



# Use of digital resources in the virtual teaching of STEM subjects in Foundation Courses during national lockdown<sup>1</sup>

## Uso de recursos digitales en la docencia virtual de asignaturas STEM en Foundation Courses durante el confinamiento

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### Abstract:

The lockdown caused by COVID-19 led to the adoption of new virtual methodologies using digital tools. The aim of this study was to design and validate a questionnaire on the use of digital media in the virtual teaching of STEM subjects in Foundation Courses. For this purpose, a

### Resumen:

El confinamiento provocado por la COVID-19 supuso la adopción de metodologías docentes virtuales aplicadas a través del uso de herramientas digitales. El objetivo del presente trabajo fue diseñar y validar un cuestionario sobre el uso de los medios digitales en la docencia virtual de las asignaturas STEM en los cursos de Fundamentos.

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descriptive non-experimental quantitative design was used and, with the administration of the designed questionnaire, data were collected from 61 students enrolled in these courses during the academic year 2021/2022 at Northumbria University (United Kingdom). The results showed that the reliability and internal consistency of the implemented questionnaire were good (Cronbach's Alpha = .78; Composite Reliability = .79; Mean Extracted Variance = .48; Omega = .95; KMO = .64) and that in general the student body stated that they had good access to and use of digital media and smooth communication with lecturers during the placement. In addition, they stated that they had adapted favourably to virtual teaching and that they had successfully acquired subject competences. The pandemic has brought about the implementation of these new methodologies and has meant a renewal and implementation of new resources, with the consequent acquisition of digital competences by both teaching staff and students.

### **Key words:**

Foundation courses; Information and Communication Technologies (ICT); teaching-learning; online learning; STEM.

### **Résumé:**

Le confinement provoqué par la COVID-19 a conduit à l'adoption de nouvelles méthodologies virtuelles grâce à l'utilisation d'outils numériques. L'objectif de cette étude était de concevoir et de valider un questionnaire sur l'utilisation des médias numériques dans l'enseignement virtuel des matières STEM dans les cours de base (Foundation Courses). À cette fin, un design quantitatif descriptif non expérimental a été utilisé et, avec l'administration du questionnaire conçu, des données ont été recueillies auprès de 61 étudiants inscrits à ces cours pendant l'année universitaire 2021/2022 à l'Université Northumbria (Grande-Bretagne). Les résultats ont montré que la fiabilité et la cohérence interne du questionnaire mis en œuvre étaient bonnes (Alpha de Cronbach = 0,78; Fiabilité composite = 0,79; Moyenne de la variance extraite = 0,48; Omega = 0,95; KMO = 0,64) et qu'en général, le corps étudiant a déclaré avoir un bon accès aux médias numériques et une bonne utilisation de ceux-ci, ainsi qu'une communication fluide avec les professeurs pendant le stage. En outre, ils ont déclaré qu'ils s'étaient adaptés favorablement à l'enseignement virtuel et qu'ils avaient réussi à acquérir des compétences disciplinaires. La pandémie a entraîné la mise en œuvre de ces nouvelles méthodologies et a signifié un renouvellement et une mise en œuvre de nouvelles ressources, avec pour conséquence l'acquisition de compétences numériques tant par le personnel enseignant que par les étudiants.

naturas STEM de los *Foundation Courses*. Para ello, se empleó un diseño cuantitativo descriptivo no experimental y, con la administración del cuestionario diseñado, se recogieron datos de 61 estudiantes matriculados en estos cursos durante el curso académico 2021/2022 en la Universidad de Northumbria (Reino Unido). Los resultados mostraron que la fiabilidad y consistencia interna del cuestionario implementado fueron buenas (Alfa de Cronbach = .78; *Fiabilidad compuesta* = .79; *Varianza Media Extractada* = .48; *Omega* = .95; *KMO* = .64) y que en general el alumnado afirmó que tuvo un buen acceso y uso de los medios digitales, y una fluida comunicación con el profesorado durante el confinamiento. Además, manifestó que se había adaptado favorablemente a la docencia virtual y que había adquirido satisfactoriamente las competencias de las asignaturas. La pandemia ha consolidado la implementación de estas nuevas metodologías que han supuesto una renovación e implementación de nuevos recursos, con la consiguiente adquisición y mejora de las competencias digitales tanto por parte del profesorado como por parte del alumnado.

### **Palabras clave:**

Cursos básicos; TIC; enseñanza-aprendizaje; aprendizaje en línea; STEM.

**Mots-clés:**

Cours de base; TIC; enseignement-apprentissage; apprentissage en ligne; STEM.

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## **Introduction**

The SARS-CoV-2 coronavirus caused an international health crisis during the second half of the 2019/2020 school year and the consequent confinement of the entire population. In this context, educational institutions at all levels were forced to implement alternative methodologies to continue teaching virtually. In this context, Information and Communication Technologies (ICT) played a leading role as tools to facilitate the understanding of the competences to be acquired by students, while at the same time, through their use and management, students' digital competence was also improved (Díaz-Arce & Loyola-Illescas, 2021; Mateo-Berganza & Lee, 2020; Sá & Serpa, 2020; Slavova & Garov, 2019).

The entire teaching had to be moved to the online world and face-to-face teaching was minimised, challenging staff, faculty and institutions beyond expectations (Bonfield et al., 2020; Hu et al., 2021; Ibáñez-López et al., 2022; Nuñez-Canal et al., 2022). Teachers' motivation and skills related to the use of digital technologies for teaching have changed since the start of the pandemic. Teachers perceived that their competence in using digital technologies for teaching has improved (Beardsley et al., 2021; Hernández-Ramos et al., 2021) and their confidence in applying these technologies to prepare lectures, teach in class, assess and provide feedback, and communicate with students and families increased along with motivation to improve their digital skills and use technological resources for teaching (De Pablos Pons & Llorent-Vaquero, 2020; Panisoara et al., 2020; Tandon, 2020).

Digital education should be considered as one of the pathways that can ensure the achievement of the Sustainable Development Goals (Dragunova & Sokolova, 2021). The health lockdown has highlighted barriers to its development and implementation, so that if addressed and resolved, this online learning can continue in the future (González Velázquez, 2020; Hu et al., 2021; Trujillo-Sáez et al., 2020). Difficulty in engaging

students when online, inadequate family support for learning activities, poor training for e-learning and low level of digital competence of students are among the main ones (Andraca-Sánchez et al., 2022; Cabero & Valencia-Ortiz, 2021; Eickelmann & Drossel, 2020; Hidayah et al., 2021; Klapproth et al., 2020).

Although online learning resources are proliferating in all modes of delivery, from traditional classrooms to distance education, institutions may not have recognised their potential to serve diverse student populations by providing them with learning experiences in line with their individual needs (Istenič, 2021; Popa, 2020). If lecturers embrace online learning and customise their approaches to make resources accessible to students, the interactive and collaborative nature of virtual learning can help reduce the lack of interaction in large classes and isolation in distance education. There is a need to examine the accessibility of online learning across the digital divide that different institutional studies and research had already highlighted (Unesco, 2017; Peral-Peral et al., 2015). The pandemic circumstances have highlighted the inequality in access to education caused by access to technology and online delivery, where teaching approaches do not necessarily address the voice of the learner with appreciation of their needs and culture (Almenara & Valencia, 2021; Macchiarola et al., 2020; Manco-Chavez et al., 2020; Perosa et al., 2020; Rappoport et al., 2020).

Different studies analyse students' perceptions of virtual teaching methodologies. The feelings they reflect most frequently are insecurity (Macchiarola et al., 2020). Students do not perceive a coherent and comprehensive approach to online education. Therefore, it was necessary to implement programmes that encourage and motivate students in their learning during confinement (Enríquez Quispe, 2020).

On the other hand, research also expresses high levels of acceptance with the resources used, the resolution of practical problems and the organisation of teaching by the teaching staff (Hernández-Ramos, 2021). While it is true that students identify digital tools and learning platforms as very useful, it also stands out that they consider the experience developed from face-to-face processes to be much more significant, since they observe greater interaction in communication and participation (Avendaño et al., 2021; Pérez-López, 2021). However, regarding the acquisition of competences, no marked differences are perceived (Ojeda-Beltrán et al., 2020).

They also highlight the positive impact of e-learning on issues such as knowledge, independence, management of emotions, development of digital competences and teaching skills in general. The overall perception of university students is favourable towards e-learning, particularly with regard to the rapid adaptation of teaching staff and the preparation of virtual materials and tools. Therefore, University teachers have shown flexibility in adapting to the demands of Covid-19 in the educational field and have made a great effort to guarantee quality and inclusive teaching that takes into account the educational needs of students, as well as the basic skills required to use the available technological means and resources (Avendaño et al., 2021; Gil et al., 2021; Pérez et al., 2021).

This study shows the perception that students at Northumbria University in the UK had of the online teaching they received, the availability of digital resources and their communication with lecturers during their studies in the Foundation Courses. By completing the Foundation year courses, students are guaranteed a place on the undergraduate degree course of their choice within the University. Through these courses, students gain a varied view of the field in which they are interested and first-hand experience in different areas that will help them select the studies with which they feel most comfortable. These programmes are ways of supporting students' transition to degree courses, as they offer an opportunity for those who do not have the necessary qualifications to start working at degree level. The extent to which these courses succeed in preparing students for the degree courses they will subsequently pursue has not yet been evaluated (Sanders & Daly, 2013).

## **Empirical framework**

### **Objectives**

Having highlighted the advantages and disadvantages of online teaching, it is worth asking what the students' opinion is of their experience during the pandemic: how did the students perceive the virtual teaching, did they have sufficient digital means to attend the online material (lectures, quizzes and practical lessons) and complete their assignments, how was their communication with the teachers, did this methodology comply with the acquisition of the competences, and

what was the impact of this methodology on the acquisition of the competences? To answer these research questions, the following objectives were established in this study:

1. To design and to validate a questionnaire on the use of digital media in the online teaching of STEM subjects in Foundation Courses during the COVID-19 confinement.
2. To analyse the previous results of students' perception of their use of digital tools, their communication with teachers and the acquisition of competences during virtual classes.

## Design

A quantitative descriptive approach was used, in which quantitative data collection techniques and instruments were implemented. A non-experimental research design (Creswell, 2012) was chosen to respond to the research objectives. Specifically, the questionnaire technique was used by means of a survey with items measured on a Likert scale, with which the data were collected for subsequent analysis and discussion of the results.

## Participants and context

This research involved 61 students from Northumbria University who were enrolled in one of the Foundation Year STEM modules during the 2021/2022 academic year, with a total of 35 females (57.38%) and 26 males (42.62%), and an average age of 22 years. Of the participating students, 9 students were single sons (14.8%); 26 reported having one sibling (42.6%); 18 reported having 2 siblings (29.5%); and finally, 8 students reported having 3 siblings (13.1%). When asked if their parents were working, 34 students stated that both parents were working (55.74%), 19 stated that only one parent was working (31.15%) and the remaining 8 students stated that neither parent was working (13.11%). Furthermore, 37 of the participants (60.66%) indicated that they combined their studies with work, compared to 24 who did not (39.34%).

## Instrument

The instrument used for data collection was an *ad hoc* 12-item Likert scale survey with five response values (where 1 meant "Strongly Disagree",

2 “Disagree”, 3 “Indifferent”, 4 “Agree” and 5 meant “Strongly Agree”). From the first to the sixth item, in a first dimension of the questionnaire, we asked about the access and use of digital media in the virtual classes of the courses and their communication with the teachers during the confinement:

1. I have had adequate access to the Internet in the development of the virtual classes.
2. I have appropriate electronic devices to perform my tasks.
3. I share these devices with the rest of the members of the family unit.
4. I have no technical difficulties to access virtual resources offered by teachers.
5. I use email or other means to request guidance and advice from teaching staff.
6. Communication with the teaching staff has been fast and fluid.

The second dimension, from the seventh to the twelfth question, asked about the students’ perception of their adaptation to online teaching and the acquisition of competences with this teaching methodology:

7. I have adapted myself well to working with my classmates in virtual classes.
8. I think I have improved my ICT skills.
9. My participation in virtual classes is the same as in face-to-face classes.
10. Virtual classes have altered my academic performance.
11. In general, I think I have acquired the basic skills of the course.
12. The training received is appropriate for my future university training.

In addition, participants were initially asked about their gender, age, number of siblings, whether their parents worked, parents’ studies and whether they combined their studies with work. At the end of the questionnaire, an open-ended question was posed so that participants could include comments or suggestions about the activity.

Overall, reliability and internal consistency were calculated for this instrument using different indices. *Cronbach’s alpha* yielded a result of = .78 being this result as good according to George and Mallery (2003). A *Composite Reliability* index of .79 was also obtained, considered as very good, and an *Average Variance Extracted* (AVE) index of .48, considered



as good (Hair, 2009). Finally, *McDonald's Omega* gave a value of .95, considered as excellent (Ventura-León and Caycho-Rodríguez, 2017).

Next, construct validity was carried out to measure the latent variable "Student perception of the online teaching carried out" by means of a principal components factor analysis with *varimax* rotation. A significant *p-value* of .000 was obtained for *Bartlett's test* of sphericity and a *Kaiser-Meyer-Olkin* (KMO) coefficient for the proportion of variance that the variables analysed have in common of .64 (good sampling adequacy is considered to be .5 or above). For the subsequent analysis and presentation of the results, we chose to group the first six questions referring to the students' perception of the use of digital media and communication with teachers and the rest of the questions referring to the students' perception of the adaptation to virtual teaching and the acquisition of competences.

## Procedure

After an exhaustive review of the literature, the questionnaire used in this research was designed and its content validated by expert judgement. Four experts in the field reviewed the questionnaire and provided suggestions for its final wording. The questionnaire was then administered via email during the academic year 2021-2022 (January-March) and was completed individually and anonymously through the web application *Encuestas de la Universidad de Murcia*, Spain (ATICA, 2018). In order to achieve the highest number of participants, the collaboration of several teachers was requested and, in addition, several mailings of the instrument were made.

## Data analysis

The quantitative data collected using the Likert scale were processed and analysed with the R *free software* statistical package. In the search for significant differences in the items according to sociodemographic variables, non-parametric tests were applied, as these tests are the most robust for ordinal data (Ibáñez-López et al., 2022). Specifically, the *Mann-Whitney U test* was used for independent variables with two levels of response (*p-value* less than .05 and significance level  $\alpha = .05$ ). These non-parametric tests mainly act on the median of the data, although for



a better understanding of the data analysed, the mean and standard deviation of the data are also presented in the descriptive statistics tables.

## Results and discussion

### Design and validation of the questionnaire on the use of digital media in the online teaching of STEM subjects of the Foundation Courses during the COVID-19 lockdown

The first dimension of the questionnaire consisted of 6 items on the access and use of digital media for the virtual classes of the courses and their communication with the lecturers by the students during the lockdown. The dimensionality of this dimension was determined by means of an Exploratory Factor Analysis (EFA), after studying the non-existence of variables that did not correlate well enough or that could cause multicollinearity. A significant value was obtained in *Bartlett's Test* with  $\chi^2(15) = 92.88$  and *p-value* = .000, which ruled out that the matrix was like the identity matrix. A *Kaiser-Meyer-Olkin Index* (KMO) for factorial adequacy of .59 (considered good) and the factor loadings shown in Table 1 were obtained.

**Table 1**

*Factorial loadings of the items of the dimension access and use of digital media for the virtual classes of the courses and their communication with teachers*

Question	Loading	Communality (h <sup>2</sup> )
Q1	.77	.59
Q2	.48	.24
Q3	-.38	.15
Q4	.69	.47
Q5	.25	.36
Q6	.55	.31

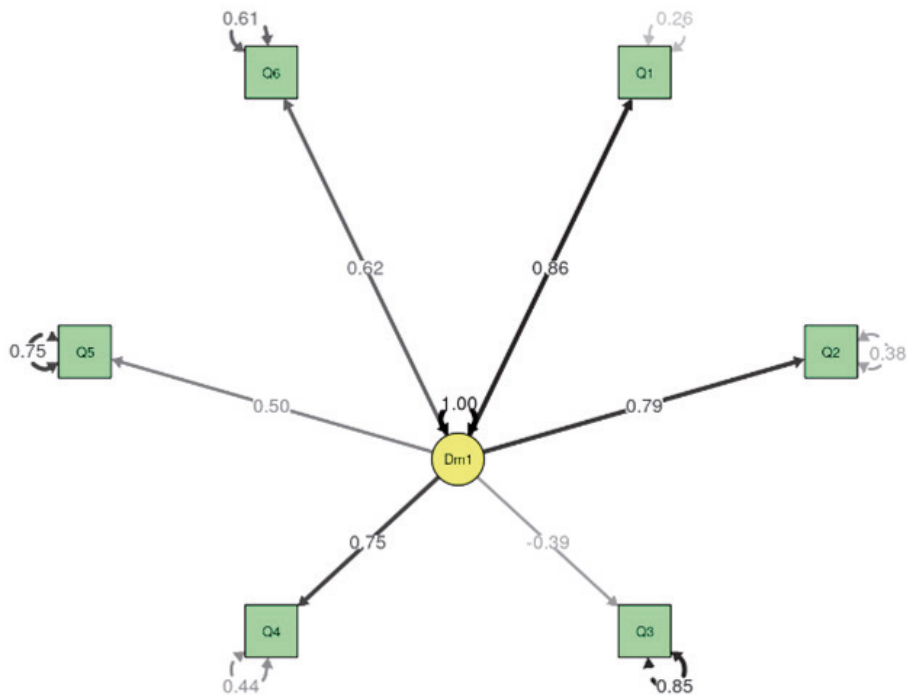
The total variance explained in this dimension was 30%.

Regarding the analysis of the internal consistency of the items of this dimension, a *Cronbach's Alpha* index of .63 was obtained, considered as acceptable (George, 2011); a *Composite Reliability* of .54 and an *AVE* index of .30 were obtained, considered as questionable (Hair, 2009) and

finally, the *Omega* was also calculated, obtaining .69, considered as good (Ventura-León and Caycho-Rodríguez, 2017).

In addition, a Confirmatory Factor Analysis was performed in order to check the adequacy of the model. Figure 1 shows the covariances between the latent variables and the influence of each latent variable on the respective observed variables (items). Several fit indices were calculated for this model. The *Diagonal Weighted Least Squares* (DWLS) weighted least squares estimator took a value of 56.14 with 9 degrees of freedom and  $p\text{-value} = .000$ , indicating that the model fits well (Beaujean, 2014). Moreover, .89 and .91 *TLI* and *CFI* values were obtained indicating a moderate fit. However, the *RMSEA* value obtained (.18) was slightly above .1, falling between poor and good fit. Considering these indices, it can be confirmed that the proposed model was adequate.

**Figure 1**  
*Structural Equation Model for the first dimension*



As for the second dimension of the questionnaire, it was again made up of 6 questions, this time on the students' perception of their adaptation to online teaching and the acquisition of competences with this teaching methodology. Once again, the dimensionality of this dimension was determined by means of an Exploratory Factor Analysis (EFA), verifying the non-existence of variables that did not correlate well or that could cause multicollinearity. A significant value was obtained in *Bartlett's Test* with  $\chi^2(15) = 168.07$  and  $p\text{-value} = .000$ , which ruled out that the matrix was like the identity matrix. A *Kaiser-Meyer-Olkin Index* (KMO) for factorial adequacy of .73 (considered good) and the factor loadings shown in Table 2 were obtained.

**Table 2**

*Factorial loadings of the items of the dimension of students' perception of their adaptation to virtual teaching and the acquisition of competences*

Question	Loading	Communality (h <sup>2</sup> )
Q7	.77	.59
Q8	.79	.62
Q9	.50	.25
Q10	-.35	.88
Q11	.82	.67
Q12	.80	.65

The total variance explained in this dimension was 48%.

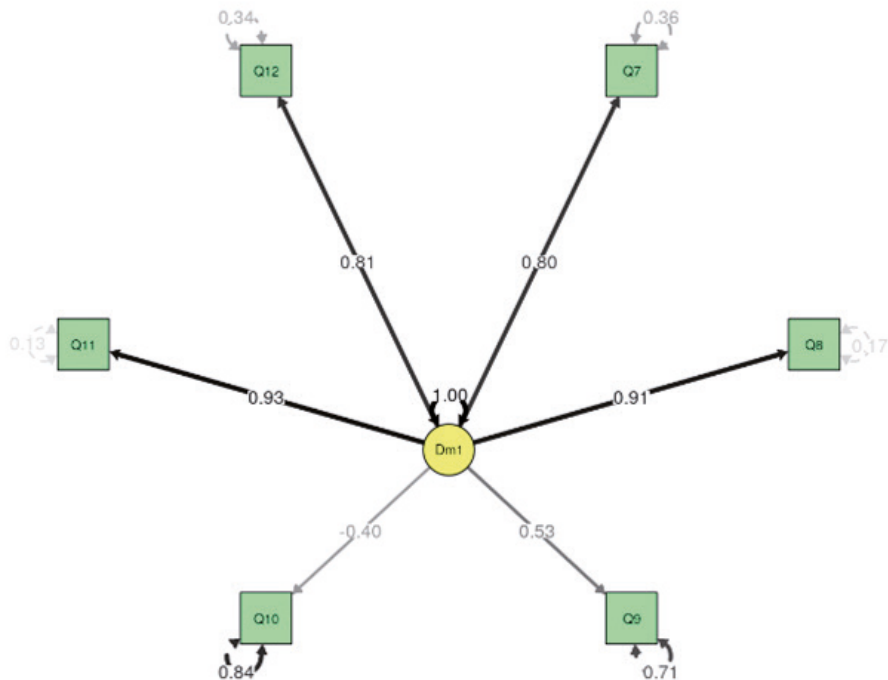
With respect to the analysis of the internal consistency of the items in this dimension, a *Cronbach's Alpha* index of .81 was obtained, considered as good (George, 2011); a *Composite Reliability* of .78 and an *AVE* index of .48 were obtained, both considered as good (Hair, 2009) and finally, the *Omega* was also calculated, obtaining 0.83, considered as good too (Ventura-León and Caycho-Rodríguez, 2017).

Moreover, a Confirmatory Factor Analysis was performed again in order to check the adequacy of the model and Figure 2 shows the covariance of this analysis. Several fit indices were calculated for this model; The *Diagonal Weighted Least Squares* (DWLS) weighted least squares estimator took a value of 40.84 with 9 degrees of freedom and  $p\text{-value} = .000$ , indicating that the model fits well (Beaujean, 2014). In addition, .97 and .98 TLI and CFI values were obtained, indicating an excellent fit. However, again, the *RMSEA* value obtained (.11) was slightly above .1,

falling between poor and good fit. Considering these indices, it can be confirmed that the proposed model was adequate.

**Figure 2**

*Structural Equation Model for the second dimension.*



### **Analysis of previous results of students' perception of their use of digital tools, their communication with teachers and the acquisition of skills during virtual classes**

The descriptive statistics of the first dimension of the questionnaire shown in Table 3, indicate that practically all the participants, 96.7%, agreed or strongly agreed with the first question, regarding adequate access to internet for the development of their classes, and 63.9% indicated not having technical difficulties in accessing the virtual resources provided by the teaching staff, compared to 9.84% who stated that they did have these problems (question 4). Also, 83.6% pointed out that they agreed or totally agreed with the fact that they had the appropriate elec-

tronic tools to carry out the tasks (question 2) and 73.8% stated that they did not have to share them with the rest of the members of the family unit.

On the other hand, 73.8% of the participants stated that they used e-mail or other electronic tools to communicate with lecturers, compared to 16.4% who did not (question 5). Finally, regarding the fluidity of this communication (question 6), there was more controversy in the responses, with 42.6% stating that communication was fluid and fast, compared to 21.3% who did not think so, and 36.1% who were indifferent.

**Table 3**

*Descriptive statistics dimension access and use of digital media for the online classes of the courses and their communication with lecturers*

Question	N	Min	Max	Mean	Median	%1	%2	%3	%4	%5	SD
Q1	61	2	5	4.43	4	.00	3.28	.00	47.54	49.18	.67
Q2	61	3	5	4.46	5	.00	.00	16.39	21.31	62.30	.77
Q3	61	1	5	2.00	1	52.46	21.31	9.84	6.56	9.84	1.34
Q4	61	1	5	3.82	4	6.56	3.28	26.23	29.51	34.43	1.15
Q5	61	2	5	4.03	4	.00	16.39	9.84	27.87	45.90	1.11
Q6	61	1	5	3.39	3	8.20	13.11	36.07	16.39	26.23	1.24

Regarding the search for significant differences in these questions, with respect to gender, differences were found in question 2 ( $W = 231$ ,  $p$ -value = .00,  $d = 1.23$ ;  $mean = 4$  and  $median = 4$  for males, and  $mean = 4.8$  and  $median = 5$  for females) and in question 5 ( $W = 261$ ,  $p$ -value = .00,  $d = 1.01$ ;  $mean = 3.46$  and  $median = 4$  for males, and  $mean = 4.46$  and  $median = 5$  for females).

Regarding the variable do you combine studies with work, differences were found in question 1 ( $W = 580$ ,  $p$ -value = .02,  $d = .62$ ;  $mean = 4.67$  and  $median = 5$  for students who only study, and  $mean = 4.27$  and  $median = 4$  for students who only study, and  $mean = 4.27$  and  $median = 4$  for those who study and work) and in question 2 ( $W = 261$ ,  $p$ -value = .00,  $d = 1.01$ ;  $mean = 4.75$  and  $median = 5$  for participants who only study, and  $mean = 4.27$  and  $median = 5$  for those who study and work).

The results show that the students had no problem in accessing and using digital media for the development of their tasks and the monitoring of online teaching, in line with other studies (Hernández-Ramos, 2021; Avendaño et al., 2021; Gil et al., 2021; Pérez et al., 2021; Perosa et al., 2020) and contradict the results of Andraca-Sánchez et al., 2022, con-

textualised in another country and continent, who identified as factors associated with problems to continue studying virtually not having devices for their classes, bad or very bad communication with their teachers, regular to very bad form of virtual work, insufficient progress in the contents, and having three or more family members studying.

On the other hand, the descriptive statistics for the second dimension shown in Table 4 show that 80.3% of the students agreed or strongly agreed that, in general, they considered that they had acquired the basic competences of the course (compared to 3.28% who did not; question 11) and 70.5% considered that they had received appropriate training for their future university studies (compared to 9.84% who did not; question 12). In addition, 73.8% agreed or strongly agreed that these virtual classes had helped them to improve their ICT skills, compared to 16.4% who did not (question 8).

However, 60.7% of the participants indicated that their participation in online classes is not like their participation in virtual classes, compared to 23% who indicated that their participation does not vary according to the mode of teaching (question 9). Furthermore, 57.4% agreed with the statement in question 10, which indicated that virtual classes had altered their academic performance (compared to 13.1% who did not and 29.5% who were indifferent). Finally, the question that showed the most contradiction among participants was question 7, where 44.3% of students indicated that they had adapted well to virtual classes, compared to 29.5% who did not and 26.2% who were indifferent.

**Table 4**

*Descriptive statistics dimension of students' perception of their adaptation to virtual teaching and the acquisition of competences*

Question	N	Min	Max	Mean	Median	%1	%2	%3	%4	%5	SD
Q7	61	1	5	3.23	3	6.56	22.95	26.23	29.51	14.75	1.16
Q8	61	1	5	3.74	4	6.56	9.84	9.84	50.82	22.95	1.12
Q9	61	1	5	2.70	2	8.20	52.46	16.39	6.56	16.39	1.23
Q10	61	1	5	3.80	4	3.28	9.84	29.51	18.03	39.34	1.17
Q11	61	2	5	3.98	4	.00	3.28	16.39	59.02	21.31	.72
Q12	61	1	5	3.95	4	6.56	3.28	19.67	29.51	40.98	1.16

Again, a search was conducted for significant differences in these questions, with respect to the gender of the participants and the variable

combining studies and work. Regarding gender, differences were found in question 8 ( $W = 598$ ,  $p\text{-value} = .02$ ,  $d = .42$ ;  $mean = 4$  and  $median = 4$  for males, and  $mean = 3.54$  and  $median = 4$  for females), in question 10 ( $W = 642$ ,  $p\text{-value} = .00$ ,  $d = .68$ ;  $mean = 4.23$  and  $median = 5$  for males, and  $mean = 3.49$  and  $median = 3$  for females) and in question 11 ( $W = 641$ ,  $p\text{-value} = .00$ ,  $d = .86$ ;  $mean = 4.31$  and  $median = 4$  for males, and  $mean = 3.74$  and  $median = 4$  for females). With respect to the variable combining studies and work, no differences were detected in any of these questions.

The results obtained indicate that the students had a good adaptation to online teaching and a favourable perception regarding the acquisition of the competences of the STEM subjects in the same way as the acquisition of the same competences in face-to-face teaching. In addition, they stated that they considered that they had experienced an increase in digital competences as a result of these digital methodologies, in line with the studies by Manco-Chavez et al. (2020), Ojeda-Beltrán et al. (2020), Perosa et al. (2020) and Hernández-Ramos et al. (2021).

## Conclusions

The pandemic has brought about the implementation of new methodologies based on digital resources and applications that have led to a renewal and implementation of new techniques with the aim of facilitating students' understanding and monitoring of subjects through virtual teaching. In addition to favouring certain social skills, they have also led to the consequent acquisition of digital competences by both teaching staff and students. These new methodologies are going to be maintained during the time and that is why it is absolutely necessary to continue promoting the training of lecturers and students, and the development and application of new resources with the aim of improving the teaching-learning processes.

The aim of this work was the design and development of an instrument to measure the use of digital tools and media in the virtual teaching of STEM subjects in the Foundation Courses during the Covid-19 lockdown and the subsequent blended learning teaching delivery. The final questionnaire implemented consisted of a first section of socio-demographic questions, followed by two dimensions of six questions each, the



first on the use of digital media and communication with lecturers, and the second on the adaptation and acquisition of competences during the lockdown. As can be seen, it is a simple and easy-to-use instrument which, in its initial results, showed that students did not experience major problems in accessing and using digital media to be able to follow the courses, carry out their homework and maintain fluid communication with lecturers, regardless of the number of people in the family nucleus, the employment situation or training of the parents, or the fact of combining studies with work simultaneously. In addition, the results also showed that the student adapted satisfactorily to these new techniques and resources, and more importantly, felt that they had acquired the final competences necessary to pass the courses in the same way as they would have acquired them face-to-face.

Considering the results obtained with the factor analyses of the instrument in each of its dimensions, both exploratory and confirmatory, it can be concluded that it is a questionnaire that can satisfactorily measure the variables proposed in its design. However, this evidence does not eliminate the need to continue applying this tool in future studies to further deepen the results obtained and to be able to make comparisons through its application in other studies, other insitutions and contexts, or even in other Universities from other countries. It would be very interesting and necessary to check that this validity is confirmed in other conditions.

Its usefulness and good application do not prevent us from recognising the limitations of the present work. It would have been desirable to have had a larger number of participants in this pilot test, so that the results would have confirmed the validity of the instrument even more emphatically. This questionnaire could also have been applied in other settings and degree programmes. Therefore, its continued application should be sought to continue analysing whether or not online teaching represented an advance in the different methodologies that can be applied to achieve really quality teaching that ensures continuous training and the acquisition of student skills and competences.

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