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THE CURIOSITY AND EXPLORATION INVENTORY: STRUCTURE AND RELIABILITY

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Abstract: The present article deals with the psychological construct of curiosity and presents Curiosity Exploration Inventory (CEI), from American authors Kashdan, Rose and Fincham (2004). The CEI originated as reaction to unsatisfactory methods measuring curiosity. The article presents several foreign studies concerning curiosity and results of verification of structure and reliability of the CEI in two Slovak samples – 88 college students (average age = 22.59) and 157 school children (average age = 9.31). Results show that the CEI measures two distinct but related components of curiosity, Exploration and Absorption, and its reliability is satisfactory.

Key words: curiosity, exploration, absorption, factor analysis

Introduction

Curiosity is described as a desire for information in absence of any external reward (Loewenstein, 1994) and it is the key motive of human behaviour. It is considered as driving force in child development, school achievement, scientific discoveries and also consumption behaviour and it holds critical position at the boundary of cognitive processes and motivation. Humankind's natural curiosity has been a major impetus behind scientific discovery and the advancement of civilization. Piaget (1993) considered curiosity as prerequisite for extension of one's knowledge. Bruner (cit. Reio, 1997) theorized that curiosity is so important that it "is essential to the survival not only of the individual but of the species" (1966, s. 115). Maslow (1970) posited curiosity to be an important element in the development of a psychologically healthy person. Voss and Keller (1983) stressed that curiosity and the exploratory behavior it elicits is vitally important to human development because it assists in the flexible adaptation to changing environmental conditions and implies "a direction of development toward differentiated interaction patterns and more effective problem solving" (p. 156). Thus, curiosity, or the desire to seek information and knowledge, has been often thought of as one

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of the important motivators of human behaviors throughout the lifespan (Loewenstein, 1994). Maslow (1970) also claimed that satisfying one's curiosity is one of the important positive determinants for acquiring knowledge.

In the past, curiosity had often negative connotation, especially in the common language. It was often viewed as expression of lack of self-regulation or even inquisitiveness. However, in 50-ties of the last century it has begun to be viewed as desirable feature in education, mainly due to the experiments with primates, which showed existence of the curiosity drive in animals and they stimulated renewal of the interest for research of human curiosity in 60-ties and 70-ties. Majority of research of that time concentrated on the curiosity of children, adolescents and college students (e.g. Ainley, Maw and Maw, etc.), mainly due to the impression that curiosity is typical characteristic of children and it is essential part of the learning process (Reio, 1997).

The examination of curiosity has been exacerbated by problems with its definition. Some researchers refer to curiosity as "sensation seeking" (e.g. Zuckerman); others prefer to think of it as "exploratory behavior" (Voss & Keller, 1983), or interest" (Fink, 1994). Overall, researchers dispute whether curiosity is more meaningful as a "motivational state" or a "personality trait". We prefer the notion of Kashdan et al. (2004) who define curiosity as positive emotional-motivational system associated with the recognition, pursuit, and self-regulation of novelty and challenge.

History of curiosity research

Berlyne (1963) was among the first to discuss the multidimensional nature of the curiosity construct. Berlyne claimed that curiosity has two dimensions: the epistemic/perceptual and specific/diversive curiosity dimensions. Perceptual curiosity relates to the behaviour, which is stimulated by the new stimulus and is reduced when exposed to this stimulus (Loewenstein, 1994). Essentially, this kind of curiosity corresponds with the exploratory behaviour of animals. Epistemic curiosity relates to the desire for knowledge and is typical only for humans. Specific curiosity tells about desire for concrete information and on the contrary, diversive curiosity relates to the more general seeking out stimulation, which is connected with boredom. Berlyne believed that multivariate statistical methods would be able to unify these various kinds of curiosity.

Similarly, Vidler (1974) later pointed out to other evidence supporting the multidimensionality of the construct: the low to modest interrcorrelations between the extensive range of instruments purportedly measuring curiosity. Thus, although some evidence exists to indicate that the various measures of curiosity are measuring the same variable, their compatibility is much less than desirable, suggesting that curiosity is quite definitely a multidimensional construct.

In alternative efforts to continue to clarify the nature of the curiosity construct, researchers like Giambra, Camp and Grodsky (1992), Ainley (1986), and Reio (1997) used adult populations to answer self-reported, questionnaire measures of curiosity. The participant's total and subscale scores on the instruments were then factor analyzed to determine a parsimonious number of curiosity factors. These researchers believed these factor-analytic studies would support their hypothetical notions of what exactly curiosity is, thus facilitating further exploratory research. Nevertheless, according to some authors, what has resulted is further confusion and controversy (Reio, 1997). In the following part we briefly present results from two classical studies of curiosity, which used factor analysis to identify multidimensional nature of curiosity.

Curiosity – „breadth-of-interest“ and „depth-of-interest“

Reio (1997) cites in his work Langevin´s research. Langevin, noting the need to test the hypothesis that curiosity is multifaceted, compared five representative curiosity measures and two intelligence instruments. He concluded that the curiosity measures were distinct from IQ tests. Two weak curiosity factors emerged, i.e., breadth-of-interest and depth-of-interest curiosity (the breadth and depth factors accounted for 12.5 percent and 6.6 percent of the total variance, respectively). He claimed that the breadth-of-interest curiosity style may reflect both a personality dimension and diversive curiosity. Further, he thought that the depth-of-interest curiosity style may alternatively reflect the intensity of a motivational state and specific curiosity.

Ainley (1986), with a population of 227 teacher education students in Australia, continued Langevin's Canadian research. She noted that Langevin later claimed that the two fore mentioned weak curiosity factors may be simply artifacts of the difference between combining two kinds of curiosity instruments (teacher ratings to self-report questionnaire measures). She instead used eight self-reported questionnaire measures with an adult

population to correct for the possible artifact problem. After factor analyzing five distinctly different curiosity instruments (from the Langevin study), she concluded that there was not a unitary curiosity factor; moreover, she interpreted the varimax rotated factors to mean there was either a two-factor or a three-factor solution. She preferred the two-factor solution and thus supported Langevin's two-factor curiosity model.

Nevertheless, considerable controversy exists over Ainley's (1986) interpretations as there were really three clear, strong factor groupings, with the third factor accounting for an extra 9.1 percent of the total variance. Reio (1997) cites critiques of Boyle and Byman who re-analyzed Ainley´s findings and pointed out to the fact that different statistic methods clearly show the existence of the three factors.

Loewenstein (1994) added to the confusion as he claimed that the breadth and depth of interest curiosity factors were manifestations or categories of only one kind of curiosity, i.e. specific curiosity. He defined *breadth curiosity* as the number of interests an individual has, whereas *depth curiosity* reflects the degree to which an individual might pursue a single area of interest. Although the breadth-depth distinction appeared similar to the distinction existing between diversive and specific curiosity, he thought both were really instances of a desire to seek information, not a desire to seek stimulation in general. Nevertheless, by simply viewing breadth and depth curiosity along a continuum of interests, Loewenstein seems to have strayed from Langevin and Ainley's original definitions. It is clear that both Langevin and Ainley considered breadth curiosity an orientation to seek varied and changing experiences as a result of boredom, with an emphasis on actually physically experiencing what the novel event is like.

The main point here is that while breadth curiosity does reflect one's diversity of interests per se, it also indicates a desire for stimulation, that is stimulation to avoid boredom, which is an aversive state. Therefore, Langevin and Ainley's definition of breadth curiosity is similar to description of diversive curiosity and does not appear to be a part of specific curiosity (Reio, 1997). As we can see, there are still a lot of contradictory findings in this area of research.

Curiosity – information seeking vs. stimulation seeking

Reio (1997) presents Olson and Camp's research, in which they attempted to validate Langevin´s study from the 70-ties with adult population and they used 6 self-report questionnaires of curiosity (two of which were used also in Langevin´s original study) to

reveal the exact nature of the curiosity construct. Factor analysis of the total scale scores yielded a two-factor solution and they labeled the factors as *General Curiosity* and *Experience Seeking*. However, factor analysis of the subscale scores resulted in a three-factor solution, with the new factor being identified as *Venturesomeness*.

Giambra, Camp a Grodsky (1992) considered Olson and Camp's general curiosity/ experience seeking distinction to be quite useful, but argued to change the factor names to *Information Seeking* and *Stimulation Seeking*. In addition, they considered Olson and Camp's two factors to be synonymous with Ainley's depth/breadth curiosity dimensions.

Despite all these conceptual confusions two things seem to be undoubted: curiosity is not unidimensional construct and very real need exists to clarify its nature. This could be accomplished by considering and using the variety of perspectives and measures the prevailing research recommends in efforts to guide additional curiosity investigation. The resulting new knowledge about curiosity's nature may, in turn, more concretely illustrate curiosity's importance to educational practitioners and theorists. Therefore we decided to study theoretical background of curiosity construct and to verify psychometric properties of the Curiosity Exploration Inventory with college and children population, because we expect that in these age groups the scale would be used the most often.

Curiosity Exploration Inventory

In our study we used the CEI (Curiosity Exploration Inventory) by T. Kashdan, P. Rose a F. Fincham (2004), which comprises of two dimensions: exploration (appetitive endeavor for novelty and challenges) and absorption (full engagement in specific activities). According to the authors´ study with adult population of college students (Kashdan et al., 2004), the CEI has good psychometric properties, is relatively unaffected by social desirability of respondents, is relatively independent on positive affects and has nomological network consistent with the theoretical framework.

This scale emerged as reaction to existing methods measuring curiosity. Though there is many clear evidence of the two interrelated components of curiosity: diversive appetitive motivation and flow-like engagement in activities (as postulated by Csikszentmihalyi, 1997), earlier questionnaires did not reflect these components in their items from several reasons. For example, STCI (State-Trait Curiosity Inventory; Spielberger, 1979) used items that in essence assess positive affect, such as “I am excited” and “I feel mentally alive”, which are states,

which are not unique for curiosity and can occur as the result of the wide scale of positive experience.

Another reason for unsatisfaction with existing methods was that prior attempts to measure curiosity have failed to address the breadth of the construct. Most measures have focused on different objects of curiosity including high-risk activities (e.g. Zuckerman's Sensation Seeking Scale) and effortful mental activities (e.g. Littman's and Spielberger´s Epistemic Curiosity Scale). The problem is that focusing on the objects of curiosity is different from focusing on the qualities of curiosity. An individual high in trait curiosity does not necessarily prefer and seek out novel situations that are high in physical risk and disinhibition or high in intellectual stimulation (Kashdan et al., 2004).

What object induces curiosity is largely based on individual differences in interests, expectations and prior knowledge. A number of measures use items that focus on domain-specific activities and stimuli (Ainley´s questionnaire, Spielberger´s State-Trait Curiosity Inventory, Zuckerman's SSS, etc.).

Two-dimensional approach of the authors of the CEI focuses on the defining features of curiosity rather than different objects that induce curiosity. To capture the proposed two core dimensions of curiosity, scale construction was guided by theoretical and empirical work on curiosity, appetitive motivation, and flow. In addition, all items are global, thereby avoiding the problem of domain specificity.

The Curiosity Exploration Scale is concise; it contains seven items, four of them load dimension of exploration and three load dimension of absorption, so it can be used also with children. Respondents answer at 7-point Likert-type scale and the score is added. After rephrasing of the items into 3rd person it can be used also for assessing by the second person. In case of version of the CEI for children we excluded item 4, which was phrased in negative way (reverse-scored) and thus was not sufficiently clear for this age category.

Methods

We explored psychometric properties of the Curiosity Exploration Inventory (Kashdan, Rose a Fincham, 2004). As the first step we adapted the scale from English language for the use in Slovak conditions. After translation of the scale the Slovak version was translated back to English by independent professional translator. Translated English version of the scale was sent to American authors for consulting, who approved our version

with minor modifications (Kashdan, personal correspondence, December 1, 2005). Original, as well as translated, versions are attached as appendix.

Research sample

Research sample constituted of 88 students of Faculty of Social Science and Health Care in Nitra and 157 children from two elementary schools of Zvolen district. Sample 1 were college students, majority of them comprised of social work students (N=68) and two-major psychology (N=20). Sample 2 constituted of pupils of 4th and 5th grade in elementary school (N=157). Women constituted majority of our college sample (N=80), there were only 8 men. In children sample there were 73 girls and 84 boys. Average age of Sample 1 was 22.59 years (SD=1.48), ranging from 20 to 28 years. Average age of all children ranged from 8.5 to 10.3 years, with average 9.31 (SD=0.37).

Students filled in the scale on one seminar together with other tests. Given their age, children filled in simplified version of CEI together, so that every item was read out loud and discussed before filling in. When analyzing reliability we had to exclude reverse-scored item number 4 (for more check Čavojová, 2005). Similarly, Kashdan (personal correspondence, December 1, 2005) found out in sample of Hong-Kong students that reverse-scored item did not have desired psychometric qualities.

Results

Data from the college sample and children sample were analyzed for reliability. Cronbach´s alpha ranged from 0.61 to 0.71 for CEI-Exploration, from 0.61 to 0.67 for CEI-Absorption and from 0.58 to 0.72 for total CEI score in both samples. Coefficients of internal consistency are somewhat lower but still acceptable for this kind of short scale, as asserts Kashdan et al. (2004). Average score of CEI items was slightly lower than is the middle of the scale (about 4 to 5 at 7-point Likert scale), with exception of item 6, where score was slightly lower (3.91).

Table 1: Descriptive statistics for CEI in individual samples

	Sample 1	***Sample 2***
Descriptive data		
N	88	157
Women	80	73

Men	8	84
Age		
M	22.84	9.31
SD	1.42	0.37
R	8	2
Exploration subscale		
M	20.58	15.71*
SD	3.963	3.828
α	0.71	0.61
Absorption subscale		
M	13.30	16.83
SD	2.976	4.154
α	0.61	0.67
Total score		
M	33.99	32.52*
SD	5.845	5.900
α	0.72	0.58

* Children have lower score in exploration factor, because item 4, which loaded this factor, was excluded on the base of our preceding findings (for more check Čavojová, 2005).

Exploratory factor analysis

To determine factor structure of the scale we used data from the sample of college students from Faculty of Social Science and Health Care in Nitra and from the sample of children from two elementary schools in Zvolen district. To figure out exploratory factor analysis we used statistic program SPSS 11.5.

To determine factors we used, similarly as authors of the scale (Kashdan et al., 2004), factor analysis with Oblimin rotation because of expected correlation of the factors (Szeliga, 2005). In the both samples we found out same two factors with eigenvalue exceeding 1.0, accounting for 59.4 % of total variance. The first factor (Exploration) accounted for 39.5 % of total variance and the second factor (Absorption) accounted for 19.9 % of total variance. Table 2 shows the factor loadings of individual items in sample of college students; table 3 shows children's data. Each item significantly loaded just one of the two factors and items-total correlations were acceptably high.

Table 2: Means, standard deviations, factor loadings and item-total correlations for the CEI in college students

CEI items	Factor Loading				
	Exploration	Absorption	M	SD	r

1. I would describe myself as someone who actively seeks as much information as I can in a new situation.	.683	.423	5.08	1.04	.55
2. When I am participating in an activity, I tend to get so involved that I lose track of time.	.444	.701	4.78	1.33	.52
3. I frequently find myself looking for new opportunities to grow as a person (e.g., information, people, and resources).	.821	.280	5.22	1.21	.58
4. I am *not* the type of person who probes deeply into new situations or things.	-.746	.028	4.97	1.64	.32[a]
5. When I am actively interested in something, it takes a great deal to interrupt me.	.064	.788	4.60	1.37	.31
6. My friends would describe me as someone who is "extremely intense" when in the middle of doing something.	.200	.814	3.91	1.27	.40
7. Everywhere I go, I am out looking for new things or experiences.	,686	,203	5,09	1,32	.41

Extraction method: Principal component analysis.

Rotation method: Oblimin with Kaiser's normalization.

a = item is reversed for correlation

Correlation between the CEI subscales r = .24, p < .05

Table 3: Means, standard deviations, factor loadings and item-total correlations for the CEI in elementary school children

CEI items	Factor loading				
	Exploration	Absorption	M	SD	r
1. When I meet with a new thing, I want to learn as much as possible about it.	.762	-.032	5.32	1.64	.23
2. When I do something, I usually get so involved that I lose track of time.	-.029	.756	5.60	1.90	.25
3. I often try to learn something new and ask many questions.	.665	.139	4.85	1.77	.28
5. When I am interested in something, it takes time to interrupt me.	,060	,741	5,50	1,79	.30
6. When I do something I enjoy, I am absolutely absorbed in it.	.201	.846	5.74	1.62	.49
7. Everywhere I go I am searching for new things to do or see.	.823	.088	5.51	1.68	.33

Extraction method: Principal component analysis.

Rotation method: Oblimin with Kaiser's normalization.

Correlation between the CEI subscales r = .01, p = ns.

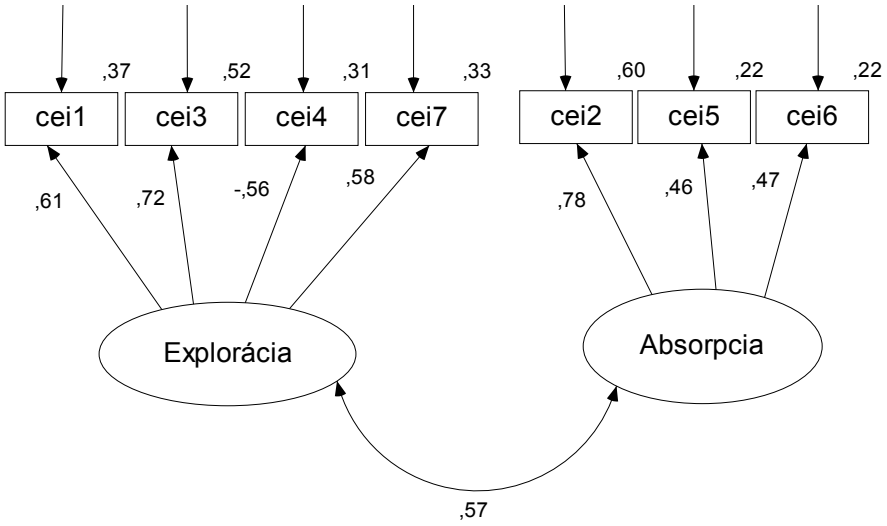
Confirmatory factor analysis

Similarly as Kashdan et al. (2004) we tested two models by means of confirmatory factor analysis. First model presumed that exploration and absorption are separate but correlated components of curiosity. Second model was one-factor model. We attempted to determine whether data confirmed two-factor or one-factor model of curiosity. Fit of the models with data were assessed by various indexes of fit proposed and used by many authors (Arbuckle, Wothke, 1999; Urbánek, 2000; Halama, 2001, 2002, 2005a, 2005b; Bollen, 1980; Kashdan et al., 2004). To figure out confirmatory factor analysis we used statistic program AMOS 6.0.

Results of confirmatory factor analysis in college sample are shown at the figure 1. The proposed two-factor model with exploration and absorption as separate but correlated components of curiosity fit the data very well, , χ^2 (13, *N*=88) = 17,91, p >.15; relative chi-square $\chi^{2/df}$ = 1.38; goodness-of-fit index (GFI) = .94, comparative fit index (CFI) = .95, root mean square of approximation (RMSEA) = .06.

Similarly as Kashdan et al. (2004), we tested whether a two-factor model was more appropriate than a unidimensional model. We used comparison procedure introduced by Bollen (1980). By comparing the hypothesized two-factor model to a model in which the zero order association between the two dimensions of curiosity is constrained to be one (thereby positing a single factor), two- and one-factor models can be compared directly by interpreting the change in chi-square (per change in *df*) as a chi-square statistic. When the association between exploration and absorption was constrained to unity, there was not an acceptable fit to the data, χ^2 (14, *N*=88) = 29,03, p = .01; $\chi^{2/df}$ = 2.07; GFI = .90, CFI = .84, RMSEA = .11. When comparing two presented models we achieved significantly higher fit of two-factor model with the data, χ^2 (1, *N* = 88) = 11.12, p < .001. Therefore, in agreement with previous studies with American population we note that the CEI measures two distinct but related components of curiosity.

Figure 1: Confirmatory factor analysis of the CEI (n=88); χ^2 (13, *N*=88) = 17,91, p = >.15; $\chi^{2/df}$ = 1.38; GFI = .94, CFI = .95, a RMSEA = .06, p_{CLOSE} = .32. Regression weights shown are standardized, and Item 4 was reverse scored prior to analysis.



Results of confirmatory factor analysis of above mentioned models in the children sample also support suitability of two-factor model with two separate, but related factors. In both models item 4 is excluded. Two-factor model fits the data well, χ^2 (8, *N*=137) = 12.25, p = .14; $\chi^{2/df}$ = 1.53; GFI = .97, CFI = .96, RMSEA = .06. Fit of the model, in which the relationship between exploration and absorption was limited to the value 1, was (as in case of college sample) not satisfactory, χ^2 (9, *N*=137) = 30.11, p = < .001; $\chi^{2/df}$ = 3.34; GFI = .93, CFI = .83, RMSEA = .13. When comparing two presented models we also achieved significantly higher fit of two-factor model with the data, χ^2 (1, *N* = 137) = 17.86, p < .001. We conclude that the CEI measures two distinct, but related components of curiosity in both samples of college students and school children.

Discussion

Our present study was a replication of Kashdan et al. (2004) Study 1 on reliability and structure of their measure of curiosity and exploration and our results confirm their findings. In both samples we confirmed the structure of the CEI with the two distinct but related components, exploration and absorption. In the study of Kashdan et al. (2004) two factors emerged with eigenvalues exceeding 1.0, accounting for 60.77 % of the variance, our results show the same pattern (59.4 % of total variance). We can observe similar pattern also when comparing α-coefficients. In the five samples of undergraduate students in the original study, α-coefficients ranged from .63 to .74 for Exploration factor compared with our .71 for the college sample and .61 for children sample (which was lower because of excluding of item 4 from the analysis). For Absorption factor α ranged from .66 to .73 in the samples of American

undergraduate students and it was .61 (college students) to .67 (children) in our two samples. α-coefficients for total score in our samples were somewhat lower (.58 to .72) than in the original study (.72 to .80). The lower value was in children sample, thus the further examination is needed.

Analysis showed that the two factor model is better than one factor model and this finding corresponds with Kashdan et al. (2004) results. The concept of the CEI seems to work in our population in the same way than in the American population.

In the present study we did not examined validity of the Curiosity Exploration Inventory in Slovak population, however, there are some results on this subject from the original authors of the CEI. Kashdan et al. (2004) examined convergent and discriminant validity of their measure. Results revealed that both Exploration and Absorption showed the strongest positive correlations with other curiosity measures, Openness to Experience, and slightly lower, albeit large correlations with domain-specific curiosity scales (i.e., sensation seeking, need for cognition), appetitive motivations, and activated positive affective states (p. 298). For discriminant validity, negligible relationships were found between Absorption and Exploration with the behavioral inhibition system, extrinsic motivation, and the Big Five factors Conscientiousness and Agreeableness. Although Absorption had no relationships, Exploration had small, although significant, negative relationships with indexes of global negative affect.

Because the Curiosity Exploration Inventory is still relatively new measure, especially in our conditions, there are still many questions concerning its psychometric properties and contribution to the field of psychology to be answered. However, available results indicate that the CEI is very promising tool for assessing such complicated construct as curiosity certainly is.

Conclusion

In the article we dealt with brief presentation of various approaches to curiosity and correspondent methods based on these approaches, which can be used in school setting also in our conditions. Although curiosity and related constructs (desire for knowledge, need for cognition, etc.) are very important in school environment, there are virtually no studies concerning this theme in our setting.

Our preliminary findings suggest that the CEI can be used also in Slovak conditions, it has satisfactory psychometric properties and it measures two meaningful, interrelated factors

of curiosity: exploration and absorption. Based also on our previous findings (Čavojová, 2005) it appears that it can be used (with minor modifications) also with children population from approximately 9 years of age.

Our ambition was to introduce various theoretical approaches to curiosity, which is still not thoroughly studied in Slovakia. Based on our research findings we incline, similarly as majority of curiosity researches, to the opinion that curiosity is multidimensional construct comprising at least from two interrelated factors of exploration and absorption. From the perspective of comparing these factors with the original factors of Ainley and Langevin we can conclude that exploration partially overlaps with breadth of interest curiosity (in terms of active seeking out impulses and stimulation), while absorption partially overlaps with depth of interest curiosity (in terms of engaging in the activity). However, we consider division of curiosity to exploration and absorption as more suitable, because it reflects also qualitative aspects of curiosity and these factors are independent on subject of curiosity. We attempted to enrich scientific knowledge of the empirical findings of our study, which confirm reliability of the CEI and its suitability in Slovak conditions and school environment. Also from this reason we consider studying the validity of presented scale as important. One of the possible fields of the future research is studying the relationship of curiosity with other constructs, such as creativity or school achievement of curious children. Interesting challenge would be studying curiosity in elder people.

Curiosity has relevance to nearly all facets of human functioning and opportunities for future research extend beyond psychology to areas such as business, education, politics, and journalism (Kashdan et al., 2004). Curiosity is a ubiquitous part of human's lexicon and daily experiences. Refinements in theory and measurement will increase the likelihood that curiosity is given its long overdue attention in basic and applied research.

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