Journal of Information Technology Education: Research

An Official Publication of the Informing Science Institute InformingScience.org

JITEResearch.org

Volume 17, 2018

FACTORS WITH INFLUENCE ON THE ADOPTION OF THE FLIPPED CLASSROOM MODEL IN TECHNICAL AND VOCATIONAL EDUCATION

M. Teresa Villalba*	Universidad Europea de Madrid, Madrid, Spain	maite.villalba@universidadeuropea.es
Guillermo Castilla	Universidad Europea de Madrid, Madrid, Spain	guillermo.castilla@universidadeuropea.es
Sara Redondo-Duarte	Universidad Europea de Madrid, Madrid, Spain	sara.redondo@universidadeuropea.es

* Corresponding author

ABSTRACT

Aim/Purpose	The aim of this work is to explore which factors impact on the adoption of the flipped classroom in vocational education to pave the way for the schools which want to apply this model.
Background	Although various experiences in the use of the flipped classroom have been reported in recent years in the literature, fewer efforts have been done on how to implement this model from a pedagogical standpoint. The factors that influence its adoption have not been studied in depth, at least not in a global way. These factors include the use of technology and teaching methodologies active in the classroom, the trend towards innovation of teachers and schools, and whether teachers have the necessary ICT training and infrastructures. Moreover, although the results of many experiences in Higher Education have been published, this is not so for other levels of education, such as vocational schools.
Methodology	A quantitative research method was used by constructing a questionnaire. The questionnaire included open questions in order to obtain qualitative information, which enriched the results obtained. Descriptive and factor analysis was used to analyze data, within the framework of the project FlipIT!–Flipped Classroom in the European Vocational Education", ERASMUS+ Strategic Partnership (2015-1-HU01-KA202-013555) funded by the European Union, with the participation of Hungary, the United Kingdom, Ireland, the Czech Republic, and Spain. The research sample includes 625 teachers (434 from

Accepted by Editor Tian Luo | Received: April 26, 2018 | Revised: July 9, August 20, September 16, 2018 | Accepted: September 17, 2018.

Cite as: Villalba, M. T., Castilla, G., & Redondo-Duarte, S. (2018). Factors with influence on the adoption of the flipped classroom model in technical and vocational education. *Journal of Information Technology Education: Research, 17,* 441-469. https://doi.org/10.28945/4121

Spain, 121 from Hungary and 61 from the Czech Republic) from schools participating or somehow associated to the project.

Contribution — An empirically validated framework of the factors influencing the adoption of the flipped classroom approach in schools was obtained. This framework can guide the curriculum design of flipped classroom model courses for vocational education teachers.

Findings — Empirically validated factors for the adoption of the flipped classroom in technical schools are presented.

In addition, descriptive analysis results from a sample of 625 vocational education teachers confirmed that the countries involved in the survey fulfill the factors needed for the adoption of the flipped classroom in vocational education schools. Another important result is that, according to the surveyed teachers, the flipped classroom is a strongly practice-oriented method very suitable for vocational education.

Recommendations for Practitioners — The framework here presented can guide the curriculum design of flipped classroom model courses for vocational and technical education teachers and allow schools to know the factors to review and improve in order to use the model.

Recommendations for Researchers — This study is a first step toward determining the factors needed for the adoption of the flipped classroom model in vocational and technical schools. More studies using alternative data sources and methods are needed to obtain a definite model to support this adoption since FC has proved to be a very successful model for motivating students. We hope these results pave the way for schools who want to adopt the FC model and for focusing teaching training on the competences that this work detected.

Impact on Society — Recently, we are witnessing an important debate about the future of education at every level. Different innovative methodologies have emerged in a search for more motivating and effective ways to learn, as well as to develop in our students the so-called 21st-century skills such as critical thinking, communication and collaboration, creativity, and information, media and technology skills. The flipped classroom approach can help to improve vocational education by changing traditional classes and teaching students other important soft skills, such as teamwork and collaboration, reflection, digital skills, and self-study.

Future Research — The model is currently being implemented in schools in Spain, Hungary, and the Czech Republic using the results obtained here under the framework of the European project "FlipIT!–Flipped Classroom in the European Vocational Education", ERASMUS+ Strategic Partnership (2015-1-HU01-KA202-013555). After checking the criteria obtained in the framework for each of the participating schools, as a first step, an online course has been created using the competences obtained in this framework, both pedagogical and ICT. Once the course is completed, the teachers will carry out a pilot project to use the model. We hope the framework is useful to other researchers in order to implement the model in other countries and extend it with other criteria to obtain a validated international framework. This study is a first step toward determining the factors needed for the adoption of the flipped classroom model in technical schools. More studies using alternative data sources and methods are needed to obtain a definite model to support this adoption since FC has proved to be a very successful model for motivating students. We hope these results pave the

way for schools who want to adopt the FC model and for focusing teacher training on competences.

Keywords flipped classroom approach, inverted classroom, active learning, educational technology

INTRODUCTION

Recently, we are witnessing an important debate about the future of education at every level. Different innovative methodologies have emerged in a search for many motivating and effective ways to learn, as well as to develop the so-called 21st-century skills such as critical thinking, communication, and collaboration, creativity, and information, media, and technology skills (Bellanca & Brandt, 2010) in our students. One of the most used and researched methodologies is the flipped classroom. The last 3 years of Horizon reports of higher education highlighted the flipped classroom model as one of the six important developments in Educational Technology for Higher Education in the category of digital strategies (Johnson et al., 2016; Johnson, Adams Becker, Estrada, & Freeman, 2015, 2014).

There is no clear consensus on the definition of flipped learning; however, most researchers agree that in a flipped classroom tasks traditionally carried out in the classroom must take place outside the classroom, and vice versa, i.e., homework in the classroom (Al-Zahrani, 2015). In essence, it is not a new concept: homework to do before class, such as studying or reading-up on a lesson, has been used for a long time. What makes a flipped classroom different is the systematic use of technology to deliver declarative knowledge. The use of online videos is very similar to a master class, and the tools of today make it easy for teachers to create their own videos, which has given a boost to this model. This allows better use of the time in class to learn through practice, which is proven to lead to significantly better long-term retention (Clark & Mayer, 2008). Among the limitations, some authors include the difficulty to engage students in their own learning at home, as well as in group discussions in the classroom (Tanner & Scott, 2015).

Spain has been leading the list of early leavers from education in Europe since 2011 (Eurostat, 2017), with a high percentage of students who drop out at an early age (16 years). This is motivating a national movement of innovation from teachers and institutions in the last years in search for new educational methods that fit the needs of the current student profile. A crucial stage of education is secondary education. This stage is the last obligatory educational stage that prepares some students for the labor market. This is even more important for students who choose vocational education. In an attempt to motivate children and youth, in past years, teachers and researchers are testing new methodologies, most of which involving technologies and more practical approaches in order to adapt education to the new learners. Among them, flipped learning has received a lot of attention these last years in higher education, but there are not many experiences published in the case of vocational and technical education. According to CEDEFOP (European Centre for the Development of Vocational Training), VET is "the Education and training which aims to equip people with knowledge, know-how, skills and/or competences required in particular occupations or more broadly on the labor market" (CEDEFOP, 2014). Vocational education is characterized by learning by doing, because of the high number of hours of practice needed. Flipped learning can help here by moving the theoretical content outside the classroom, and using class time for practical activities. In Spain, high youth unemployment rates are shifting the attention to technical schools, promoting youth to study a vocational program and strengthening vocational studies. Innovative models such as flipped learning can help improve the quality of vocational education, motivate students, and thus reduce the number of dropouts. The flipped classroom approach offers the opportunity to move away from theory-based summative assessment methods to more practical activities and assessments based on developing students' real-world skills. Since in Vocational Education students learn by doing, the flipped classroom approach could give teachers more face-to-face time with their students to focus on work-orientated scenarios. The flipped classroom also encourages the use of learning by doing using active methodologies such as work-based learning. In addition, if work-based learning were carried out in partnership with companies or non-profit organizations, it would facilitate student's connection with professional work starting in their first academic year.

This work is part of a research project funded by the European Union "FlipIT!–Flipped Classroom in the European Vocational Education", ERASMUS+ Strategic Partnership (2015-1-HU01-KA202-013555). The main objective of the project is to improve the quality of learning in technical schools by adapting the flipped learning model to vocational education.

The paper is organized as follows: the next section summarizes the related work about the factors that support or decline the use of flipped learning in education; then, the research methodology used in this work is detailed; next, the results from data analysis are presented followed by a discussion of the results. Finally, the conclusions and the future directions of work are presented.

Related Work

The education landscape is undergoing significant change as a result of technological innovations. These new technologies and approaches to education are already having a clear and positive impact on the provision of higher education (High Level Group on the Modernisation of Higher Education, 2014). Flipped or inverted classrooms have become increasingly popular, and sometimes controversial. The flipped classroom approach consists of teaching and learning activities where students watch a video lesson outside the class through distance learning and have hands-on activities in the class (Hamdan, McKnight, McKnight, & Arfstrom, 2013). The activities traditionally conducted in class are now conducted during the students' own time before class. In many definitions and models, this means students watch a video of pre-recorded lectures before class. Then, when they are in class, they work through assignments or activities with their peers and the instructor.

The idea of the flipped classroom came about during the early 19th century. The United States Military Academy at West Point created a set of teaching methods, i.e., students utilized sources provided by their teachers to learn before class, while classroom time was used for group cooperation to solve problems jointly. This teaching method reflected a basic concept of the flipped classroom (Z. Wang, 2014). In 2007, high school teachers Sams and Bergmann from the state of Colorado began recording their classes for students who could not attend to their lectures. After some time, they found that the majority of their students used these videos for repetition during homework. This formed the basis of the flipped classroom teaching methods (Bergmann & Sams, 2012).

The flipped classroom model agrees with the idea of blended learning. In blended learning, traditional classroom methods are combined with online digital media. The flipped classroom includes some elements of student control over time, place, path, and/or pace because the model allows students to choose the location where they receive online content and instruction and to control the pace at which they move through the online elements (Staker & Horn, 2012). The use of technology is a key component in allowing lectures to be pre-recorded and made available to students outside of the classroom setting. However, as Sams and Bergmann (2012) claim (Sams & Bergmann, 2013), "Ultimately, flipping a classroom involves shifting the energy away from the instructor and toward the students and then leveraging educational tools to enhance the learning environment."

This instruction methodology is based on the premise that "direct instruction and lecture is not an effective teaching tool in the group learning space but is effective when delivered to the individual (Sams & Bergmann, 2013). Thus, the flipped classroom model describes a reversal of traditional teaching where students gain first exposure to new material outside of class, usually via reading or lecture videos, and then class time is used to do the harder work of assimilating that knowledge through strategies such as problem-solving, discussion, or debates.

Proponents of the flipped classroom approach provide many arguments for engaging students in the content outside of the class to free up time in class, such as increased student engagement, strengthening of team-based skills, personalized students guidance, focused classroom discussion, and creative freedom of faculty while maintaining a standardized curriculum (Milman, 2012). On the other hand, Enfield (2013) discusses concerns with accessibility to instructional resources being provided online, the growing move towards no homework, increased time requirements without improved pedagogy, lack of adapting the lesson environment to reflect the flip classroom's ability to support student-centered learning, and the use of lectures without taking into account the individual students learning styles.

The theoretical foundations used for justifying the flipped classroom typically focused on reasons for not using classroom time to deliver lectures. This change is usually motivated by a desire to give students the opportunity to learn through active participation in the classroom. According to Piaget (1971), people actually learn something when they have developed a system of knowledge that allows them to transform (actively) the object of their thinking, adjusting it to the reality that surrounds them. One method to facilitate these processes is to propose to students practical activities that engage them to participate actively in the classroom, thus allowing the teacher to act as a guide in the creation of said knowledge processes. In this trend, the flipped classroom offers opportunities for students to learn through a variety of different kinds of activities, participating actively in the classroom. For example, some studies recommend use other forms of active learning together with flipped classroom, such as, collaborative learning, cooperative learning, and problem-based learning which are broadly used group learning activities with varying levels of support (DeLozier & Rhodes, 2016).

One of the most comprehensive reviews of the existing literature is due to O'Flaherty and Phillips (2015). In the review, about thirty implementations of flipped learning in higher education are described in certain detail, although O'Flaherty and Phillips's article focuses on higher education. Throughout the literature review for this paper, it was difficult to find research in primary and secondary education, as higher education was the level where the great majority of research lay. For vocational education, there are a certain number of peer-reviewed articles but mostly centered around case studies and experiences, such as Camacho (2014).

A more recent systematic review, but focused only on Engineering, examines 62 studies on flipped learning in engineering education (Karabulut-Ilgu, Jaramillo Cherrez, & Jahren, 2017). The paper states that there is a lack of theoretical or conceptual frameworks guiding the development and evaluation of the flipped approach. Following this trend, an editorial for the flipped classroom special issue monographic (Song, Jong, Chang, & Chen, 2017) summarizes how "there is still a pressing need for studying 'HOW' to implement the flipped classroom and, moreover, to be able to connect this pedagogical design with evidence of advantages related to various aspects of student learning." The same editorial underlines concerns related to a series of factors that have been taken into concern in this study. Namely, that literature reveals that most published studies on the topic of flipped classroom either do not present a pedagogical design or lack a theoretical foundation for said design (Kim, Kim, Khera, & Getman, 2014). Also, since the flipped classroom presents such mixed results on students' learning outcomes and students' perceptions on the methodology vary greatly, in order to create a solid foundation, research must be approached from multiple angles, as presented in Jungić, Kaur, Mulholland, & Xin, (2015) or implementations linked to the Flip-IT European Project.

Vocational education, the educational level on which this article focuses, goes particularly untapped by researchers, although some experiences in the classroom have been published (Camacho, 2014; Little, 2015). In Malaysia, authors Embi, Hussin, and Panah (2014) have established some pedagogical grounds on which to establish implementations in all levels of education including a flipped learning readiness survey instrument. This instrument is being used by other Southeast Asian researches such as Techanamurthy, Alias, and Dewitt (2015) in their implementations in vocational education.

In Europe, institutions like the University of Winchester have created reports on how to approach teaching vocational education from a pedagogical standpoint (Lucas, Spencer, & Claxton, 2012), but there are no joint efforts among these lines, and it would seem that there is no central reference frame but a series of isolated initiatives. There are evidences of focus groups picking up on vocational education and upper secondary school students' opinion and standpoint on the flipped classroom in Sweden and in Spain (Fernández Gámez & Guerra Martín, 2016; Ölmefors, 2016), as well as a Spanish initiative that made an effort to establish a comparison between the application and non-application of flipped classroom to different educational levels (including vocational education) (González Velasco et al., 2017). In every case, sample sizes were small (n<30), the theoretical framework they were based on was unscaffolded in various areas, and, as it was established before, they were isolated in nature.

All in all, the international vantage point that the Flip-IT project starts off from provides the implementations which arise from it a solid methodological base that will be discussed in this paper.

RESEARCH METHODOLOGY

The aim of this research was to carry out an analysis of the needs in order to obtain a clear understanding of the current situation and know the requirements needed to use flipped learning in vocational education. We focused mainly on teachers' perception since our primary concern is to know the knowledge, motivation, and needs that teachers have to apply this model. The methodology applied was both qualitative and quantitative. Studies based on quantitative data allow conclusions that can be generalized, however, do not provide context information. Qualitative evaluations make a good complement allowing one to do the following: study the underlying reasons to the obtained data in the quantitative surveys; understand some of their results; study in depth the dimensions, even identify some others not identified yet, but that worry the respondents; and; finally, provide decisive information from the perspective of the participants. The instrument used in the study was a questionnaire with both Likert-scale and open-ended questions to collect quantitative and qualitative data. The questionnaire was composed of an initial section explaining the goal of the study and collecting anonymous demographic data, and another section with the questions based on the previously defined hypothesis.

The flipped classroom is an innovative model that makes extensive use of technology. According to other studies, there are several factors that influence the use of technology in teaching methodologies, the most repeated in the revised bibliography are teacher training, level of resources, pedagogies and teaching practices, attitudes of teachers, ICT competence, and positive attitude towards innovation (Bordbar, 2010; Buabeng-Andoh, 2012; Cox, Cox, & Preston, 1999; Hernandez-Ramos, Martinez-Abad, Penalvo, Garcia, & Rodriguez-Conde, 2012; Marcinkiewicz, 1993; Peralta & Costa, 2007; van Braak, 2001; Woodrow, 1990). In addition, FC requires the use of technologies, both outside and in the classroom, so we need to have the appropriate ICT infrastructure (computer or tablet and Internet connectivity at least). Students need to watch videos or other educational resources proposed by the teacher before having the session in the classroom with the teacher and the rest of their classmates. Therefore, they need equipment and Internet access in their homes, and also in schools. With regard to the possibility of accessing the Internet from their homes, Eurostat (Statistical Office of the European Communities) publishes statistics every year on the use of ICT in homes in all EU countries (questionnaire "Internet access and use statistics - households and individuals ") (EuroStat, 2018). These data are obtained every year from public consultation of the EU member countries. The questionnaire includes questions about whether the respondents have the necessary infrastructure to access the Internet from their homes, both in relation to the necessary hardware (PC or laptop, tablet, mobile, etc.) and to the Internet connection. These data are public and accessible on the Internet. The dataset is also public and allows you to filter by certain parameters such as age, country, and level of studies. For this reason, we do not include in our instrument any question about the availability of the ICT infrastructure necessary to implement the model in the homes. Instead, we use such data collected by Eurostat. According to this dataset, all of the participant's countries of the project (Spain, Hungary, and the Czech Republic) have very similar figures in the last published statistics (Eurostat, 2016). The percentage of households with Internet access was of 82% for Spain and the Czech Republic, and 81% for Hungary. Thus, the level of infrastructure of households is very similar in all three countries with levels slightly below the median of the European Union (the median for EU-28 was 85%).

Based on these factors with an influence on the application of technology in teaching methodologies, and bearing in mind that the purpose of the study was to know the factors which impact on the application of FC in vocational schools in Hungary, the Czech Republic, and Spain, the research questions considered here were:

- RQ1: What other active innovative pedagogical practices influence teachers to apply FC?
- RQ2: What attitudes do teachers have towards the introduction of the flipped classroom as a new innovative teaching methodology that includes the use of technology?
- RQ3: What IT skills do teachers need for applying the FC model?
- RQ4: Which training do teachers need to apply the FC model: pedagogical or technological aspects of using the FC model or both?
- RQ5: What ICT infrastructures do technical school teachers need to implement FC?

Instrument Design

Through these research questions, 5 dimensions were defined in order to design the instrument: teachers' innovative practices, teacher´s attitudes, teachers' IT skills, teachers' training, and ICT infrastructures in schools. Factors were collected from the literature review (Buabeng-Andoh, 2012; Hamdan, McKnight, & McKnight, 2013; Kwan Lo & Foon Hew, 2007; Špilka & Maněnová, 2014; Vuorikari, Punie, Carretero Gómez, & Van Den Brande, 2016; T. Wang, 2017; Wolff & Chan, 2016). Once all the factors were collected, they were cleaned, grouped and analyzed by a focus group of experts from the multinational research group working on the European research project. The group included 10 researchers and pedagogues with experience in the flipped classroom model from Hungary, the Czech Republic, the United Kingdom, Ireland, and Spain, and 6 vocational school teachers. The final number of factors was 92. Based on these factors, an online questionnaire was created using the online tool provided by the European Commission, EUSurvey. Before applying the survey to the sample, we conducted content validation of the instrument through an inter-judge method. Twelve external experts, all of them teachers and/or researchers with a doctoral degree in a related area, more than 10 years of experience in innovative education, and at least 1 academic year in the application of FC, were asked to complete the questionnaire in order to qualitatively and quantitatively evaluate the instrument. Every section was evaluated (scope of the study, demographic data, and dimensions) on a Likert scale of 5 points for clarity, validity, and relevance. A space for suggestions in each question and dimension was also provided. Kendall's coefficient of concordance (W) was calculated to assess the degree of agreement between experts (Kendall & Smith, 1939). The Kendall concordance coefficient provides an index of the agreement between different sets of rankings. Kendall's W varies from 1 to 0, where 1 equals a full agreement and 0 does not equal an agreement between the judges. The quantitative analysis showed moderate inter-assessors' reliability with Kendall's W values among 0.33 and 0.72 ($p>.001$). There was also very good internal consistency for the seven sections with Cronbach's alphas from 0.811 to 0.972, with 0.7 conventionally considered as an acceptable reliability (Tabachnick & Fidell, 2013). The qualitative answers were also analyzed. The proposed changes were all minor, and related to the clarity of some questions or answer options. Therefore, they were all included after agreement by the research group of experts.

Finally, the online self-administered questionnaire was disseminated via email to teachers. (See the Appendix for a copy of the questionnaire.

Data Collection

The survey process collected a total of 625 completed and valid answers. The sampling error with 95% of the confidence interval is 3.9. Table 1 shows the responses per country and per stage of education. As shown in Table 1, out of those 625 valid surveys, 27% would correspond to lower vocational school teachers, whilst the remaining 74% would be upper vocational school teachers. Table 1 includes the data segregated by countries, where the number of respondents per country is also indicated: 121 for Hungary, 434 for Spain, and 61 for the Czech Republic.

Table 1. Distribution of responses by country and educational level

Respondents	Hungary	Spain	Czech Republic	Respondents p/ stage of education
Lower vocational education (12-14 years old)	18%	5%	4%	27%
Upper vocational education (15-17 years old)	21%	39%	14%	74%
Respondents per country	120	444	61	62%

From a demographic standpoint, process data showed that 72% of surveyed teachers were between 36 and 54 years old, 19% 35 or younger, and the remaining 9% were 55 or older, with no significant variation in distribution attending to the countries of origin.

Age is evenly distributed with 43% male and 57% female respondents. In this case, Spain presents an equal number of males versus females, whilst in Hungary females outnumber males approximately 2 to 1, and in the Czech Republic the other way around with a ratio of 1 to 2. From the point of view of teaching experience, 40% of surveyed teachers had more than 15 years of teaching experience, 37% from 6 to 15 years, and 24% less than 5. Segregating by nationality, Hungarian instructors counted were mainly very experienced (74 out of 103 had more than 16 years of teaching experience), the majority of Spanish instructors (56 of 118) had from 5 to 15 years of teaching experience, finally the Czech Republic data was collected from less experienced instructors with the majority (17 out of 47) having less than 5 full years of experience. The level of studies of instructors was mainly ISCED level 6 studies (Bachelor's or equivalent level) and 7 (Master's) with circa 82% of respondents at that level. Hungary is the country with the strongest formative background, with only 2 of 103 instructors educated at Bachelor's degree level, and the remaining instructors at Master's degree level, while Spain (17 of 47) and the Czech Republic (10 of 47) compose the bulk of the earlier stated 11%.

Most institutions are small, with 40% of them having between 200 and 500 students and close to 60% of them have less than 50 teachers. Hungarian institutions are somewhat larger with approximately the same amount of schools with 500 to 1000 students as smaller ones. Spanish surveyed schools have the least average number of students with almost half of them with less than 200 students. Czech schools follow the aggregated averages both for students and for teachers, without any remarkable outliers.

On the other hand, to drive change, we need not only to have the knowledge, motivation, and attitudes to do it but the institutional support too. So, a question about whether schools support teachers with innovation was added to the questionnaire. Teachers perceive that innovation is usually accepted and encouraged, however innovative endeavors are considered to be individual initiatives in 49% of cases, and as the result of a group consensus in 51% of cases. Table 2 compares individual efforts versus institutional and group backing of innovative initiatives segregated by countries. Here we see that Hungary, currently undergoing a technological renewal of its school technologies, encourages institutional backing of innovative initiatives whilst in Spain and the Czech Republic most initiatives are of an individual nature.

Table 2. Individual efforts versus institutional and group backing of innovative initiatives

Respondents	Hungary	Spain	Czech Republic	Respondents p/ support type
Individual efforts	31	74	25	130
Institutional backing	72	44	22	138
Respondents per country	103	118	47	268

Reliability and Construct Validity

Reliability and construct validity were analyzed using IBM SPSS Statistics 21. Firstly, the item-total correlation indices were analyzed in order to evaluate the contribution of each item to the total scale. Two questions, 13.12 and 13.13 of the questionnaire (see the Appendix) showed low item-total correlation (<0.3) meaning that they were a low relation with the rest of questions. Those questions were the following: (13.12) not all of the students have tools for watching videos or reading the online text; and, (13.13) it makes it difficult to ensure students' accountability. After analyzing the relationship of these questions with the dimension in which they were defined, we realized, in fact, that their (semantic) relationship with the rest is low since they are both more related to the students than to the attitudes of the teachers themselves, so they were eliminated to reach greater reliability. After elimination, the number of items was 44. Next, the internal consistency reliability was tested using Cronbach's alpha coefficient. This measure helps to verify if all the factors measure the same concept and if the results are precise and consistent. The conventional minimum for Cronbach's alpha coefficient is established in 0.7 (Tabachnick & Fidell, 2013). The Cronbach's alpha was calculated for the total questionnaire and for each dimension. The final Cronbach's alpha coefficient values for each dimension and total scale range from 0.723 to 0.919 demonstrating that results are consistent and precise. It was checked too that Cronbach's alpha coefficient is greater without the 2 items before their elimination (13.12 and 13.13), for cross-confirmation of their elimination.

Construct validity is the degree to which the instrument measures the construct. Factorial analysis, specifically Exploratory Factorial Analysis (EFA), was used for each dimension. Firstly, the conditions for applying EFA were checked (Kaiser-Meyer-Olkin test, commonly known as KMO, and Bartlett's test of Sphericity). Both showed that factorial analysis could be applied with Sig.<0.000 (Barlett's test significance) and KMO 0.864, which is considered a meritorious value (Tabachnick & Fidell, 2013). The factorial analysis showed a structure that was slightly different than the originally proposed dimensions deducted from the research questions. The structure obtained had 6 components instead of 4. After analysis of the factors included in each component, it can be observed that they are the same except that the dimensions "innovative methodologies" and "teacher training" have each been separated into two components. The new components were renamed based on the factors included, as is shown in Table 3. Table 3 shows the final values for reliability and construct validity with the final structure, as well as the equivalence with the initial research questions. As can be observed, Cronbach's alphas are all above 0.7, and KMO too; both are considered good values (Tabachnick & Fidell, 2013). Chi-square distribution values (Chi-square) with their degrees of freedom (d.f.) are shown too in the table.

Table 3. Reliability and construct validation final results

Research question	Factor	Cronbach's alpha	KMO	Bartlett's test
RQ1	**Teacher pedagogies and innovative practices**	0.723	0.714	Sig. 0.000 d.f. 21 Chi-square 302.335
	Project-based learning			
	Collaborative learning			
	Cooperative learning			
	Problem-based learning			
	Inquiry-based learning			
	Game-based learning			
RQ2	**Teachers' attitudes on FC**	0.821	0.847	Sig. 0.000 d.f. 45 Chi-square 580.783
	The pedagogical methodology is essential; it is not only about introducing technology			
	It helps me to collaborate more intensively with my students			
	It enables parents' involvement			
	It is motivating in practice-oriented subjects			
	It makes the teaching process more enjoyable			
	It gives me a chance to develop professionally			
	Although I need time the first time to search or produce resources, it will allow me to reuse and improve learning materials			
	It allows to make students responsible for their own learning			
	It may support a work-based approach			
	It helps to develop 21st-century skills in the students (creativity and innovation, critical thinking, communication, and collaboration)			
	It requires more class time than traditional methods			
RQ3	**IT skills**	0.919	0.918	Sig. 0.000 d.f. 36 Chi-square 1326.345
	Basic IT skills			
	Digital pictures			
	Creating videos			
	Creating/modifying animations			
	Use of blogs			
	Creation of concept maps			
	Creation of digital timelines			
	Hypertext			
	Presentations			
	Social networks			

Research question	Factor	Cronbach's alpha	KMO	Bartlett's test
RQ4	**Teachers' pedagogical training in FC**	0.873	0.861	Sig. 0.000 d.f. 45 Chi-square 1076.746
	Designing class activities			
	Preparing FC lesson plans			
	Learn strategies to integrate at-home and classroom phases			
	Assessment of students' work in FC lessons			
	Assessment of students' processing new information at home			
	Managing the collaboration of students in class time			
	Problem-solving team-work strategies			
	Teachers' ICT training in FC			
	Creating. editing and publish attractive learning content			
	Find quality, free and meaningful educational applications			
	Designing interesting and attractive digital presentations			
Total		0.821	0.825	Sig 0.000 d.f. 903 Chi-square 5001.661

RESULTS

After confirming the reliability and validity of the construct, we will report the results of the descriptive analysis of the data in order to answer the initial research questions.

INNOVATIVE METHODOLOGIES USED BY TEACHERS IN THE COUNTRIES INVOLVED

First, we asked teachers about their possibilities to innovate, in order to isolate regulatory or normative limitations inherent to the curricula in each country, or due to the schools, students, or their families not supporting innovation, all of which are beyond teachers' control. As shown in Figure 1, according to the results, legal and normative specifications of the curriculum in the three countries is not a barrier to innovate in teaching methods (98.65%). Regarding schools, it seems that the majority (89.49%) of them do encourage teachers to innovate. In addition, most of the students (86.56%) support the change in teaching practices. Then, we can assume that most of the teachers surveyed have the necessary conditions to be able to innovate in the classroom.

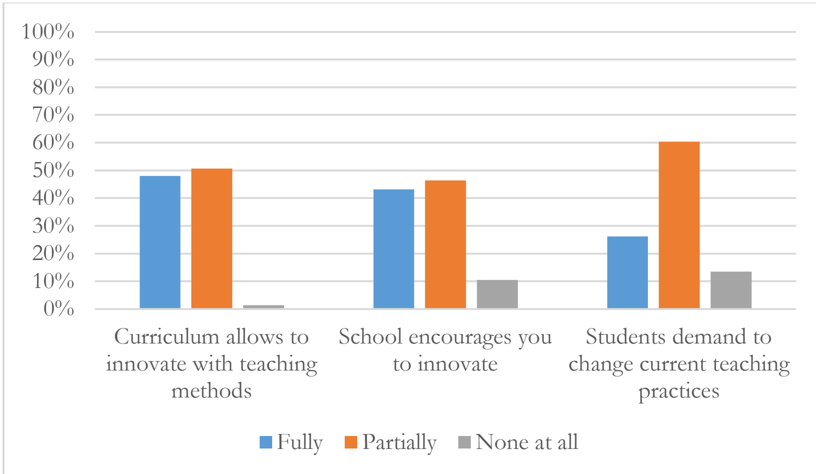

Figure 1. Conditions for innovation

From a descriptive standpoint, Table 4 collects the survey results for research question RQ1. All surveyed methodologies are used with 75% of the answers ranging from "sometimes" to "always" for every factor except for "challenge-based learning (11.7)" where this value drops 63%. The reason for this could be that it is a relatively new methodology that has had less time to be incorporated into traditional curricula (Kirriemuir & McFarlane; 2004; O'Flaherty & Phillips, 2015).

Table 4. Survey results for research question RQ1

TEACHER PEDAGOGIES AND INNOVATIVE PRACTICES						
Survey item	Factor	Never	Rarely	Sometimes	Often	Always
11.1	Project based learning	6%	17%	43%	24%	10%
11.2	Collaborative learning	15%	10%	34%	28%	14%
11.3	Cooperative learning	3%	10%	38%	34%	15%
11.4	Problem-based learning	4%	11%	34%	34%	16%
11.5	Inquiry-based learning	11%	15%	33%	29%	12%
11.6	Game-based learning	13%	23%	34%	25%	6%

A series of analyses were performed using Spearman's correlation since the Likert scale is ordinal. This technique is often used in studies of human behavior, where the magnitude of the correlation is of primordial interest (Bonett & Wright, 2000).

Spearman correlation testing was applied to the pairs of factors grouped under research question 1. Active Learning Methodologies (ALM) factors were significantly correlated with each other (at the 0.01 level, 2-tailed) as expected.

In addition, it seems reasonable to think that teachers who have previously innovated using other methodologies or innovative practices are more likely to use new models such as FC. To confirm this, the Chi-square test was applied, obtaining a significant relationship (sig. <0.000) in all of them, as shown in Table 5.

Table 5. Relationship between having used other innovative pedagogies and the FC model

Teacher pedagogies and innovative practices	Chi-square	Sig. (bilateral)
Project-based learning	64.080	0.000
Collaborative learning	64.862	0.000
Cooperative learning	45.039	0.000
Problem-based learning	54.013	0.000
Inquiry-based learning	53.234	0.000
Game-based learning	79.713	0.000

Moreover, no significant differences were observed among the 3 countries, which suggests that teachers who have innovated before are more likely to apply FC, regardless of the country of origin or factors specific such as limitations, regulations, or culture of each country, although, of course, it should be confirmed through more studies in other countries.

Teachers' Attitudes Towards the Introduction of the Flipped Classroom

In these questions (items from question 13), as we asked about their opinion on flipped classroom, we only analyzed the answers from teachers with experience in applying the method. In this case, the sample was n=385, with 61 teachers from Hungary, 280 from Spain, and 33 from the Czech Republic. The sampling error with a confidence interval of 95% is 5.

Upon Spearman pair testing, all factor pairs were found to present a significant correlation at the 0.01 and 0.05 levels (2-tailed). The stronger correlations were "flipped classroom makes the teaching process more enjoyable" (13.6) and "flipped classroom gives me a chance for professional development" (13.7) with a Spearman coefficient of 0.69 in the described conditions, "flipped classroom involves and make students responsible for their own learning process" (13.9) and "flipped classroom may support a work-based approach" (13.10) with a Spearman coefficient of 0.71, and finally "flipped classroom may support a work-based approach" (13.10) and "flipped classroom helps to develop 21st century skills in the students" (13.11) with a Spearman coefficient of 0.68. All three instances address the fact that flipped classroom is a strongly practice-oriented methodology that transfers well to the foundations behind most practice-oriented or learning by doing education, which is, after all, designed to enable students to become practitioners.

Table 6 presents a descriptive summary of the results of research question 2 (RQ2). All factors except one show an asymmetry clearly to the right. The only factor that presents a joint disagreement score with a 24% score in disagree or strongly disagree is that "flipped classroom takes more class time than traditional methods". So, it could depend on the class time management, class planning, or method used in the classroom. Therefore, although more research is needed, a factor to consider in the development of teacher training on flipped classroom is the management of class time, as well as the planning of time and the methodology used in the classroom.

Table 6. Survey results for research question 2

TEACHERS' ATTITUDES TOWARDS FC						
Survey item	**Factor**	**Strongly disagree**	**Disa-gree**	**Neither agree, or disa-gree**	**Agree**	**Strongly agree**
13.1	Pedagogy is essential, not only technology	0%	2%	14%	44%	39%
13.2	It helps me to collaborate more intensively with my students	0%	1%	12%	57%	30%
13.3	It enables parents' involvement	0%	2%	19%	38%	40%
13.4	It is motivating in practice-oriented subjects	0%	1%	10%	44%	44%
13.5	It makes the teaching process more enjoyable	0%	1%	11%	46%	42%
13.6	It gives me a chance to develop professionally	0%	1%	14%	48%	37%
13.7	It will allow me to reuse and improve learning materials year on year	0%	2%	16%	47%	35%
13.8	It allows to make students responsible for their own learning	0%	1%	14%	46%	39%
13.9	It may support a work-based approach	0%	2%	13%	50%	35%
13.10	It helps to develop 21st century skills in the students	0%	1%	11%	41%	47%
13.11	It requires more class time than traditional methods	1%	23%	28%	28%	19%

Teachers' IT Skills Needed for Applying the FC Model

Eurostat collects data on IT skills every year in European countries (Eurostat, 2016), but they are data from the general population (not specific to the teacher) and about basic skills such as file and folder management, use of word processing programs and spreadsheets, presentations, or photo editing. For this reason, we added questions to the questionnaire (questions 15 and 16) about IT skills based on the competency framework of DigCompEdu (Redecker & Punie, 2017), although not exhaustively due to the complexity of the questionnaire. Therefore, since DigCompEdu includes 22 competences organized in 6 areas, we chose those related to the dimension of digital resources. This dimension includes the skills to select, create and modify, and manage and share content. The competency levels used are from less to more level of proficiency of digital skills as follows: newcomers (A1), explorers (A2), integrators (B1), experts (B2), leaders (C1) and pioneers (C2). Table 7 shows as the ones presented beforehand, the joint results for Spain (n=434), Hungary (n=121) and the Czech

Republic (n=61). For a better understanding, we show the collapsed levels: beginners (A1, A2), intermediate (B1, B2), and high level (C1, C2).

As shown in Table 7, the declared level of digital skills is, in general, intermediate, with no variations exceeding 5% from country to country or from the collective set. This is in line with the data published in Eurostat of the 3 countries where significant differences in any of the measured IT skills are not evident (Eurostat, 2016). The biggest difference is in the use of software for photographic editing with a difference of almost 10 points between Spain and the Czech Republic (Spain = 61.01%, Hungary = 58.81% and the Czech Republic = 51.44%).

As can be seen in Table 7, digital timelines, animations, and creation/use of blogs are the skills in which more than 30% of teachers declare having an initial level of competence. For the remaining skills, the teachers surveyed placed themselves at an intermediate level. Therefore, we could affirm that the teachers surveyed have an adequate level of basic digital skills to apply the model.

Table 7. Survey results for research question RQ3

IT SKILLS LEVEL				
Survey item	**Factor**	**Newcomers/ Explorer (a)**	**Integrators/ Experts (b)**	**Leaders/ Pioneers (c)**
15	Basic IT skills	2%	78%	20%
16.1	Photo editing	13%	73%	13%
16.2	Multimedia (videos)	25%	65%	11%
16.3	Animations	34%	59%	7%
16.4	Blogs	33%	55%	12%
16.5	Concept maps	28%	61%	11%
16.6	Digital timelines	43%	48%	9%
16.7	Hypertext	29%	60%	10%
16.8	Presentations	5%	69%	25%
16.9	Social networks	10%	76%	15%

Teacher Training Needed to Apply the FC Model

Table 8 shows the results from the descriptive analysis carried out to answer RQ4. Teachers generally declare that all pedagogical and digital skills are important to a greater or lesser extent. The values for null importance are not significant (<= 0.3%), and for little importance are also very low (<= 3.4% in ICT and <= 1.1% in pedagogical competences). The asymmetry in all cases is clearly to the right.

Although with minor differences, pedagogical training was considered more important that FC-specific digital training, with the following factors considered highly important for more than half of teachers: “Learn strategies to integrate into the home and in classroom phases” (58%), and “Design of class activities” (53%).

Table 8. Survey results for research question RQ4

TEACHERS’ PEDAGOGICAL TRAINING IN FC						
Survey item	**Factor**	**Not important at all**	**Slightly important**	**Somewhat important**	**Moderately important**	**Highly important**
14.1	Preparation of FC lesson plans	0%	4%	14%	35%	47%
14.2	Design of class activities	0%	2%	10%	34%	53%
14.3	Learn strategies to integrate in home and classroom phases	0%	2%	10%	30%	58%
14.4	Assessment of students’ work in FC lessons	0%	2%	20%	44%	34%
14.5	Assessment of students’ processing new information at home	0%	1%	19%	43%	36%
14.6	Managing the collaboration of students in class time	0%	0%	16%	39%	45%
14.7	Problem-solving teamwork strategies	0%	1%	16%	38%	44%
TEACHERS’ ICT TRAINING IN FC						
Survey item	**Factor**	**Not important at all**	**Slightly important**	**Somewhat important**	**Moderately important**	**Highly important**
14.8	Creating. editing and publishing attractive learning content	0%	5%	18%	34%	44%
14.9	Find quality, free and meaningful educational applications	1%	3%	15%	31%	50%
14.10	Designing interesting and attractive digital presentations	0%	5%	17%	32%	46%

Table 9 presents the color-coded correlation table for Spearman pairs in Research Question 4 (RQ4). The blue sections are internal correlations between pairs of factors inside the two blocks in which RQ4 is divided: “Teachers’ Pedagogical Training in FC” (TPT) and “Teachers’ ICT Training in FC” (TIT). Correlations higher than 0.30 are presented in yellow and those higher than 0.50 in green. As in the previous questions, Spearman pair testing all factor pairs were found to present a significant correlation at the 0.01 and 0.05 levels (2-tailed), with an average score of 0.43. The most significant results are (Spearman coefficient greater than 0.5) those of "Preparing FC lesson plans" (14.1) and "Designing class activities" (14.2) at 0.59, "Designing class activities" (14.2) and "Learn strategies to integrate in home and in classroom phases" (14.3) at 0.60, "Assessment of students' work in FC lessons" (14.4) and "Assessment of students' processing new information at home" (14.5) 0.61, and "Managing the collaboration of students in class time" (14.6) and "Problem-solving team-work strategies" (14.7) at 0.58, for TPT factors. These correlations can be segregated into ones which describe the creation and curation of content, and those devoted to the layout of classroom strategies and assessment. Both of these are recurring concerns between instructors during their first experiences in flipped classroom as described in O'Flaherty & Phillips' (2015) literature review.

Table 9. Spearman correlation map for research question 4

	14.1	14.2	14.3	14.4	14.5	14.6	14.7	14.8	14.9	14.10
14.1	1.00									
14.2	0.59	1.00								
14.3	0.38	0.60	1.00							
14.4	0.43	0.43	0.44	1.00						
14.5	0.39	0.42	0.55	0.61	1.00					
14.6	0.35	0.44	0.46	0.42	0.49	1.00				
14.7	0.33	0.44	0.48	0.39	0.47	0.58	1.00			
14.8	0.27	0.34	0.37	0.35	0.33	0.30	0.53	1.00		
14.9	0.25	0.41	0.42	0.34	0.34	0.39	0.42	0.61	1.00	
14.10	0.30	0.36	0.37	0.33	0.42	0.35	0.46	0.68	0.62	1.00

From the analysis of the open question about which other competences they consider important to apply FC, no conclusive results were extracted. Results showed that there is a very uneven landscape in pedagogical training, with some instructors asking for very basic training and resources and others considering mean well beyond a basic scope, such as streaming real-time video.

ICT Infrastructures Needed by Vocational School Teachers for the Implementation of FC

Table 10 summarizes the results (by country) of items 17 and 18 on the classroom resources that instructors have available for their lessons. Results for Spain and the Czech Republic are on par, showing that computers with Internet access in class are commonplace for both countries. Hungary falls behind in most aspects. Item 21 reveals that there are computers in Hungarian classrooms, but that these must not be connected to the Internet. Also, high-speed Internet access is particularly common in Spanish institutions (78%), with Czech schools falling behind by 10 points (68%) and Hungarian schools by another 10 (58%). Regarding other devices provided by schools, digital cameras, tablets, and drawing tablets are infrequent, particularly the latter two.

Table 10. Segregated descriptive contingency map for research question 5

RQ5	Respondents	Hungary (n=121)		Spain (n=434)		Czech Republic (n=61)	
		Mainly no	Mainly yes	Mainly no	Mainly yes	Mainly no	Mainly yes
(17) Does your school provide…	Computer with Internet access?	51%	49%	10%	90%	19%	81%
	Digital camera?	69%	31%	44%	56%	53%	47%
	Drawing tablet?	89%	11%	72%	28%	79%	21%
	Tablet?	74%	26%	62%	38%	72%	28%
(18) Do you have access to your classroom work for...	Presentation set (computer + projector)?	7%	93%	14%	86%	17%	83%
	Interactive board?	46%	54%	44%	56%	36%	64%
	High speed Internet access?	42%	58%	22%	78%	32%	68%

DISCUSSION

In this section, we will try to answer the research questions posed initially.

As explained above, one of the factors reported in the literature as influential in the use of educational technology is the positive attitude towards innovation. Based on this, we asked teachers for their opinion about the use of innovative methodologies, in particular, active methodologies due to their relation to flipped learning. According to Prince (2004), active learning consists of instructional methods characterized by engaging students in the learning process. Therefore, we asked teachers how often they used the more common active methodologies named in literature: project-based learning, collaborative and cooperative learning, problem-based learning, inquiry-based learning and challenge-based learning (Gil, Montoya, Herrada, Baños, & Montoya, 2013; Johnson et al. 2014; Prince, 2004). According to the results of the study carried out in these 3 countries, there is an inclination towards the application of FC in teachers from technical schools who have used other innovative practices before, such as project-based learning, collaborative and cooperative learning, problem-based learning, inquiry-based learning and game-based learning.

On the other hand, the second research question asked about the attitudes teachers have towards the introduction of flipped classroom as a new innovative teaching methodology. All the factors, collected from the literature and presented to the teachers in the questionnaire, showed positive results, except for one of them in which there was no agreement: FC takes more class time than traditional methods. The reasons could be related to each teacher's class time management, class planning, or the method used in the classroom, even with the teachers' experience applying the model. In line with this, as one of the two most important factors for the necessary training to successfully apply the model, teachers have considered the design of class activities, as well as the integration of work done at home and in class. This result suggests teachers' concern for the design of class activities, which could be motivated precisely by the need to learn to reduce the class time required in the application of the model. More research is needed on how the use of some methodologies or others influences these aspects of the model in order to facilitate a successful implementation. Another important conclusion, according to the Spearman coefficients obtained in the results (Table 5), is that the FC model is clearly oriented towards practice and is, therefore, part of the educational methodologies commonly known as learning by doing, thus having a high applicability to vocational education.

The following research question (RQ3) was trying to find out the level of digital skills of teachers who have applied the method. According to the results, most of the teachers consulted had an intermediate proficiency level of skills. This allows teachers and schools to know what proficiency level of digital skills teachers need before applying the method.

We also asked teachers who had applied the model in what pedagogical and digital competencies of FC other teachers interested in implement the model would have to be trained. All pedagogic and ICT competences presented to teachers for their training in FC were considered important. According to the Spearman coefficients of correlations obtained in Table 9, the training needs of teachers can be grouped into the following categories: planning of the FC lesson, content creation/curing, teaching the class, and student assessment. This grouping provides a possible structure for the design of training courses for the FC method according to the phases that teachers must follow to convert a traditional lesson into an FC lesson, or it provides the necessary topics to be dealt with in different teacher training courses.

Finally, we asked about the ICT infrastructures technical school teachers need to implement FC. According to the results, most teachers used a computer with an Internet connection to implement the model. Digital cameras, tablets, and drawing tablets are infrequent, particularly the latter two. All these elements serve as tools to create the materials tailored to each class instead of having to rely on the research of outside resources that adapt to a class' syllabus (Smith & McDonald, 2013), which can be a problem for those teachers who need to create new resources because they do not have the necessary infrastructure to do so in their schools.

CONCLUSION

Formal education is going through a period of crisis in Europe, which is leading many teachers to search for new methodologies and teaching practices that improve student learning and motivation. One of these models is the flipped classroom. This research is aimed at contributing to successfully implement the model by providing schools and managers with the factors which influence the adoption of the model. We have defined a framework to support the process of adoption of the flipped classroom model in technical and vocational schools through a complete literature review and a quantitative analysis of a sample 634 answers of teachers from Hungary, the Czech Republic, and Spain to confirm (or not) these factors. Among these factors are pedagogical training and digital skills that teachers need to be able to apply the FC model successfully.

Firstly, we have collected, from the literature, the factors influencing the use of technology in the classroom, with the aim of finding out which are specifically for the use of flipped classroom in vocational education. According to the literature, these criteria are teacher training, level of resources, teachers' pedagogy and practices, teachers' attitudes, teachers' ICT competences, and positive attitudes toward innovation. Research questions to find out the particular factors for the use of the flipped classroom in vocational education have been stated and validated using description and factorial analysis with the aim of reducing the factors to the set of the most important. Results from the questionnaire to 634 teachers from Spain, Hungary, and the Czech Republic showed that teachers in those participating countries use active methodologies, and their attitudes toward the flipped learning is positively confirming all but one of the factors collected from the literature. In addition, teachers answered that they had an intermediate level of ICT skills, meaning that they can identify and assess suitable resources, create and modify resources using at least some advanced features, and they can effectively share resources. We can conclude that they have an appropriate level to apply the flipped classroom model, although some training could be useful in photo and video editing, creation/edition of animations, blogs, and use of hypertext. Regarding the pedagogical and ICT training, teachers confirmed the collected factors from the literature and consider pedagogical training more important that ICT training. Finally, the infrastructure needed to apply the model was defined. Spanish and Czech schools have the required infrastructure to apply the model. However, Hungarian schools are far behind them in almost all factors and require an initial investment in ICT infrastructure before the implementation of the model. In addition, although Spanish and Czech schools have the basic infrastructure, some schools lack the needed infrastructure to create new resources.

We hope this framework can help managers and technical and vocational schools that so wish to carry out a smooth and successful implementation of the model. The framework includes other methodologies or active pedagogical practices that teachers who have applied FC have also used previously. Therefore, this information can be used by schools in the selection process of teachers who carry out pilots and subsequently be mentors to their peers in the implementation of the model. Likewise, the framework includes both the required attitudes of teachers, the basic and specific digital skills to implement the model, as well as the pedagogical training necessary for the teachers to successfully implement the model. All this can help managers to know what training their teachers require to be able to implement the FC model, and the content managers/creators to know what competencies must be included in flipped classroom teacher training courses.

In addition, it is worth highlighting that teachers considered pedagogical training very important in all the aspects explored. Among them, the most important was how to design in-class activities and how to integrate the work done at the home and in the classroom. Moreover, teachers thought that the educational digital competences presented were very important in all the steps of the FC model, from planning to assessment. Moreover, from the results, we could draw a possible structure for the design of the training courses for the FC method according to the phases that teachers must follow to convert a traditional lesson into an FC lesson: planning of the FC lesson, content creation/curating, teaching the class and student assessment.

The model is currently being implemented in schools in Spain, Hungary, and the Czech Republic using the results obtained here under the framework of the European project FlipIT!–flipped classroom in the European Vocational Education", ERASMUS+ Strategic Partnership (2015-1-HU01-KA202-013555). After verifying the criteria obtained in the framework in each of the participating schools, as a first step, an online course has been created using the competences obtained in this framework, both pedagogical and ICT. Once the course is completed, the teachers will carry out a pilot project to use the model. We hope the framework is useful to other researchers in order to implement the model in other countries and extend it with other criteria to obtain a validated international framework. This study is a first step toward determining the factors needed for the adoption of the flipped classroom model in technical schools. More studies using alternative data sources and methods are needed to obtain a definite model to support this adoption since FC has proved to be a very successful model for motivating students. We hope these results pave the way for schools who want to adopt the FC model and for focusing teaching training in the competences as part of this work detected.

REFERENCES

Al-Zahrani, A. M. (2015). From passive to active: The impact of the flipped classroom through social learning platforms on higher education students' creative thinking. *British Journal of Educational Technology*, *46*(6), 1133-1148. https://doi.org/10.1111/bjet.12353

Bellanca, J. A., & Brandt, R. S. (2010). *21st century skills: Rethinking how students learn*. Bloomington, IN: Solution Tree Press.

Bonett, D. G., & Wright, T. A. (2000). Sample size requirements for estimating Pearson, Kendall and Spearman correlations. *Psychometrika*, *65*(1), 23–28. https://doi.org/10.1007/BF02294183

Bordbar, F. (2010). English teachers' attitudes toward computer-assisted language learning. *International Journal of Language Studies*, *4*(3), 179–206. Retrieved from http://journaldatabase.info/articles/english_teachers_attitudes_toward_computer-assisted.html

Buabeng-Andoh, C. (2012). Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature. *International Journal of Education and Development Using Information and Communication Technology*, *8*(1), 136–155. Retrieved from http://files.eric.ed.gov/fulltext/EJ1084227.pdf

Camacho, P. (2014). Flipped classroom: Programación de bases de datos [Flipped classroom: Programming of databases]. In *XI Jornadas Internacionales de Innovación Universitaria*, Villaviciosa de Odón, July 7-8, 2014. Retrieved from http://hdl.handle.net/11268/3464

CEDEFOP (European Centre for the Development of Vocational Training) (2014). *Terminology of European Education and training policy: a selection of 130 key terms*, 2nd edition. Luxembourg: Publications office of the European Union. Retrieved from http://www.cedefop.europa.eu/files/4117_en.pdf

Clark, R. C., & Mayer, R. E. (2008). Learning by viewing versus learning by doing: Evidence-based guidelines for principled learning environments. *Performance Improvement*, *47*(9), 5–13. https://doi.org/10.1002/pfi.20028

Cox, M. J., Cox, K., & Preston, C. (1999). What factors support or prevent teachers from using ICT in their classrooms? In *British Educational Research Association Annual Conference*. Brighton: British Educational Research Association. Retrieved from https://www.leeds.ac.uk/educol/documents/00001304.htm

DeLozier, S. J., & Rhodes, M. G. (2016). Flipped classrooms: A review of key ideas and recommendation for practice. *Education Psychology Review*, *29*(1), 141–151. https://doi.org/10.1007/s10648-015-9356-9

Embi, M. A., Hussin, S., & Panah, E. (2014). Flipped learning readiness among graduate and postgraduate students in UKM. *Blended & Flipped Learning: Case Studies in Malaysian HEIs*. Malaysia: Centre for Teaching & Learning Technologies, Universiti Kebangsaan Malaysia & Department of Higher Education, Ministry of Education Malaysia.

Enfield, J. (2013). Looking at the impact of the flipped classroom model of instruction on undergraduate multimedia students at CSUN. *TechTrends*, *57*(6), 14–27. https://doi.org/10.1007/s11528-013-0698-1

Eurostat. (2016). *Internet access and use statistics - Households and individuals*. Statistics Explained. Retrieved April 4, 2017 from http://ec.europa.eu/eurostat/statistics-explained/index.php?title=Archive:Internet_access_and_use_statistics_-_households_and_individuals

Eurostat. (2017). *Early leavers from education and training*. Statistics explained. Retrieved July 22, 2018 from http://ec.europa.eu/eurostat/statistics-explained/index.php/Early_leavers_from_education_and_training

EuroStat. (2018). *Digital economy and society statistics - Households and individuals*. Statistics explained. Retrieved July 22, 2018 from http://ec.europa.eu/eurostat/statistics-explained/index.php?title=Digital_economy_and_society_statistics_-_households_and_individuals

Fernández Gámez, D., & Guerra Martín, M. D. (2016). Aprendizaje inverso en Formación Profesional: Opiniones de los estudiantes [Flipped learning in vocational training: Student opinions]. *Innoeduca. International Journal of Technology and Educational Innovation*, *2*(1), 29. https://doi.org/10.20548/innoeduca.2016.v2i1.1048

Gil, C., Montoya, M. G., Herrada, R. I., Baños, R., & Montoya, F. G. (2013). Engaging students in computer-supported cooperative learning. *International Journal of Learning Technology*, *8*(3), 297. https://doi.org/10.1504/IJLT.2013.057064

González Velasco, C., Feito Ruiz, I., González Fernández, M., Valdunciel Bustos, L., Álvarez Arenal, J. L., & Sarmiento Alonso, N. (2017). Modelo de enseñanza-aprendizaje basado en la clase invertida: una experiencia de innovación docente en diferentes niveles educativos [Teaching-learning model based on the flipped classroom: An experience of teaching innovation in different educational levels]. *Revista Infancia, Educación y Aprendizaje*, *3*(2), 59. https://doi.org/10.22370/ieya.2017.3.2.700

Hamdan, N., McKnight, P., & McKnight, K. (2013). *A review of flipped learning*. Retrieved from http://flippedlearning.org/wp-content/uploads/2016/07/WhitePaper_FlippedLearning.pdf

Hamdan, N., McKnight, P., McKnight, K., & Arfstrom, K. M. (2013). What is the approach motivation? *Emotion Review*, *5*(3), 291–295. https://doi.org/10.1177/1754073913477509

Hernández-Ramos, J. P., Martinez-Abad, F., Penalvo, F. J. G., Garcia, M. E. H., & Rodriguez-Conde, M. J. (2012). Teacher attitude scale regarding the use of ICT. Reliability and validity study. *2012 International Symposium on Computers in Education (SIIE)* (pp. 1-6). Andorra La Vella: IEEE.

High Level Group on the Modernisation of Higher Education. (2014). *Report to the European Commission on new modes of learning and teaching in higher education*. Publications Office of the European Union. Retrieved from http://ec.europa.eu/dgs/education_culture/repository/education/library/reports/modernisation-universities_en.pdf

Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A., & Hall, C. (2016). *NMC Horizon report: 2016 higher education edition.* Austin (Texas): The New Media Consortium. Retrieved from http://cdn.nmc.org/media/2015-nmc-horizon-report-HE-EN.pdf

Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2014). *NMC Horizon report: 2014 higher education edition.* Austin (Texas): The New Media Consortium. Retrieved from http://cdn.nmc.org/media/2014-nmc-horizon-report-he-EN-SC.pdf

Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2015). *NMC Horizon report: 2015 higher education edition.* Austin (Texas): The New Media Consortium. Retrieved from http://cdn.nmc.org/media/2015-nmc-horizon-report-HE-EN.pdf

Jungić, V., Kaur, H., Mulholland, J., & Xin, C. (2015). On flipping the classroom in large first year calculus courses. *International Journal of Mathematical Education in Science and Technology*, *46*(4), 508–520. https://doi.org/10.1080/0020739X.2014.990529

Karabulut-Ilgu, A., Jaramillo Cherrez, N., & Jahren, C. T. (2017). A systematic review of research on the flipped learning method in engineering education. *British Journal of Educational Technology, 49*(3), 398-411. https://doi.org/10.1111/bjet.12548

Kendall, M. G., & Smith, B. B. (1939). The problem of m rankings. *The Annals of Mathematical Statistics*, *10*(3), 275–287. https://doi.org/10.1214/aoms/1177732186

Kim, M. K., Kim, S. M., Khera, O., & Getman. (2014). The experience of three flipped classrooms in an urban university: An exploration of design principles. *The Internet and Higher Education*, *22*, 37–50. https://doi.org/10.1016/j.iheduc.2014.04.003

Kirriemuir, J., & McFarlane, A. (2004). *Literature review in games and learning: A Report for NESTA Futurelab*. Retrieved from http://www.futurelab.org.uk/resources/documents/lit_reviews/Games_Review.pdf

Kwan Lo, C., & Foon Hew, K. (2007). A critical review of flipped classroom challenges in K-12 education: Possible solutions and recommendations for future research. *Research and Practice in Technology Enhanced Learning*, *12*(4), 1–22. https://doi.org/10.1186/s41039-016-0044-2

Little, C. (2015). The flipped classroom in further education: Literature review and case study. *Research in Post-Compulsory Education*, *20*(3), 265–279. https://doi.org/10.1080/13596748.2015.1063260

Lucas, B., Spencer, E., & Claxton, G. (2012). *How to teach vocational education: A theory of vocational pedagogy*. Centre for Real-World Learning, University of Winchester. doi:10.13140/RG.2.1.4538.3446

Marcinkiewicz, H. R. (1993). Computers and teachers. *Journal of Research on Computing in Education*, *26*(2), 220–237. https://doi.org/10.1080/08886504.1993.10782088

Milman, N. B. (2012). The flipped classroom strategy: What is it and how can it best be used? *Distance Learning*, *9*(3), 85+. Retrieved from http://go.galegroup.com/ps/i.do?id=GALE%7CA305660562&v=2.1&u=monash&it=r&p=AONE&sw=w&asid=83eb2cb972cfc092f59ad15b94e4f337

O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. *The Internet and Higher Education, 25*, 85-95. https://doi.org/10.1016/j.iheduc.2015.02.002

Ölmefors, O. (2016). *Student attitudes towards Flipped Classroom: A focus group study on attitude change in Swedish upper secondary school, within Mathematics towards Flipped Classroom* (Master thesis, KTH Royal Institute of Technology and Stockholms Universitet). Retrieved from http://kth.diva-portal.org/smash/get/diva2:943881/FULLTEXT01.pdf

Peralta, H., & Costa, F. (2007). Teachers's competence and confidence regarding the use of ICT. *Educational Sciences Journal*, *3*(1), 75–84.

Piaget, J. (1971). *Biology and knowledge: An essay on the relations between organic regulations and cognitive processes.* Chicago: University of Chicago Press.

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, *93*(3), 223–231. https://doi.org/10.1002/j.2168-9830.2004.tb00809.x

Redecker, C., & Punie, Y. (2017). *European framework for the digital competence of educators: DigCompEdu*. JRC Working Papers JRC107466, Joint Research Center (Seville). doi:10.2760/159770

Sams, A., & Bergmann, J. (2012). *Flip your classroom: Reach every student in every class every day.* International Society for Technology in Education.

Sams, A., & Bergmann, J. (2013). Flip your students' learning. *Technology-Rich Learning*, *70*(6), 16–20. Retrieved from http://www.ascd.org/publications/educational-leadership/mar13/vol70/num06/Flip-Your-Students'-Learning.aspx

Smith, C. M., & McDonald, K. (2013). The flipped classroom for professional development: Part II. Making podcasts and videos. *The Journal of Continuing Education in Nursing*, *44*(11), 486–487. https://doi.org/10.3928/00220124-20131025-93

Song, Y., Jong, M. S. Y., Chang, M., & Chen, W. (2017). Guest editorial: "How" to design, implement and evaluate the flipped classroom? – A synthesis. *Journal of Educational Technology & Society, 20*(1), 180-183. doi:10.2307/jeductechsoci.20.1.180

Špilka, R., & Maněnová, M. (2014). Flipped classroom, web-based teaching method analysis focused on academic performance. *Proceedings of Communications, Circuits and Educational Technologies (ICLS 2016), 1282-1285*. Prague. Retrieved from http://www.inase.org/library/2014/prague/bypaper/ECS-EET/ECS-EET-13.pdf

Staker, H., & Horn, M. B. (2012). *Classifying K-12 blended learning*. Innosight Institute. Retrieved from https://eric.ed.gov/?id=ED535180

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics*. California: Pearson Education.

Tanner, M., & Scott, E. (2015). A flipped classroom approach to teaching systems analysis, design and implementation. *Journal of Information Technology Education: Research*, *14*, 219–241. https://doi.org/10.28945/2266

Techanamurthy, U., Alias, N., & Dewitt, D. (2015). Readiness for flipped learning among culinary arts students. *Proceedings of Seminar Kebangsaan Majlis Dekan-dekan Pendidikan Universiti.* Malaysia: Universiti Tun Hussein Onn Malaysia. doi:10.13140/RG.2.1.1388.8487

van Braak, J. (2001). Factors influencing the use of computer mediated communication by teachers in secondary schools. *Computers & Education*, *36*(1), 41–57. https://doi.org/10.1016/S0360-1315(00)00051-8

Vuorikari, R., Punie, Y., Carretero Gómez, S. & Van Den Brande, G. (2016). *DigComp 2.0: The digital competence framework for citizens. Update phase 1: The conceptual reference model.* Luxembourg: Publication Office of the European Union. https://doi.org/10.2791/11517

Wang, T. (2017). Overcoming barriers to 'flip': Building teacher's capacity for the adoption of flipped classroom in Hong Kong secondary schools. *Research and Practice in Technology Enhanced Learning*, *12*(6), 1–11. https://doi.org/10.1186/s41039-017-0047-7

Wang, Z. (2014). Research on teaching design and application of flipped classroom mode. *Proceedings of 2nd International Conference on Education Technology and Information System (ICETIS 2014)*, 379–383. https://doi.org/10.2991/icetis-14.2014.85

Wolff, L.-C., & Chan, J. (2016). *Flipped classrooms for legal education*. Hong Kong: Springer. https://doi.org/10.1007/978-981-10-0479-7_2

Woodrow, J. E. J. (1990). Locus of control and student teacher computer attitudes. *Computers & Education*, *14*(5), 421–432. https://doi.org/10.1016/0360-1315(90)90036-7

.

APPENDIX

The questionnaire used in the study consisted of the following questions:

PERSONAL DETAILS

1. **Your country** (Hungary / Spain / all European countries)
2. **Age group** (22-28; 29-35; 36-44; 45-54; 55+)
3. **Gender** (Male, Female)
4. **Teaching experience (years)** (0-5; 6-15; 16-25; 25+)
5. **Your subject category**?
   - Natural sciences
   - Social Sciences
   - Computer Sciences
   - Economics
   - Languages
   - Arts
   - Physical Education
   - Technical Engineering
   - Medicine and Health

   Other, please specify: ……

WORKING ENVIRONMENT

6. **Your school type**
   - lower vocational school
   - vocational high school
7. **Number of students at your school**
   - less than 200
   - 201-500
   - 501-1000
   - 1001-3000
   - more than 3001
8. **Number of teachers/educators in the school**
   - less than 20
   - 21-50
   - 51-100
   - 101-300
   - more than 301
9. **Conditions for Innovation in Teaching**

9.1.	Fully	Partially	Not at all
Does your curriculum allow you, as a teacher, to innovate with teaching methods?			
Does your School encourage you to be innovative in a similar way?			
Do you feel any demand from students to change current teaching practices?			

9.2. If you do innovate, then	a like-minded group within your School will provide mutual support.	you are left to do so on your own.

10. Describe any innovative techniques you use at your School

11. Do you use the following pedagogical methods in your class?

	Always, in every lesson	Often, almost in every lesson	Sometimes, in some part of some subjects	Rarely, I have applied this method and use it for a specific part of one subject	Never
Project-based learning					
Collaborative learning					
Cooperative learning					
Problem-based learning					
Inquiry-based learning					
Frontal instruc-tion					
Game-based learning					

Implementation: radio buttons, one choice per lines

12. Have you used and know well the flipped classroom model?

13. (Only visible for those who have used and know well the flipped classroom model). Please, share your degree of agreement with the following statements:

My opinions, ideas: …………………..

	Strongly agree	Agree	Neither agree, or disagree	Disagree	Strongly disagree
1. The pedagogical methodology is essential; it is not only about introducing technology					
2. It helps me to collaborate more intensively with my students (e.g. the students can give me technical support, like video recording)					
3. I can facilitate the parents to discuss the learning content with the students at home					

4. Using technology (like video on a working process) could be very motivating in practice-oriented vocational subjects					
5. It makes the teaching process more enjoyable not only for the students but for me as well					
6. FC gives me a chance for professional development - to compose easy to understand, highly motivating learning packets is a challenge what I like					
7. I will be able to reuse and improve the learning materials year on year					
8. With FC I have a chance to involve and make students responsible for their own learning process					
9. FC may support a work-based approach in teaching vocational subjects					
10. It helps to develop 21st-century skills in the students					
11. It takes much more class time than traditional teaching methods.					
12. Not all of the students have tools for watching videos or reading the online text.					
13. It complicates the evaluation of the students					

14. If you were to take part in an FC training course, what would be the most important competences to be developed?
Rank: 5=highly important, 4=moderately important, 3= somewhat important, 2=slightly important, 1 =not important at all

	5	4	3	2	1
Preparing FC lesson plans					
Designing class activities					
Learning strategies to integrate into the home phase with the activities in the classroom.					
Assessment of students' work in FC lessons.					
Assessment of students' processing of new information at home.					
Managing the collaboration of students in class time.					
Understanding a range of methods to support problem-solving team-work.					
Creating, editing storing attractive learning content, and publishing them on the web.					
Finding quality, free educational applications (offline & online) for learning, practice, creating, etc.					
Designing interesting and attractive digital presentations.					

15. What level of IT skills do you think you have?

Beginner level (A): I know how to use a computer for basic tasks (startup and shutdown, storage files, work with folders, windows, etc.), connection to the Internet), surfing the Internet and basic use of the Office Suite (word processing, spreadsheets, e-mail)

Intermediate level (B): I know how to use the Office Suite generally, manage a computer as an advanced user, online collaboration tools, social media sites, edit images and websites.

Advanced level (C): I know how to conduct administrative tasks on a computer, use the Office Suite package, online collaboration tools, create videos and images, and use social media sites, all at a professional level. I can assess content and provide guidance to colleagues.

16. Are you trained on how to create, edit and publish the following digital media?

Newcomer (A1): I make a little use of the Internet to find resources, I cannot modify them either sharing resources.
Explorer (A2): I make basic use of digital technologies for finding resources, I can create and modify using basic tools and managing resources using basic strategies.
Integrator (B1): I can identify and assess suitable resources using basic criteria, I can create and modify using advanced tools, and I can effectively share using basic strategies.
Expert (B2): I can identify and assess suitable resources using complex criteria, I can adapt advanced digital resources to a concrete learning context, and I can share professionally.
Leader (C1): I can comprehensively identify and assess suitable resources, considering all relevant aspects, I can create, co-create and modify resources according to the learning context using a range of advanced strategies, and I can digitally publish self-created resources.
Pioneer (C2): I promote the use of digital resources in education, I can create complex, interactive digital resources, and professionally publishing self-created digital content.

	A1	A2	B1	B2	C1	C2
Digital pictures						
Videos						
Animations						
Blogs						
Concept maps						
Digital timelines						
Hypertext, embedding different media elements						
Presentations						
Social networks						

17. Does your school provide the following tools?

	Yes, always, for all teachers	Yes, but difficult to get it	Not at all	I have my own
Computer with Internet access				
Digital camera				
Drawing tablet				
Tablet				

Other, please specify: ……

18. Do you have access to the following IT tools/features for your classroom work?

	For every lesson	Only for IT lessons	Occasionally	Not at all
Presentation set (computer + projector)				
Interactive board				
High-speed Internet access				

Poor Internet access				

19. Are the following tools available for students in the school after official lessons?

	Yes, at any time	Yes, occasionally	Not at all
Computer			
Digital camera			
Drawing tablet			
Tablet			
Internet access			

20. In the Flip-IT project, we will develop an online FC course for teachers in 2018. If you are interested in taking part, please provide your e-mail address.

BIOGRAPHIES

M. Teresa Villalba was awarded a B.Sc. degree in Mathematics from Universidad Complutense, Madrid, Spain in 1996, and an M.Sc. in Computer science respectively in 1998. She was awarded a Ph.D. degree in Computer Science at Universidad de Alcalá, Madrid, Spain, in 2009. She is an associate professor at the Computer Science Department of Universidad Europea, which has been a part of the Laureate Network Universities network for 16 years.

Since 2008, she has been in charge of the Master's Degree in ICT Security, and since 2016 she is the head of the Research Group in Educational Technology as a senior researcher in the School of Doctoral Studies and Research. She has authored or co-authored over 60 papers in refereed journals, book chapters, and international conferences. As a researcher in more than 25 competitive research projects at national, regional or local level; she has been leading 4 EU-funded research projects. Her research interests are technology applied to education and ICT security. Dr. Villalba is the Spanish representative of the Legal & Security Issues Task Force in CEPIS (Council of European Professional Informatics Society), and member of the Engineering Commission Expert Panel for quality evaluation of undergraduate and graduate degrees at the regional Council for Education dependent on the Ministry of Education. Dr. Villalba's awards and honors include the special award for her dissertation at Universidad de Alcalá (Madrid) and the award for the best research on ICT Security in Spain in 2011. More recently, she received the David A. Wilson International Award for Excellence in Teaching and Learning recognizing research on innovation in teaching and learning in higher education from Laureate Network Universities (Baltimore, May 2018).

Guillermo Castilla is currently a full-time professor at UEM (Universidad Europea de Madrid) and former Chair of the Scientific Committee of Education at Gamification World. Dr. Castilla currently collaborates with Dr. Villalba's research team in two Erasmus+ European projects.

PhD in Engineering, in the branch of technology applied to education by Universidad Europea and Master in Civil Engineering Systems by Polytechnic University of Madrid (UPM) and Civil Engineering (Ingeniería de Caminos, Canales y Puertos - 6 year long studies) by Polytechnic University of Madrid (UPM), he is currently working on a second doctoral dissertation in Traffic Engineering with various publications in journals, presentations and poster sessions in National and International forums. His original line of research under which he published his first dissertation is experimental and seeks to understand the impact of the flipped learning methodologies in long-term learning. He has done research in the area of Education and Educational Innovation (Gamification, flipped classrooms, English in Education, Project Based Learning) with various publications in journals, presentations and poster sessions in National and International forums. He has been the author of various 100% online Subjects offered at UEM as well as the author and Project Lead for the MOOC "Diseño y Evaluación de Videojuegos y Gamificación" (Design and Evaluation of Videogames and gamification) available on the MiriadaX platform, which has so far had 4 editions with over 16000 students. He also led a team of researchers and developers in a joint effort between UEM and the IT Company Avanzo for the creation of a Gamification Platform for companies and education institutions.

Sara Redondo currently works as Head of the Educational Innovation and Faculty Development Unit. She also teaches Educational Research in the Master's Degree in Secondary Teacher Training. She holds a degree in Pedagogy from Universidad Complutense de Madrid and a Ph.D. in Education from Universidad Europea de Madrid. She was awarded a Master's degree in Technology Education from Universitat de Illes Ballears and a Master's degree in Business Administration.

Previously, she worked at the Center for Educational Research and Documentation (Spanish Ministry of Education) for three years, where she developed educational research both at the national and the international level (UNESCO and Eurydice Network, belonging to European Commission). Some of these projects were related to education and values, young people displaying marked potential ability, integration of immigrants in the Spanish education system, or guidance and counseling programs in schools, among others. She regularly participates as a researcher or principal researcher in projects funded by the European Commission (Eurydice Erasmus+ Strategic Partnerships and), companies and/or public bodies (Ministry of Education, Ministry of Economy). She is a co-author on various publications and books from the Eurydice Network, the Ministry of Education and Science, and educational research journals.