MEDICAL EDUCATION ONLINE
2023, VOL. 28, 2198117
https://doi.org/10.1080/10872981.2023.2198117

Taylor & Francis
Taylor & Francis Group

RESEARCH ARTICLE

OPEN ACCESS Check for updates

Measuring an understudied factor in medical education – development and validation of the medical curiosity scale

Till Johannes Bugaj, Tim Alexander Schwarz, Valentin Terhoeven, Ede Nagy, Anna Cranz, Hans-Christoph Friederich and Christoph Nikendei

Department of General Internal Medicine and Psychosomatics, University of Heidelberg Medical Hospital, Heidelberg, Germany

ABSTRACT

Curiosity, which has been called the third pillar of academic achievement and positively predicts academic performance (von Stumm et al., 2011), is widely recognized as an important factor in acquiring knowledge and skills in medical training, and may be critical for students´ sound mental health. Medical educators have advocated that curiosity should play a more significant role in medical training and have criticized didactic barriers impeding student curiosity. However, in medical training, curiosity is understudied partly due to a lack of methods for measuring curiosity. Therefore, this study was designed to develop and validate a scale to measure medical curiosity. After reviewing the literature and interviewing a panel of experts (n = 7), 25 preliminary items assessing medical curiosity were developed and administered to n = 305 medical students (n = 163 female and n = 142 male) at Heidelberg University across all medical school years. Following exploratory factor analysis (EFA) with oblique (promax) rotation, we measured medical curiosity in a medical student sample. We have identified two distinct factors: intellectual medical curiosity (IMC) and social medical curiosity (SMC). IMC describes the desire to acquire medical knowledge for curiosity's sake, while SMC refers to curiosity about human nature and, in particular, patient health. Both factors showed good psychometric properties, with eigenvalues of 6.7 and 3.5, explaining 26.6% and 14.0% of the variance and internal consistencies of 0.796 and 0.866, respectively, and high convergent and discriminant validity. While first-year students showed significantly higher IMC scores than final-year medical students, SMC scores remained stable and tended to increase throughout medical school. This study has succeeded in developing the first scale to measure aspects of medical curiosity and, thus, lays the groundwork for future studies examining medical students' curiosity. A deeper understanding of medical students' curiosity can help to foster this curiosity effectively.

ARTICLE HISTORY
Received 11 August 2022
Revised 2 November 2022
Accepted 2 February 2023

KEYWORDS
Curiosity; epistemic curiosity; medical school; medical studies; medical student; mental health; empathy; questionnaire; scale; instrument

Introduction

Curiosity plays a central role in how we spend our everyday lives. It influences the news we follow, the books we read, which people we choose to spend time with, and which topics engage our interest [1]. While curiosity research has a long history in psychology [2,3], Daniel Berlyne [4] laid the foundation for much of the modern research in the field. Berlyne described curiosity as the uniquely 'need to know' [5] innate to human nature. Curiosity research has thrived in recent decades, complementing the growing body of research on personality and its effects on human behavior [6,7]. The term curiosity covers several dimensions, which can be roughly divided into two categories: Firstly, intellectual curiosity (IC), also called epistemic (EC), or academic curiosity, refers to a person's desire to further their education and expand their knowledge [8]. Secondly, social [9] or interpersonal curiosity [10] describes the motivation to learn new information on human behavior.

Curiosity has been found to impact medical training in several ways. It is positively linked to memory [11], recall [12], and predicts test accuracy; the more curious participants were about a test question, the better they performed on it [13]. In addition, curiosity has been associated with positive indicators of mental and emotional well-being [14,15]. Moreover, curiosity may be critical for sound mental health [16]. It is established that medical students need to be fast learners in a field characterized by heavy workload and rigorous exams. Unfortunately, it is also acknowledged that this leaves a toll on students' mental health, with burnout and depression rates consistently higher in medical students than in other student samples [17]. Thus, the effects of curiosity on learning and mental health are particularly noteworthy [18], (under review).

CONTACT Till Johannes Bugaj Till.Bugaj@med.uni-heidelberg.de Department of General Internal Medicine and Psychosomatics, University Hospital Heidelberg, Im Neuenheimer Feld 410, Heidelberg D-69120, Germany

Many medical educators have emphasized the importance of curiosity in becoming and remaining a good physician and have criticized didactic barriers, such as a narrow curriculum that focuses on easily verifiable facts and leaves very little room for students to think outside the box of medical science, hence impeding curiosity in medical training [19–21]. However, while curiosity research has flourished in the field of psychology, medical education seems to have overlooked curiosity's potential. To date, only one study has quantified medical students' curiosity. It concludes that medical teaching may not adequately cultivate students' curiosity and calls for further research [22]. That study used a general curiosity inventory, although contextual attribute measures are preferable to general measures when examining a specific domain, such as curiosity in the medical field [7,23]. The absence of a good instrument to measure medical curiosity could be a possible reason for the gap between faculty members' appreciation of the role of curiosity in medical training and the lack of research in the medical field.

This study aimed to address this gap and to develop a scale measuring curiosity in the medical setting. In the future, this scale could be used to assess what facilitates and what hinders curiosity in medical teaching.

Methods

Development of the medical curiosity scale (MCS)

In a first step, the authors reviewed existing scales of curiosity. For this the authors searched pubmed ('curio*[Title/Abstract] AND ("Personality Inventory"[Mesh] OR "Personality Tests"[Mesh] OR scale OR questionnaire OR inventory)') and google scholar ('allintitle: curiosity AND scale OR questionnaire OR inventory OR measurement OR instrument'), identified relevant studies and then additionally considered the curiosity measurements mentioned therein.

The preliminary items for the MCS scale were developed in 4 iterative steps:

1) The authors of the study jointly designed an initial pool of items consisting of:
   a. 45 items, aiming to assess different facets of curiosity in a medicine-specific context.
   b. All ten items of the I/D-type Epistemic Curiosity Scale (ECS) [24] adapted for the medical context, all five items of the General Social Curiosity (GSC) subscale of the Social Curiosity Scale [9] and all five items of the Curious About Emotion (CAE) subscale of the Interpersonal Curiosity Scale [10])
2) All items were assessed by an expert panel (n = 7 medical training and medical education professionals, i.e., physicians and psychologists). These experts judged individual items on what personality trait they were assessing and whether they were appropriate for the aim of this study. The experts could also recommend changes to the items.
3) On this basis, the authors of the study decided in joint discussions which items would finally be used for the preliminary scale. This led to the selection 18 self-designed items, and seven items from other scales (three adapted items from the ECS, four from the CAE).
4) These items were again presented to the experts for final authorization.

Instruments

The authors administered four curiosity scales alongside the MCS to measure convergent and discriminant validity (see Table 1). All items were rated on a 7-point Likert Scale ('strongly disagree', 'disagree', 'rather disagree', 'neutral', 'rather agree', 'agree', 'strongly agree').

Procedure and ethical considerations

All study participants were medical students at the University of Heidelberg. Students were approached in groups of approximately n = 20 after seminars and asked to participate voluntarily. All participants were informed about the study's purpose and gave written informed consent before completing the instruments. Refusal to participate did not impact medical training or assessment. The study protocol was approved by the Ethics Committee of the University of Heidelberg (ethics application no. S-592/2019) and conducted following the Declaration of Helsinki [29].

Data analysis

The data were analyzed using IBM SPSS Statistics for Macintosh, version 25.0. The data analysis was performed in two parts:

(1) Factor analysis of the preliminary MCS (25 items): Before factor analysis, skewness and kurtosis scores were calculated to determine whether items needed to be removed. In addition, a Little's MCAR test was performed to assess the distribution of missing responses. Next, the Kaiser-Meyer-Olkin criterion was calculated to confirm that the data were suited for factor analysis. Then, an exploratory factor analysis (EFA) with oblique (promax) rotation was performed. Finally, the internal consistency of the scales was determined using Cronbach's alpha.

Table 1. Curiosity measurements used for the preliminary items of the MCS or administered alongside the MCS.

Instrument	Description	Usage
I/D-type Epistemic Curiosity Scale (ECS)	This ten-item-scale [25] divides EC into interest- (ECS-I) (α = 0.75) and deprivation-type (ECS-D) (α = 0.8) (German translation [24]). Type I EC reflects broad curiosity and imagination, while Type D EC indicates perseverance and is more strongly associated with conscientiousness.	Used adapted items for the preliminary MCS (three items), **administered to study sample (ten items)**
Curiosity and Exploration Inventory (CEI)	The CEI (α = 0.72–0.8) [14] consists of seven items. It is divided into CEI-Exploration (CEI-E) and CEI-Absorption (CEI-A) dimensions. The German translation was published by Renner [9]. The CEI-E measures individual differences in the predisposition to explore, while the CEI-A focuses more on the tendency to experience flow states.	**Administered to study sample (seven items)**
HEXACO – Openness to Experience (OE)	OE is a subcategory of the HEXACO-60 [26] measuring the Big-Five personality traits. The German version ([27] consists of ten items addressing curiosity regarding various themes, e.g., "I'm interested in learning about the history and politics of other countries" or "I find it boring to discuss philosophy" (negatively rated). Its Cronbach's α is 0.75 [28].	**Administered to study sample (ten items)**
General Social Curiosity subscale (GSC)	GSC is a subscale of the Social Curiosity Scale (α = 0.82) [9] which measures curiosity regarding other people. It correlates significantly with trait curiosity, extraversion, and social competence and negatively with social anxiety.	**Administered to study sample (five items)**
Curious About Emotion subscale (CAE)	The CAE subscale of the IPCS (α = 0.76–0.81) was not administered alongside the MCS. However, four items from this scale were translated and used as preliminary items of the MCS as the wording suited the medical context. It correlates slightly with extraversion [10].	Used items for the preliminary MCS only (four items) – **not administered to study sample!**

(2) Study of convergent and discriminant validity of the MCS: Analysis of the correlations with the other scales in use (4 scales, 32 items).
(3) Results

Out of the $n = 330$ approached students, $n = 305$ ($n = 163$ female, $n = 142$ male) completed and returned the questionnaire, resulting in a response rate of 92.4%. This corresponds to a number of 12 participants per variable with regard to the factor analysis carried out, which can therefore be regarded as rather robust [30]. First- to sixth-year students were included in the study and grouped according to their medical school stage. Therefore, $n = 85$ preclinical students (1st- and 2nd-year students), $n = 147$ clinical students (3rd- to 5th-year students), and $n = 73$ final-year students (6th-year students) participated in the study (see Table 2 for more details). See Nikendei et al. [31] for a more detailed description of the German medical school curriculum. The mean age of participants was 24.0 years, with a standard deviation of 4.0 years. $N = 12$ participants did not report their age.

Preparation for factor analysis

Regarding the factor analysis of the preliminary 25-item MCS, all items had an internal consistency of 0.883. Overall, only eleven of 7625 answers were missing (0.14%), and per item, at maximum, two out of 305 responses were missing (0.7%). Little's MCAR test was not significant (0.536), indicating that the missing responses were randomly distributed; consequently, the data were excluded pairwise. As shown in Table 3, the omission of items did not increase Cronbach's alpha. There was a tendency towards affirmative answers with item means ranging from 4.69 to 6.13 on a 7-point scale. However, skewness was less than 2, indicating that the items did not deviate significantly from a normal distribution. Kurtosis values were less than 10, the highest being 3.3; thus, no item had to be dropped before factor analysis. The Kaiser-Meyer-Olkin criterion was 0.876, indicating a good factor analysis fit.

Exploratory factor analysis

The EFA revealed five factors with eigenvalues of 6.7, 3.5, 1.4, 0.79, 0.71, explaining 26.6%, 14.0%, 5.5%, 3.2% and 2.9% of the variance in the results. Applying the scree test [32] revealed that a two-factor solution best describes the underlying factors. This resulted in $n = 15$ items loading on factor I and $n = 10$ on factor II. None of the items loaded significantly (>0.4) on both factors. The five items

Table 2. Number of students (per year) who were approached for the study and the response rate.

Stage	Year	Approached	Participated	Response Rate
Preclinical	1	33	31	93.94%
	2	54	54	100.00%
Clinical	3	36	35	97.22%
	4	53	41	77.36%
	5	81	71	87.65%
Final Year	6	73	73	100.00%
	Total	**330**	**305**	**92.42%**

Table 3. Descriptive statistics of all 25 preliminary items prior to factor analysis.

Item	N	Mean	SD	Skew	Kurtosis	Corrected item-total correlation	α if item is deleted
01	303	6.13	0.84	−1.32	3.32	0.516	0.879
02	304	5.76	1.26	−1.45	2.62	0.376	0.881
03	303	5.51	1.14	−0.98	1.55	0.596	0.876
04	304	5.52	1.34	−1.02	0.77	0.435	0.880
05	304	5.83	1.05	−0.90	0.79	0.464	0.879
06	305	5.46	1.18	−1.03	1.70	0.455	0.879
07	305	5.50	1.05	−0.66	1.02	0.537	0.877
08	305	5.12	1.35	−0.66	0.24	0.493	0.878
09	305	5.68	0.98	−0.71	1.55	0.556	0.877
10	304	5.59	1.26	−0.78	0.11	0.298	0.883
11	305	4.34	1.57	−0.18	−0.67	0.457	0.880
12	305	5.39	1.18	−1.02	1.33	0.471	0.879
13	305	5.89	0.93	−1.00	1.72	0.496	0.879
14	305	5.64	1.13	−1.08	1.57	0.363	0.881
15	304	5.67	0.93	−0.55	0.43	0.604	0.876
16	305	5.64	1.22	−1.20	1.88	0.422	0.880
17	305	5.87	1.06	−1.35	2.90	0.560	0.877
18	304	5.86	1.02	−0.79	0.65	0.480	0.879
19	305	4.24	1.67	−0.31	−0.82	0.483	0.879
20	305	5.78	1.02	−0.96	1.60	0.264	0.883
21	305	5.74	1.00	−0.64	0.35	0.491	0.879
22	305	4.70	1.39	−0.39	−0.35	0.478	0.879
23	305	4.77	1.43	−0.44	−0.24	0.500	0.878
24	305	4.72	1.40	−0.42	−0.07	0.434	0.880
25	305	4.69	1.39	−0.50	−0.12	0.351	0.882

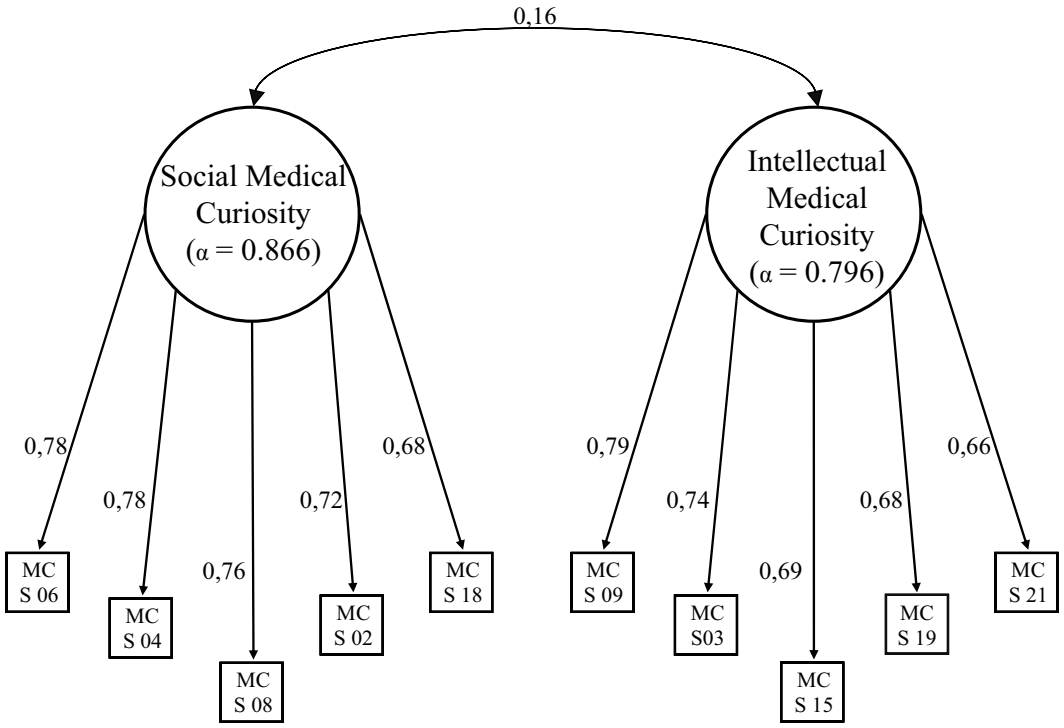

Figure 1. Correlation of SMC and IMC and the factor loadings of the final items.

with the strongest loadings on each factor were retained (see Figure 1. Factor I in the two-factor solution explains 28.5% of the variance, factor II 15.6%. The correlation of the factors with each other was 0.16. The factor I consisted of items that inquire about intellectual curiosity, characterized by the best loading item *'I've got strong intellectual curiosity about medical topics.'* Therefore, this factor was called **'Intellectual Medical Curiosity' (IMC)**. The item *"I am interested in patients' life stories"* loaded the strongest on factor II. This reflects the rating of sympathy and patient interest; thus, this factor was named **'Social Medical Curiosity' (SMC)**. Table 4 shows the final items, with an English translation. The internal consistencies of the scales were good, with Cronbach's alpha of 0.796 (IMC) and 0.866 (SMC), respectively.

Table 4. Final items (n = 10) for SMC and IMC after factor analysis with an English translation.

German Item	English translation
Social Medical Curiosity	
MCS02 Am Arztberuf interessiert mich die Begegnung mit Menschen.	Interacting with people is what interests me about being a doctor.
MCS18 Ich versuche die Gefühle anderer Menschen zu verstehen.	I try to understand other people's feelings.
MCS04 Ein wichtiger Grund, warum ich mich für das Medizinstudium entschieden habe, ist die Tatsache, dass ich mich für Menschen interessiere.	Being interested in people is an important reason why I chose to study medicine.
MCS06 Die Lebensgeschichten von Patienten interessieren mich.	I am interested in patients' life stories.
MCS08 Hinter jeder Erkrankung interessiert mich die betroffene Person.	I am interested in the person behind every medical condition.
Intellectual Medical Curiosity	
MCS03 Es macht mir Spaß, so viel Medizinisches wie möglich zu lernen.	I enjoy learning as much about medicine as possible.
MCS09 Meine Wissbegierde bezüglich medizinischer Themen ist stark ausgeprägt.	I've got strong intellectual curiosity about medical topics.
MCS15 Medizinische Themen fesseln mich.	I am fascinated by medical topics.
MCS19 Würde ich alle Fragen einer Prüfung kennen, würde ich aus purer Neugier trotzdem darüber hinaus lernen.	Even if I knew all the questions on an exam, I would still study past them out of sheer curiosity.
MCS21 Mir ist es äußerst wichtig, medizinische Zusammenhänge tiefgreifend zu verstehen.	I care deeply about understanding medical issues.

Convergent and discriminant validity

Table 5 depicts the correlations of IMC and SMC with the other administered curiosity inventories. IMC correlated moderately with the CEI (0.42) and ECS (0.41), indicating high convergent validity. CEI and ECS were the scales most congruent with intellectual curiosity. At the same time, IMC was only weakly associated with the GSC (0.13) and did not correlate with OE. As the GSC measures social curiosity and OE measures curiosity in various non-medical contexts, this was a sign of discriminant validity of the IMC. SMC correlated moderately with the GSC (0.65) and weakly with OE (0.14) and ECS-I (0.13). The moderate correlation with the GSC showed convergent validity, as both scales measure social curiosity. IMC and SMC were weakly correlated, suggesting that they had underlying commonalities – a curiosity in the context of medicine – yet measured different concepts. The low correlation between those two factors was insufficient to calculate a combined rating of both scales.

IMC and SMC scores in medical students

Table 6 displays the IMC and SMC scores of the students. Figure 2 shows IMC and SMC by the students' phase in medical school. Students in the preclinical phase scored significantly higher ($p < 0.05$) on IMC than last-year students. There were no statistically significant differences regarding the medical school stage and SMC. The age or gender of the students had no statistically significant influence on IMC or SMC.

Discussion

The authors aimed to develop the first scale to measure context-specific curiosity in medical students, the Medical Curiosity Scale (MCS). For this purpose, $n = 25$ preliminary items were created and administered to $n = 305$ students. Exploratory factor analysis revealed two correlated but distinct dimensions, Intellectual Medical Curiosity (IMC) and Social Medical Curiosity (SMC). The five best loading items were retained. IMC describes the need to acquire new medical knowledge and to continue professional development. In parallel, SMC describes curiosity directed toward human behavior, especially concerning patient health. The internal consistency of the scales was good.

IMC correlated moderately with other scales measuring intellectual curiosity, which showed good convergent validity. Furthermore, the lack of correlation with OE indicates discriminant validity. The OE items address curiosity across a wide range of topics, such as '*If I had the opportunity, I would like to attend a classical music concert*' or '*I have never really enjoyed looking through an encyclopedia*' (negatively

Table 5. Correlation of all curiosity assessments administered.

	IMC	SMC	OE	CEI	CEI-E	CEI-A	ECS	ECS-I	ECS-D	GSC
IMC	1	.163**	0.049	.420**	.275**	.372**	.414**	.319**	.376**	.127*
SMC	.163**	1	.136*	0.092	0.104	0.034	0.054	.132*	-0.010	.648**
OE	0.049	.136*	1	.279**	.220**	.128*	.296**	.533**	0.091	.305**
CEI	.420**	0.092	.279**	1	.519**	.835**	.574**	.459**	.508**	.151**
CEI Exploration	.275**	0.104	.220**	.519**	1	.369**	.464**	.402**	.393**	.234**
CEI Flow	.372**	0.034	.128*	.835**	.369**	1	.455**	.262**	.459**	0.048
ECS	.414**	0.054	.296**	.574**	.464**	.455**	1	.737**	.922**	.190**
ECS I	.319**	.132*	.533**	.459**	.402**	.262**	.737**	1	.417**	.296**
ECS D	.376**	-0.010	0.091	.508**	.393**	.459**	.922**	.417**	1	0.078
GSC	.127*	.648**	.305**	.151**	.234**	0.048	.190**	.296**	0.078	1

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

Table 6. Average IMC and SMC scores by year and med-school stage.

	Year / Stage	1	2	Preclinical total	3	4	5	Clinical total	6
IMC	**N**	31	52	83	34	41	71	147	72
	Mean	5.50	5.66	5.60	5.41	5.40	5.28	5.34	5.15
	SD	0.73	0.80	0.78	0.86	0.82	0.95	0.89	0.89
SMC	**N**	31	53	84	34	41	71	146	73
	Mean	5.45	5.48	5.47	5.57	5.58	5.51	5.54	5.63
	SD	1.19	0.87	0.99	1.18	0.95	1.03	1.04	0.93

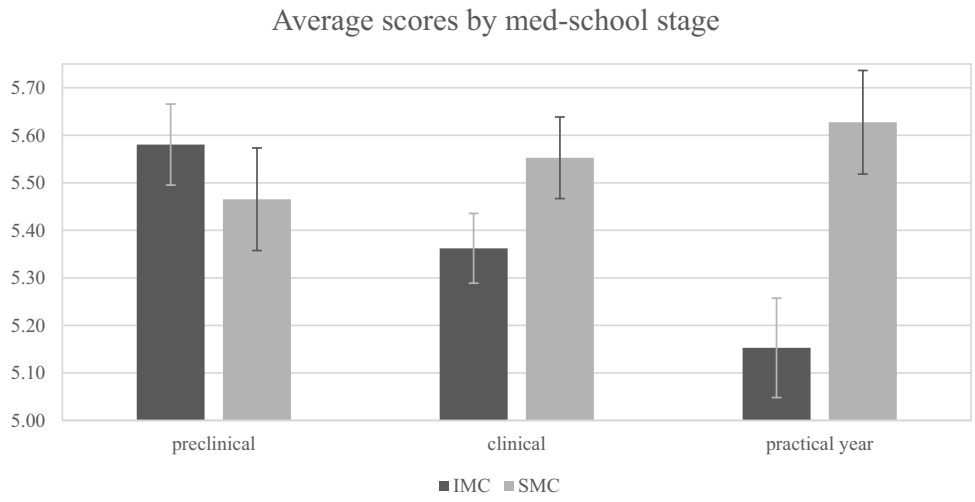

Figure 2. Visual representation of the average SMC and IMC scores by med-school stage.

rated). Although this may reflect curiosity in general, it does not indicate context-specific curiosity. Accordingly, intellectual curiosity scales (CEI, ECS) assessing context-independent curiosity were highly congruent with OE [14,24], while, in contrast, IMC was not correlated as it measures medicine-specific intellectual curiosity.

SMC was associated with the only scale measuring social curiosity which indicated convergent validity. However, the mixed correlations with the other curiosity scales showed no clear direction. Even if there is a difference between social curiosity in the medical context and (intellectual) curiosity in general, SMC was expected to measure a different aspect of the same trait. Consequently, low correlations with the other scales were expected. Future research should explore the relationship between SMC and other constructs of curiosity and non-curiosity in greater detail.

This was the first study to develop a context-specific scale measuring medical curiosity and only the second study assessing medical students' curiosity. The first study [22] showed that Canadian medical students' curiosity was stable across a four-year curriculum using the Melbourne Curiosity Inventory. This study now provides a more detailed examination of students' curiosity.

Final-year medical students scored significantly lower on the IMC than first- and second-year students. A possible explanation for this result could be that students experience intellectual fatigue during their studies. Students likely chose to enroll in medical school because they were curious about medical science. However, some aspects of medical school teaching or examinations may discourage them along the way. Medical students already show signs of burnout in their final year, with 20% of interviewees surpassing clinical burnout cutoffs Koehl-Hackert et al., [35]. Another explanation could be that medical students' curiosity has become saturated at the end of their medical studies. While at the beginning there is still a wide wealth of knowledge to be learned, this decreases from year to year. As research generally suggests that people become more interested in a subject the longer they engage with it, this is particularly concerning [33]. However, this also echoes many medical educators' concerns that medical teaching may stifle curiosity rather than encourage it [21,22]. Further studies are needed to explore this in more detail.

Research on psycho-social emotions such as empathy, with which SMC has conceptual overlap, suggests that empathy decreases during medical school [34]. In contrast, SMC remained stable and showed a slight increase from the preclinical phase to the final year in this study. One might theorize that the sequential increase of student-patient interaction during medical school may at least stabilize, if not increase, SMC scores. First-year medical students might begin medical school driven by intellectual curiosity, having had little previous interaction with patients. Additionally

in Germany, patients mostly remain textbook cases' in the first two years. However, this changes in the third year of medical school when various methods of patient-centered learning are introduced, e.g., bedside teaching, encouraging students to become more curious about patients' behavior and developing their understanding of the psycho-social component of being a medical professional. In their final year of study, medical students work full-time in a clinical setting with daily face-to-face contact with patients. It is likely that these interactions positively impact medical students' SMC. Further research is needed to analyze the relationship between SMC and other psycho-social emotions, such as empathy, and to assess whether and how teaching methods affect medical students' SMC.

Limitations

The students' IMC and SMC scores revealed interesting results. However, only the difference in IMC between preclinical and practical year students was statistically significant. Further examination in larger samples may be needed to determine the differences in students' curiosity at different stages of medical school. Besides, due to the cross-sectional design of this study, causal relationships cannot be inferred. Therefore, prospective studies examining IMC and SMC of a single cohort of students throughout medical school are needed to compare and analyze medical curiosity comprehensively. In addition, future studies should examine which factors influence medical students' IMC and SMC, such as teaching methods.

Conclusions

This study developed and validated the MCS to assess medical students' medical curiosity. Factor analysis revealed that IMC and SMC are distinct but related domains with good psychometric properties. Our results showed that students' IMC scores decreased significantly during medical training: the final year students examined reported lower IMC scores than the first-year students. Interestingly, SMC scores did not show significant differences but tended to increase during medical school. Our scales and results highlight opportunities and shortcomings in medical training by opening the possibility of examining curiosity in medical school more closely in the future. The MCS is the first scale to assess medical curiosity. It therefore opens up the possibility of assessing specific teaching practices or entire curricula in terms of how they influence students' curiosity – positively or negatively. Furthermore, the MCS could be the starting point for targeted interventions to promote curiosity in medical students.

Acknowledgment

For the publication fee we acknowledge financial support by Deutsche Forschungsgemeinschaft within the funding programme, "Open Access Publikationskosten" as well as by Heidelberg University.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work has not had any external funding. Dr. med Till Johannes Bugaj was funded by the Physician-Scientist program of the Heidelberg Faculty of Medicine.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

ORCID

Till Johannes Bugaj http://orcid.org/0000-0001-8287-2635

References

[1] von Stumm S, Hell B, Chamorro-Premuzic T. The hungry mind: intellectual curiosity is the third pillar of academic performance. Perspectives Psychol Sci. 2011;6(6):574–588.
[2] James W. The principles of psychology. Vol. 1636. New York: American Science Series; 1890.
[3] Pavlov IP (1927). *Conditioned reflexes: An investigation of the physiological activity of the cerebral cortex*. Oxford Univ. Press. (pp. xv, 430).
[4] Berlyne DE. A theory of human curiosity. Br J Psychol General Sec. 1954;45(3):180–191.
[5] Berlyne DE. Conflict, arousal, and curiosity. McGraw-Hill Book Company; 1960; DOI:10.1037/11164-000.
[6] Arnone MP, Grabowski BL, Rynd CP. Curiosity as a personality variable influencing learning in a learner controlled lesson with and without advisement. Educ Technol Res Dev. 1994;42(1):5–20.
[7] DeGroot T, Kluemper D. Evidence of predictive and incremental validity of personality factors, vocal attractiveness and the situational interview. Int J Sel Assess. 2007;15(1):30–39.
[8] Grossnickle EM. Disentangling curiosity: dimensionality, definitions, and distinctions from interest in educational contexts. Educ Psychol Rev. 2016;28(1):23–60.
[9] Renner B. Curiosity about people: the development of a social curiosity measure in adults. J Pers Assess. 2007;87:305–316.
[10] Litman J, Pezzo M. Dimensionality of interpersonal curiosity. Pers Individ Differ - PERS INDIV DIFFER. 2007;43:1448–1459.
[11] McGillivray S, Murayama K, Castel AD. Thirst for knowledge: the Effects of curiosity and interest on

memory in younger and older adults. Psychol Aging. 2015;30(4):835–841.
[12] Gruber MJ, Gelman BD, Ranganath C. States of curiosity modulate hippocampus-dependent learning via the dopaminergic circuit. Neuron. 2014;84(2):486–496.
[13] Wade S, Kidd C. The role of prior knowledge and curiosity in learning. Psychon Bull Rev. 2019;26:1377–1387.
[14] Kashdan TB, Rose P, Fincham FD. Curiosity and exploration: facilitating positive subjective experiences and personal growth opportunities. J Pers Assess. 2004;82(3):291–305.
[15] Park N, Peterson C, Seligman MEP. Strengths of character and well-being. J Soc Clin Psycho. 2004;23(5):603–619.
[16] Gallagher MW, Lopez SJ. Curiosity and well-being. J Posit Psychol. 2007;2(4):236–248.
[17] Erschens R, Keifenheim KE, Herrmann-Werner A, et al. Professional burnout among medical students: systematic literature review and meta-analysis. Med Teach. 2019;41(2):172–183.
[18] Schwarz TA, Nikendei C, Cranz A, et al. An untapped potential: curiosity in medical education. 2023.
[19] Bugaj TJ. Did medical curiosity kill the cat?Vol. 7. MedEdPublish; 2018. DOI:10.15694/mep.2018.0000161.1
[20] Burke AE, Benson B, Englander R, et al. Domain of competence: practice-based learning and improvement. Acad Pediatr. 2014;14(2 Suppl):S38–54.
[21] Fitzgerald FT. Curiosity. Ann internal med. 1999;130(1):70.
[22] Sternszus R, Saroyan A, Steinert Y. Describing medical student curiosity across a four year curriculum: an exploratory study. Med Teach. 2017;39(4):377–382.
[23] Heggestad ED, Gordon HL. An argument for context-specific personality assessments. Ind Organ Psychol. 2008;1(3):320–322.
[24] Litman JA, Mussel P. Validity of the interest-and deprivation-type epistemic curiosity model in Germany. J Individ Differ. 2013;34(2):59–68.
[25] Litman JA. Interest and deprivation factors of epistemic curiosity. Pers Individ Dif. 2008;44(7):1585–1595.
[26] Ashton M, Lee K. The HEXACO-60: a short measure of the major dimensions of personality. J Pers Assess. 2009;91(4):340–345.
[27] *The HEXACO Personality Inventory—Revised*. (2022, August 9). Hexaco.Org. Available from: http://hexaco.org/hexaco-inventory
[28] Moshagen M, Hilbig B, Zettler I. Faktorenstruktur, psychometrische Eigenschaften und Messinvarianz der deutschsprachigen Version des 60- Item HEXACO Persönlichkeitsinventars. Diagnostica. 2014;60:86–97.
[29] World Medical Association. World medical association declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA. 2013;310(20):2191–2194. doi: 10.1001/jama.2013.281053.
[30] Kyriazos TA. Applied psychometrics: sample size and sample power considerations in factor analysis (efa, CFA) and SEM in general. Psychology. 2018;9:2207–2230.
[31] Nikendei C, Weyrich P, Jünger J, et al. (2009). Medical education in Germany.
[32] Cattell RB. The scree test for the number of factors. Multivariate Behav Res. 1966;1(2):245–276.
[33] Bornstein RF. Exposure and affect: overview and meta-analysis of research, 1968–1987. Psychol Bull. 1989;106(2):265–289.
[34] Neumann M, Edelhäuser F, Tauschel D, et al. Empathy decline and its reasons: a systematic review of studies with medical students and residents. Acad Med. 2011;86(8):996–1009.
[35] Koehl-Hackert N, Schultz JH, Nikendei C, Möltner A, Gedrose B, van den Bussche H, Jünger J. Belastet in den Beruf - Empathie und Burnout bei Medizinstudierenden am Ende des Praktischen Jahres [Burdened into the job – final-year students' empathy and burnout]. Z Evid Fortbild Qual Gesundhwes. 2012;106(2):116-24. German. doi: 10.1016/j.zefq.2012.02.020.