para mejorar el contexto educativo de Melilla. En este caso la tecnología no solo se emplea en la enseñanza de contenidos, sino para paliar una de las principales causas que hace que la ciudad tenga uno de los mayores índices de abandono y fracaso escolar de Europa, un problema de comunicación derivado de la diversidad lingüística y el analfabetismo existente en parte de la población. Esto demuestra que la tecnología permite mejorar la educación desde diferentes perspectivas que van mucho más allá de ser un recurso didáctico.

Se le ha dado respuesta a la cuestión planteada en el objetivo general a lo largo de las cinco publicaciones. Se ha estructurado la tesis de forma que cada uno de los objetivos específicos es abordado en un artículo, ofreciendo además una aplicación práctica del uso de las nuevas tecnologías en el contexto de estudio en la quinta publicación. Esto permite profundizar en los diferentes aspectos ofreciendo una visión completa del fenómeno estudiado.

9.2. Objetivo específico 1: conocer la percepción del profesorado en formación de Melilla sobre las carencias en su competencia digital.

El grupo de estudiantado de máster obtuvo los mejores resultados, seguido del alumnado de Educación Primaria y por último los de Educación infantil. Observamos que cuanto mayor es el nivel de educación, más positiva es su autoevaluación (Berrios et al., 2020; Gómez, 2015). Además, se ha de tener en cuenta que ha podido influir la

experiencia adquirida mediante el desempeño docente y la autoformación (Instefjord & Munthe, 2017), debido a que muchos de ellos habían terminado su carrera y estaban trabajando, habiendo recibido alguna formación adicional. Además de que cada grupo de estudiantado recibe una formación universitaria en competencias digitales acorde al nivel educativo en el que van a trabajar (Ramírez-Montoya et al., 2017) y que el estudiantado que impartirá clases en niveles educativos superiores está más preocupado por adquirir una mejor competencia digital (Falcó, 2017). Los resultados de aprendizaje fueron positivos para todas las titulaciones analizadas, aunque apuntan a la necesidad de una mayor y mejor formación en competencia digital (Escudero et al., 2019; Ortega-Sánchez et al., 2020; Rojo-Ramos et al., 2020). La parte en la que obtuvieron menor puntuación ha sido en el Área de Competencia 4 relacionada con la seguridad (INTEF, 2017).

Este objetivo fue abordado en la publicación “Analysis of the digital teaching competence (digcompedu) in teaching in training”.

9.3. Objetivo específico 2: encontrar las metodologías y pedagogías idóneas que permitan emplear eficazmente las nuevas tecnologías en el proceso de enseñanza-aprendizaje.

Para conseguir la correcta implantación de las nuevas tecnologías es necesario disponer de unos objetivos de aprendizaje bien definidos y un currículo contextualizado. También es fundamental crear un entorno de aprendizaje crítico natural (Sosa et al., 2017) y formar al estudiantado principalmente en competencias (Klaassen et al., 2017) mediante metodologías activas como el aprendizaje basado en proyectos y el aprendizaje basado en problemas. Todo ello adaptando las metodologías al contexto del estudiantado (Koehle et al., 2013; López Castellano et al., 2019) y a su nivel de competencias (Dong & Newman, 2016). Además, se recomienda evitar el empleo de muchas metodologías debido a que puede crear confusión en la comunidad educativa y es necesario que tengan confianza.

La tecnología tiene que apoyar el proceso de aprendizaje, no ser el centro de la misma (O'Flaherty & Phillips, 2015). Empleada correctamente puede mejorar significativamente el proceso de enseñanza-aprendizaje, pero mal usada puede ser perjudicial (Cairns & Malloch, 2017; García-Carmona, 2019). Es importante no

introducir la tecnología antes de la pedagogía porque sería contraproducente (Hennessy et al., 2015). Además, se debe integrar el uso de las nuevas tecnologías de forma paulatina, comenzando por sus funciones básicas e ir aumentando su complejidad hasta aprovechar todo su potencial (Foronda et al., 2017). Por ello, el elemento más importante es el profesor (Gros, 2016).

Este objetivo fue abordado en la publicación “Teaching-pedagogical aspects regarding the integration of Emerging technologies. The view of international experts”.

9.4. Objetivo específico 3: averiguar la mejor forma de implantar las nuevas tecnologías en contextos socioeconómicos desfavorecidos.

El uso de las tecnologías emergentes en contextos socioeconómicamente desfavorecidos favorece la inclusión social mediante la mejora de la comunicación y la colaboración (Wogu et al., 2018). Las nuevas tecnologías (Fang et al., 2019) y la alfabetización digital (Wilson et al., 2015) son fundamentales por los beneficios que ofrecen. Sin embargo, el uso de la tecnología no puede basarse únicamente en la asequibilidad financiera (OCDE, 2010a). Se ha de utilizar la tecnología que mejor se adapte al contexto (Alshahrani & Ally, 2016) y proporcionar los recursos al estudiantado (Van Den Beemt & Diepstraten, 2016), asegurando la equidad y confianza en ellos. Además de dar tiempo suficiente para que se aprecien los resultados (Bingimlas, 2009), se debe fomentar el pensamiento crítico (Paul & Elder, 2003) y emplear correctamente la pedagogía (Alshahrani & Ally, 2016; Markus & Mentzer, 2014). Se debe guardar un equilibrio (Claro et al., 2015) ya que un uso excesivo de la tecnología es igual de nocivo e incide de la misma manera en la brecha digital (Hinojo-Lucena et al., 2021; Hohlfeld et al., 2008; Mérida-López & Extremera, 2017). Para ello, el estudiantado es vital en este proceso (Bocconi et al., 2013), tiene que ser parte central del mismo y ser siempre tratado con empatía; aunque para conseguir un cambio educativo debe participar toda la comunidad educativa.

Este objetivo fue abordado en la publicación “The integration of emerging technologies in socioeconomically disadvantaged educational contexts. The view of international experts”.

9.5. Objetivo específico 4: descubrir cómo ha de ser la formación de los docentes para que cuenten con una avanzada competencia digital que les permita desarrollar las competencias digitales de su alumnado.

El profesorado debe aprender a utilizar la tecnología de forma práctica (Pérez-Escoda et al., 2016; Siddiq et al., 2016), como un apoyo a su labor docente. La formación práctica con un maestro veterano en el aula en una variedad de entornos se considera como la mejor opción (Van Acker et al., 2013). Deben adquirirse las competencias digitales básicas durante la formación inicial y exigirse una acreditación de haber obtenido unas mínimas competencias digitales para poder convertirse en maestros (Aslan & Zhu, 2017). La acreditación permitiría de la misma forma verificar y reconocer las competencias digitales avanzadas de aquellos docentes que destacan por encima de la media. De este modo, la formación de los docentes requiere de un aprendizaje permanente a lo largo de su carrera profesional, que puede realizarse en línea (Laurillard, 2016) e incluso recibir retroalimentación de otras comunidades también en línea (Tondeur et al., 2019; Trujillo et al., 2015). A su vez, para conseguir mantener la calidad en los planes de estudio, estos han de estar basados en estándares (Almerich et al., 2016). Por otro lado, algunos docentes temen que su estudiantado sepa más que ellos sobre nuevas tecnologías (Cairns & Malloch, 2017) y esa inseguridad hace que no las usen. Ese temor en ocasiones se corresponde con la realidad, puesto que el estudiantado, según diversas investigaciones, suele ser más competente en nuevas tecnologías que su profesorado (Cairns & Malloch, 2017; Wang et al., 2014). Por ello, es importante la colaboración del estudiantado (Thieman & Cevallos, 2017) para facilitar el aprendizaje continuo del profesorado. Esto permitiría al profesorado ver al estudiantado como ayudante, reduciendo así sus dudas para emplear las nuevas tecnologías en el aula. Es importante apoyar y motivar al profesorado para que se sienta seguro (Archer et al., 2014) y valorado (Drossel et al., 2017).

Este objetivo fue abordado en la publicación “Teacher training for educational change: the view of international experts”.

9.6. Objetivo específico 5: emplear las nuevas tecnologías para mejorar la situación educativa de la ciudad de Melilla.

La versión final de la app de mensajería instantánea reúne las características principales que permiten realizar transcripciones y traducciones de forma simultánea entre varios interlocutores. De esta forma, su uso puede mejorar la comunicación entre los centros escolares y las familias del estudiantado (García-Carmona, 2014; Trujillo Torres, et al., 2012), permitiéndoles involucrarse de forma más activa con el centro escolar (Henderson & Mapp, 2002; National PTA, 1998, 2000, 2007, 2010; Henderson & Berla, 1994; Olivos, 2010). Las limitaciones de la financiación obtenida para el proyecto no han permitido la creación de una app nativa y se ha creado a partir de otras. Esta versión funcional muestra el potencial de la herramienta. Mas adelante se continuará trabajando en una nueva versión con nuevas funcionalidades y características que nos permitirá personalizar aún más la app a las necesidades de los centros educativos de Melilla (Ruiz-Montero, et al., 2019). De esta forma conseguiremos adaptar mejor la app a las necesidades de los centros educativos (Chuang, 2005) y de las familias (Bas Peña & Pérez de Guzmán, 2010; García-Carmona, 2020). Se busca que la app tenga una aplicación real y práctica (Sáenz, 2007 citado en Aguilar Ramos y & Leiva Olivencia, 2012) y que contribuya a mejorar la situación educativa de Melilla. En un futuro se contempla la posibilidad de desarrollar una app nativa que no requiera del soporte de otras apps para su funcionamiento. También se considera la posibilidad de incluir entre sus funcionalidades el análisis de los datos o metadatos obtenidos, siempre respetando la privacidad, para satisfacer necesidades del estudiantado y para conocer aún mejor el fenómeno objeto de estudio.

Financiación: este estudio ha sido financiado por una de las becas a la investigación científica sobre interculturalidad en el ámbito de la Ciudad Autónoma de Melilla del Instituto de las Culturas (publicado en BOME el 5 de diciembre de 2018). El proyecto también fue seleccionado para el programa de emprendimiento internacional de telefónica llamado Telefónica Open Future, en la convocatoria realizada en la Ciudad Autónoma de Melilla denominado “Ideas Melilla”. En este programa se enfocó el proyecto desde una perspectiva empresarial para que pudiera ser rentable, permitiendo de esta forma la autofinanciación y con ello su continuidad y mejora.

Este objetivo fue abordado en la publicación “Creando lazos interculturales entre las familias y los centros educativos de Melilla. La comunicación mediada por TIC como herramienta facilitadora de la inclusión educativa de las diferentes culturas”.

9.7. Limitaciones

Durante el proceso de la investigación se han encontrado diversas dificultades que se han conseguido subsanar con éxito. No obstante, han limitado ciertos aspectos de su realización.

En primer lugar, el estudio sobre la evaluación de las competencias digitales del profesorado en formación se realizó mediante su autopercepción sobre las mismas. Habría resultado interesante poder evaluar sus competencias digitales docentes en base al Marco Común Europeo de Competencias Digitales Docentes de una forma práctica para conocer con mayor exactitud y fiabilidad sus competencias digitales docentes. Posiblemente varíe la percepción sobre sus propias competencias respecto a las que realmente tienen.

Por otro lado, cabe destacar la dificultad espaciotemporal de cuadrar entrevistas presenciales con algunos de los expertos. Esto obligó a la realización de algunas de las entrevistas mediante métodos telemáticos. En las entrevistas presenciales los expertos suelen ofrecer mayor información debido a que oralmente durante una conversación se sienten cómodos y es más fácil hablar que tener que plasmar todo lo que piensan por escrito en un registro más formal.

9.8. Futuras líneas de investigación

La investigación realizada estudia un proceso importante sobre el que existe poca bibliografía, como es el uso de las nuevas tecnologías en contextos educativos socioeconómicamente desfavorecidos. Futuras investigaciones pueden contribuir a expandir el conocimiento sobre el tema y sobre aspectos más concretos que se hayan tratado en la presente tesis. En este sentido, los datos obtenidos permiten futuras líneas de investigación como las siguientes:

- Nuevas investigaciones sobre la implantación de tecnologías emergentes en contextos socioeconómicamente desfavorecidos con el fin de alcanzar una mejora educativa y del conjunto de la sociedad.
- Los resultados ofrecen una visión global del fenómeno estudiado. Futuras investigaciones pueden profundizar en aspectos más concretos como el papel de las familias o de los directores de escuelas en el proceso.
- Comprobar si la percepción de los futuros docentes sobre sus propias competencias digitales se ajusta a su competencia digital real.
- Aplicar los procesos recogidos en la investigación y ponerlos en práctica para arrojar mayor conocimiento sobre ellos. Por ejemplo, sobre la formación del profesorado, las metodologías empujadas, el proceso de implantación de las nuevas tecnologías en el aula, etc.
- Realizar el estudio en otras partes del mundo. La ciudad que se toma como referencia de contexto educativo socioculturalmente desfavorecido es Melilla y los expertos pertenecen a diferentes países de occidente. La realización del estudio en otras partes del mundo podría evidenciar nuevos factores que limiten la implantación de las nuevas tecnologías en educación. Por ejemplo, en países asiáticos el alumnado suele ser más pasivo (Mendoza, 2021; Zhong, 2013), por lo que situarlo en el centro de su aprendizaje y darle la iniciativa debe ser más complejo que en otros lugares.

Para finalizar, mencionar que el estudio ha terminado abarcando una mayor perspectiva del fenómeno que se pretendía estudiar. Originalmente el estudio estaba enfocado en la Ciudad Autónoma de Melilla, pero la información recogida abarca los contextos educativos socioeconómicamente desfavorecidos en su conjunto. Esto permite que las conclusiones extraídas de la información aportada por los informantes sean extrapolables a contextos similares, no únicamente a la Ciudad Autónoma de Melilla, siempre teniendo en cuenta las peculiaridades de cada lugar. Este hecho debe ser tenido en cuenta para las futuras líneas de investigación que puedan surgir a partir de esta tesis doctoral.

9.9. Decálogo “Elementos clave para alcanzar la implementación exitosa de las nuevas tecnologías en contextos educativos socioeconómicamente desfavorecidos”.

En base a los resultados obtenidos a lo largo de la realización de la tesis, se presenta a continuación un decálogo en el que se recogen los elementos clave que se han identificado y que permitirían la implantación de las nuevas tecnologías en contextos sociológicamente desfavorecidos. De esta forma se pretende aportar una herramienta para futuros estudios

1. El profesorado es el elemento más importante y por ello, también lo es su formación. La formación del profesorado debe emplear las nuevas tecnologías de forma pragmática. Debe tener conocimiento de los contenidos, de la herramienta y de la metodología necesaria para usarla. Además, deben poder llevar a cabo prácticas contextualizadas en entornos reales y supervisadas por otros docentes veteranos.
2. El estudiantado tiene un papel principal en su aprendizaje y es colaborador junto al profesor para implantar las nuevas tecnologías en clase. Se debe dotar al estudiantado de los dispositivos de forma equitativa y orientar para que hagan buen uso de ellos.
3. Contar con objetivos de aprendizaje claros y alineados con el currículo.
4. Disponer de un currículo enfocado en formar al alumnado en habilidades para la sociedad que habrá dentro de 10 o 15 años.
5. Generar un ambiente de aprendizaje crítico y emplear metodologías activas. Necesidad de despertar el interés del alumnado y situarlo en el contexto de aprendizaje.
6. La tecnología es solo una herramienta que debe apoyar el proceso de enseñanza-aprendizaje. Se debe seleccionar la tecnología que mejor nos permita alcanzar nuestros objetivos de aprendizaje e introducir la tecnología y la pedagogía de forma simultánea. Un uso excesivo de tecnología es igual de nocivo que su ausencia.
7. En contextos desfavorecidos se debe trabajar por adaptar la docencia y recursos disponibles al contexto y luchar por eliminar los prejuicios. Es muy importante el papel de las familias del estudiantado.

8. Para alcanzar un cambio educativo es necesaria la participación de toda la comunidad educativa (docentes, estudiantado, escuelas, universidades, gobiernos, etc)
9. Se requiere de tiempo además de apoyo y confianza en los docentes para conseguir apreciar los resultados.
10. La máxima meta es conseguir el autoaprendizaje permanente del profesorado y del alumnado.

9.10. Decálogo de inclusión de las nuevas tecnologías en contextos desfavorecidos.



9. Conclusions

9.1. General objective: Identify ways to improve the educational situation in disadvantaged socio-economic contexts through the implementation in education of new technologies to develop digital competence.

The survey on the perception of digital competences of trainee teachers in Melilla provides a better understanding of the main element for educational change in the city of Melilla. In what follows, the information gathered from teacher trainees of Melilla and international experts includes key factors regarding the methodology to be used, how to implement new technologies in socio-economically disadvantaged contexts, and what teacher training should involve. Finally, an example of the practical use of new technologies to improve the educational context in Melilla is shown. In this case, technology is not only used to teach content, but also to alleviate one of the main causes of one of the highest school dropout and failure rates in Europe: a problem of communication due to the linguistic diversity and illiteracy of part of the population. This shows that technology goes beyond being a didactic resource to one that can improve education from different perspectives.

The question posed in the general objective has been addressed in the five publications. The thesis has been structured in such a way that each of the specific objectives is achieved in an article, while a practical application of the use of new technologies in the context of the study is presented in the fifth publication. This allows for an in-depth analysis of the distinct aspects and provides a complete vision of the phenomenon studied.

9.2. Specific objective 1: Determine the perception of trainee teachers in Melilla regarding their shortcomings in digital competence.

The best results were obtained by trainee teachers at master's level, followed by primary education and pre-school teacher trainees. We observed that the higher the level of education, the more positive their self-assessment (Berrios et al., 2020; Gómez, 2015). Furthermore, the experience gained through teaching and self-training (Instefjord & Munthe, 2017) may have had an influence, as many of them had completed their degrees and were working after having received some additional training. In addition, each group of students received university training in digital competences according to

the level of education in which they would be working (Ramírez-Montoya et al., 2017). Those who would be teaching at higher levels of education were more concerned about acquiring better digital competence (Falcó, 2017). The learning outcomes were positive for all the degrees programmes analysed, although they point to the need for more and better training in digital competence (Escudero et al., 2019; Ortega-Sánchez et al., 2020; Rojo-Ramos et al., 2020). The students scored lowest was in Competence Area 4 related to safety (INTEF, 2017).

This objective was achieved in the publication entitled “Analysis of digital competence of educators (DigCompEdu) in teacher trainees: the context of Melilla, Spain”.

9.3. Specific objective 2: Seek suitable methodologies and pedagogies for the effective use of new technologies in the teaching-learning process.

The successful implementation of new technologies requires well-defined learning objectives and a contextualised curriculum. It is also essential to create a natural, critical learning environment (Sosa et al., 2017) and to train students mainly in competences (Klaassen et al., 2017) through active methodologies such as project-based learning and problem-based learning. This should be done by adapting the methodologies to the students’ context (Koehle et al., 2013; López Castellano et al., 2019) and competence level (Dong & Newman, 2016). In addition, the use of a wide diversity of methodologies should be avoided, as this can create confusion in the educational community, and it is important to instil confidence in their ability to teach.

Technology must support the learning process, not be at the centre of it (O’Flaherty & Phillips, 2015). When used correctly, technology can significantly enhance the teaching-learning process, but can be detrimental when misused (Cairns & Malloch, 2017; García-Carmona, 2019). It is important not to introduce technology before pedagogy because it would be counterproductive (Hennessy et al., 2015). Moreover, the new technologies should be integrated gradually in the classroom starting with basic functions and increase in complexity until their full potential is realised (Foronda et al., 2017). For this reason, the teacher is the most important element in the process (Gros, 2016).

This objective was addressed in the publication entitled “Teaching-pedagogical aspects regarding the integration of emerging technologies. The view of international experts”.

9.4. Specific objective 3: Determine how best to implement new technologies in disadvantaged socio-economic contexts.

The use of emerging technologies in socio-economically disadvantaged contexts promotes social inclusion through improved communication and collaboration (Wogu et al., 2018). New technologies (Fang et al., 2019) and digital literacy (Wilson et al., 2015) are essential for the benefits they offer. However, technology use cannot be based solely on financial affordability (OECD, 2010a). Technology that best suits the context should be used (Alshahrani & Ally, 2016) and resources must be provided to learners (Van Den Beemt & Diepstraten, 2016) to ensure equity and build trust among students. In addition to allowing sufficient time to achieve the desired outcomes (Bingimlas, 2009), critical thinking should be encouraged (Paul & Elder, 2003) and pedagogy should be used correctly (Alshahrani & Ally, 2016; Markus & Mentzer, 2014). A balance should be maintained (Claro et al., 2015), as the excessive use of technology is equally harmful and has the same impact on the digital divide (Hinojo-Lucena et al., 2021; Hohlfeld et al., 2008; Mérida-López & Extremera, 2017). To this end, students are vital in this process (Bocconi et al., 2013). Indeed, they must be given a central role in their learning and always be treated with empathy, although in order to achieve educational change, it is essential that the entire educational community be involved.

This objective was addressed in the publication entitled “The integration of emerging technologies in socioeconomically disadvantaged educational contexts. The view of international experts”.

9.5. Specific objective 4: Determine how to best train teachers in advanced digital competences so that they can develop the digital competences of their students.

Teachers need to learn to use technology in a practical manner (Pérez-Escoda et al., 2016; Siddiq et al., 2016) to support their teaching. Practical training with a veteran teacher in a variety of classroom settings is considered the best option (Van Acker et al., 2013). Basic digital competences should be acquired during initial training and

certification of having obtained a minimum level of digital competence should be required to become a teacher (Aslan & Zhu, 2017). Certification would also serve to verify and recognise the advanced digital competences of above-average teachers. In this regard, teacher education requires lifelong learning throughout the professional career. This can be done online (Laurillard, 2016) and feedback can be provided by other online communities (Tondeur et al., 2019; Trujillo et al., 2015). At the same time, to ensure quality, curricula need to be standards-based (Almerich et al., 2016). On the other hand, some teachers fear that their students know more about new technologies than they do (Cairns & Malloch, 2017) and this insecurity can lead teachers to not use them. Such fears are sometimes real. According to the literature, students are often more proficient in new technologies than their teachers (Cairns & Malloch, 2017; Wang et al., 2014). Therefore, student collaboration (Thieman & Cevallos, 2017) is important in teachers' own continuous learning as it enables them to see students as helpers, thus reducing their hesitation to use new technologies in the classroom. In this regard, it is important to support and motivate teachers so that they feel more confident in the use of new technologies (Archer et al., 2014) and valued (Drossel et al., 2017).

This objective was addressed in the publication entitled “Teacher training for educational change: the view of international experts”.

9.6. Specific Objective 5: Use new technologies to improve the educational situation in the city of Melilla.

The final version of the instant messaging app includes the main features that allow for simultaneous transcriptions and translations between several speakers. The features of the app can improve communication between schools and students' families (García-Carmona, 2014; Trujillo Torres, et al., 2012), allowing them to become more actively involved with the school (Henderson & Mapp, 2002; National PTA, 1998, 2000, 2000, 2007, 2010; Henderson & Berla, 1994; Olivos, 2010). Due to the limited funding obtained for the project, we were unable to develop a native app and it was created from other applications. This functional version shows the potential of the tool. In the future, we will continue working on a new version with new functions and features that will allow us to better tailor the app to the needs of schools (Ruiz-Montero, et al., 2019; Chuang, 2005) and families (Bas Peña & Pérez de Guzmán, 2010; García-Carmona,

2020). The app is intended to have a real and practical application (Sáenz, 2007, cited in Aguilar Ramos and & Leiva Olivencia, 2012) and to contribute to improving the educational situation in Melilla. In the future, the possibility of developing a native app that does not require the support of other apps to work is being considered. We are also considering the possibility of including among its functions the analysis of the data or metadata obtained (respecting users' privacy) to better meet students' needs and learn more about the phenomenon under study.

Funding: this study was funded by one of the grants for scientific research on interculturality in the Autonomous City of Melilla awarded by the Institute of Cultures (published in the Official Gazette of the Autonomous City of Melilla [BOME] on 5 December 2018). The project was also selected for the Telefónica telecommunications company's international entrepreneurship programme Telefónica Open Future in the call held in the Autonomous City of Melilla called "Ideas Melilla". In this programme, the project was approached from a business perspective so that it could be profitable, thus enabling self-financing and its continuity and improvement.

This objective was addressed in the publication entitled "Creando lazos interculturales entre las familias y los centros educativos de melilla. la comunicación mediada por TIC como herramienta facilitadora de la inclusión educativa de las diferentes culturas" (Creating intercultural links between families and schools in Melilla. ICT-mediated communication as a tool to facilitate the educational inclusion of different cultures).

9.7. Limitations

Several difficulties were encountered during the research process but were successfully overcome. Nonetheless, they have limited certain aspects of its implementation.

Firstly, trainee teachers' digital competences were assessed by means of their self-perception of these competences. However, it would have been interesting to assess their digital teaching competences in a more practical manner in line with the European Framework for the Digital Competence of Educators (DigCompEdu) to determine their digital teaching competences more accurately and reliably, since the teacher trainees' perceptions of their own competences may differ from their actual competences.

Secondly, it is worth noting the difficulty of scheduling face-to-face interviews with some of the experts. This made it necessary to conduct some of the interviews in writing. In face-to-face interviews, experts tend to provide more information because they feel more comfortable speaking and it is easier to talk than having to write down their ideas in a more formal register.

9.8. Future lines of research

The research has addressed an important process on which there is little literature, namely, the use of new technologies in socio-economically disadvantaged educational contexts. Future research may contribute to expanding our knowledge on the subject and on more specific aspects that have been dealt with in this thesis. In this regard, the data obtained open up new avenues for future research such as:

- The implementation of emerging technologies in socio-economically disadvantaged contexts to improve education and society as a whole.
- The results provide an overview of the phenomenon studied. Future research could delve deeper into more specific aspects such as the role of families or heads of schools in the process.
- Determine whether prospective teachers' perception of their own digital competence is in line with their actual digital competence.
- Apply the processes addressed in the research and put them into practice to gain more knowledge about them, such as teacher training, the methodologies used, the process of implementing new technologies in the classroom, etc.
- Perform the study in other countries. The city taken as a reference for the socio-culturally disadvantaged educational context is Melilla, Spain, and the experts were from various Western countries. Conducting the study in other parts of the world could reveal new factors that limit the implementation of new technologies in education. For example, in Asian countries, students tend to be more passive (Mendoza, 2021; Zhong, 2013), so it may be more difficult to place them at the centre of their learning and give them the initiative than in other parts of the world.
- Finally, it is worth mentioning that the study has covered a wider perspective of the phenomenon than was originally intended. The study originally focused on

the Autonomous City of Melilla, but the information gathered is applicable to socio-economically disadvantaged educational contexts in general. This allows the conclusions drawn from the information provided by the informants to be extrapolated to similar contexts (not only to the Autonomous City of Melilla) taking into account the specific characteristics of each location.

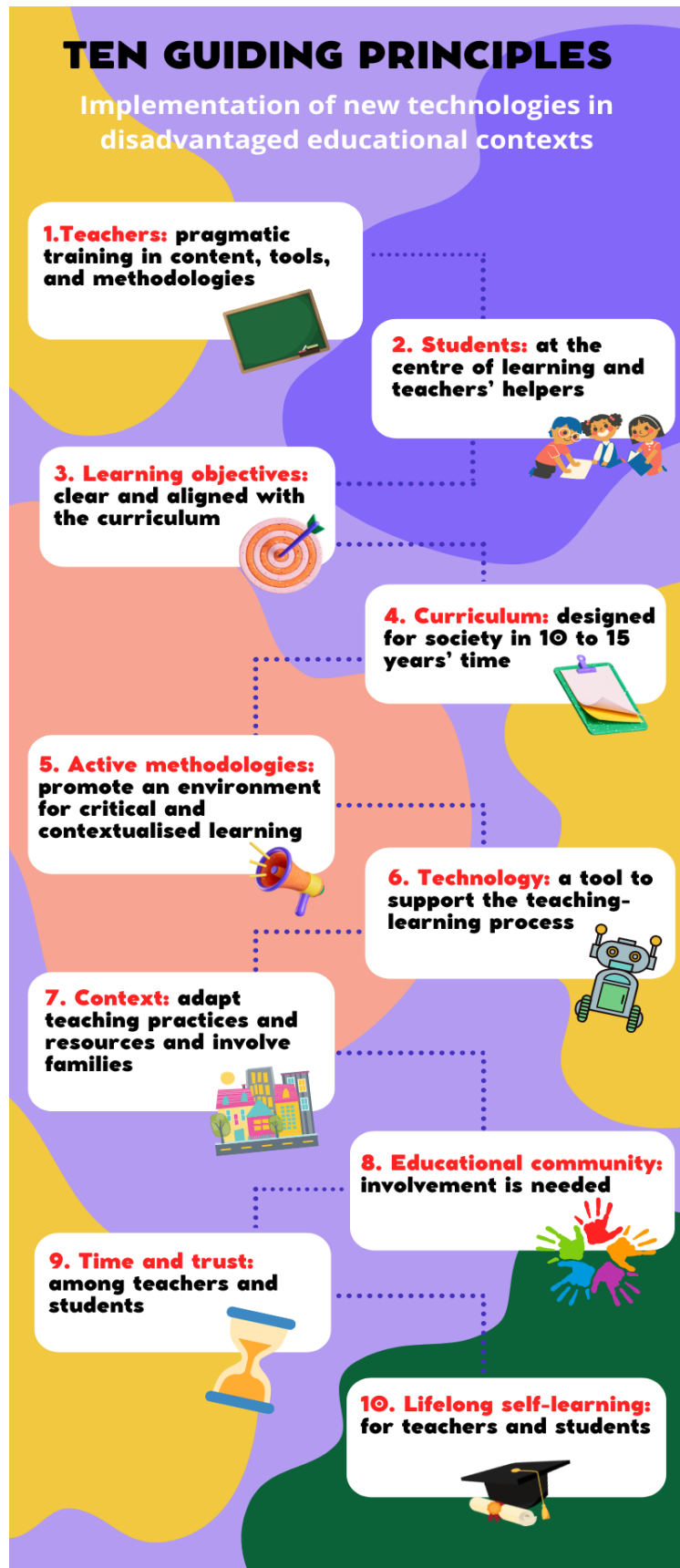
9.9. Ten guiding principles to successfully implement new technologies in socio-economically disadvantaged educational contexts.

Based on the results obtained over the course of the thesis, below we present ten principles for the successful implementation of new technologies in socio-economically disadvantaged contexts that may serve to guide future studies.

11. Teachers are the most important element as is the training they receive. Teachers must be trained to use new technologies in a pragmatic way. They must have knowledge of the content, the tools, and the methodology needed to use them. In addition, training must be of a practical nature and contextualised in real environments under the supervision of veteran teachers.
12. Students play a key role in their learning in partnership with the teacher in implementing new technologies in the classroom. Students should be provided the necessary devices in an equitable way and receive guidance to ensure they use them properly.
13. Clear learning objectives should be set in line with the curriculum.
14. The curriculum should focus on training students in skills for society that will be useful in 10 to 15 years' time.
15. A critical learning environment and the use of active methodologies should be fostered. It is important to stimulate students' interest and place them at the centre of their learning.
16. Technology serves only as a tool to support the teaching-learning process. Therefore, it is important to select the technology that best enables us to achieve our learning objectives and introduce the technology and pedagogy simultaneously. The excessive use of technology is just as harmful as not using it at all.

17. In disadvantaged contexts, efforts must be made to adapt teaching practices and the available resources to the context and to eradicate prejudices. Students' families play a very important role in this process.
18. To achieve educational change, it is essential to involve the entire educational community (teachers, students, schools, universities, governments, etc.).
19. It takes time as well as support and trust in teachers to see results.
20. The ultimate goal is to promote lifelong self-learning among both teachers and students.

9.10. Ten guiding principles for integrating new technologies in disadvantaged educational contexts.



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