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Development and Validation of a Teacher Innovation Behavior Assessment Scale (EECI-E): Confirmation by Bifactorial Modeling

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Abstract

This study aimed to develop and validate the *Échelle d'Évaluation du Comportement Innovant chez les Enseignants* (EECI-E), a scale for evaluating innovation behavior in teachers using bifactor modeling within five Moroccan secondary schools and universities with regulated access. Drawing on Churchill's model of scale development and measurement theory, the research followed a multi-step process involving item generation, selection, scaling, field testing, and refinement. An initial pool of items was assessed through exploratory factor analysis (EFA) with a sample of 290 teachers recognized for their innovative pedagogical practices across 17 institutions in five Moroccan cities. The construct validity of each emergent factor was subsequently evaluated. The results yielded a 24-item scale comprising four distinct dimensions: *Design and Evaluation*, *Objects*, *Conditions of Achievement*, and *Intervention Strategy*. These four dimensions accounted for 77.178% of the total variance, with strong internal consistency (Cronbach's alpha $\alpha = 0.961$) and high test-retest reliability ($r = 0.922$). Confirmatory factor analysis supported a bifactor structure, identifying a general factor that captures a teacher's overall capacity to drive innovative instructional change. Model fit indices indicated satisfactory levels, supporting

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the robustness of the proposed scale. Despite minor limitations, the EECI-E scale demonstrates strong psychometric properties and can be applied in similar educational contexts to support ongoing quality improvement in teaching innovation.

Keywords: Innovation; Validation; Bifactorial Model; Confirmatory Analysis; Scale Development; EECI-E

INTRODUCTION

The Higher Council for Education, Training and Scientific Research (CSEFRS) has placed education at the heart of our country's societal project, because of the missions it must assume in the training of future citizens and in achieving the goals of sustainable human development (CSEFRS, 2015). The Strategic Vision of the reform (2015-2030) summarizes the educational ambition carried by the CSEFRS which translates into two main goals: equity, equal opportunities and quality for all. A vision of which one of the decisive levers consists in encouraging innovation in education (CSEFRS, 2015)

"Dramatic" data decry the education crisis in Morocco (Zerrouqi, 2015). Such as the poor performance of the system, including the school dropout rate (315,273 students left school in 2018), the results of Moroccan students in national (PNEA) and international assessments (75th place among 79 countries), the atmosphere of routine and demotivation which has taken hold and become the norm in the work of teachers and in the attitudes of pupils, the increasingly degraded skills of pupils and their inability to cope with the demands of life for all days (73% of 15-year-old students in Morocco do not have a sufficient level of reading skills.) and finally the increasingly discouraging and pessimistic image that the community has formed about the public school.

Currently, several countries (Australia, Finland, the Netherlands, Norway and the United Kingdom) include innovation in education in their innovation strategies. The demographic explosion, the growing demand for public services, the high expectations of citizens and the budgetary constraints, factors that push the public sector to find innovative solutions that improve productivity by lowering costs and increasing user satisfaction. In our country, social competition as well as competition between access to private and public schools has put pressure on actors in the pedagogical and educational field to innovate in the

sector in order to stand out in order to have more registrations, because competition and the location of establishments are constantly changing.

It is essential to understand what innovation is. Strengthening the ability to measure this innovation, as well as its levers and effects, is a first step in deepening this understanding (Vincent-Lancrin, 2019). The purpose of this research is in the sense of developing a scale to measure the innovative behavior of teachers in Moroccan schools and aims to answer the question: "How to evaluate the behavior of the innovative teacher in schools and universities in Morocco? »

Theoretical background

It should be emphasized that our research comes up against a somewhat passive vision of the school faced with an innovation that seems to come from nowhere. Innovation does not arise out of thin air; it results at least from the school, from its strategy, from its actions. The school can help shape it. Nevertheless, and to clarify our perspective, even if it means oversimplifying it, we reason here by considering that the announced innovation is largely, if not exogenous to the school, at least imposed on it. Different elements, foreign to the school, are indeed combined: competitive forces, the autonomous evolution of technologies, the dynamics of an idea generated elsewhere, of an innovative concept which is tested, which disseminates, which is improved, refined, taken up, imitated, reshaped by the multiple actors present through the complexity of the feedback loops of the innovation process. Each school involved in the future of multimedia and interactive digital boards will contribute to shaping its future; yet none can claim paternity and each is, in the main, confronted with a revolution coming from elsewhere.

Our problem thus formulated relates to a concrete problem which directly concerns the persons in charge and the actors of the education confronted with announced innovations and eager to evaluate the changes as the associated opportunities. Our problematic also aims to provide the management researcher with an appropriate methodology to try to test different conjectures around innovation. These conjectures are sometimes presented as evidence by certain heralds of education and asserted as such with forceful conviction, whereas they still constitute for us only hypotheses, plausible without doubt but which remain to be validated.

We are concerned here with innovation but by asking a different question:

- What is the potential impact of an expected innovation on the strategic position of the Moroccan school in the face of economic and industrial change, globalization and the freedom to transfer skills?

- How can we evaluate innovative behavior in an education system that is vulnerable to the announced changes?

Our problem here concerns innovation, which we will indifferently qualify as change, in its broadest sense. Behind these words, we will therefore include educational innovation (product innovation and process innovation) as well as organizational and social innovation. It should be noted, moreover, that an innovation is rarely exclusively one or the other of these categories and that it generally combines, but to varying degrees, several of these facets of change.

Approaches to measuring educational innovations:

Measuring innovation in education is an innovative attempt adopted by the OECD in 2014. They applied two overarching approaches by presenting indicators based on existing international data sets. The OECD has proposed in its publication "Measuring Innovation in Education, 2014" new methods to create more systematic collections of reliable measures of innovation in education.

Recent initiatives can be grouped into two broad approaches to measuring innovation:

The first approach to measuring innovation in the public sector is to adapt existing innovation surveys. These surveys are a well-established means of measuring innovation, carried out over several decades for (selected) private sectors. In recent years, efforts have been made to adapt them for use in the public sector (e.g. Bloch and Bugge, 2013). Measuring Innovation in Education: A New Perspective (OECD, 2014) adopts this approach to measure innovation in education and presents indicators based on the analysis of two surveys (REFLEX and HEGESCO) in accordance with the methodology of the European survey on innovation (the innovation survey is inspired by the Oslo Manual and its definition of innovation). Five years after graduation, REFLEX and HEGESCO are interviewing higher education graduates in European countries and Japan. The survey questions cover respondents' current employment, including the intensity of innovation in their organization,

the type of innovation (product, process, organization and marketing) and their involvement in the innovation process. The data therefore provides an assessment of innovation in different sectors, including education. The data compares innovation by type and level in different education sub-sectors (secondary and university). This 'survey of innovation' approach has recently been implemented to measure innovation in education in Hungary. An innovation survey has been designed and administered to 5,000 teaching units of all sub-systems (from preschool to higher education) and is linked to student performance through regular national assessments (Halasz, 2018). The survey showed good levels of innovation in all systems and a strong association between innovation and performance in the case of low performing schools. In Australia and New Zealand, a survey of management and service innovations in universities was carried out with a similar methodology (Arundel et al., 2016). A similar approach has also been used in the Netherlands to analyze innovation in secondary education (Haelermans, 2010)

The second approach used to improve the measurement of innovation in the public (and business) sector relies on surveys of organizational change. These surveys have been developed more recently than innovation surveys and have been integrated into national or European surveys (for example, the "Organisational change and computerization" survey in France or the "Measuring the dynamics of the organization and work" in Europe). These surveys capture innovation with a combination of "subject-based" and "object-based" approaches. They usually measure the diffusion of specific innovations in the economy, for example computers or organizational practices. In terms of method, they implement matched employer-employee surveys, asking workers and employers about their current working conditions or tools compared to those of the past. The difference between the current situation and the past situation makes it possible to determine whether there has been innovation in different dimensions of interest. However, to the knowledge of 2014, no international database using this approach covers the education sector.

Measuring Innovation in Education: A New Perspective (OECD, 2014) also adapted this approach and measured innovation as a new or significantly changed process, practice, organizational method, or marketing method observed at the education system level using micro data collected in schools. The approach presents indicators based on an approximation of the traditional definition of innovation. It captures innovation as a significant change in some key practices in schools using PISA, TIMSS and PIRLS databases. Although these studies are designed to measure student outcomes, they also collect information about

educational and instructional practices at any given time. The repeated cross-sectional nature of the studies makes it possible to map trends over time. The indicators are therefore based on the analysis of the answers to questions that were asked at least twice in the study in order to identify changes in professional practices or in class or school resources.

Classroom-level practices (teaching and learning) are often the most difficult education practices to change, and research and innovation literature shows that classroom practices are often unaffected by school reform. education. An important reason for measuring change in classroom practices is precisely to see whether the intended effects of reform, professional development efforts, or educational research are materializing in changed practices. The approach examines three dimensions: pedagogical practices, the use of educational resources and the availability of resources for teaching. In the context of the Oslo Manual, significant changes in any of these dimensions would correspond to a process innovation.

School-level practices are more easily influenced by education policies and decision-makers, and are perhaps also easier to measure. They encompass practices that can affect students directly, for example through special programs, or indirectly, through new human and organizational resource management practices and new ways of engaging with parents. Again, there is a direct correspondence with the Oslo Manual types of innovation, as changes to school practices cover organizational and marketing innovations (such as outreach to parents), even if these categories could be broader. In summary, the organizational change approach can easily be linked to the Oslo Manual innovation framework.

The organizational change approach identifies innovative practices at the school and classroom level. The existence of these practices in a school or classroom signifies the existence of some degree of innovation in that institution. The results of the work, in particular those of the OECD, cover several educational practices. Most of them are pedagogical practices used by teachers during their lessons. These pedagogical innovations cover a large number of teaching and learning strategies, including information on the use of homework and assessment and can be grouped into eight categories of practices: teaching methods, pedagogical practices , the organization of the class, the methods of evaluation, taking the initiative, remediation and support for pupils, the use of textbooks and the use of ICT. Based on the findings that emerge from these studies, the most innovative solutions that specialists can provide to the challenges and issues facing education systems are those

that result primarily from the creative and innovative efforts of educational actors. . The teacher, as a central educational actor in the teaching act, is most often the initiator of innovation. He seeks to innovate to solve a problem or improve an approach or a pedagogical relationship, this requires a state of mind and an encouraging environment. But can a teacher innovate and succeed in his innovation in training and practice conditions that are not very favorable to innovation? What is driving this state of mind, which promotes and awakens innovation in the teacher?

METHODOLOGY

1.Development of corpus of items

The first phase concerns the development of items related to pedagogical innovation involving teachers of the qualifying cycle is developed from the literature review. At the end of this phase, we thus constituted a corpus of **76** statements related to the attributes, indicators and dimensions of pedagogical innovation in secondary education.

In the second phase, the series of statements is first submitted to a panel of experts formed by four research professors, to select the most relevant and coherent items capable of covering each dimension. Then, through a phase of qualitative analysis in a "focus group" (Narang, 2012 ; Paillé & Muchielli, 2012) , we managed to improve the sorting, formulation, clarity and precision.

At the end of this phase, 17 statements are eliminated. The rules for removing items are either semantic imprecision, conceptual impertinence, difficulty in measuring the item, lack of neutrality so as not to generate bias in the responses (Mayer and Ouellet, 1991), or that the item has a relationship with several dimensions. Thus, 59 statements are retained to constitute the first version of the scale which will be the subject of a psychometric validation study.

2. Description and administration of the first version of the Innovative Teaching Behavior Rating Scale

This preliminary version, made up of 59 items, is called the Innovative Behavior in Teaching Assessment Scale. It is administered to a sample of 290 teachers providing Mathematics teaching subjects (15 %), Physics-Chemistry (10%), Life and Earth Sciences (15%), HG (%), IT (13%), Languages (27%), EPS (15%), Others (5 %). The sample is formed by 148 male teachers (51%) and 142 (49%) female, aged 25 to 56, with classroom

teaching experience of 10±5.23 years, belonging to 17 establishments of the secondary education spread over five cities. The participants included in this study are those who have expressed an attitude or have had an experience of educational innovation. They are asked to respond to 59 items on a four-level Likert scale, ranging from 1 (totally disagree) to 4 (totally agree).

3. Method for analyzing the psychometric properties of the EECI-E Scale

a- Loyalty Analysis Methods

The internal consistency of the scale is tested by the split-half method (Nunnally, 1978). While internal consistency is achieved by Cronbach's alpha coefficient (Cronbach, 1951; 1971), for which a threshold of 0.7 is considered very acceptable. Note that we re-examined the same indices after eliminating items whose skewness and kurtosis coefficients are greater than ±1, and whose loading coefficient in the exploratory factor analysis (EFA) is less than 0.4 .

b- Exploratory Factor Analysis (EFA) method

Exploratory factor analysis is used to identify the latent factors of the scale to be constructed from the measured variables (Costello & Osborne, 2005).

The factorial structure was examined by the principal component analysis (PCA) technique, using the *Oblimin -type extraction method* assuming inter-factor correlations (Kieffer, 1998). It thus makes it possible to study the factorial structure of the data collected without reference to predetermined dimensions. We retained the maximum number of interpretable factors, whose eigenvalue is greater than 1, and the explained variance is greater than or equal to 50% (Guttman, 1954).

The indices used in the factor analysis are the KMO index (Kaisser-Mauer-Olin) and the determinant of the correlation matrix. These are two indices showing the existence of correlation patterns between the items of the scale to be validated (Bourque et al., 2006). A saturation coefficient greater than 0.40 makes it possible to retain the items on the factor.

c- Confirmatory factor analysis (CFA) method

Based on the results from the exploratory factor analyses, confirmatory analysis is conducted to assess whether the factor structure adequately matched the data. For this, we adopted the method of estimation by maximum likelihood (maximum Likelihood), with standardized coefficients. Thus, calculated we considered several adequacy indices as suggested (Hoyle, 1995; Hu & Bentler, 1999): the Chi-square ($\chi 2$) and its ratio with the

number of degrees of freedom (X2/dll), the Comparative Fit Index (CFI) (Bentler, 1990) and the Root Mean Square Error of Approximation (RMSEA) (Steiger, 1990),

A non-significant Chi-square (X2) test reveals an adequate model. However, the chi-square test is highly sensitive to sample size, so other indicators are usually considered when estimating a model (Bollen, 1990) like GFI, AGFI, RMR, AIC . Thus, the authors suggest that an X2/dl ratio below 3 and CFI values above 0.80 reveal an adequate model (Bentler, 1990; Bollen, 1990; Kline, 1998, 2005).

RMSEA values below 0.05 indicate that the proposed model is excellent, while values between 0.05 and 0.08 mean an acceptable fit of the model to the data (Browne & Cudeck, 1993).

These thus, the indices will be compared between the 1st order, second order and bifactorial models, to identify the confirmatory model having the best adequacy values. When the identified model does not meet suggested standards of fit, modifications described by Jöreskog and Sörbom (1984) will be performed. Depending on the results obtained by the Software, we proceed to the decisions to include modifications on the model which are carried out with precaution by taking references either from theoretical or methodological bases (Silvia & MacCallum, 1988). The results will be presented in the form of standardized regression weights and correlation coefficients in the figure and the non-standardized coefficients in a table with their significance level ($p<0.5$). Factorial analyzes are performed in SPSS 28 while confirmatory analyzes are processed by Amos 25 (Arbuckle, 2006).

RESULTS

1. Exploratory factor analysis (EFA)

The results of the exploratory factor analysis are presented in Table 2, including the factor structure obtained, the criteria for eigen values and the percentage of variances explained (Reckase, 2009). The first factorial analysis showed an insufficient total variance of 68,230 with 4 factors with a predominance of a single factor representing 52,080 partial variance, which shows the presence of a super-factor comprising 44 items. This finding led us to carry out a second AFE on this dominant super-factor, neglecting the other three weak factors. The results thus showed four factors having 77.178% of total variance, with an almost balanced distribution of the partial variances on these factors (Table 2).

Table 1. Eigenvalues and total explained variance of each factor identified by the factor analysis carried out in two stages.

Factor	1st stage Exploratory factor analysis (EFA)			2nd stage Exploratory factor analysis (EFA)		
	Own value Initial	% of variance	Cumulative % of variance	Own value Initial	% of variance	Cumulative % of variance
1	13.020	52,080	52,080	3,427	23,049	23,049
2	1,728	6.911	58,991	2,306	19,331	42,380
3	1,284	5,138	64,128	1,927	17,339	59,719
4	1.025	4,102	*68,230*	1,131	17,460	*77,178*
Number of times	44 items retained + 15 items deleted (<0.40)			24 items retained + 20 items deleted <0.40)		

Table 1 presents the measure of the KMO (Kaisser-Mauer–Olin) index and the determinant of the correlation matrix. The value of KMO recorded is 0.82. This is a value well above the recommended threshold (0.70). Our items therefore present fairly compact correlation patterns, making it possible to clearly distinguish factors (Neuville & Frenay, 2010). As for the determinant of the correlation matrix (DMC), it represents a fairly small value (0.004) but not zero, which is well within the norm.

Table 2. KMO index and Determinant of the EECI-E scale correlation matrix

Clues		EECI-E scale
KMO [1] index for measuring sampling quality		0.862
Bartlett's sphericity test	Approximate chi-square	935.388
	DOF	300
	Meaning of Bartlett	0.000

[1] : Precision measurement of Kaiser-Meyer-Olkin sampling.

The results of the AFE highlight four major factors forming the ECI-E scale, whose eigenvalue is greater than 1. These four factors explain 77.178 % of the total variance. Which is a satisfactory proportion (Gorsuch, 1983), knowing that the threshold for retaining the number of factors generated is at least 60% explanation of the variance, with eigenvalues exceeding 1 (Guttman, 1954). Thus, the factorial matrix represented in Table 3, summarizes the loading coefficients of each item by factors.

The first factor-explains 23.049 % of the total variance. It has an eigenvalue of 3.427 and includes six items evaluating: the planning of the goal and the evaluation procedures, the continuous evaluation of the innovative process, the positive feedback of the actions initiated, the innovation takes place within a framework of project, the new action is due to inspirations, the planning of the innovation is an individual strategy. We call this axis *design and evaluation of innovation*.

The second factor also consists of nine items representing *the pedagogical objects of innovation* this factor-explains 19.331 % of the total variance with an eigenvalue of 2.306 . The concepts are teaching methods, student learning strategies, organization of groups in class, new procedure for operating and creating didactic tools, management of school work, student behavior in class, the organization of learning tasks, the organization of the school timetable, the organization of extra-curricular activities.

The third factor includes six items reflecting the *conditions for carrying out the innovation* . It explains 17.339 % of the variance (1.927 as its own value) , its items make up: the favorable pedagogical and administrative climate within the establishment, the provision of material resources (installations, didactic tools), the provision of the teacher for initiating innovation, confronting obstacles, the need for theoretical knowledge, and research skills adapted to deal with the problems raised by the new action.

The fourth factor includes three items related to *intervention strategies* . This factor is expressed by three items: the mode of organization of the innovative content, the preparation of educational resources and external skills necessary for the realization, and a plan to overcome the constraints. This factor has an eigenvalue of 3.1 and explains 17.460 % of the total variance.

Table 3. EECI-E EFA factor matrix [a and its] statistical characteristics.

Item code	4 factors explaining 77.178 %			
	F1 (IEP)	**F2 (Ol)**	**F3 (THAT)**	**F4 (IF)**
CEI1	0.907			
PIE2	0.740			
CEI3	0.723			
CEI4	0.636			
CEI5	0.567			
IEC6	0.462			
OI1		-0.908		
OI2		-0.871		
OI3		-0.834		
OI4		-0.822		
OI5		-0.720		
OI6		-0.700		
OI7		-0.670		
CI8		-0.647		
CI9		-0.604		
CA1			0.708	
CA2			0.654	
CA3			0.567	
CA4			0.511	
CA5				
CA6				
SI1				-0.580
SI2				-0.505
SI3				0.552
Variance explained	23.049 *%*	19.331 *%*	17.339 *%*	17.460 *%*
Mean and Standard Deviation	3.133 ± .063	2.977 ± .17	2.963 ± .15	3.035 ± 0.18

Extraction method: Principal component analysis.
Rotation method: Oblimin with Kaiser normalization.
a. Convergence of rotation in
b. 38 iterations.
The coefficients of items below 0.40 are eliminated and not taken into consideration for our measurement scale.
Design & Evaluation of Innovation (CEI); Objects of innovation (IO); Fulfillment conditions (CA), Intervention strategy (SI),

2. Analysis of the reliability of the EECI-E scale

Based on the results of the exploratory factor analysis, the new version of the scale has four dimensions for the concept of educational innovation. We examined the internal consistency and the internal coherence of the four sub-scales, then we re-examined the same indices after having eliminated 20 statements whose coefficients of asymmetry (Kurtosis) and flattening (Skeweness) are greater than ±1, and whose saturation coefficient is less than 0.4 (Sneyers, 1974; Thode Jr., 2002). The results are shown in Table 4.

After eliminating the 20 items, the value of internal consistency, expressed by Cronbach's Alpha, went from 0.719 to 0.961. Similarly, the internal consistency value, expressed by the correlation coefficient, is improved from 0.592 to 0.922. Thus, all the values of the four subscales improved well beyond the threshold of 0.70 set by Nunally (1978), and recommended by Plano Clark & Ivankova (2015) and Creswell (2013). Moreover, some researchers (Field, 2005; Kline, 1999) argue that an alpha greater than or equal to 0.80 reveals good internal consistency.

Table 4. Characteristics of internal consistency and consistency of the EECI-E.

Sub scales	Coded	Number of items			Correlation between the 2 parts [b]		Alpha from Cronbach [c]	
		rough	eliminated at	retained	Before	After	Before	After
Design and Evaluation of Innovation	IEC	11	5	6	0.700	0.824	0.740	0.920
Innovation objects	OI	15	6	9	0.558	0.879	0.711	0.945
Fulfillment condition	THAT	11	5	6	0.784	0.643	0.720	0.811
Intervention strategy	IF	5	5	3	0.606	0.285	0.714	0.699
Scale	EECI-E	42	20	24	0.592	0.922	0.719	0.961

has. Out of interval ±1 of the asymmetry and symmetry coefficient, saturation coefficient less than 0.4.
b. internal consistency coefficient.
vs. internal consistency coefficient.

3. Confirmatory factor analysis (CFA)

In order to validate the factorial structure of the scale, we present here the results of the confirmatory analysis. We evaluated six models introduced in the step-by-step analysis in order to identify the confirmatory model with the best fit indices: two models of the 1st order SEM (covariate and non-covariate (orthogonal), two models of the 2nd SEM order (covariate and non-covariate), and two bifactorial models (classical and inter-factor specific covariation).The results are presented in Table 5.

Table 5. FCA Model Comparison

Models	Absolute Clues							Incremental indices			Parsimonious Indices	
	x2-	***df***	***p***	***GFI***	***AGFI***	***CMA***	***RMSEA***	***NFI***	***TLI***	***CFI***	***X ² /df***	***AIC***
1st order orthogonal model	2615,316	252	0.000	0.616	0.616	0.294	0.180	0.602	0.589	0.624	10,378	2711,316
1st order : with inter-factor covariance	1850.523	246	0.000	0.699	0.634	0.058	0.150	0.718	0.714	0.745	7,522	1958.523
2nd Order: without inter-factor covariance	2249	249	0.000	0.693	0.63,	0.173	0.151	0.731	0.712	0.740	7,560	2222.568
2nd Order: with covariance	1651,479	240	0.000	0.726	0.657	0.195	0.143	0.748	0.742	0.776	6,881	1771,479
Bifactorial without inter-factor covariance	1320.876	216	0.000	0.764	0.672	0.039	0.133	0.799	0.776	0.824	6.115	1488.876
Bifactor with interfactor and inter-error covariance	1269.790	214	0.000	0.773	0.682	0.038	0.062	0.807	0.784	0.832	2,934	1441,790

Notes: Traditionally, the standard cut-o_s for RMSEA (<0.06) and CFI, TLI, NFI, and IFI (>0.95) indices were used to indicate acceptable model fit [Hu, L.; Bentler, PM Cuto_ criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Struct. Eq. Model. Multidisciplinary. J. **1999** , 6, 1–55. [CrossRef]]

The comparison of the results of the six models showed that the bifactor model with specific inter-factor covariances presented the best absolute, incremental and parsimonious indices than those of the other confirmatory models. This model signifies the presence of a general factor that we have called the index of innovative teacher behavior which directly influences all the items, and four specific interrelated factors explaining other facets of pedagogical innovation.

Indeed, the values of the correlations between the items and the general factor are higher than those of the correlations with the four specific factors, which consequently corroborates the strength of this bifactor model compared to the other models (**Figure 1**). In addition, all the values of the regression weights the covariations in this bifactorial model are observed to be significant ($p<0.05$) except between the *Design and Evaluation* factor and the *Objects of Innovation factor* and between items 5 and 6 on *the Innovation Design and Evaluation* factor (**Table 6**).

- pronged model led to the conclusion that its adequacy indices do not all sufficiently reach the set standards : ; RMSEA= 0.131). For this, modifications were made to this model, in terms of introducing covariances of errors between the items in pairs on the same factor representing a single semantic field: two modifications concerned the *Design and evaluation factor* (e2-e5 ; e4-e5) and four modifications to the *Innovation Objects factor* (e8-e9; e9-e10; e10-13; e10-e14) and a single modification *to the Innovation Achievement Condition factor* (e20-e21). These modifications are theoretically based on the fact that each dimension of our scale is made up of items characterizing the same and only one. We also removed a non-significant correlation between *the Innovation Design and Evaluation factor and the Innovation Objects* factor ($p= 0.502$) with a very low standardized regression weight ($r= -0.017$). On the other hand, we did not delete item 5 and 6 even if their regression weight item 5 and 6 on the factor 1, are not significant, their deletion made the model non-operational, for that we decided to keep them in the model. Thus, the introduction of these modifications in this model of bifactorial scale having a general factor and four specific factors, improved in a very satisfactory way the indices of adjustment to the data: ($\chi2$ (290) = 1269.790, p = 0.000 ; $\chi2$ /dl = 2.934; CFI = 0.832; RMSEA = 0.062).

Therefore, our model, thus readjusted, has an implicit general factor that we have called "Innovation Index", which represents the teacher's ability to create innovative pedagogical change within the establishment, starting from design to the evaluation of the innovative project moving on to its implementation.

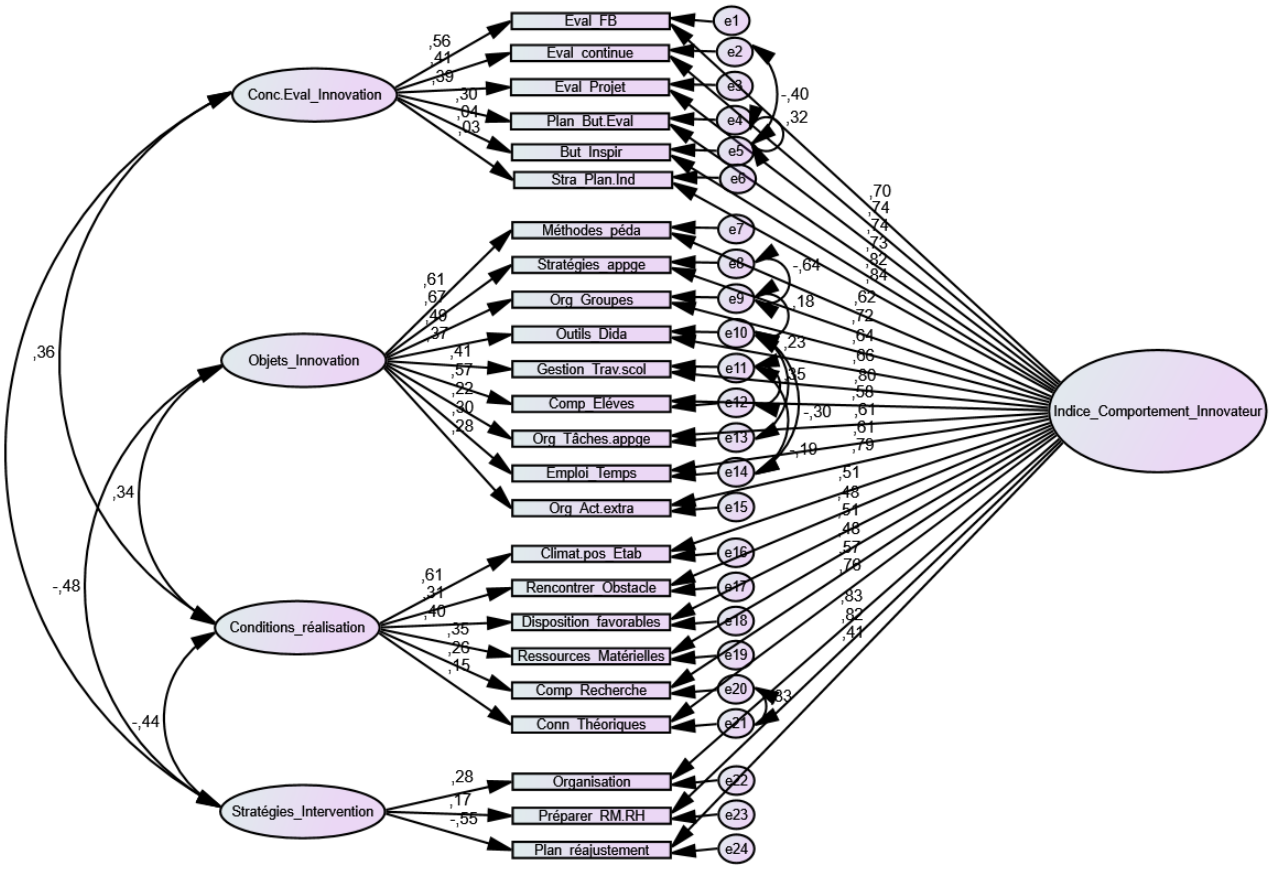


Figure 1. Selected confirmatory bifactorial model. The estimates of the regression weights between items and the general factor and the four specific factors are standardized. The inter-error specific inter-factor values express the Bravais Pearson correlation coefficients ($p<0.05$).

Table 6. Unstandardized regression weights between the general factor, the 24 items, and the four specific latent factors of the Innovative Behavior Scale according to the bifactor model.

Parameters per pair		**Estimate** [1]	**standard error**	**RC** [2]	***p* -value** [3]
Conc.Eval_Innovation	→ Eval_FB	1,000			
Conc.Eval_Innovation	→ Eval_continue	0.682	0.092	7,399	<0.001
Conc.Eval_Innovation	→ Eval_Project	0.605	0.084	7,215	<0.001
Conc.Eval_Innovation	→ Plan_But.Eval	0.461	0.080	5,773	<0.001
Objects_Innovation	→ Peda_methods	1,000			<0.001
Objects_Innovation	→ appge_strategies	1,056	.063	16,647	<0.001
Objects_Innovation	→ Org_Groups	0.848	0.085	10.008	<0.001
Objects_Innovation	→ Tools_Dida	0.548	0.067	8.145	<0.001
Objects_Innovation	→ Management_Trav. scol	0.674	0.057	11,933	<0.001
Objects_Innovation	→ Comp_Students	0.932	0.076	12,313	<0.001
Objects_Innovation	→ Org_Tasks.appge	0.344	0.077	4,458	<0.001

Parameters per pair			Estimate [1]	standard error	RC [2]	*p* -value [3]
Objects_Innovation	→	Job_Time	0.439	0.071	6.165	<0.001
Objects_Innovation	→	Org_Act.extra	0.473	0.065	7,249	<0.001
Realization_conditions	→	Climat.pos_Etab	1,000			
Realization_conditions	→	Meet_Obstacle	0.448	0.104	4,286	<0.001
Realization_conditions	→	Favorable_dispositions	0.574	0.112	5,121	<0.001
Realization_conditions	→	Material resources	0.519	0.110	4,702	<0.001
Realization_conditions	→	Comp_Research	0.403	0.103	3,918	<0.001
Strategies_Intervention	→	Organization	1,000			
Strategies_Intervention	→	Prepare_RM.RH	.579	.185	3,132	.002
Strategies_Intervention	→	Plan_readjustment	-1.889	.475	-3.976	<0.001
Realization_conditions	→	Conn_Theoretical	.208	.074	2,807	.005
Index_Behaviour_Innovator	→	Eval_FB	1,000			
Index_Behaviour_Innovator	→	Eval_continue	0.987	0.060	16,441	<0.001
Index_Behaviour_Innovator	→	Eval_Project	0.921	0.057	16,304	<0.001
Index_Behaviour_Innovator	→	Plan_But.Eval	0.885	0.061	14,555	<0.001
Index_Behaviour_Innovator	→	Peda_methods	0.841	0.085	9.942	<0.001
Index_Behaviour_Innovator	→	appge_strategies	0.947	0.082	11,544	<0.001
Index_Behaviour_Innovator	→	Org_Groups	0.908	0.088	10,280	<0.001
Index_Behaviour_Innovator	→	Tools_Dida	0.804	0.076	10,580	<0.001
Index_Behaviour_Innovator	→	Management_Trav.scol	1,086	.085	12,803	<0.001
Index_Behaviour_Innovator	→	Comp_Students	.790	.084	9,379	<0.001
Index_Behaviour_Innovator	→	Org_Tasks.appge	.794	.081	9,851	<0.001
Index_Behaviour_Innovator	→	Job_Time	.754	.076	9,910	<0.001
Index_Behaviour_Innovator	→	Org_Act.extra	1,110	.088	12,550	<0.001
Index_Behaviour_Innovator	→	Climat.pos_Etab	0.804	0.088	9,162	<0.001
Index_Behaviour_Innovator	→	Meet_Obstacle	0.660	0.081	8,171	<0.001
Index_Behaviour_Innovator	→	Favorable_dispositions	0.707	0.080	8,797	<0.001
Index_Behaviour_Innovator	→	Material resources	0.680	0.082	8,279	<0.001
Index_Behaviour_Innovator	→	Comp_Research	0.839	0.087	9,668	<0.001
Index_Behaviour_Innovator	→	Conn_Theoretical	1,030	0.082	12,636	<0.001

Parameters per pair		Estimate [1]	standard error	RC [2]	*p* -value [3]
Index_Behaviour_Innovator	→ Organization	1,134	0.093	12,235	<0.001
Index_Behaviour_Innovator	→ Prepare_RM.RH	1,085	0.087	12,511	<0.001
Conc.Eval_Innovation	→ Goal_Inspire	0.068	0.071	0.961	**0.337**
Conc.Eval_Innovation	→ Stra_Plan.Ind	0.043	0.066	0.640	**0.522**
Index_Behaviour_Innovator	→ Goal_Inspire	1.017	0.075	13,589	<0.001
Index_Behaviour_Innovator	→ Stra_Plan.Ind	1.008	0.074	13,704	<0.001
Index_Behaviour_Innovator	→ Plan_readjustment	0.549	0.077	7,113	<0.001

1. Estimate: value of the non-standardized regression weight, 2. CR: ratio of the regression weight to the standard error,
3. p value: significance at the threshold $p<0.05$.

DISCUSSION

The objective of our study was to develop and validate a multidimensional scale for Development and Validation of an Assessment Scale of Innovation Behavior in Teachers (EECI-E) in seventeen Moroccan schools that provide innovative actors representing five cities. The relevance of our study lies in the double fact that it covers several dimensions of validation of an innovation action evaluation tool on the one hand, and on the other hand that it addresses the concept of innovation that has only been able to emerge in our education system in recent years. Indeed, to our knowledge, few studies have been conducted to obtain evidence of the validity and reliability of scales measuring innovative behavior among teachers. The methodological approach adopted was based on the classic theory of scale validation, namely the Churchill Paradigm. This model, initiated by Churchill in 1979 and supported by Bailey & Pearson De Vellis (2003) and Roussel (2005). Our approach is also informed by measurement theory, which has become increasingly codified (Brennan, 2006; Guilford, 1954; Thorndike, 1971; Bertrand & Blais, 2004).

In the literature, few researchers have attempted to assess teacher innovation behavior using this theoretical framework and testing the metrological properties of the scale used. After completing the preliminary steps of this process, including item generation, expertise and tool format evaluation, we proceeded to administer the first version of the scale. A sample of 290 teachers from 17 schools, with regulated access, was mobilized. The size of the sample of teachers is largely satisfactory since Hair et al. (2006) estimate that a satisfactory sample should consist of at least 200 teachers. This approach is used in the

majority of field studies (Lagrosen et al., 2004; O'Neill and Palmer, 2004), as the main objective at this stage is to test the proposed scale on a sample rather than to generalize the results. To the population. From a methodological point of view, the approach taken during our study is in line with the current evolution of the processes of construction and validation of measuring instruments (Borsboom & Markus, 2013; Newton and Shaw, 2014; Laveault et Gregory, 2014). However, this approach cannot claim to have highlighted all the potential determinants of the behavior of the innovative teacher: some of them, which are particularly subjective and difficult to verbalize and measure, may have resisted the protocol of generation and item evaluation. We verified the main metrological qualities of EECI-E through the reliability and validity of indices (Fortin, 2010 ; Newton & Shaw, 2014).

In this regard, exploratory factor analysis (EFA) allowed us to identify the factor structure of our scale. It revealed eight major factors, whose eigenvalue is greater than 1, and which very satisfactorily explain 77.178% of the total deviation. What constitutes good value in psychometrics (Hair et al., 2006). In terms of semantic consistency, items having a low correlation with their respective factors, and providing little explanation, were automatically deleted. The KMO index reached a very satisfactory value of 0.82 for a recommended threshold of (0.70). Similarly, the results of the temporal stability of the scale showed a correlation coefficient of 0.922, which is considered to be sufficiently acceptable. Alpha values greater than 0.70 are considered good (Nunally, 1978). Similarly, after eliminating non-homogeneous items, the correlation coefficient showing the level of internal consistency of the scale reached a fairly high value of .803. Therefore, the overall results of these edumetric studies and tests are a good guarantee of the validity and reliability of our scale. The EECI-E measurement scale demonstrates good psychometric property. The results of the confirmation factor analysis allowed us to readjust and significantly improve our constructed model ($\chi 2$ (290) = 1269.790, p = 0.000).

However, the results of this two-factor model led to the conclusion that its adequacy indices do not all sufficiently reach the set standards. For this, modifications were made to this model, in terms of introducing covariances of errors between the items in pairs on the same factor representing a single semantic field. Four major factors retained: Design and evaluation of the innovation, Objects of Innovation, Condition for carrying out the Innovation, and intervention strategy.

The first factor design and evaluation of the innovation *includes* six items evaluating: the planning of the goal and the evaluation procedures, the continuous evaluation of the innovative process, the positive feedback of the actions started, the innovation takes place in a project framework, the new action is due to inspirations, the planning of the innovation is an individual strategy.

The second factor is also made up of nine items representing the pedagogical objects of innovation: The concepts are teaching methods, student learning strategies, organization of groups in class, new operating procedure and creation of didactic tools, the management of school work, the behavior of pupils in class, the organization of learning tasks, the development of the school timetable, the organization of extra-curricular activities.

The third factor includes six items reflecting the conditions for carrying out the innovation: the favorable pedagogical and administrative climate within the establishment, the availability of material resources (facilities, didactic tools), the disposition of the teacher to begin the innovation, the confrontation with obstacles, the need for theoretical knowledge, and research skills adapted to deal with the problems raised by the new action.

The fourth factor includes three items relating to intervention strategies. This factor is expressed by three items: the mode of organization of the innovative content, the preparation of educational resources and external skills necessary for the realization, and a plan to overcome the constraints.

The introduction of these modifications in this model of bifactorial scale having a general factor and four specific factors, improved in a very satisfactory way the indices of adjustment to the data. So our model thus readjusted, has an implicit general factor that we have called "Index of innovation behavior", which represents the teacher's ability to create an innovative pedagogical change within the establishment starting from the design to the evaluation of the innovative project by moving on to its implementation.

Other work on the measurement of pedagogical innovation of teachers has been made at the level of Moroccan primary schools consisting in detecting innovative practices in schools. To detect these innovative practices, the researcher calculated scores inspired by the organizational change approach (OECD, 2014). A teacher's innovation score (the total scale) is therefore the score of all the sub-scales (teaching methods, pedagogical practices, class organization, assessment methods, Taking the initiative, remediation and support, the use of textbooks and the use of ICT): $\boldsymbol{Yi} = \boldsymbol{MAi} + \boldsymbol{PPi} + \boldsymbol{OCi} + \boldsymbol{MEi} + \boldsymbol{PIi} + \boldsymbol{RAi} +$

MSi + TI (AOMAR IBOURK Group Director economic and social research (GRES) Cadi Ayyad University Marrakech, Morocco)

Other research on the evaluation of innovative teaching practices such as: Evaluating the interactive profile of teachers in training for secondary school using the Coding System for Individualized Interactions Occurring in the Classroom (SCIIC) (Laura Luiu, Lara Laflotte, Philippe Wanlin Proceedings of the colloquium 3rd colloquium From 2 to 4 September 2015 HEP Vaud, avenue des Bains 21, Lausanne).

Nevertheless, this research topic needs further investigation. He is necessary to seek the contextualized objectivity of a barometer in different pedagogical practices and to determine how innovation skills develop in the course of teaching . In order to better respond to needs of working life , to produce innovative graduates and to develop effective learning environments , future research should also focus on the integration of working life. Novation of deeper skills, including external (e.g. environments , learning methods, support and guidance) and internal (e.g. gender, cultural background , language) which may be related to skills.

Despite some limitations of this study, the results are encouraging. The redeveloped instrument brings a new perspective and support to pedagogical practices and the culture of assessment in school education in several ways. The assessment tool could present a method in scientific research and be applied to practical work. It can be used to measure the development of actors' perceptions of innovation skills throughout their action and measure the effectiveness of commitments and their pedagogical practices to produce innovative experiences. It also contributes to the development of the design , teaching and assessment of study topics in teaching . Kivunja (2014) points out that the key to teaching creativity and innovation skills lies in creating quality learning environments that give learners the opportunity to solve authentic and real problems , and to be curious and open -minded

Nevertheless, our study - of course not being exhaustive - would have certain limitations which should be noted. Some hidden dimensions can still be identified and exploited, by other measuring instruments. This opens the door to many avenues of research, which will make it possible to examine more factors predicting the behaviors and skills of teaching actors. As a corollary, the sampling method chosen is both simple and voluntary random (Satin & Shastry, 1993; Laveaux & Grégoire, 2014). Our study was conducted with teachers from seventeen establishments solely for reasons of feasibility and accessibility. It

would therefore be important to obtain proof of the validity of this scale from samples belonging to other establishments and disciplines affecting all educational sectors.

CONCLUSION

The objective of this research was to develop a measure of the pedagogical innovations of teachers and to understand the determinants that influence or hinder these innovations among teachers in secondary and university establishments in Morocco. The methodology used is a survey of which we developed at the beginning 100 items requesting several axes of reflection which are in relation with all the didactic and pedagogical parameters of teaching - learning. We administered this scale to innovative teachers in three phases over three phases, to remain with 59 items which were the subject of a psychometric analysis . This preliminary version is called the Innovative Teaching Behavior Rating Scale. It is administered to a sample of 290 teachers (148 male and 142 female), providing different teaching subjects, belonging to 17 secondary education establishments spread over five cities. The participants included in this study are those who have expressed an attitude or have had an experience of educational innovation. They are asked to respond to 59 items on a four-level Likert scale, ranging from 1 (totally disagree) to 4 (totally agree). We have adopted the method for analyzing the psychometric properties of the EECI-E scale for the search for internal consistency between the items selected. We performed three analyses; first a reliability analysis (FA), followed by an exploratory factor analysis (EFA) and finally a confirmatory factor analysis (AFC). The results of the first factor analysis showed an insufficient total variance with a predominance of only one of a super-factor. This observation led us to carry out a second AFE on this dominant super-factor. The results thus showed that four factors had an almost balanced distribution of the partial variances on these factors. In order to validate the factorial structure of the scale, we evaluated six models introduced in the stepwise analysis in order to identify the confirmatory model with the best indices of adequacy. The comparison of the results of the six models showed that the bifactor model with specific inter-factor covariances presented the best absolute indices. This model means the presence of a general factor that we have called the index of innovative behavior of the teacher which directly influences all the items, and four specific interrelated factors explaining other facets of pedagogical innovation, which are: Design and evaluation, Objects of Innovation, Conditions for carrying out the Innovation and intervention strategy

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