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Explanatory variables of educational innovation: A model based on personality traits

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Abstract

Introduction. Innovation is a relevant concept in the field of education inasmuch as it refers to planned processes aimed at improving school organization, teachers' professional development, student learning, and more. However, it is an element that is influenced by a wide variety of variables. Teachers' personality traits are those elements that are capable of describing, explaining, and predicting their behaviour.

Method. The objective of this study is to offer a statistical model that explains teaching innovation factors based on teachers' personality factors. A survey was carried out with 1,040 Spanish teachers in basic education. They were given the Teaching Innovation Factors Questionnaire and the 16 Personality Factors Questionnaire.

Results. The multiple linear regression analysis resulted in significant models to predict Institutional Participation (R^2 = .16), Psychopedagogical Openness (R^2 = .18), and Didactic Planning (R^2 = .11). The first of these factors can be predicted based on the following personality traits: self-reliance, liveliness, openness to change, affability, social boldness, and perfectionism. The regression model for the second factor consists of openness to change, affability, dominance, liveliness, self-reliance, and stability. The third factor can be predicted based on openness to change, sensitivity, perfectionism, rule-consciousness, dominance, social daring, liveliness, and vigilance.

Discussion and Conclusion. In conclusion, some personality factors are part of models that can predict teaching innovation, especially the opening.

Keywords: educational innovation; multiple regression analysis; personality traits; teaching characteristics.

Resumen

Introducción. La innovación supone un concepto relevante en el ámbito de la educación en cuanto que se refiere a procesos planificados y orientados a la mejora de la organización escolar, al desarrollo profesional docente y, entre otras cuestiones, al aprendizaje del alumnado. Sin embargo, es un elemento que se encuentra influido por una amplia diversidad de variables. Y los rasgos de personalidad del profesorado son aquellos elementos capaces de describir, explicar y predecir su comportamiento.

Método. El objetivo principal de este estudio fue ofrecer un modelo estadístico que explique los factores de innovación docente a partir de los factores de personalidad del profesorado. Se realizó un estudio por encuesta con 1040 profesores españoles de Educación Básica, quienes cumplimentaron en Cuestionario de Factores de Innovación Docente y el Cuestionario de 16 Factores de la Personalidad.

Resultados. El análisis de regresión linear múltiple resultó significativo para un modelo que predecía la Participación Institucional (R^2 = .16), la Apertura Psicopedagógica (R^2 = .18) y la Planificación Didáctica (R^2 = .11). El primero de estos tres factores pudo predecirse a partir de los siguientes rasgos de personalidad: autosuficiencia, vivacidad, apertura al cambio, afabilidad. audacia social y perfeccionismo. El modelo de regresión para el segundo de estos factores se compuso de: apertura al cambio, afabilidad, dominancia, vivacidad, autosuficiencia y estabilidad. Y el tercer factor pudo producirse a partir de la apertura al cambio, la sensibilidad, el perfeccionismo, la aceptación de normas, la dominancia, el atrevimiento social, la vivacidad y la vigilancia.

Discusión y **Conclusión**. En conclusión, algunos rasgos de personalidad forman parte de modelos que son capaces de predecir la innovación docente, especialmente la apertura al cambio.

Palabras clave: análisis de regresión múltiple; características docentes; innovación educativa; rasgos de personalidad.

Introduction

Educational innovation is a process of planned change designed to improve education, but it is fundamentally different from other school change processes, such as educational reform, in its origins: innovation is managed and developed within schools, while reform is effected through governments and administrations. In any event, teachers are responsible for implementing these change processes, given that "the main force driving and limiting change are teachers" (Carbonell, 2001, p. 29). Thus, knowing how they act, how they think, what they are like, or what characteristics they have is extremely important for adapting both initial and ongoing education processes for teachers. As Fullan (2007) remarked, it is a mistake to think that what is truly important is educational innovation in and of itself, while forgetting the true agents of school change.

Conceptually defining educational innovation is a truly challenging, complex task, and it is even more complicated to address all the individual differences of innovative teachers. This difficulty arises for several reasons: determining how teachers should be distributed on the traditional-innovative continuum; including the innumerable individual differences (e.g.: personality, motivation, attitudes, intelligence, etc.) in research studies; and, even if the most relevant differences are selected, choosing a framework for the study from among the numerous theories and models surrounding each construct (e.g.: stable traits versus dynamic processes, standardized questionnaires compared to open-ended reports, single traits versus multiple traits).

This first difficulty can be addressed through the use of the Teaching Innovation Factors Questionnaire (Monge et al., 2018, 2022; Monge & Gómez, 2022), which offers suitable validity and reliability criteria, which will be presented below. This instrument distributes teachers across a normal curve for three factors: Institutional Participation (IP), Psychopedagogical Openness (PO), and Didactic Planning (DP). The first factor refers to how the entire educational community is involved in the teaching/learning process within the school; the second references the set of ideas, values, attitudes, and perceptions that promote educational innovation; and the third is defined as the organization and adaptation of the elements of the curriculum to the context of an innovative classroom. However, like any standardized questionnaire, it does not account for the unique individual features of the participants and contexts, but it can be administered to a large group at a low cost.

With regard to the second difficulty, the literature seems to be a bit more conclusive. Personality traits and cognitive abilities are the most extensively researched and published individual differences with important implications in education (Williams et al., 2008). Several studies, which will be analyzed and discussed below, indicate the importance of teachers' personalities in processes of school change and improvement.

After having selected the construct of personality as the variable to analyze, the third difficulty in researching teachers' individual differences must be addressed. In this case, debate tends to center around stability versus variability of personality, assessment techniques, and origin. Although not without controversy, there is important evidence that helps confirm the absolute and differential stability of personality, such as the studies by Costa and McCrae (e.g.: Terracciano et al., 2006, 2010). Generally, variance due to genetics is distributed similarly to variance due to the non-shared environment (Moore et al., 2010). Thus, there seems to be some evidence to support factorial theories and models of personality. Cattell is one of the creators of personality traits; he found 12 traits based on approximately 18,000 adjectives from the English lexicon that describe personality. He transformed lists of adjectives into multiple choice items, and through factor analysis obtained the 16 primary scales for his questionnaire (Ruiz, 2006). Cattell's data led other researchers to carry out variations on his study with different forms of rotation and factor extraction. Most of them confirmed five main traits and, while Cattell's initial analysis led him to find four secondary traits, modern revisions of his instrument confirm that there are five second-order factors (Russell & Karol, 2005): extraversion, anxiety, hardness, independence, and self-control. Additionally, Cattell's revised model allows for an analysis of other individual differences thanks to the creation of personal profiles and analysis of conglomerations.

Given all of this prior research, the fundamental objective of this study is to offer a statistical model that explains teaching innovation factors based on teachers' main personality traits. To do so, first it is essential to analyze two key issues: the concept of teaching innovation and some of the characteristics of teachers that influence these change processes.

Conceptualization of Educational Innovation

Educational innovation is a *buzzword* that is frequently used to sell projects, attract students, generate investments or, among other issues, lead the commercial sector, but it really must be considered from a commitment to social justice and equity (Ellis et al., 2019).

The concept of innovation in the field of education arose at the end of the 1960s and began to grow in importance until becoming a widely-used term from 1970 on, thanks, in large part, to a series of studies published by UNESCO (Barraza, 2005): *How to Operate the Changes in Education: Contribution to the Study of Innovation* (Huberman, 1973), *El tiempo de la innovación en materia de educación* (UNESCO, 1975), *Solving educational problems: The theory and reality of innovation in developing countries* (Havelock & Huberman, 1980).

Etymologically, innovation comes from the Latin term innovatio, which is made up of (Rivas, 2000): *in-* (which references introducing something), *-nova-* (which denotes newness) and *-tio* (which gives the meaning of action). Thus, from a linguistic perspective, educational innovation can be seen as the action of introducing something new in the field of education. In Rivas' (2000) words, it can be seen as "deliberate action to incorporate something new in the school institution, the result of which is efficient change in its structures or operations, improving its effectiveness in order to achieve educational objectives" (p. 31).

However, although there is a general definition of this term, it is understood by each author in accordance with their different perspectives. Each expert has his own definition, which is based on this general conception but with different nuances. Thus, for example, in an attempt at integration, Carbonell (2001) defines educational innovation as a "series of interventions, decisions, and processes with a certain degree of intentionality and systematization that attempt to modify attitudes, ideas, cultures, content, models and teaching practices" (p. 17). Along general lines, he highlights 13 basic attributes that characterize the innovative process in education, although it is obvious that all these factors are not always present simultaneously and that sometimes they manifest themselves timidly, while on other occasions they appear in full force:

- It is a personal experience that acquires a particular meaning in practice because it responds to group and individual interests.
- It allows for significant relationships to be progressively established between different fields of knowledge, which leads to a more complex perspective on reality.
- It attempts to turn educational organizations into more democratic, appealing and stimulating places.
- It promotes theoretical reflection on experiences and interactions in the classroom.
- It breaks away from the classical split between conception and execution.
- It broadens teachers' and schools' educational autonomy.

- It appeals to the reasons and purposes of education and to continually rethinking them in light of specific, changing contexts.
- It is undertaken through permanent exchange and cooperation, and not isolation and solitude.
- It attempts to translate ideas into everyday practice, without ever forgetting theory.
- It makes hidden wishes, inquisitiveness, and interests flourish in students.
- It facilitates the acquisition of knowledge and of the things which give knowledge meaning.
- It is controversial and generates a constant focal point of intellectual debate.
- It sees education and instruction as two complementary elements.

Pérez (2009), meanwhile, in an analysis of educational institutions through case studies of innovative schools and practices, suggests some aspects of how to innovate and how to learn to innovate. In this regard, the essential principles of all innovation are: (a) willingness to change, (b) knowledge, (c) vision, (d) creation, guidance, and dissemination, (e) leadership, (f), hierarchy, and (g) broadness of perspectives.

Teachers can be organized according to three factors of innovation (Institutional Participation, Psychopedagogical Openness, and Didactic Planning), given that the data produced through the administration of a questionnaire have been confirmed by other empirical and theoretical studies (Monge, 2018; Monge et al., 2022; Monge & Gómez, 2022).

Institutional Participation references how involved the entire educational community is in the teaching/learning processes within the school. This factor also refers to collective success through individual work within the school organization (Ismail et al., 2002), the school's assessment and interpersonal relationships within the school (Vicent-Lancrin et al., 2014), to collaboration and participation in innovation processes, in the management of other educational sectors' participation and participation in organizational structures (Marcelo et al., 2011), and to democratic cooperation (Zhu & Wang, 2014). Stefani (2014) also refers to these relationships inside the school when she addresses the issue of the identity of innovative teachers, while Emo (2015) and Herrán (2009) underline teachers' encouragement of student participation through different teaching techniques, such as assemblies, corners, or recess laboratories. Institutional Participation is also discussed by Torrego (2008) when he defines

teachers in a changing world as the managers of a group/class and members of an organization.

Psychopedagogical Openness is viewed as the set of ideas, values, attitudes, perceptions, and others subjective elements favorable to educational innovation. This factor seems to be closely related to what Ismail et al. (2002) call "innovation-leadership," and also corresponds to other factors such as ongoing assessment, self-learning, and reflection on teaching quality (Marcelo et al., 2011). Openness of thought is related to innovative teachers' learning competency (Incik, 2020; Zhu & Wang, 2014), as well as new proposals that students view as necessary for a teacher to be innovative (Jaskyte et al., 2009). Lin (2002) also argued that an open mind and a capacity for reflecting on teaching/learning processes are key elements of innovative teachers. Leadership and ethical-professional commitment to innovation can also be included here (Fix et al., 2021). This factor refers to the teachers' emotional adaptation and management to collaboratively innovate and improve showed by Campbell and Lawson (2018).

Finally, Didactic Planning is defined as the organization and adaptation of the elements of the curriculum to the context of an innovative classroom. This factor is identified in exactly the same way by Marcelo et al. (2011), who call it "planning." It is also closely related to teaching models (Vicent-Lancrin et al., 2014), and addresses several indicators at the same time, such as the educational justification for innovations or teaching strategies (Ismail et al., 2002). Didactic Planning must be conceived as an essential element of innovative teachers' educational competency (Loogma et al., 2012). In fact, teachers must be good planners and implementers of teaching in all environments, selecting the culture, organizing the curriculum, specializing in methodological aspects, and evaluating processes and results in accordance with social and academic progress (Torrego, 2008).

These three factors should not be seen as isolated elements, but rather they are interrelated factors. From a quantitative approach, there are significant relationships already demonstrated (Cakir, 2021; Monge, 2018; Monge et al., 2022; Monge & Gómez, 2022). And, from a qualitative approach, for example, Matthews and Djawoto (in press) highlight how the participation of internal actors and external agents can be encouraged through innovation in evaluation methods as curricular elements.

Factors of Innovative Teachers

The variables that help explain teaching innovation factors are innumerable and immeasurable, such as teaching styles, creativity, motivations, attitudes, leadership styles, teacher personality, and identity.

Innovative teachers are mainly characterized by a markedly open teaching style, facilitating active learning, considering new content outside of the syllabus, motivating students with new practical activities, promoting teamwork, changing methodology, promoting originality in tasks, proposing a wide variety of open-ended activities, learning from their students, breaking with routine, working collaboratively, being active, creative, improvisational, flexible, and spontaneous (Renes et al., 2013). The different behaviors of innovative teachers have also been described as interaction, participation, and freedom of action (Nemerzitski et al., 2013), or opportunity exploration, idea generation, idea promotion, idea realization (criterion-based implementation and learning-based communication), and idea sustainability (external dissemination and internal embedding) (Lambriex-Schmitz et al., 2020).

The first high-impact study on innovative teachers dates to 1967 (Monge et al., 2018), and by the beginning of the 1970s, Huberman (1973) offered results from several prior studies on the personality of innovative teachers:

- They have a high degree of abstractedness and a greater ability to adapt to immediate situations; they are less absolutist, more relativist, free to solve problems and look for solutions without fearing punishment for deviating from the official truth and social imperatives; they have a distinct practical orientation, with exploratory, risk-accepting behavior.
- They strongly feel the need for independence, success, and order, as well as to help and be supported by others.
- They accept risks, have a sense of professional duty, and trust in their own ability to control the environment.
- They have the authority to direct classroom life; they search for information on class activities with their colleagues; they are committed to the profession, and are willing to debate professional matters.

- They have relatively high status, are generally young, consider impersonal/cosmopolitan sources of information, exercise democratic leadership, and are probably seen as differing from the norm.
- They have often been imperfectly socialized and, therefore, do not know what their purpose is in certain situations, which results in acts of improvisation.

Ríos is one of the most important authors on this subject today. In his first study, in which the Edwards Personal Preference Schedule was applied to a sample of teachers participating in innovation projects, he characterized them as persistent, resistant, methodical, and planning people (Ríos, 2004). Then, in a subsequent study similar to the first but which used the Myers-Briggs Type Indicator instrument, he defined them as realistic, practical people, who are uninterested in what they do not think is useful, who love to organize and lead activities, and who use thought more for their exterior life and feeling for their interior life (Ríos, 2006). Finally, based on information from qualitative interviews on educational innovation and self-perceived personal and professional characteristics, he found that they are warm, affectionate people, caring, happy, overprotective, consistent, and honest (Ríos, 2009). In order to fulfil the research objectives, in all of these studies the number of participants was intentionally limited to innovative Chilean teachers. Some of these results are also found with innovative teachers from Turkey (Incik, 2020; Yilmaz, 2021).

More current studies use the same instrument as Ríos (2006). For example, after applying this instrument to approximately 1,000 teachers, Rushton et al. (2007) find statistically relationships between teaching innovation and extraversion, intuition, feeling, and perception. But some studies that use other instruments can also be highlighted, such as the research developed by Jurgena et al. (2015), who find a strong presence of enthusiasm and transgression of roles in innovative teachers. Another study with the NEO-Five Factor Inventory shows some explanatory power of personality traits on innovation factors in educational contexts, obtaining results of beta from -.24 to .17 (Ee et al., 2007).

There is evidence that link the teachers' innovative practices with a proactive personality oriented to the free and creative solution of problems (Avsec & Savec, 2021; Kong & Li, 2018).

The topic of the current work has a greater tradition in Asian countries, being able to find relationships between innovation factors and personality characteristics in Russian pro-

fessors (Avakyan, 2018), Korean teachers (Lee et al., 2012; Shin & Myong-Sook, 2017), Turkish teachers (Cakir, 2021; Incik, 2020; Yilmaz, 2021), Singaporean university students (Ee et al., 2007), Chinese teachers (Kong & Li, 2018), Indian innovative expert teachers (Chand et al., 2020), and Asian experts in teacher training (Park et al., 2018). Despite being a fairly researched topic in Asia, in European countries, such as Spain, it is still a little studied topic despite its importance.

In a pilot study based on Cattell's theories on personality traits, innovative teachers scored high in affability and openness to change, and low on privateness, vigilance, abstractedness, and dominance (Monge et al., 2016). Innovative teachers are usually respectful, democratic, fair, careful, understanding, positive, accessible, independent, responsible, and, above all, open to change (Tateo, 2012). Indeed, in both the former and latter studies, openness to change is a key factor in teachers who innovate. This aspect, which other authors already indicated theoretically (Monge et al., 2015), could probably be replicated in other personality models, due to the repetition of openness as a factor (e.g.: openness to change in Cattell and in Costa and McCrae, mental openness in Caprara, adventure in Eysenck, or novelty seeking in Cloninger). There are even correlations between innovation and openness to change on other questionnaires, as well as with bravery (Othman, 2016), sensitivity (Cakir, 2021), and risk assumption (Incik, 2020; Parlar & Cansoy, 2017).

Objectives

Given this prior research, the main objective of this study is to offer a statistical model that explains teaching innovation factors (independent variables) based on teachers' personality factors (explanatory variables); to do so, a stepwise multiple linear regression procedure is followed.

Method

The research design is a quantitative descriptive study using a survey method. The questionnaire used as a data collection strategy and instrument considerably facilitates statistical analysis of the data and the ability to reach a large number of the population. However, in a self-administered questionnaire, the truthfulness of the subjects' responses cannot be fully and empirically controlled.

Participants

The sample consisted of 1,040 teachers, the majority of whom were women (68.08%), in public (84.23%), state-subsidized private (14.23%), and private (1.54%) schools offering early childhood and elementary education (54.23%) and secondary education (45.77%). The subjects' ages ranged from 22 to 62 years old (M = 43.57; SD = 8.76), and their years of experience from 0 to 38 (M = 17.42; SD = 8.94). Of this sample, 25.38% held an administrative position and 43.85% held a teaching coordination position.

Instruments

The aim of the Teaching Innovation Factors Questionnaire (TIFQ) is to identify self-perceived teaching innovation factors among teachers in early childhood, elementary, and secondary education in public, state-subsidized private, and private schools in Spain (Monge, 2018; Monge & Gómez, 2022). It consists of 16 Likert-style items (1 = Totally disagree; 2 = Somewhat disagree; 3 = Somewhat agree; 4 = Totally agree), grouped into three main factors: Institutional Participation, Psychopedagogical Openness, and Didactic Planning. For this study's sample, the questionnaire's total explained 54.51% of variance (24.59% for the first factor, 16.67% for the second factor, and 13.25% for the third), resulting in a composite reliability coefficient (omega) of .87 for the entire instrument (.86 for the first factor, .81 for the second, and .79 for the third).

Cattell's 16 Personality Factor Questionnaire (16PF-5) is based on 18,000 adjectives from the English lexicon that describe personality, which were then transformed into multiple-choice options grouped into 16 primary factors (Table 1). Originally, all of these factors were reduced to four second-order factors (low anxiety-high anxiety, introversion-extraversion, socialization-superego and dependence-independence), which were increased to five factors in subsequent revisions (Russell & Karol, 2005). Indeed, there is ample evidence for the existence of five personality traits (such as those proposed by Costa and McCrae, Caprara, Barbaranelli and Borgogni, or by Zuckerman), although most of this evidence comes from different extraction and rotation methods using Cattell's questionnaire, thereby making him the father of personality as a psychometrically measurable trait (Ruiz, 2006).

Table 1. *Description of 16PF-5 factors*

	Symbol	Personal Characteristics
Primary scales		
Affability	A-	Cool, impersonal and distant
	A+	Warm, outgoing, generous and attentive to others
Reasoning	B-	Concrete
	B+	Abstract
Emotional Stability	C-	Reactive and emotionally changeable
	C+	Emotionally stable, adaptive and mature
Dominance	E-	Deferential, cooperative and avoids conflict
	E+	Dominant, assertive and competitive
Liveliness	F-	Serious, restrained and prudent
	F+	Animated, spontaneous, active and enthusiastic
Rule-Consciousness	G-	Nonconforming, disregards rules and self-indulgent
	G+	Rule-conscious, dutiful and conscientious
Social Boldness	H-	Shy, threat-sensitive and timid
	H+	Socially bold and venturesome
Sensitivity	I-	Objective, unsentimental and utilitarian
	I+	Sensitive, aesthetic and sentimental
Vigilance	L-	Trusting, unsuspecting and accepting
	L+	Vigilant, suspicious, sceptical and wary
Abstractedness	M-	Practical, grounded and realistic
	M+	Abstract, imaginative and idealistic
Privateness	N-	Forthright, genuine, artless and unpretentious
	N+	Private, shrewd, discreet and nondisclosing
Apprehension	O-	Self-assured, unworried and complacent
	O+	Apprehensive, self-doubting and worries
Openness to change	Q1-	Traditional and attached to familiar
	Q1+	Open to change, experimental and analytical
Self-reliance	Q2-	A follower and joiner
	Q2+	Self-reliant, individualistic and solitary
Perfectionism	Q3-	Flexible and tolerates disorder
	Q3+	Perfectionist, organized and disciplined
Tension	Q4-	Relaxed, placid and patient
	Q4+	Tense, high energy, impatient and driven
Global scales		
Extraversion (A+, F+, H+, N- and Q2-)	Ext-	Introverted and socially inhibited
	Ext+	Extroverted and socially participating
Anxiety (C-, L+, O+ and Q4+)	Anx-	Low anxiety, imperturbable
	Anx+	High anxiety, perturbable
Hardness (A-, I-, M- and Q1-)	Har-	Receptive, open-minded and intuitive
	Har+	Tough-minded, resolute, inflexible, cool and objective
Independence (E+, H+, L+ and Q1+)	Ind-	Accommodating, agreeable and gives in easily
	Ind+	Independent, critical and willful
Self-Control (F-, G+, M- and Q3+)	SeC-	Unrestrained and follows urges
	SeC+	Self-controlled and inhibits urges

Source: Russell and Karol, 2005, p. 16

In addition to the primary and secondary/global scales, the questionnaire offers three response bias scales: image manipulation (conscious or unconscious manipulation of one's own image), unusualness (high number of elements that are different from the majority of people), and acquiescence (tendency to give the desired or most socially acceptable response). It shows suitable reliability and validity indicators both for the original sample and the Spanish adaptation, and also offers profiles related to leadership potential, empathy, self-esteem, adaptation, social skills, and creative potential as validity criteria (Russell & Karol, 2005).

Procedure

For the sample selection – an essential procedure in survey studies – a series of schools throughout Spain were randomly selected. Some of these schools decided not to participate in the study, and in the schools that did, some teachers participated and others did not. However, the final sample by far exceeded the 384 individuals recommended at a 95% confidence level for a population of approximately 899,300 teachers (Ministry of Education, Culture and Sport, 2019).

Following the ethical standards for research in education, the participants were always informed of the objectives of the study and of the voluntary nature of their participation; they were also informed that their data would be processed for strictly scientific purposes.

Datal Analysis

After the TIFQ and 16PF-5 were completed and corrected, statistical analysis was carried out with the SPSS software package and the program Factor (the latter was used exclusively to calculate the composite reliability index). In order to offer a model capable of predicting innovation factors based on personality factors, regression analysis was used, as "regression analysis allows researchers to predict the specific value of a variable when we know or assume the values of other variables" (Cohen et al., 2007, pp. 536-537). Regression analysis offers different options related to the different types of procedures (e.g.: stepwise, forward, backward and linear). The most common procedure is stepwise, which is generally of great use when the number of predictive variables is high or when the theoretical framework has not been sufficiently studied. It combines the forward and backward procedures, performing a constant reassessment of the variables included in the model (Kelley & Holden, 2013).

Results

The sample's mean scores for teaching innovation factors were very close to the population mean according to normal distribution (M_{IP} = 48.00; SD_{IP} = 28.98; M_{PO} = 50.92; SD_{PO} = 29.27; M_{DP} = 50.69; SD_{DP} = 30.43) (Table 2). With regard to the first-order factors included in the 16PF-5, the participants' lowest scores were in emotional stability (*M* = 39.92; *SD* = 9.61), social boldness (*M* = 41.87; *SD* = 10.77), liveliness (*M* = 41.96; *SD* = 17.14), and dominance (*M* = 42.46; *SD* = 16.95), while their highest scores were for sensitivity (*M* = 70.96; *SD* = 11.04), self-reliance (*M* = 67.96; *SD* = 16.86), apprehension (*M* = 65.50; *SD* = 16.06), and tension (*M* = 65.15; *SD* = 14.54). Anxiety (*M* = 60.65; *SD* = 9.87) and hardness (*M* = 38.45; *SD* = 9.43) were the highest and lowest second-order factors obtained by the sample. The response biases were within normal ranges. Finally, the profiles offered by this instrument indicate low emotional adaptation (*M* = 39.04; *SD* = 9.46) and leadership potential (*M* = 40.27; *SD* = 6.71) and high social receptiveness (*M* = 55.14; *SD* = 7.91).

Table 2. *Descriptive statistics for TIFQ and 16PF-5*

Teaching innovation factors	*M (SD)*
Institutional participation	48.00 (28.98)
Psychopedagogical Openness	50.92 (29.27)
Didactic Planning	50.69 (30.43)
Personality primary traits	***M (SD)***
Affability (A)	46.96 (18.14)
Reasoning (B)	59.31 (20.45)
Emotional stability (C)	39.92 (9.61)
Dominance (E)	42.46 (16.95)
Liveness (F)	41.96 (17.14)
Rule-consciousness (G)	47.58 (13.07)
Social Boldness (H)	41.87 (10.77)
Sensibility (I)	70.96 (11.04)
Vigilance (L)	51.88 (14.84)
Abstractedness (M)	62.92 (15.20)
Privateness (N)	51.92 (20.43)
Apprehension (O)	65.50 (16.06)
Openness to change (Q1)	62.35 (18.72)
Self-reliance (Q2)	67.96 (16.86)
Perfectionism (Q3)	49.81 (13.77)
Tension (Q4)	65.15 (14.54)
Personality secondary traits	***M (SD)***
Extraversion (Ext)	42.78 (11.81)
Anxiety (Anx)	60.65 (9.87)
Hardness (Har)	38.45 (9.43)

Independence (Ind)	49.64 (8.93)
Self-control (SeC)	48.13 (8.79)
Response bias	*M (SD)*
Image manipulation (IM)	49.62 (14.06)
Unusualness (UN)	53.27 (10.06)
Acquiescence (AC)	52.27 (18.49)
Profiles and constructs	*M (SD)*
Self-esteem	44.60 (6.32)
Social adaptation	43.77 (7.33)
Emotional adaptation	39.04 (9.46)
Occupational adaptation	45.85 (7.97)
Emotional expressivity	49.81 (8.11)
Emotional receptivity	53.62 (14.01)
Emotional control	48.54 (10.93)
Social expressivity	47.38 (11.24)
Social receptivity	55.14 (7.91)
Social control	49.81 (7.92)
Empathy	44.73 (8.20)
Creative potential	52.00 (8.50)
Leadership potential	40.27 (6.71)

Source: Compiled by authors

The three teaching innovation factors are explained by a series of personality factors (Table 3); openness to change (Q1) and liveliness (F) appear in all models, always with positive standardized coefficients ($\beta_{Q1} \geq .13$; $\beta_F \geq .10$). Low self-reliance (Q2-), high liveliness (F+), high openness to change (Q1+), high affability (A+), low social boldness (H-), and low perfectionism (Q3-) help explain 16.60% of the variance in Institutional Participation. High openness to change (Q1+), high affability (A+), high dominance (E+), high liveliness (F+), low self-reliance (Q2-), and high emotional stability (C+) explain 18.01% of the variance in Psychopedagogical Openness. Finally, high openness to change (Q1+), high sensitivity (I+), low perfectionism (Q3-), low rule-consciousness (G-), high dominance (E+), low social boldness (H-), high liveliness (F+), and low vigilance (L-) explain 11.24% of variance in Didactic Planning. While most of the dependent variables are included in the model with a significance level of .00, the standardized or beta coefficients are never higher than .25.

Table 3. *Explanatory variables of teaching innovation factors*

	t (sig.)	*Beta*	*Adjusted R^2*	*F (sig.)*
Institutional participation				
Constant	7.41 (.00)		.16	35.46 (.00)
Self-reliance (Q2)	-7.09 (.00)	-.24		
Liveness (F)	4.83 (.00)	.16		
Openness to change (Q1)	4.65 (.00)	.13		
Affability (A)	3.27 (.00)	.11		
Social boldness (H)	-2.46 (.01)	-.08		
Perfectionism (Q3)	-2.00 (.04)	-.06		
Psychopedagogical openness				
Constant	4.39 (.00)		.18	15.85 (.00)
Openness to change (Q1)	-3.68 (.00)	.15		
Affability (A)	2.80 (.00)	.19		
Dominance (E)	2.04 (.04)	.09		
Liveness (F)	2.26 (.02)	.10		
Self-reliance (Q2)	2.12 (.03)	-.09		
Stability (C)	2.08 (.04)	.08		
Didactic Planning				
Constant	7.35 (.00)		.11	17.67 (.00)
Openness to change (Q1)	5.26 (.00)	.18		
Sensibility (I)	5.12 (.00)	.15		
Perfectionism (Q3)	-4.36 (.00)	-.13		
Rule-consciousness (G)	-3.12 (.00)	-.10		
Dominance (E)	3.70 (.00)	.12		
Social boldness (H)	-3.32 (.00)	-.11		
Liveness (F)	2.81 (.00)	.10		
Vigilance (L)	-2.10 (.04)	-.07		

Source: Compiled by authors

Discussion and conclusion

The importance of teachers in school innovation and improvement processes has been clearly demonstrated (Carbonell, 2011; Fullan, 2007), as in the end it is the teachers who must put said processes into practice, changing, as Carbonell (2001) would say, their attitudes, ideas, cultures, content, models, and teaching practices. Thus, understanding how they think and behave can be of great use when designing and developing training plans, advising programs, and teacher hiring strategies.

Despite the difficulty and/or lack of consensus to define and characterize educational innovation, it seems that there are certain common factors in innovative teachers: Institutional Participation (e.g.: Emo, 2015; Herrán, 2009; Ismail et al., 2002), Psychopedagogical Open-

ness (e.g.: Jaskyte et al., 2009; Marcelo et al., 2011; Zhu & Wang, 2014) and Didactic Planning (e.g.: Loogma et al., 2012; Torrego, 2008; Vicent-Lancrin et al., 2014). The individual differences of innovative teachers that could be analyzed are almost innumerable; however, personality traits are one of the most widely-studied aspects in the field of differential psychology (Williams et al., 2008).

Until now, the most relevant publications on this topic seemed to be a bit out of date (Huberman, 1973), focused on very specific contexts (Ríos, 2004, 2006, 2009), not backed by other empirical studies (Monge et al., 2015, 2018), preliminary, not generalizable (Monge et al., 2016), and, sometimes, contradictory. For example, some studies indicate that innovative teachers, among other aspects, are characterized by being improvisational (Huberman, 1973; Renes et al., 2013), while others describe them as methodical and planning (Loogma et al., 2012; Ríos, 2004; Yilmaz, 2021).

The data from this study demonstrate that Institutional Participation, Psychopedagogical Openness, and Didactic Planning can be predicted through some of the personality traits proposed by Cattell. In this regard, positive liveliness (F+) and positive openness to change (Q1+) result in high values for these three teaching innovation factors. Indeed, educational innovation has a considerable attitudinal component, whether due to broadness of perspectives (Pérez, 2009), an open teaching style (Incik, 2020; Renes et al., 2013), exploratory behaviors (Huberman, 1973), or openness to change (Monge et al., 2016; Othman, 2016; Parlar & Cansoy, 2017; Tateo, 2012).

Low self-reliance (Q2-), high affability (A+), low social boldness (H-), low perfectionism (Q3-), and high dominance (E+) are personality factors that appear in two of the three innovation teaching factors. Characteristics that define people with low self-reliance were found previously by other authors who defined innovative teachers as professionals who work in and are part of groups (Renes et al., 2013) and who are interactive with their colleagues (Nemerzitski et al., 2013). Similarly, innovative teachers tend to help others (Huberman, 1973), be relatable and affectionate (Ríos, 2009; Yilmaz, 2021), as well as accessible (Tateo, 2012), which coincides with the high affability found in the regression analysis. According to Cattell's 16 personality traits theory, the characteristics that define people with low perfectionism (flexible and tolerate disorder) have not always been conclusive: for some authors, innovative teachers are planners and highly organized (Huberman, 1973), while for others

they are flexible (Renes et al., 2013). The results of the regression analysis coincide with this much more recent study. On the other hand, the data found regarding high dominance seem to contradict the studies that had been published thus far indicating that cooperative attitudes are characteristic of innovative teachers. This may be due to the fact that the most prominent characteristic of dominance is conflict seeking, and educational innovation is conflictive and generates a constant focal point of intellectual debate (Carbonell, 2001).

As can be seen, there are some factors associated with the extraversion that are present in innovative teachers, such as Rushton et al. (2007) pointed out. These personality factors are a low self-reliance (Q2-) and a high affability (A+) and liveliness (F+). In fact, this last factor is found in other studies (Jurgena et al., 2015).

Other personality traits that explain high levels of teaching innovation are high emotional stability (C+), high sensitivity (I+), low rule-consciousness (G-), and low vigilance (L-). Of these traits, perhaps the most important is low rule-consciousness, given that innovative teachers are characterized by considering new contents outside of the syllabus (Renes et al., 2013), being free to act (Lambriex-Schmitz et al., 2020; Nemerzitski et al., 2013), and free to solve problems (Avsec & Savec, 2021; Kong & Li, 2018) and look for solutions without fearing punishment for deviating from the official truth and social imperatives (Huberman, 1973). In addition, emotional stability is also essential for innovation because it allows greater emotional adaptation and, therefore, better resilience as a fundamental element for innovation (Campbell & Lawson, 2018). Other studies agree also in highlighting the low acceptance of rules (Jurgena et al., 2015). Although it is true that sensitivity is a key factor in innovation, it should also be noted that it is a very complex element for analysis and interpretation, because there are statistical differences depending on age, sex or previous training (Cakir, 2021).

The results of this research are similar to those found in the pilot study done by Monge et al. (2016), especially with regard to affability and openness to change.

This study has provided current data on the personality traits that explain the factors of teaching innovation, which was a question planned by Lee et al. (2012) as a future research topic. Given the size and characteristics of the sample, the results offer a greater level of generalizability than other studies published thus far. This information could be very useful when designing teacher training plans and advising programs, with special emphasis on both the

visible (teacher behaviors) and the invisible (beliefs, values, and attitudes) of innovation (Ellis et al., 2019). However, neither the variance explained nor the regression coefficient are extremely high, which could be due to the enormous number of variables that can characterize factors of innovation (Chand et al., 2020; Ee et al., 2007). Thus, future lines of research could include other individual differences between teachers with regard to educational innovation (e.g.: motivations, attitudes, teaching styles, etc.).

To conclude, the teaching innovation factors Institutional Participation, Psychopedagogical Openness, and Didactic Planning can be explained by several personality traits, with affability and openness to change playing a prominent role.

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