

DIAGNOSTIC POSSIBILITIES OF CREATIVITY AND DEVELOPMENT OF A NEW SELF-REPORTING ASSESSMENT TOOL: CREATIXO INVENTORY

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Abstract: In this article, we discuss some limits of methods being used most frequently for testing creativity and describe the process of developing a new diagnostic tool – a self-reporting inventory of creativity and innovativeness based on a complex set of skills and competencies identified in the review of existing research, relevant literature, and available diagnostic tools. Our complex applied creativity construct involves imagination, idea creation, openness, flexibility, and features like braveness, analytical skills, assertiveness, and even empathy, which are all necessary to transform a new idea into practical application beneficial for a company or society. We first gained data from 125 respondents and analyzed the structure of the first version of the questionnaire (reduction from 80 to 77 items had to be done based on correlation analysis). Then we undertook a series of exploratory factor analyses. After the iterative process of eliminating all the items with low loadings or problematic cross-loadings, we suggested the six-factor solution for the new, second version of the Creatixo inventory consisting of 47 items. On the new sample of 106 respondents confirmatory factor analysis supported the six-factor structure of the inventory (GOF indices: $CFI = .990$, $GFI = .909$, $RMSEA = .025$, $SRMR = 0.101$). The Creatixo tool has shown good results in internal consistency measures – e.g., McDonald's omega of all individual factors varies from .740 to .887. Now we are about to gather the bigger sample of the quota-representative population and cross-validate the psychometric analysis current outputs. We discuss the further validation studies and some limits of the self-reporting inventory approach to assess creativity, innovativeness, and productivity.

Keywords: creativity, innovativeness, questionnaire, test, competence, development

Možnosti diagnostiky tvořivosti a vývoj nového sebespozovacího nástroje: Creatixo Inventory

Abstrakt: V tomto článku pojednáváme o některých limitech metod, které se nejčastěji používají k diagnostice kreativity a popisujeme proces vývoje nového diagnostického nástroje – sebespozovacího inventáře kreativity a inovativnosti založeného na komplexním souboru dovedností a kompetencí identifikovaných v přehledu stávajícího výzkumu, relevantní literatury a dostupných diagnostických nástrojů. Náš komplexní konstrukt aplikované kreativity zahrnuje představivost, vytváření nápadů, otevřenost, flexibilitu a charakteristiky, jako jsou statečnost, analytické dovednosti, asertivita nebo dokonce empatie, které jsou nezbytné k transformaci nové myšlenky do podoby aktivity prospěšné pro určitou firmu nebo společnost jako takovou. Nejprve jsme získali údaje od 125 respondentů a analyzovali jsme strukturu první verze dotazníku (redukci z 80 na 77 položek bylo nutné provést na základě korelační analýzy). Poté jsme provedli řadu exploratorních faktorových analýz. Po iterativním procesu eliminace všech položek s nízkým sycením (low loadings) nebo s problematickou vzájemnou provázaností (problematic cross-loadings) jsme navrhli šestifaktorové řešení pro novou, druhou verzi inventáře Creatixo skládající se ze 47 položek. Na novém vzorku 106 respondentů potvrdila konfirmatorní

faktorová analýza šestifaktorovou strukturu inventáře (indexy GOF: CFI = .990, GFI = .909, RMSEA = .25, SRMR = .101). Nástroj Creatixo ukázal dobré výsledky v opatřeních vnitřní konzistence - např. McDonalldovo omega všech jednotlivých faktorů se pohybuje od .740 do .887. Nyní se chystáme shromáždit větší vzorek kvótně reprezentativní populace (quota-representative) a ověřit současně výstupy psychometrické analýzy. Diskutujeme o dalších validačních studiích a některých limitech sebeposuzovacího nástroje v přístupu k posouzení kreativity, inovativnosti a produktivity.

Klíčová slova: kreativita, inovativnost, dotazník, test, kompetence, rozvoj
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Introduction

Creativity is one of the necessary human skills needed for children to adapt to society. Later in adulthood, it is a prerequisite for all innovations and many problem-solving solutions in the working environment. For example, in the aged but well-known longitudinal studies using the NASA admittance test (Land & Jarman, 1992), 98% of healthy five-year-old children showed a high level of creativity over 130 on the IQ scale, while only 2% of the 25-year-olds and older scored the same. We can see how important it is to find out what features and traits lie behind the development or vanishing of this competence.

As the definition of creativity and innovativeness that brings real benefits for the society, we can use Urban's specification (2002, p. 8) included in the preface to his *Figural Test of Creative Thinking*:

“Creativity manifests itself in a new, surprising product, so it is the ability:

1. to create a new, unusual and surprising product as a solution to a sensibly perceived or assigned problem,
2. based on a sensitive perception of the broadest context of the submitted and other ‘investigated’ information,
3. through analysis and flexible solution-oriented processing, using unusual associations, restructuring or combining of this information with data from experience and imagination,
4. to elaborate new solutions (tangible and intangible) by synthesizing, structuring, and compiling these data, elements, and structures;
5. expressed as a product, or in a product in any form,
6. which is ultimately understood by others in communication as meaningful.”

We can see that this definition does not describe creativity as only ideation or imagination but as a set of more complex additional competencies in one cluster like analysis, sensitivity, or communication. It is in line with Singer's (2011) specification and also with the shorter definition of Kaufman, Plucker & Baer (1, 2008) which states: “Creativity is the integration among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context,” so we will understand creativity here including its practical application.

All these definitions explain some of the trouble we have with most presently used tests on creativity because they mostly emphasize more or less just the creation of new and unusual ideas. Still, most of them lack other mentioned features, namely practical application up an innovative product.

In the Czech Republic, the four most used, well-known and relatively widespread tests are the Torrance's Test of Creativity (Jurčová, 2004), the Urban's Figural Test of Creative

Thinking (Urban, 2002), Schürer's (1977) KREATOS, which is a modified Wartegg's test of creativity and finally most recently published Schuler's and Hell's ASK – The Test of Deductive and Creative Thinking (2014).

The first three of them are drawing tests. They evaluate fantasy and probands' abilities to see unusual aspects in given stimuli (usually simple graphical objects like circles or lines as a basis for probands' drawings) and finish pictures or sentences by themselves with features that would hopefully have non-conformity meanings. All of them focus on a narrower conception of creativity consisting of just imagination, originality, out-of-box thinking, idea creation, fluency of ideas, and flexibility. However, they lack the social aspects needed for promoting an idea among people, like assertiveness and empathy. And we miss there also analytical and systematic thinking required to assess the usefulness of an idea critically. What is also not included is the enthusiasm and perseverance necessary to finally bring the matter to a new, practically usable product or service. Not talking about braveness to go forward, sometimes against the opinion and resistance of others, or the ability to accept critical feedback, change and develop ourselves, which are also necessary to move elaboration forward.

The closest to what we would need to test creativity and innovativeness in a more holistic and complex view is the ASK test (Schuler, Hell, 2014), which is not based on pictures and tries to build on solutions to given problems. But social and personality aspects of creativity are not included here either, not talking about getting the matter to a usable product.

Until now, we have not found any entirely appropriate golden standard for our broadly defined applied creativity, which would include assessing and bravely promoting the idea and bringing it into practical realization for the benefit of the company or society.

Of course, we could make a test battery and use selected items or subscales from some standard personality questionnaires. These cognitive and performance tests usually include a lot of features we are searching for. To name just a few, Hogan Personality Inventory (HPI, 2019), Hexaco (Ashton, Lee, 2009), Clifton StrengthsFinder (Gallup Strengths, 2012) or Big Five (e.g. DeYoung, Quilty, Peterson, 2007) come into account. For instance, from the Big Five model, we could utilize all five scales: openness to experience, conscientiousness, agreeableness, extraversion, and the opposite trait of neuroticism: resilience and confidence. Hexaco can also help when it adds to the Big Five factors sixth one.

As an example of a closer look at some classical personality assessment tool subscales, we can take the Hogan Personality Inventory – HPI (2019). It includes seven primary scales, out of which six seem to fit well to what we wish to measure: Self-assertion, Sociability, Cooperativeness, Systematic approach, Curiosity, and Ability to learn. But from their subscales (each basic competence consists of 4 to 8 different features) only a few fit our construct, and the majority do not. The compatible ones are, for example, Empathy (as part of Stability), Competitiveness (part of Self-assertion), Searching for stimuli (in Sociability), and Easy cooperation (as part of Cooperativeness). Under the Systematic approach scale, features like Diligence, Perfectionism, Autonomy, and Prevention of problems would also be interesting. And under the Curiosity scale are items like Searching for experiences and Imagination.

But other features differ so much that the seven main scales as a whole will not correspond to the results we would like to obtain. For example, the contents of the Ability to learn scale seem to differ quite a lot from our construct based on accepting feedback and

openness for change because they include education, mathematics, memory, and reading, which is out of our focus.

On top of that, Hogan does not fully exhibit its inventory's exact structure to researchers, so it would be challenging to select and appropriately compare the individual features. So neither Hogan nor any other personality inventory known to us at present, includes all the features we wish to measure in an appropriate combination consistent with our construct.

Why should we invent a new psychometric tool and not just use the battery consisting of several personality, cognitive, and performance tests? Because we miss one comprehensive tool that would quickly measure competencies that the companies require the most today. Our intent can be supported by the regular annual LinkedIn research (Van Nuys, 2019), which examines more than 20 million jobs and over 660 million professionals on their platform. Among the top list of competencies valid for the year 2020, creativity remains even for several years in the first place, followed by persuasion, collaboration, adaptability, emotional intelligence, and analytical reasoning. All these aspects are included in our definition of applied creativity. From this fact, we derive our persuasion that a new tool concentrating just on these most valued competencies is needed. Applied creativity is considered long-term by companies to be the essential competence, so we believe it deserves more attention and a specific comprehensive tool to measure it in all its aspects.

That is why we decided to design a new self-assessing questionnaire with the aim first to validate its items and the construct as a whole, later on, to transfer its proven features into more objective test based on problem-solving and role-playing.

Our new tool is called Creatixo (or DKI-CXO, where DKI stands in Czech for a questionnaire of creativity and innovativeness and CXO for a start-up company Creatixo that cooperates on its development). Creatixo should assess company employees primarily and help them to develop in selected aspects. Its construct is defined in such a way that a highly creative, innovative, and productive person is able to create, systematically analyze, critically and strategically evaluate ideas, assert and enforce them among the colleagues or customers, bravely overcome obstacles and follow them up to a practical implementation to a new original product or service that will benefit the company and/or society and will be accepted by the social environment.

Using a review of existing tests, inventories, expert monographs, and research on creativity undertaken until now (see more detailed literature references at the end), which is summarized, for example, in Franková's (2011), Pritzker & Runca's (2011), Sternberg's (2008) or in Kaufman, Plucker, Baer's (2008) reviews, we identified dozens of different main features and skills that relate to our construct of ability to create and test ideas with their promotion, assertion, and finalization up to the specific product or service beneficial for the company and/or society. We made a list of all the attributes and competencies mentioned in these sources and created a list of more than 80 most frequent descriptive words.

To these creative features belong above all divergent thinking (Jurčová, 1984) measured already from Guilford (1950) until today by fluency (number of relevant answers), flexibility (scope of different approaches), originality, and elaboration (i.e., amount of details). But for example, Sternberg (2008) correctly objects that these features do not cover all aspects of creativity. On top of the creative process's generative phase, when new ideas arise (that require divergent thinking), he also distinguishes the explorative phase where many other skills are needed: logic, analysis, synthesis, or critical reasoning. Petrowski (2000) adds intuition and insight, the ability to keep stability and a low

level of arousal (that means to overcome stress and be resilient), but at the same time in contrary also necessity to be exposed to a certain level of excitement, new experiences, and stimuli. Moreover, Sternberg (2008) emphasizes the personality features of creative people like braveness, courage, spontaneity, and self-acceptance. MacKinnon (1975) adds self-awareness, self-control, sensitivity, emotiveness, openness to complex experience, and complexity preference. Both of them also talk about inner motivation to achieve results, overcome obstacles and bring a matter to its end. Csikszentmihalyi (1997) underlines socio-cultural aspects like willingness to give up public appraisal but at the same time ability to finally achieve necessary consent and approval from the society, which requires communication skills like empathy, negotiation, and assertiveness.

We took different features like these from the referenced sources and used them as individual items in our test. The first version of the DKI-CXO (Creatixo) inventory consisted of 80 of such items rated by a four-point grading scale: how fully the statement corresponds with respondent's usual behavior at work (I fully agree; partially agree; partially do not agree; I fully disagree with the statement).

We have preliminarily grouped them according to their logical similarity and coherence into nine clusters of supposed basic competencies. Those were 1. Braveness and Fighting Spirit (abbreviated as B), 2. Perseverance (V), 3. Imagination, Ideation and Artistic Eye (P), 4. Openness (O), 5. Analytical and Systematic Mindset (S), 6. Enthusiasm and Curiosity (N), 7. Empathy (E), 7. Assertiveness (A), and finally 9. the Ability of Self-Development (R).

In this article, we introduce the process of designing this creativity and innovativeness self-reporting questionnaire and the results of the pilot psychometric analyses on the first two verification groups of 125 and 106 respondents. The second group obtained a new, improved version of the test thanks to exploratory factor analysis. The work done so far includes item analysis, correlation analysis, reliability, and internal consistency verification, exploratory factor analysis for exploration of the test structure, and confirmatory factor analysis on the new sample to verify the structure of the second version of the inventory.

The article also presents researchers' further plans to gather a larger, quota-representative sample and undertake various kinds of validation studies so the test could be utilized in a real working environment.

Method

RESPONDENTS

We collected data from the first group of respondents by publishing the inventory online. The sample was composed of people who found the questionnaire on the server themselves (www.vyplnto.cz). Further on, the information about the questionnaire was posted on social networks like Facebook and LinkedIn and among the authors' university students. In the pilot phase, data from 90 respondents were collected in this way within four weeks (61% of women and 29% of men in the age range from primary school to retired), with 39% aged 25-35 years and 28% between 16-24 years of age). 62% of respondents were currently studying university or have completed university education. The professional structure varied from managers, entrepreneurs, helping professionals to students

without a permanent job (19% of the sample), and even manually working people. Afterwards, data from the other 35 more respondents were gathered from the business environment – mainly company managers around 40 years of age (85% of them were men).

With this sample of 125 participants, we conducted the first psychometric analyses, including item analysis, a preliminary study of internal consistency, reliability, and the series of exploratory factor analyses focused on exploring the internal structure of the inventory and the process of item reduction.

To perform the confirmation factor analysis on a new version of the inventory consisting of 47 items, we collected a sample of new respondents (also utilizing the same online server). Within three weeks, we received 107 responses, out of which 106 were valid. The demographics of this second sample: 33.6% consisted of women and 66.4% of men. Concerning the age structure, 41% were 25 to 35 years, 28 % between 16 and 24, 13% between 36 and 45.6 % were previous or present university students, and 30% with at least a school-leaving examination. The proportion of administrative, helping, or managerial positions was approximately the same – around 14%. The technicians (11%), entrepreneurs (6%), and other professions (including manual – 3%) formed the remaining part.

DATA ANALYSIS

We analyzed the data by using Excel, SPSS, and JASP. On the first sample of 125 respondents, we explored the inventory's internal structure by using EFA. As a method of extraction, we decided to use principal axis factoring. The confirmatory factor analysis (CFA) was applied to the new sample of 106 participants to validate the structure of six factors (output of EFA) and verify the level of item loadings (Kogar & Yilmaz Kogar, 2015).

As the estimation method, we used DWLS (diagonally weighted least squares) as recommended for the ordinal data with abnormal distribution (Nye & Drasgow, 2011). The selected fits were RMSEA, TLI, CFI, and SRMR. The widely used recommended critical values of these indices are $RMSEA \leq .06$, $SRMR \leq .08$, $TLI \geq .95$, and $CFI \geq .95$ (Schermelele-Engel, Moosbrugger, & Müller, 2003). However, these indicators have been established primarily for estimation methods other than DWLS and may be affected by the data's abnormality (Nye & Drasgow, 2011). Therefore, greater caution is needed when interpreting them. The internal consistency was analysed using McDonald's ω and Cronbach's α coefficients, and the split-half reliability was verified using the Guttman's coefficient.

Results

EXPLORATORY FACTOR ANALYSIS

We conducted an exploratory factor analysis on the first original sample of respondents (N=125). Results showed the existence of 23 factors with the eigenvalue higher than 1 and ten factors with eigenvalue over 2 (see Fig. 1).

Ten not rotated factors explained more than half (52.47%) of all the variability of the 77 items. Other factors had fewer items that loaded them and stronger cross-loadings with other factors.

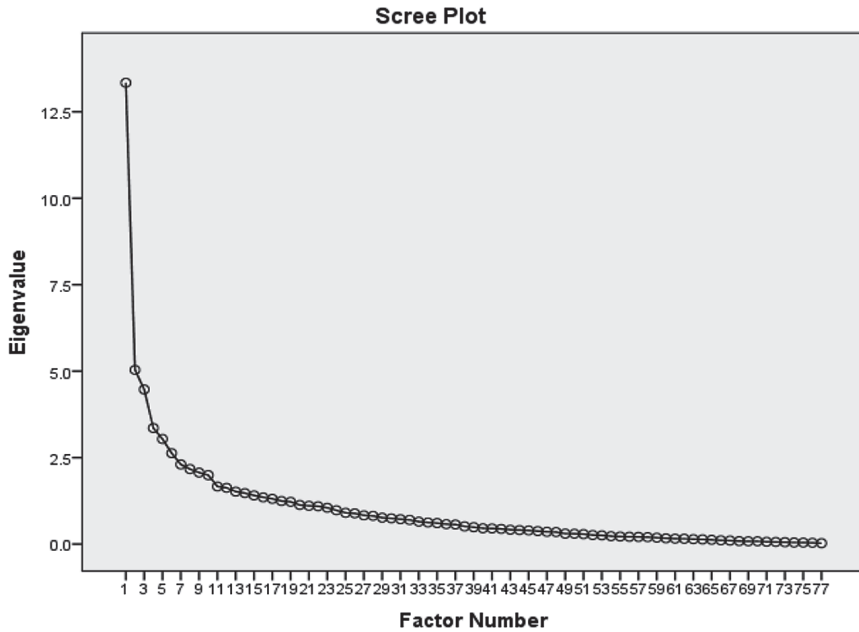


Figure 1: Scree plot graph with 23 factors, 10 with eigenvalue over 2 ($N=125$)

In item screening and reduction, we further eliminated all items with low loadings and high cross-loadings values. After this process, 43 items seemed to perform sufficiently, and for this reduced number of items, EFA showed a 6-factor solution.

The eigenvalues of 6 rotated factors (Oblimin) explain 49.53% of all items' variance (Tab.1).

Table 1: Final EFA outputs after removing problematic items: Eigenvalues of 6 factors ($N=125$)

Factor	Initial Eigenvalues			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total
1	7.276	16.921	16.921	4.354
2	3.798	8.832	25.753	4.114
3	3.449	8.020	33.773	4.200
4	2.894	6.730	40.503	2.744
5	2.020	4.698	45.201	3.228
6	1.860	4.325	49.526	2.472

Factor loadings of the remaining 43 items are shown in Tab. 2, displaying higher loadings than 2. The factors are coded with new labels of A, E, N, O, P and R, and in this way, the individual items are already grouped into new factor clusters.

Table 2: Exploratory factor analysis – loadings of 43 newly structured and coded items (N=125)

Factor Loadings							
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Uniqueness
A1	.	.	.	.	.690	.	.470
A2	.	.	.	.	.470	.	.731
A3	.	.	.	.	.665	.	.474
A4	.	.	.	.	.408	.	.754
A5	.	.	.215	.	.486	.	.570
E1	.	.741	.	.	.	.	.431
E2	.	.704	.	.	.	.	.461
E3	.	.600	.	.	.	.	.630
E4	.	.491	.252	.	.	.	.561
E5	.	.509	.	-.207	.	-.278	.530
E6	.	.556	.	.	.261	.	.588
E7	.	.679	.	.	-.226	.	.515
E8	.	.601	.	.	.	.	.593
N01	.619	.	.	.	.214	.	.420
N02	.613	.	.	.	.	.	.578
N03	.735	.	.	.	.	.	.430
N04	.477	.	.	.	.	.	.760
N05	.626	.	.	.	.	.	.569
N06	.610	.	.230	.	.	.	.518
N08	.658	.	-.245	.	.	.	.497
N11	.498	.	.	.	.	.	.629
N13	.425	.	.	.	.	.236	.695
O1	.	.	.584	.	.	.	.478
O2	.	.	.503	.	.214	.	.586
O3	.	.	.626	.264	.217	.	.390
O4	.	.	.445	.210	.	.	.708
O5	.	.	.366	.	.	.	.765
O6	.231	.	.698	.	.	.	.407
O7	.	.	.463	.	.	.	.775
O8	.	.	.630	.	.	.	.487
O9	.	.	.420	.	.	.227	.738
P1	.	.220	.	.	.207	.659	.368
P2	.	.	.225	.	.	.474	.651
P3	.	.	.	.	.	.428	.743
P4	.	.	.	.	.	.443	.762

Factor Loadings							
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Uniqueness
P6	.	.413	.	.	.243	.246	.523
R1639	.	.	.497
R2431	.	.	.801
R3	.	.211	.	.479	.	.	.718
R4632	.	.	.575
R5657	.	.	.515
R6584	.	.244	.559
R7510	.	-.285	.619

Note: Applied rotation method is oblimin

THE CONTENTS OF THE 2ND VERSION OF THE CREATIXO INVENTORY

To 43 items that remained after EFA, we added four new ones to strengthen the factors with fewer items. In this way, we created a second version of the test with a 6-factor structure and 47 items.

We examined the meanings of individual items grouped in each factor, discovered what joined them together and what they had in common, and finally formulated the new titles and descriptions of factors. In this way, the new set of 6 competencies was established, forming together our complex applied creativity and innovativeness construct:

ASSERTIVENESS, INDEPENDENCE (coded as A), EMPATHY, SOCIAL INTERACTION (code E), IDEATION, INNOVATIVENESS (N), COURAGE, DECISIVENESS, ENDURANCE (O), OPENNESS FOR FEEDBACK (P) and finally SYSTEMATIC AND CRITICAL THINKING (R).

As an example, we show here the detailed wording of items included in factor O = COURAGE, ENDURANCE (first the specific skill is named, and then the item is exhibited):

Skill:

1. Courage to go into risks – Item O1: If necessary, I do not hesitate to go into risk, even though it might be disadvantageous for me.
2. Ability to overcome rejection – O2: When I come across disagreement or rejection, I can get over it and continue without losing the vigor.
3. Courage to make decisions – O3: Under challenging situations, I usually decide on myself and do not question the chosen steps anymore.
4. Fighting spirit, not giving up – O4: Though sometimes things seem to be lost entirely, I never give up and fight to the very end.
5. The capability of intense commitment – O5: When necessary, I can turn to higher speed and, for a short time, work with high intensity and deployment.
6. Courage to step into the unknown – O6: I like to venture into unexperienced things, and I am not afraid to step into the unknown.

7. Stress resistance – O7: I can handle the load very well - under heavy (short-term) pressure, and in stressful situations, my performance even grows.
8. Ability to start again after failure – O8: If I experience failure, loss, or defeat, I am not having trouble starting again.
9. Following through till the end – O9: When I begin something, I'll also see to make it up to the end.

Contents of the other five competencies are as follows:

Competence N = IDEATION, INNOVATIVENESS consists of items Out-of-box-thinking, Fluent generation of ideas, Originality, Sense for opportunities for improvement, Interest in new ideas, Explorer's mind, Ability to think in pictures, Ability to initiate changes, and Thinking flexibility.

E = EMPATHY, SOCIAL INTERACTION is formed by items Showing interest in others, Sensitive communication, Ability to empathize, Acceptance of others as they are, Intuition, Recognition of moods and motivations of others, Willingness to help others, Ability to listen and accept other people's differences, and Negotiation with respect to a counterparty.

R = SYSTEMATIC AND CRITICAL THINKING consists of Analysis – breaking up a problem into smaller sections and identifying causes, Thoroughness and conscientiousness, Sense of order and ability to be well organized, Systematics and structure, Logical mindset, Anticipation, and evaluation of risks, and Consistency and check-out.

A = ASSERTIVENESS, INDEPENDENCE is formed by Ability to make one's own opinion, Ability to say "No", Ability to defend and advocate for oneself, Presentation of an opinion that does not bring advantage for the author, Ability to be a convincing presenter and win others over, and Ability to assert oneself.

And the last competence P = OPENNESS FOR FEEDBACK includes Courage to admit mistakes and failures in front of others, Admittance of ignorance, Ability to adjust one's behaviour based on feedback, Willingness to change opinions, Ability to develop in skills, and Ability to adapt to changes.

CONFIRMATORY FACTOR ANALYSIS ON THE NEW SAMPLE

We used data from the second sample of respondents (N=106) for confirmation of our 6-factor model. Based on CFA results (Tab. 3), we removed further 4 items with an insufficient level of factor loadings – i.e., with standard estimation under .300 (R2 = Being thorough and conscientious, R3 = Sense of order and being well organized, R7 = Consistency, and check-out, and P2 = Admitting ignorance).

The CFA performed on the reduced final version with 43 items showed overall supportive results of the inventory's six-factor structure (*GOF indices*: CFI = .990, GFI = .909, RMSEA = .025, SRMR = .101), only SRMR did not meet the criterium level of .08.

Table 3: Factor loadings according to confirmatory factor analysis (N=106)

Factor	Indicator	Est.	Std. Error	z-value	p	95% Confidence Interval		Std. Est. (all)
						Lower	Upper	
Factor 1	N01	1.000	.000			1.000	1.000	.671
	N02	1.054	.077	13.628	< .001	.902	1.205	.721
	N03	1.032	.079	13.106	< .001	.878	1.186	.662
	N04	1.163	.085	13.610	< .001	.995	1.330	.739
	N05	.799	.067	11.858	< .001	.667	.931	.505
	N06	.922	.073	12.656	< .001	.779	1.064	.585
	N07	.879	.081	10.799	< .001	.719	1.039	.482
	N08	1.168	.083	14.087	< .001	1.005	1.330	.754
	N09	1.239	.088	14.003	< .001	1.065	1.412	.814
	N10	.999	.077	12.949	< .001	.848	1.151	.650
Factor 2	S1	1.000	.000			1.000	1.000	.649
	S2	.890	.094	9.467	< .001	.706	1.074	.572
	S3	.627	.080	7.848	< .001	.470	.783	.377
	S4	.765	.087	8.775	< .001	.594	.935	.473
	S5	1.238	.115	10.737	< .001	1.012	1.464	.780
	S6	1.097	.103	10.658	< .001	.895	1.299	.694
	S7	.762	.088	8.638	< .001	.589	.935	.461
	S8	.733	.084	8.736	< .001	.568	.897	.487
	S9	1.193	.108	11.024	< .001	.981	1.405	.803
Factor 3	O1	1.000	.000			1.000	1.000	.545
	O2	.670	.071	9.449	< .001	.531	.809	.420
	O3	1.172	.097	12.066	< .001	.982	1.362	.660
	O4	.823	.077	10.644	< .001	.671	.974	.518
Factor 3	O5	.820	.071	11.537	< .001	.680	.959	.578
	O6	1.165	.098	11.827	< .001	.972	1.358	.651
	O7	1.522	.126	12.092	< .001	1.276	1.769	.675
	O8	1.057	.092	11.531	< .001	.877	1.237	.625
	O9	.524	.067	7.841	< .001	.393	.655	.310
Factor 4	R1	1.000	.000			1.000	1.000	.715
	R4	1.050	.102	10.323	< .001	.851	1.249	.657
	R5	.983	.097	10.132	< .001	.793	1.174	.649
	R6	.726	.079	9.210	< .001	.571	.880	.564

Factor	Indicator	Est.	Std. Error	z-value	p	95% Confidence Interval		Std. Est. (all)
						Lower	Upper	
Factor 5	A1	1.000	.000			1.000	1.000	.380
	A2	1.411	.179	7.896	< .001	1.061	1.761	.409
	A3	2.330	.251	9.273	< .001	1.837	2.822	.700
	A4	2.153	.236	9.119	< .001	1.691	2.616	.673
	A5	2.676	.283	9.454	< .001	2.121	3.231	.758
	A6	2.681	.284	9.452	< .001	2.125	3.237	.796
Factor 6	P1	1.000	.000			1.000	1.000	.527
	P3	1.047	.105	9.995	< .001	.841	1.252	.609
	P4	.948	.102	9.283	< .001	.748	1.149	.505
	P5	1.070	.106	10.113	< .001	.863	1.278	.625
	P6	1.620	.150	10.803	< .001	1.326	1.914	.763

DESCRIPTIVE STATISTICS

Basic descriptive statistics figures of the individual scales and the whole test are shown in Tab. 4. Answers to test items were coded into four levels marked from 1 to 4.

RELIABILITY ANALYSIS

The reliability of the whole test (Tab. 5) shows very high values: Cronbach's Alpha is .932, McDonald's Omega .934 and Gutmann's split-half correlation .970, which suggests that there might be one factor over all of the individual ones, something like applied creativity, but a larger sample of at least 500 probands is required for us to be able to examine these factors of the second order.

Table 4: *Descriptive statistics*

	mean	sd
N	2.820	.158
S	2.896	.147
O	2.672	.362
R	2.833	.080
A	2.761	.321
P	2.860	.177
All	2.803	.238

Table 5: Reliability of the overall score

	McDonald's ω	Cronbach's α	Gutmann's λ_6	Average interitem correlation	95% Confidence Interval	
					Lower	Upper
Overall score	.934	.932	.970	.244	.913	.950

Reliabilities of individual factors make much more sense here and show a very good level (Tab. 6). As the required figure should be minimally .7, we can see that all the scales overcome this level.

Table 6: Reliability of the individual scales (factors)

	McDonald's ω	Cronbach's α	Gutmann's λ_6	Average interitem correlation	95.0% Confidence Interval	
					Lower	Upper
Scale N	.887	.883	.896	.436	.846	.913
Scale S	.845	.837	.860	.366	.786	.880
Scale O	.802	.797	.814	.304	.734	.850
Scale R	.740	.738	.692	.412	.646	.811
Scale A	.800	.797	.807	.390	.730	.851
Scale P	.765	.756	.728	.391	.674	.822

FACTOR CORRELATIONS

Then we undertook an exploration of the new test version results concerning correlations between individual factors. Tab. 7 shows that factors correlate with each other in a reasonably moderate way, just doubles N – O and O – A are interrelated a bit more than the others (over .6).

Table 7: Mutual correlations of final 6 factors (HS=overall raw score)

	HS	F1 – N	F2 – S	F3 – O	F4 – R	F5 – A	F6 – P
F1 – N	.842	1.000					
F2 – S	.633	.413	1.000				
F3 – O	.830	.652	.387	1.000			
F4 – R	.504	.300	.112	.304	1.000		
F5 – A	.744	.582	.237	.625	.386	1.000	
F6 – P	.687	.511	.478	.525	.115	.416	1.000

Discussion

CONCLUSIONS

The undertaken steps described so far show that the Creatixo inventory might become a promising construct – it has very good reliability, inner consistency, and appropriate complexity.

Concerning internal structure and item analysis, the first version of the questionnaire needed some adjustment and reduction of items and regrouping into newly formed clusters of 6 factorial competencies. After EFA and CFA analyses, the questionnaire appears to be ready for further validation and data collection from more significant samples.

THE VALIDITY OF THE QUESTIONNAIRE CONSTRUCT

Full and thorough verification of our inventory's validity has not yet been done – we plan to do so in the next stage whenever we get a quota-representative sample of respondents.

We have just gained the first positive responses from participants concerning face validity. In general, they expressed that their results in the questionnaire correspond well to their self-evaluation. When other people, who know them well, have seen their reports, also they considered them fitting quite well to their fundamental characteristics. Further on respondents stated that the 6 new competencies of the questionnaire correspond well with their understanding of creativity and innovativeness, and individual items logically fit into these categories. Another planned way of confirming the face validity is to compare the results of the self-evaluation of participants with assessment by somebody else who knows them well using the same test. Then we will be able to correlate the two sources of answers.

Once at least some 235 respondents undergo new testing (i.e., 2.5 times the doubled number of 47 reduced questionnaire items), we will finally confirm the internal inventory structure by another iteration of confirmatory factor analysis.

Then we plan to undertake several construct validity assessments and explore convergent and discriminant validity by correlations with selected subscales of different personality and social skills inventories and creativity tests (Big Five, HPI, ASK, and Torrance test). Their scales and subscales, which we expect to correlate with our factors, are mentioned in more detail in the introduction. Concerning our inventory's ideation and imagination scale, we expect significant correlations with Torrance tests or ASK results. When talking about personality features, we will compare our results with the appropriate scales of Hogan's inventory, as mentioned earlier. We can also compare some elements of Leary's interpersonal diagnosis ICL test for corresponding social aspects like assertiveness or social interaction. We would expect positive correlations with his scales of Cooperation and Individuality and negative ones with Conformity or Submission.

After collecting more data, we will also perform a contrast validation on the population of corporate participants to assess whether employees, who their colleagues perceive as particularly creative and innovative, or people with specifically creative occupations score higher in the questionnaire than the remaining population.

NEXT STEPS

After all these validation studies, we intend to start using the questionnaire at the beginning and the end of the company creativity development programs, which could help us evaluate their impact. In a longer perspective, our ambition is to design more objective test based on problem-solving assessments that will be linked to the main 6 factors of our validated questionnaire. It could make assessing the creative and innovative competencies of participants in development programs even more objective.

LIMITS

We have to assess the method's construct validity by comparing it with the golden standard inventories (Big Five) or other creativity, personality, and social skills tests and inventories mentioned in the introduction part.

For EFA and CFA, we used two small samples of 125 and 106 probands. Therefore, the results must be considered preliminary only and need to be proven on the more extensive and quota-representative sample.

Our method's most problematic limit is assessing the creativity, innovativeness, and productivity just by a self-reporting questionnaire. It might bring numerous distortions related to a subjective view: social desirability, overestimation, low self-reflection, self-criticism, not understanding the question the proper way, etc. The test report draft shows the order of the individuals' competencies primarily; therefore, some of these distortions might be reduced in this way. But comparisons with other people or norms would not be valid at this stage.

Nevertheless, as Kaufman (2019) states, self-assessment of creativity is not ideal, but better than we would think. So, despite all of these limits, the Creatixo tool seems to be a promising way to become a valuable contribution to assessing and developing creativity, innovativeness, and productivity. Later, it might become a solid ground for designing more objective tests.

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