JOURNAL OF NEW APPROACHES IN EDUCATIONAL RESEARCH
2022, VOL. 11, NO. 1, 79-96, e-ISSN: 2254-7339
https://doi.org/10.7821/naer.2022.1.727

ORIGINAL

Design and Validation of an Instrument to Measure Educational Innovations in Primary and Pre-Primary Schools

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ABSTRACT

The creation and implementation of innovation proposals in education can provide a new key towards sustainable development. We are aware that schools perform very different innovations but often, with very low levels of impact and dissemination in their community. There are not many studies that describe, put a value on, categorize or analyse the innovations. This study sought to gain insight into the ICT innovations produced in Spanish primary and pre-primary schools. A quantitative approach based on a questionnaire was used to collect the data, named MANEDUIN, completed by 86 teachers selected by stratified random sampling (public - private, rural - urban). The reliability and the construct-related validity was evaluated from the questionnaire and the validity of content decided by means of experts' judgment. Our findings point to a good consistency in the questionnaire (Cronbach's Alpha: 0.848). The descriptive statistics and the analysis were made by factorial categories. The results of the factorial analysis confirm the dimensions proposed in the design of the questionnaire in the categories of the factors included in the innovation (social cohesion, interaction with the community, technologies, and success), the innovative schools and their characteristics, the topic and the type of innovation (on resources, direction, materials and time), as well as the obstacles to the innovation. This paper concludes that the questionnaire MANEDUIN is a valid and reliable tool to measure the management of schools' innovations.

Keywords INNOVATION, EDUCATIONAL MANAGEMENT, ICT, TEACHER EFFECTIVENESS, PRIMARY SCHOOL

Received 2021-02-15
Revised 2021-03-04
Accepted 2021-05-28
Published 2022-01-15

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DOI https://doi.org/10.7821/naer.2022.1.727
Pages: 79-96

1 INTRODUCTION

Market globalization, the surge of information technology in almost all facets of life, the competitiveness of world powers, migration and demographic changes are some of the reasons that have made innovation a priority not just for businesses but also for educational institutions. Innovations created by teachers, teacher communities and schools in their

daily practice play a crucial role in improving the quality and effectiveness of education systems (Halász, 2021). Citizens of the 21st century need to develop competences so that they can participate in social inclusion, and evolve, both personally and professionally, in a digital society (Rodríguez, Cantabrana, & Cervera, 2021), bearing in mind, that digital competence is one of the key competences (Muñoz-Repiso, Martín, & Gómez-Pablos, 2020). Recent research shows the need for a change in the educational paradigm, where education is conceived as a place of lifelong learning, and not a rigid school that conceives educational success as performance of exams (Rochovská, Droščák, & Šilonová, 2020).

Thus, in order to improve student learning outcomes, new pedagogies and teaching approaches must emerge (Bakhru, 2018). In this regard, we are fully aware that an increase in the proliferation and management of ICT educational innovations is already happening in most schools (Almandoz, 2008). Such experiences often take place in many schools, but sometimes they are not recognized or are simply ignored outside the classroom or the school where they took place. Teachers and school managers are reluctant in some cases to disclose their innovative practices, sometimes because they themselves still doubt their value, but often because they may not have the time to get the message out (Licht, Tasiopoulou, & Wastiau, 2017). Its study, besides, has traditionally remained under-researched. Accordingly, we consider it is necessary to spread these initiatives and also to characterize teachers and schools (or other innovation agents) that encourage changes for the improvement of education (Turrado-Sevilla, Mayo, & Lucía, 2020).

A few years ago Cerrillo (2000), pointed out that each community fully integrates a set of talent banks unexplored by its educational institutions. In the same way Batllé (2015), admits without reservation, that teachers do and manage great things in unjust anonymity. Similarly, Carbonell (2015, p. 18) states that:

> Some utopias are already being developed today in many schools and other learning spaces. Although these innovations always require renewal, enrichment and consolidation, they serve as a beacon for a lot of educators who think and struggle every day to make a reality the dream of an innovative, socially equitable, culturally powerful and totally free education. That is, EDUCATION in capital letters.

Innovation management is a complex process and includes the set of innovation tools, the different phases, the definition of the organizational structure, the forecast of resources for innovation, the definition of the policy and objectives of innovation and the methods of evaluation and monitoring of the system itself. It requires a continuous and deliberate change in the scope and actions to improve the elements, the participants, the organization and the management of education. Innovation is at the essence of education and the science of education (Ramírez-Montoya, 2020).

This issue has been internationally studied in a number of studies (Berrocoso, Arroyo, & Diaz, 2010; Bocconi, Kampylis, & Punie, 2012; Halász, 2021; Law, Yuen, & Fox, 2011; OECD, 2013, 2017; Paniagua & Istance, 2008; Rikkerink, Verbeeten, Simons, & Ritzen, 2016; Vincent-Lancrin, Urgel, Kar, & Jacotinet, 2019). The studies at the national level (Marcelo et al., 2009) and by communities (Gairín, Armengol, & Moreno, 2010;

Jauregui & P, 2010; Jauregui, Vidales, & K, 2012; Tójar & Mena, 2011) have an impact on the same lack of systematization, collection, management and classification of innovations. In fact, in Castile and Leon (one of the communities in Spain with the most active teachers) there is only one pilot study of innovation management in Zamora and Salamanca (Martín, González, & Costillas, 2013), which uses only qualitative tools, interviews, as a way of evaluating innovation management. Thus, despite the increase in management of these experiences that is taking place, at the national and international levels, currently there is no consensual or shared evaluation model that would allow us to advance the knowledge, management and improvement of these experiences (Tójar & Mena, 2011). There is a lack of cross-validated instruments of measurement that are a conceptual fit with the innovation literature, which challenges our common understanding of what causes innovations in schools to ultimately fail or succeed (Lambriex-Schmitz, Van Der Klink, & Beausaert, 2020). Besides, designing new questionnaires is complicated and time consuming, therefore it is tempting to use and re-use existing samples for practical and legitimation reasons (Scherbaum & Meade, 2009)

This article makes a contribution to the literature on the educational innovations by developing and validating a multidimensional, reliable instrument to measure management of schools' innovations. We chose primary and pre-primary levels since according to the authors, there is always a greater willingness among primary school teachers over secondary school teachers to innovate (Cuenca, Gorospe, Aberasturi, & Etxebarria, 2009; Evans & Leppmann, 1970; Gibbons & Silva, 2011; Hoffman & Holzhuter, 2012; Marcus, 2012; Serdyukov, 2017).

2 MATERIAL AND METHODS

While sometimes it is not simple to differentiate clearly between the many different forms of innovation, several authors have developed a number of categorizations. An interesting suggestion that we will use in this investigation (Tójar & Mena, 2011) is which differentiates between two sorts of educational innovations: vertical (top-down) and horizontal (bottom-up). Descending innovations are promoted by the authorities in charge of education (national or regional authorities) and imply a process of transforming in order to introduce organizational, academic or structural modifications. Bottom-up innovations, on the other hand, are implemented by the teachers directly and take place at the individual classroom or school level. Once grassroots innovations are created, they can be generalized or extended to other levels, strengthening their adoption to the point of becoming institutionalized, even at deep structural levels.

In this way, our questionnaire focuses on exploring these two constructs in order to gain insight into innovations management and to know which one is more likely to achieve success.

2.1 Questionnaire Validation

The developed questionnaire was first validated by a panel of experts (Aguilar, Eduardo, & Berganza, 1996; Wiersema, 2001), by means of asking their opinion on three criteria of the questionnaire: relevance, pertinence and univocity.

The panel of judges was comprised of three university professors, two primary school teachers, a headmaster of a primary school and an education inspector . Each of them was contacted personally and subsequently received an e-mail explaining the objectives of the research as well as requesting their good judgment in evaluating the effectiveness of the questionnaire in its application. Accompanying the questionnaire, they received a template to evaluate each of the variables in the questionnaire with the criteria of relevance and univocity. In addition, the possibility to make any observation or modification they considered necessary on any aspect relating to the questionnaire in each of the variables (Table 1) was left open for them.

Table 1 External grid model of annotations for expert judgment

	Univocity	Pertinence	Relevance	Comments (Suggestions, corrections)
General data	1 2 3 4	1 2 3 4	1 2 3 4	
Variable 1				
Variable 2				

Once the answers obtained by the experts had been analysed, the following validity criteria were established to determine whether each of the variables should be maintained, improved or eliminated (Table 2).

Table 2 Validity criteria for the variables evaluated by the experts

STEP	Elimination criteria	Number of eliminated variables	Eliminated variables
1	At least 1 person classifies it as non-univocal	19	37, 40, 41, 44, 49, 50, 51,53, 77, 79, 83, 92, 111, 119, 123, 147, 157, 168, 160
2	At least 1 person classifies it as non-pertinent	31	23, 28, 30, 38, 43, 45, 46, 60, 61, 63, 65, 78, 82, 84, 91, 101, 104, 110, 112, 135, 141, 145, 149, 153, 154, 155, 156, 163, 164, 165, 166
3	At least 1 person classifies it as non-relevant	25	22, 24, 29, 31, 36, 42, 52, 62, 71, 71, 72, 73, 76, 94, 97, 98, 102, 105, 122, 128, 144, 146, 159, 167, 176

2.2 Final Preparation: Final Version of the Questionnaire

In this way, the final model of the questionnaire "Analysis of the management of ICT innovations in nursery and primary education schools in the region of León" (MANEDUIN) was definitely designed with the next 13 dimensions: topic and reasons, type, approach, time devoted to innovation, resources, outside support, assessment, obstacles, satisfaction, impact and dissemination (Table 3).

Using random stratified sample, a reliability level of 95.5% (2σ) and a margin of bias of + 5% was obtained, so that a required sample size of at least 71 subjects was calculated.

Table 3 Dimensions of the definitive version of thequestionnaire "Analysis of innovations in primary and pre-primary schools"

Categories	Variables
General aspects	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Topic and reasons for innovation	13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29
Type of innovation	30, 31, 32, 33, 34, 35, 36
Approach	37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53
Time devoted to innovation	54, 55, 56, 57
Resources	58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73
Outside support	74, 75, 76, 77, 78
Assessment	79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90
Obstacles	91, 92, 93, 94, 95, 96, 97, 98, 99
Satisfaction	100, 101, 102, 103, 104
Impact	105, 106, 107, 108, 109, 110
Dissemination	111, 112, 113, 114
Others	115

Data gathering was conducted during the months of May and June 2018. The sample was intentional and convenient since an online Google Docs questionnaire for teachers was sent by email to all of them. It was specified that in the event that several teachers carried out the same project, only one questionnaire would be completed for each innovation. The online questionnaire was answered by 32 primary and pre-primary education teachers from the Province of León. In addition, the questionnaire was also sent through social networks and was additionally attended in person by different schools in the province. After the data collection process, the final sample consisted of 86 teachers.

Its reliability and internal consistency were assessed through the Cronbach Alpha coefficient, which is one of the most used by researchers' reliability indices (Ledesma, Ibañez, & Mora, 2002). 12 variables were inverted in order to guarantee all the variables in each of the scales have the same sense of response. Since the purpose of this coefficient is to determine the relationship between variables, an analysis was carried out to evaluate the consistency for the entire questionnaire. A second analysis was performed to divide the sample into two parts following the technique of the two halves. George and Mallery (2003) determine the following Cronbach's Alpha coefficient-based scale to rate the instrument's reliability: Excellent: >0.90, Good: 0.81-0.90, Acceptable: 0.71-0.80, Questionable: 0.61-0.70, Poor: 0.51-0.60, Unacceptable: <0.50. The instrument has a reliability of 0.848.

Also, to reduce the questionnaire's dimensionality we conducted an exploratory factor analysis (Ortega, Sicilia, & González-Cutre, 2013) of each of the questionnaire dimensions to to find those variables that are grouped together with a common meaning and, in this way, to try to understand and analyse the structure of the interrelationships among variables that define the management of educational innovations in primary and pre-primary schools.

This analysis is a dimensionality reduction technique that groups correlated variables into sets called factors. Principal Component Analysis was used as an extraction method with the aim of creating a linear combination that explains the highest possible percent-

age of variance, at least 60% of the total variance. First, the matrix of correlations of the variables, the communalities (percentage of the variance that can be explained by the factorial model), the Kaiser-Meyer-Olikin index (KMO) and the Bartlett spherical test were calculated to check whether the data had the right characteristics to carry out this analysis (Frías-Navarro & Soler, 2012). The KMO index was used to check if the partial correlations between the variables were small enough. This parameter can take values between 0 and 1, the closer to 1 the value is, the more meaningful the factorial analysis will be. An index lower than 0.5 indicates that this analysis should not be used with the sample being evaluated. In addition, Bartlett's spherical test was applied to test the invalid hypothesis that the correlation matrix is an identity matrix and therefore there would be no correlation between variables, making factorial analysis meaningless. Secondly, the determination of the number of factors to be kept in the analysis was made. There are various criteria to proceed in this way, but one of the most widely used is Kaiser's rule: "retain those factors whose eigenvalues are greater than one" (Jimenez, Flores, Gómez, & G, 2000). However, since these criteria tend to overestimate the number of factors, the sedimentation plot (Cattell, 1966) was also examined by identifying the turning point at which the slope of the line connecting the ordered factors ceases to decrease, including in the final analysis only the factors prior to this one. Likewise, Ferrando and Anguiano-Carrasco (2010) indicate that the minimum number of factors is determined by the number of variables, the minimum necessary number of these being a third or a fifth of the number of variables. A factor rotation was then performed following the Varimax rotation method with Kaiser normalisation to improve the interpretation of the factor structure. This procedure is useful if a variable is assigned a similar weight in two factors and because in the original factorial solution (always orthogonal) the unrotated factors are always dependent on each other. As for the criteria for interpreting the saturation of a variable, the minimum value was defined as 0.5 to be included within the factor (Jimenez et al., 2000). If a variable is within two different factors, it will be included in the factor in which it has the greatest weight. Finally, once the variables assigned to each factor were determined, each factor was named.

All the statistical analyses were carried out with Stata (version 13, Stata Corp, College Station, TX) and IBM SPSS 22 (SPSS, INC., Chicago, IL) designed for Mackintosh. Statistical significance was established at $P \leq 0.05$. For purposes of simplicity, only P values that indicate a significant difference are presented.

3 RESULTS

3.1 Cronbach's Alpha Results

The following table (Table 4) presents the results of the evaluation of the internal consistency of the questionnaire by means of the Cronbach's Alpha coefficient.

Regarding the psychometric aspects of the questionnaire, the analysis revealed a good consistency of the questionnaire following the criteria established by George and Mallery (2003) since the coefficient was 0.848. Likewise, the results were replicated through the analysis of the technique of the two halves, obtaining in one of them a good value (0.860)

Table 4 Results of the Cronbach's Alpha coefficient to analyse the internal consistency of the questionnaire

	Cronbach's Alpha
All variables: 98 variables	0.848
Part 1: 49 variables	0.860
Parte 2: 49 variables	0.907

and in the other one an excellent value (0.907).

3.2 Results of the Dimensional Factor Analysis

3.2.1 Dimension Topic and Reasons for Innovation

In the initial analysis, the innovation initiation variable *At the initiative of the Management Team* obtained a very low extraction communality with a value of 0.492, so it was decided to eliminate it from the analysis. From the variables associated with this dimension, a matrix defined by 5 factors is obtained that explain 75.3% of the variance (KMO index = 0.560, Bartlett's spherity test P <0.001). Examining the sedimentation graph, the inflection point at which the slope stops decreasing is located from the sixth eigenvalue, so it is confirmed that only the first five factors should be extracted. From the factorial structure matrix obtained with the principal component analysis extraction method, the correspondence between each variable and each of the extracted factors is inferred. Thus, factor 1 could be called "Social cohesion", including the variables *"Improvement of the coexistence of the school"*, "*Equal opportunities*", *"Attention to diversity and Promotion of the entrepreneurial spirit"*. Factor 2, called "Interaction with the community", includes the variables "*Interaction family-community-school*", "*Due to the need to prepare or modify documents of the school*" and "*Due to continuing a training course or work group*". Factor 3 would include the variables "*Exclusive ICT integration*" and "*Due to sensitivity to the didactic use of ICT exclusively*", and, therefore, we will call it "Information and Communication Technologies Exclusively". Factor 4, which includes the variables "*Educational success of the students*" and "*Due to the detection of the needs of the school or of the students*", would be called "Success of the school and the students". Finally, factor 5, which includes the variables "*Key competences*" and "*Active methodologies*" would be renamed "New methodologies".

3.2.2 Dimension Type of Innovation

The values of the communities initially assigned to the variables included in this dimension and those reproduced by the factorial solution using the method of extraction of analysis of the main factors showed that the variable "*Introduction or modification of priorities in the objectives of the school*" only reproduces 54.4% of the original variability, while the variable

"*Improvement of the relationships of the members of the school*" reproduces 76.3% of the original variability.

From these variables, a matrix is obtained and defined by 2 factors that explain 67.4% of the variance (KMO index=0.726, Bartlett's spherical test P<0.001). The sedimentation graph confirmed the number of factors. From the factor structure matrix (Table 5), the correspondence between each variable and each of the extracted factors can be deduced. Thus, factor 1 could be called "Improvement of relations" and factor 2, called "Spatial-temporal changes".

Table 5 Matrix of the structure of the rotated factors corresponding to the dimension Type of innovation

Rotated factor matrix

	Factors	
	1	2
Change in the school values or ideology	0.173	**0.808**
Variations in the distribution of spaces, in methodology and/or grouping of students	-0.073	**0.839**
Introduction or modification of priorities in the school objectives	**0.658**	0.333
Improving relations between members of the school	**0.874**	0.000
Integration of new members (teachers or students) into the school	**0.807**	0.279
Improving relations with other schools and/or the community	**0.795**	-0.030
Reduction or increase in units and/or teacher-student ratio	0.500	**0.638**

3.2.3 Dimension Approach

Once the values of the communalities initially assigned to the variables and those reproduced by the factorial solution have been calculated according to the method of extraction of analysis of the main factors, it can be seen that the majority presents a high level of extraction communality. From the variables associated with the dimension "Approach", a matrix defined by 6 factors is obtained that explains 72% of the variance (index of KMO=0.589, Bartlett's spherical test P<0.001). Results are corroborated by the sedimentation graph.

The correspondence between each variable and each one of the extracted factors, that is to say, the matrix of factor structure, obtained with the method of extraction of analysis of main components, is shown in table 6. Thus, factor 1 would be called Resources and Management Team, factor 2 would be called Materials and participation of the families, factor 3 would be called Lack of time and indifference of the Management Team, factor 4 would be called Involvement and research, factor 5 would be called Training weaknesses and finally factor 6 would be called Training and concern for the students.

3.2.4 Dimension Time Devoted to Innovation

In this dimension, which consists of only 3 variables, the KMO index <0.5 (0.457) and the Bartlett's spherical test p>0.05 (0.129) show that there is no logic in carrying out the factorial analysis.

Table 6 Structure matrix of the rotated factors corresponding to the dimension Approach

Rotated factor matrix

	Factors				
	1	2	3	4	5
Coordinators are enthusiastic and encourage collaboration between teachers	0.453	0.113	0.438	0.432	**0,839**
All team members are actively involved in the development of innovation	0.461	0.306	0.226	0.137	**0,627**
Some of the teachers are also researchers	-0.003	0.132	0.109	-0.027	0,058
Related to economic, material or personal resources	**0.640**	0.353	0.167	-0.075	0,026
Related to lack of time	0.156	-0.007	**0.758**	0.055	0,036
Motivated by the inadequeate training of the teachers themselves	0.051	0.141	0.501	-0.009	-0,029
Related to student response	0.293	0.142	0.409	**-0.593**	-0,041
Development of curriculum materials related to innovation	0.367	**0.615**	-0.257	0.350	-0,378
Observations on applications in the classroom of aspects of innovation	-0.011	**0.860**	0.007	0.163	0,126
Attendance at conferences or official training activities (courses, conferences, among others) by experts in the field of innovation	0.130	0.219	0.123	**0.682**	0,452
Innovation coordination and management	**0.704**	0.003	-0.165	-0.102	-0,092
Diffusion of the innovation	**0.804**	0.175	0.030	0.096	0,03
Indifference/inhibition to innovation	-0.444	0.053	**0.701**	-0.015	0,222
They are aware of its existence and have not shown much interest or opposition to it	**0.539**	-0.257	0.061	0.326	-0,055
They are aware of its existence, are satisfied with it and show interest in being informed and participating	0.130	**0.687**	0.362	-0.173	-0,095
They know of its existence and oppose its implementation	0.026	-0.067	0.018	0.103	-0,066

3.2.5 Dimension Resources

Analyzing the community values of this dimension, the lowest community is presented by the variable *"Other schools' staff"*, with 52.6% of the original variability while the highest is *"Expert advice"* with 83.8% of the original variability. From the variables associated with the "Resources" dimension, a matrix is obtained and defined by 5 factors that explain 72.3% of the variance (index of KMO=0.510, Bartlett's spherical test P<0.001). Examining the sedimentation graph, it is confirmed that only the first five factors should be extracted.

From the factor structure matrix (Table 7) obtained with the principal component analysis extraction method, the correspondence between each variable and each of the extracted factors is deduced. Thus, factor 1 could be called "Teacher's personal resources and material", factor 2 called "Other professionals and student material", factor 3 called "Experts and no funding", factor 4 "Audiovisuals and computer" and factor 5 called "Teachers and management team".

Table 7 Structure matrix of the rotated factors corresponding to the Dimension Resources

Rotated factor matrix

	Factors				
	1	2	3	4	5
Teachers	0,029	0,119	-0,094	-0.189	0.432
Management team	-0,273	0,243	0,526	-0.135	0.137
Schools' psychologists	0,16	**0,798**	0,107	0.114	-0.027

Continued on next page

Table 7 continued

Rotated factor matrix					
Other professionals in the school, if any (special education needs team, physiotherapist, nurse, monitors, others)	0,16	**0,871**	-0,103	0.251	-0.075
Students	**0,875**	0,079	-0,159	0.093	0.055
Families	**0,835**	0,193	-0,196	**0.626**	-0.009
Other school staff	**0,65**	0,014	0,161	0.382	**-0.593**
Textbooks and/or specialized books	**0,638**	0,233	0,208	0.220	0.350
Audiovisual resources	0,143	0,214	0,049	-0.158	0.163
Teacher-made or students-made materials	**0,658**	-0,095	-0,022	0.207	**0.682**
Materials from other schools and/or other innovation projects	**0,776**	-0,152	0,125	0.133	-0.102
Internet and computer programmes	-0,133	-0,044	-0,102	-0.083	0.096
Books, written material and consumables (paper, audio/video tapes, etc.)	103	**737**	0,325	0.083	-0.015
Technical equipment (videos, cameras, computers, tablets, etc.)	-0,363	**0,635**	0,393	0.164	0.326
Expert advice	0,212	0,046	**882**	0.162	-0.173
No funding has been provided	0,218	-0,387	**-0,643**	**0.870**	0.103

3.2.6 Dimension Outside Support

This dimension consists of only 4 variables and the KMO index is less than 0.5 (0.426), so even though Bartlett's spherical test shows a value of $p<0.05$ (0.031), it does not make sense to perform the factorial analysis. Besides its extraction, the result of two factors does not manage to explain 60% of the total variance (58%).

3.2.7 Dimension Assessment

In the initial analysis the variable "*The entire educational community*" obtained a communal extraction of 0.288 so it was decided to eliminate it from the analysis. From the variables associated with the "Evaluation" dimension, the matrix is defined by 4 factors, which explains 69.15% of the variance (index of KMO=0.510, Bartlett's spherical test $P<0.001$). From the sedimentation graph, it can be seen that only the first four factors should be extracted.

The factor structure matrix (Table 8) is obtained using the main component analysis extraction method, and from it the correspondence between each variable and each of the extracted factors can be inferred. Thus, factor 1 could be called "Type of assessment", factor 2 "Evaluators", factor 3 "External assess" and finally factor 4 "Timing of assessment".

3.2.8 Dimension Obstacles

Following the analysis of the values of the communalities initially assigned to the variables and those reproduced by the factorial solution according to the method of extraction of analysis of the main factors, the variable "*Lack of support from the families of the pupils in the centre*" obtained an extraction communality of 0.338, so it was decided to eliminate it from the analysis. Once the analysis was repeated without this variable, a matrix defined by

Table 8 Structure matrix of the rotated factors corresponding to the dimension Assessment

Rotated factor matrix

	Factors			
	1	2	3	4
Self-assessment performed by the innovation team	0,49	**-0,543**	0,114	0,111
One member of the group carries out the entire assessment	0,059	**0,878**	0,032	0,032
Assessing other teachers who are not involved in innovation	0,309	**0,779**	0,233	-0,202
External assessment	-0,075	0,23	**0,805**	-0,057
Direct observation during class time	**0,833**	0,043	-0,127	0,095
Questionnaires, interviews and/or recordings	**0,547**	-0,015	0,56	-0,034
Written reports	0,018	-0,058	**0,829**	0,194
Group meetings	**0,785**	0,08	0,068	0,04
Assess only at the end of the project	-0,015	0,075	-0,022	**-0,881**
Assess at the beginning, during the process through regular meetings and at the end	0,471	-0,105	0,111	**0,746**
The evaluation has been carried out during the process, but the need for changes in innovation has not been detected	-0,263	0,46	0,053	0,451

4 factors of the variables associated with the dimension "Obstacles" was obtained, explaining 76.82% of the variance (index of KMO=0.515, Bartlett's spherical test P<0.001). The sedimentation graph confirms the results obtained.

Analysing the factor structure matrix (Table 9) obtained with the principal component analysis extraction method, the correspondence between each variable and each of the extracted factors is inferred. Thus, factor 1 could be called Excessive time spent and lack of staff continuity, factor 2 Complexity, factor 3 Fear and lack of experience and finally and factor 4 Doubts about whether it is worth it.

Table 9 Rotated factor structure matrix for the dimensión Obstacles

Rotated factor matrix

	Factors			
	1	2	3	4
Hours spent working on the innovation outside school were unpaid	**0.815**	0.113	0.199	0.022
The scope and complexity of the innovation	0.199	**0.875**	0.136	-0.072
The paperwork and bureaucracy involved	**0.811**	0.262	-0.031	-0.075
Lack of experience, commitment and/or dedication of teachers in innovation management	0.137	0.177	**0.862**	-0.044
Fear of going outside the comfort zone of the daily routine	-0.021	-0.231	**0.784**	0.285
Doubts about whether it is really worth the effort	0.041	0.081	0.184	**0.875**
Some members of the innovating team who began the innovation were no longer at the school	**0.681**	-0.397	-0.065	0.404
The specific characteristics of the school's students make innovation management difficult	0.017	**0.680**	-0.295	0.420

3.2.9 Dimension Satisfaction

From the factor structure matrix, which is obtained with the main component analysis extraction method, the correspondence between each variable and each of the extracted factors is concluded. As we only have 1 factor, we could call it "Satisfaction".

3.2.10 Dimension Impact

Within this dimension, the variable "*On school materials and equipment* " stands out from the rest, as it reproduces almost 86% of its original variability. From the variables associated with this dimension, a matrix is obtained and defined by 2 factors that explain 70% of the variance (KMO index=0.766, Bartlett's spherical test P<0.001). The analysis of the sedimentation chart confirms the results. From the factor structure matrix (Table 10), the correspondence between each variable and each one of the factors extracted in this way is concluded. The factor 1 has been called "Changes in the students and school community" and the factor 2 "Changes in the equipment".

Table 10 Rotated factor structure matrix for the satisfaction dimension

Rotated factor matrix	
	Factor
	1
The personal challenges I set myself with innovation management have been covered	**0,819**
Innovation management has made it easier for me to teach	**0,837**
The school values the innovation management developed	**0,685**
Innovation management has provided successful relationships, both personally and professionally	**0,796**
I am proud to have carried out innovation management	**0,879**

3.2.11 Dimension Dissemination

Finally, under this dimension the KMO index is 0.688 and the Bartlett's spherical test P<0.05. However, from this analysis only one factor does not manage to explain 60% of the total variance (56%) so it does not make statistical sense to carry out the analysis.

In summary (Table 11), this factorial analysis, which will define and influence the management of teaching innovation, has made it possible to group together and reduce the number of variables that define an innovation, which is useful due to the complex relationship among variables and their association.

Table 11 Summary of the factorial analysis of the ICT educational innovations

Social cohesion	Improvement in the coexistence of the school
	Equal opportunities
	Attention to diversity
	Promotion of the entrepreneurial spirit
School community interactioon	Interaction family-community-school
	Due to the need to prepare or modify school documents

Continued on next page

Table 11 continued

	Due to continuing a training course or work group
ICT exclusively	Due to sensitivity to the didactic use of ICT exclusively
School success	Educational success of the students
	Due to the detection of the needs of the school or of the students
New methodologies	Key competences
	Active methodologies
Relations improvement	Introduction or modification of priorities in the objectives of the school
	Improvement in the relationships of the members of the school
	Integration of new members into the school
	Improving relations with other schools and/or the community
Spatial-temporal changes	Change of the school's values or ideology
	Variations in the distribution of spaces, in methodology and/or grouping of students
	Reduction or increase of units and/or teacher/student ratio
Resources and management team	Economic, material or personal resources
	Management´s team involvement has been innovation coordination
	Families know about innovation and are satisfied and show interest in it
Materials and families implications	Development of curriculum materials related to innovation
	Families know about innovation and are satisfied and show interest in it
Lack of time and indiference of the management team	Related to lack of time
	Management team show indifference and inhibition towards innovation
Involvement and research	All team members are actively involved in the development of innovation
	Some of the teachers are also researchers
Training weakness	Motivated by the inadequate training of the teachers themselves
	Families know about innovation and are opposing its development
Training and concern for the student	Related to student response
	Attendance at conferences or official training activities
Teacher personel, resources and material	Students
	Families
	Other school staff
	Textbooks and/or specialized books
	Teacher-made materials
	Materials from other schools and/or other innovation projects
Other professionals and students material	School psychologists
	Other professionals in the school
	Books, written material and consumables
	Technical equipment
Experts and no funding	Expert advice
	No funding has been provided
Audiovisual and computer	Audio-visual resources
	Internet and computer programs
Teachers and management team	Teachers
	Management team
Type of assessment	Direct observation during class time
	Questionnaires, interviews and/or recordings
	Group meetings
Evaluators	Self-assessment performed by the innovation team
	One member of the group carries out the entire assessment
	Assessing other teachers who are not involved in innovation
Externally assessed	External assessment

Continued on next page

Table 11 continued

	Written reports
Timing of assessment	Assess only at the end of the project
	Assess at the beginning, during the process through regular meetings and at the end
Excessive time spent and lack of staff continuity	The time spent working on the innovation outside school hours was unpaid
	Some members of the innovation team who began the innovation were no longer at the school
	The paperwork and bureaucracy involved
Complexity	The scope and complexity of the innovation
Fear and lack of experience	Lack of experience, commitment and/or dedication of teachers in innovation management
Doubts about whether its worthwhile	Doubts about whether it its really worth the effort
Satisfaction	The personal challenges I set myself with innovation management have been covered
	Innovation management has provided successful relationships, both personally and professionally
	The school values the innovation management developed
	Changes have an effect on the teaching-learning processes
Changes in the students and school community	Changes have an effect on the family-community-school interactions
	Changes have an effect on school spaces and timing organization
	Changes have an effect on student's motivation
Changes in the equipment	Changes have an effect on school materials and equipment

4 DISCUSSION AND CONCLUSIONS

The absence of cross-validated instruments that measure the innovations in schools, makes it difficult to assess them and challenges our common understanding of what causes innovations in schools to ultimately fail or succeed (Lambriex-Schmitz et al., 2020). The use of quantitative validation techniques allows us to present an instrument that fulfills this purpose. Unable to find other related instruments, we believe that the "MANEDUIN" questionnaire represents a contribution to research in the field of educational validation.

Results obtained with our questionnaire show high reliability and validity, so we can state it is suitable to measure innovation management in primary and pre-primary schools. Cronbach´s Alpha value obtained shows that the questionnaire demonstrates internal consistency and that the factorial analysis corroborates the dimensions proposed in the design of the questionnaire, confirming the validity of the construct. Considering the previous results (Einola & Alvesson, 2021; Gairín et al., 2010; Gobo & Mauceri, 2014; Jauregui et al., 2012; Marcelo et al., 2009), the successful use of this type of questionnaire to evaluate the management of educational innovations is evidenced. In its practical application, the questionnaire behaviour was satisfactory. In addition, it was easy to administer, correct and provide an appropriate analysis of the dimensions under study. It also approximates the technical dimensions of other questionnaires such as those indicated by the authors (García-Martín & Cantón-Mayo, 2020; Lucas, Rodríguez, & Mayo, 2020; Lueg & Vila, 2016).

However, it is important not to lose sight of the fact that the relationship between variables is complex and their association, as shown by the factor analysis in the questionnaire,

will define and directly influence teaching innovation. Likewise, this analysis has made it possible to group together and reduce the number of variables that define an innovation.

There is a high saturation rate found in the factor components when the analysis is done separately for each of the dimensions. As the questionnaire was so long, it was not possible to carry out a general factor analysis, which explains the choice of the dimensions. It is worth noting that the personal aspects are the most significant and the institutional aspects are the least important in almost all the factors analyzed.

Satisfaction and obstacles are highly sensitive to the social dimension, more than to the individual one, and represent a decisive pillar in the management of innovations in schools, which must be promoted, understood and managed in the first case and reasoned, convinced and deactivated in the second. These aspects have already been highlighted with slight nuances in other studies (Mayo, Martínez, & S, 2017).

Although the results of the present study show consistent reliability and validity, it is necessary to show some of the limitations. We are aware of the weaknesses of the questionnaire in reconstructing a reality as complex and full of relationships, attitudes and implicit meanings as that of education (Buendía & Alba, 1994; Einola & Alvesson, 2021; Hardy & Ford, 2014).

Some other limitations are the high number of questionnaires that may be lost when sent by mail and the tendency of subjects to give answers that are considered socially correct. These are frequent issues in studies by questionnaire (Anguita, Labrador, & Campos, 2003; Einola & Alvesson, 2021). Besides, we should mention that the questionnaire designed, while providing insightful information on the issues examined here, was somewhat biased in terms of the variables examined and participating teachers. Thus, not all the questionnaire items were applicable to all teachers or schools. It would also be interesting to increase the study population to confer its comparisons greater statistical power.

Nevertheless, the good psychometric properties of this questionnaire make it advisable to use it to measure the management of educational innovations that take place in pre-primary and primary schools. It may be interesting for any future research to expand the sample and apply the questionnaire to other provinces and communities, with the aim of improving knowledge and dissemination of the innovations and thus advance towards real educational change.

In accordance with the results presented, the questionnaire can be approved for application in practice to measure different dimensions of educational innovations. Therefore, the measurement instrument reported in this article provides a valuable starting point for further testing. The survey validated in this study is a powerful tool for analyzing the current situation of the Spanish educational system with regard to the management of educational innovations. The questionnaire provides a general description, which goes beyond previous questionnaires aimed at specific areas of evaluation or at specific administrative or management aspects.

As future lines of research, further replication of this study should be undertaken in other educational contexts to achieve more comprehensive levels of agreement about the reliability and validity of the instrument. Finally, it is important to emphasize the need to initiate

new research, since there is still a need for studies designed to assess the innovations undertaken by the different education contexts with an approach adapted to each environment, as well as the dissemination of such experience both nationally and internationally.

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