

# A German-language competency-based multisource feedback instrument for residents: Development and validity evidence

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## Research article

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# Abstract

## Background

In medical settings, multisource feedback (MSF) is a recognised method of formative assessment. It collects feedback on a doctor's performance from several perspectives in the form of questionnaires. Yet, no validated MSF questionnaire has been publicly available in German. Thus, we aimed to develop a German MSF questionnaire and investigate the evidence of its validity.

## Methods

We developed a competency-based MSF questionnaire in German, informed by the literature and expert input. Four sources of validity evidence were investigated: (i) Content was examined based on MSF literature, blueprints of competency, and expert-team discussions. (ii) The response process was supported by analysis of a think-aloud study, narrative comments, "unable to comment" ratings and evaluation data. (iii) The internal structure was assessed by exploratory factor analysis, and inter-rater reliability by generalisability analysis. Data was collected during two runs of MSF, in which 47 residents were evaluated once (first run) or several times (second and third run) on 81 occasions of MSF. (iv) To investigate consequences we analysed the residents' learning goals, self-reported changes, and the progress reported via MSF.

## Results

Our resulting MSF questionnaire (MSF-RG) consists of 15 items and one global rating, which are each rated on a scale and accompanied by a field for narrative comments and cover a construct of a physician's competence. Additionally, there are five open questions for further suggestions. Investigation of validity evidence revealed: (i) The expert group agreed that the content comprehensively addresses clinical competence; (ii) The response processes indicated that the questions are understood as intended and supported the acceptance and usability; (iii) For the second run factor analysis showed a one-factor solution and a Cronbach's alpha of 0.951 and an inter-rater reliability of 0.797 with 12 raters; (iv) There are indications that residents benefitted, considering their individual learning goals, their self-reported changes, and based on their progress reported via MSF itself.

## Conclusions

To support residency training with multisource feedback, we developed a German MSF questionnaire (MSF-RG), which is supported by four sources of validity evidence. This MSF questionnaire may be useful to implement MSF in residency training in German-speaking regions.

# Background

Feedback is one of the most important components of effective learning (1–3). In particular, feedback can effectively support medical training by making individuals aware of gaps in knowledge or insufficient skills (4–6) and thus guide learning. Medical training should therefore include learning with the help of feedback, e. g. through workplace-based assessment.

There are several methods of workplace-based assessment: Mini-CEX (7) and DOPS (8) are two examples which focus on one occasion with a patient encounter or one skill rather than on the overarching performance. By contrast, multisource feedback (MSF) can cover competencies, e.g. from the CanMEDS framework (9), over a longer period of time and provides feedback from several perspectives (10, 11), resulting in meaningful feedback in the setting of competency-based training.

Typically, MSF consists of feedback given to a trainee by several raters via structured questionnaires. Raters can come from the groups of peers, supervisors, medical and non-medical co-workers, and patients, and their written feedback is often transferred to and discussed in a conversation with the feedback recipient (6, 12–16). MSF can promote medical training in the long term by providing regular feedback and supporting the formulation of individual learning goals (6, 11).

There are several, mainly English-language, instruments for implementing MSF, which are used for a broad variety of purposes (17–24). These vary not only in terms of the physicians' discipline and expertise but also with respect to the aim of the assessment. While in many settings, MSF is used for formative purposes, some regions have made it a mandatory part of the

certification or re-certification process. Such instruments include mini-PAT for formative assessment during Foundation training in the UK (17), the Sheffield Peer Review Assessment Tool (SPRAT) for more senior physicians such as consultants and specialist registrars in paediatrics in the UK (18, 19), the Peer Assessment Review (PAR), which was initially used for family physicians in Canada (20) and later adapted for the certification of surgeons there (21), the Ottawa Clinic Assessment Tool for surgical residents working in outpatient clinics in Canada (22), the INCEPT for physician appraisal in the Netherlands (23), and the CEFP 360, which has been investigated for the process of revalidation for general practitioners in the UK (24).

It has been described that in order to clearly understand a questionnaire, it is important that it is administered in the respondent's native language (25). However, to date, there are no validated instruments for carrying out MSF for residents in the German language. The availability of an MSF instrument in the German language could support the wider use of MSF in the German-speaking countries. In the framework of the present study, we therefore developed a German-language MSF questionnaire and examined the evidence of its validity.

To assess the validity of an instrument, different sources of validity evidence can be sought (26–29). For the purpose of the present study, we chose to investigate the criteria of validity proposed by Messick (28), as described by Cook and Beckman (26). The latter authors define the following five sources of evidence: Content: Does the instrument represent the construct? Response process: Relation between intended construct and the thoughts of users; Internal structure: Reliability and factor structure; Relation to other variables which measure the same construct; and Consequences: What are the intended and unintended consequences of using this instrument? In the present study, we explore four of these sources (content, response process, internal structure and consequences) with respect to the developed German-language competency-based MSF instrument.

## Methods

### Context of our study

The instrument was developed and employed at the surgical clinic of the University Children's Hospital Zurich. Participation in MSF is a mandatory part of the training for all residents in the surgical clinic. For implementation we took into account the literature on MSF in medical training and followed the described best practice (13–16, 30–36) as far as possible and appropriate. In our study, for every resident, feedback was obtained from usually 12 raters. These could be chosen by each resident from a pool of trained persons following a specific composition: four consultant paediatric surgeons, four residents, three nurses from the ward, two nurses from theatre, two consultant anaesthesiologists. We deliberately left out patients from the group of raters in this study as they would have needed another version of the questionnaire. Feedback was collected and anonymously transmitted to the resident within a structured feedback conversation led by a trained supervisor. The MSF questionnaire was administered as an online questionnaire using the online platform SurveyMonkey ([surveymonkey.com](https://www.surveymonkey.com)). Furthermore, residents also completed a self-assessment on the same items included in the MSF questionnaire. In the feedback conversation, the results of this self-assessment were compared and contrasted with the feedback provided by the raters via the MSF questionnaires. This eventually provided the basis for the formulation of learning goals and next steps. In contrast to the actual participation in MSF, which was a mandatory part of the residents' training, the participation in this validation study was voluntary. All research data were pseudonymised or anonymised. The local committee of the Association of Swiss Ethics Committees on research involving humans deemed, based on the detailed study protocol, that no further approval was necessary. All participants provided informed consent.

### Demographic data on the study participants

Residents who received MSF were pursuing a specialisation in either paediatric surgery ( $n = 32$ ; 24 female, 8 male) or paediatrics ( $n = 15$ ; 10 female, 5 male). The majority of the residents had between one and five years of work experience ( $n = 43$ ), while the remainder had between six and ten years of experience ( $n = 4$ ). Raters, as far as their data are known, stem from a group of 31 consultant paediatric surgeons (13 female, 18 male; median work experience 14 years), 20 nurses from the ward (all female, median work experience 17 years), six nurses from theatre (5 female, 1 male, median work experience 21 years), 26 consultant anaesthesiologists (17 female, 9 male, median work experience 13 years), 46 residents from paediatric surgery (38 female, 8 male,

median work experience 5 years), 17 residents from paediatrics (12 female, 5 male, median work experience 4 years), and six residents from other specialties (2 female, 4 male, median work experience 6 years). Data on raters cannot be fully provided for every rating, as some of the pseudonyms overlapped.

## Development of the MSF questionnaire and investigation of validity

In line with Cook and Beckman (26), we took into account and investigated four sources of validity evidence: (i) content, (ii) response process, (iii) internal structure, and (iv) consequences.

### (i) Content

Content validity was already targeted during the development of the instrument by a panel of experts (four physicians providing perspectives from the fields of internal medicine, surgery, paediatrics, transfusion medicine and medical education). The instrument should represent the chosen construct of a physician's competence as adequately and completely as possible. The instrument should be sufficiently universal for use not only for surgical training but also with regard to non-surgical medical competence. After reviewing the literature on existing MSF instruments (6, 12, 13, 15, 21, 30, 36–38), we chose the mini-PAT questionnaire (17) as the basis for our MSF instrument as this was the closest to our affordances, including with respect to its competency-based nature. This questionnaire was then extended to meet the roles of the CanMEDS framework (9). In detail, the items of the mini-PAT were translated, discussed, and adapted by the expert group. We discussed and revised all items in the expert group until consensus on the meaning and phrasing of each item was reached. Additionally, we integrated more aspects of all CanMEDS physician roles from the 2005 edition of the framework (9) into our MSF questionnaire. Item 10 "keeps an eye on patient safety", item 14 "is open to feedback and learns from it" and item 15 "shows initiative and assumes responsibility" can be seen as complementing the CanMEDS roles Health Advocate, Scholar and Manager, respectively. Furthermore, from the mini-PAT, we retained the two open questions on strengths and areas for improvement of the residents (questions 17 and 18), and the question on the integrity of the resident (question 21), as we viewed these to be important. To further emphasise the formative nature of MSF, we added two questions (questions 19 and 20) relating to working conditions and concrete suggestions for the improvement thereof. The resulting questionnaire is shown in table 1. For the residents' self-assessment, we used a questionnaire consisting of the very same questions but written from the first-person perspective.

In formulating the questions, we drew on principles pertaining to the design and formulation of questionnaires (39). In particular, we endeavoured to use phrasing that was as clear as possible. In accordance with the recommendation that items should describe the desired behaviour (15), all items of our MSF questionnaire are phrased with a positive orientation rather than neutrally. The expert group also adjusted the scale based on experience with other instruments. We chose to use a 5-point scale on which the borderline rating is not in the middle, but is rather second from bottom. In this way, "positive" ratings might be more widely distributed, meaning across three points of the 5-point scale. The rating is not compared to an absolute goal, as in the mini-PAT ("expectations for F2"), but is rather relative to the resident's state of training ("taking into account the level of training"). For each item, in addition to the given scale, space for narrative comments was provided with the intention of encouraging concrete observations and suggestions for improvement (32). The same scale ("taking into account the level of training") and space for narrative comments were used in the self-assessment questionnaire.

### (ii) Response process

All participants (raters, residents and supervisors) were trained for their respective task in a workshop or through written information. They were informed about the objective of the MSF, the use of the MSF questionnaire and its rating scale. The technical implementation was made as simple as possible. According to Cook (26), data security and the way in which data are further used also contribute to the response process validity. We therefore took these factors into account and provided information thereupon as part of the participants' training.

Before the MSF questionnaire was finalised, the comprehensibility and clarity of the items were examined in a think-aloud study with residents and raters. For this purpose, the instruments (MSF questionnaire and self-assessment questionnaire) were completed by eight persons (two representing the group of residents, six representing the group of raters) and then discussed in order to optimise the intended understanding. These insights led to some modifications of the instruments, resulting in the final versions of the two questionnaires.

All narrative comments, which were invited for each item of the MSF questionnaire, were analysed to check whether the respective item was understood as intended. We also analysed “unable to comment” ratings, and related either the resident’s specialty or the rater’s occupation to the percentage of items answered.

For evaluation purposes, first, one question on the usage of the MSF questionnaire was posed directly at the end of the questionnaire (in both the MSF and the self-assessment questionnaire), asking whether any changes were necessary regarding technical aspects or content of the MSF questionnaire. Second, all residents were sent a short pseudonymised online survey for evaluation of the MSF, which asked about hindering or facilitating factors regarding the feedback conversation and supervisor, raters, and general conditions for MSF.

### **(iii) Internal structure**

The instrument was employed to evaluate 47 residents on 81 occasions of MSF. Thirty-two residents received MSF twice (in run 1 and run 2) and two residents received MSF three times (in run 1,2 and 3). An exploratory factor analysis was performed for the first and second run of MSF. Here, the first run is defined as the sum of MSF ratings given to residents who received their first MSF, and the second run analogously.

Generalisability studies were conducted to investigate the inter-rater reliability for the scale score. The analyses were conducted for data at the raters’ level for the 47 residents in run 1 and 32 residents in run 2, respectively. The generalisability studies show how many raters are needed per resident to achieve a reliable indication of the quality of the MSF questionnaire (40). A rater-nested-within-resident design was used, with raters as the object of measurement. This design allows for variance component estimation of two sources: (i) differences between raters (object of measurement) and (ii) differences between raters nested within residents’ judgments (41, 42). Reliability indices (generalisability (G)) coefficient and standard error of measurement (SEM) are reported as a function of the number of raters per resident.

### **(iv) Consequences**

Repeated counselling by the same supervisor and documentation of the agreed learning goals should ensure that individual support of the resident takes place. We analysed the MSF-induced consequences by taking into account supervisors’ written documentation of all feedback conversations including learning goals. The self-reported change was assessed by a survey pertaining to the desired result of improved or maintained performance.

In order to investigate the progress of those residents who participated in both runs, the mean scores they achieved were compared between the two runs using a dependent samples t-test. As the rating scale was “taking into account the level of training”, residents who developed their competencies further during their training remained at their particular rating.

The continuous opportunity to provide feedback on the instrument and process should ensure that unexpected consequences such as problems in terms of acceptance, usability of the MSF questionnaire or problems in the MSF process could be identified early on. We also checked all further available data (MSF questionnaire itself, questionnaire for self-assessment, survey on self-reported change) for hints of unexpected consequences. As a second study on MSF began one year after the implementation of MSF, where we collected data via focus group interviews, more reactions on the consequences were collected incidentally and also taken into consideration.

Statistical analyses were performed with SPSS for Windows version 25 and G\_String A Windows Wrapper for urGENOVA (43).

## Results

### Resulting MSF questionnaire

The resulting competency-based MSF questionnaire, shown in table 1, consists of 15 questions and one global assessment of medical competence as well as five additional open questions. All original items of the MSF-RG are presented in their original order. English translations and mapping against CanMEDS roles are added for the purpose of this publication only and are not part of the MSF questionnaire. The MSF questionnaire is used digitally and introduced with the following sentence: "This questionnaire is supposed to reveal the personal strengths and weaknesses of a physician in order to achieve the best individual training." („Dieser Fragebogen dient dazu, die persönlichen Stärken und Schwächen einer Ärztin/eines Arztes aufzuzeigen, um die bestmögliche individuelle Weiterbildung zu erreichen.“). The self-assessment questionnaire consists of the same questions grammatically adjusted to the first-person perspective.

### Investigation of validity evidence

#### (i) Content

We consider the validity of the content to be grounded in the development process of the MSF questionnaire, in which an interdisciplinary group of experts from several medical specialties and from the field of medical education defined the desired construct of medical competence on the basis of the CanMEDS roles. The mini-PAT (17) was taken as the basis and extended such that the resulting items cover all CanMEDS roles. The expert group formulated the items of the MSF questionnaire on the basis of the literature on MSF according to the formative objective of this MSF.

#### (ii) Response process

The think-aloud study showed that with small adjustments, the items of the MSF questionnaire and self-assessment questionnaire were understood as intended. Analysis of all narrative comments for each item showed that the items were understood as intended in 96–100% of cases (see figure 1). The highest percentage of narrative comments which did not focus on the item as intended was seen for item 3 "... is aware of her/his own limitations and asks for help in that situation.", which was also used to comment on more general aspects of collaboration and to comment on the residents' limitations.

The analysis of "unable to comment" ratings is shown in table 2. This analysis supports the response process and correct usage of the instrument by demonstrating that raters ticked "unable to comment" for items where valid judgments could not be given by the respective rater. To give some examples: Item 1 "... diagnoses patient problems correctly" was rated by many peers and consultants and some nurses from the ward, but rarely by persons from theatre. Item 8 "... communicates adequately with patients and family members" was rarely rated by nurses in theatre but often rated by nurses from the ward.

Data from accompanying evaluations during the usage of the instrument confirmed the clarity of items and good usability: Raters made suggestions for changes to technical aspects or content of the MSF questionnaire in 62 cases from all 1019 ratings (6%). Residents made suggestions in nine cases from 81 self-assessments (11%). Raters mostly commented on the reasons why they chose "unable to comment": Residents mostly commented on difficulties in matching their self-rating with the scale which reached from "below my expectations" to "far above my expectations".

The more detailed online survey for evaluation from the residents' perspective, regarding facilitating and hindering factors, indicated that the experienced MSF is feasible overall and well accepted without the need for major alterations. In terms of the feedback conversation, raters and general conditions, many facilitating factors were reported, which indicate the feasibility and high acceptance of MSF. Hindering factors mostly concerned discussions about the optimum time for MSF to take place during training.

### **(iii) Internal structure**

#### *Factor analysis*

The KMO test showed that our data are suitable for factor analysis (KMO = 0.931 (first run), KMO = 0.921 (second run), Bartlett test < 0.001). An exploratory factor analysis was performed separately for the runs using the Kaiser criterion (drop all components with eigenvalues less than 1.0). This resulted in a single-factor structure for both runs. The one-factor solution accounted for 53.5% of the total variance in the first run and 62% in the second run. Internal consistency (Cronbach's alpha) was .933 for the first and .951 for the second run.

#### *Inter-rater reliability*

Table 3 depicts the variance components obtained by generalisability study (G-study). The obtained inter-rater reliability was 0.607 in the first run and 0.797 in the second run with a mean of 11.85 and 12.03 raters per resident, respectively. The results of the D-study are also presented in table 3. A minimum of 12 ratings are needed in order to achieve an inter-rater reliability of 0.8 and seven ratings are sufficient for an inter-rater reliability of 0.7 in the second run. The also presented standard error of measurement (SEM) can be used to calculate the confidence intervals of the residents' scores.

### **(iv) Consequences**

For all residents who expected another turn of MSF, between one and four tailored learning goals were written down, enabling residents to be individually guided during their training. All those residents (n = 32), were asked to complete a pseudonymised survey on changes in their performance (self-reported change). Nine residents responded to the survey, of whom seven reported an improvement due to MSF in one or more items. Six of these also provided a narrative explanation of how MSF supported their learning from their perspective.

In order to analyse the progress between the first and second run, we compared the mean scores achieved. The comparison revealed no significant difference (mean in run 1 = 3.34, mean in run 2 = 3.41;  $t_{(31)} = -1.611$ ,  $p = 0.117$ ,  $\eta^2 = 0.07$ ), which indicates that residents developed as expected, as raters were asked to "take into account the level of training".

To provide an overview, ratings as a function of the items are shown in figure 2.

No undesired consequences such as problems in terms of acceptance, usability of the MSF questionnaire, problems in the MSF process, or worsening of performance occurred.

## **Discussion**

We developed a German-language MSF questionnaire and investigated four sources of validity evidence following a model of proposed standards (26). Our resulting MSF questionnaire (MSF-RG) consists of 15 questions and one global rating, which cover a construct of a physician's competence, and five additional open questions for further suggestions for improvement. We found evidence for the validity of this MSF questionnaire regarding content, response processes, internal structure and consequences.

*(i) Content validity* was supported by the deliberate development of the MSF questionnaire in a multidisciplinary expert group comprising experts from clinics as well as from medical education, who based the instrument on the mini-PAT questionnaire (17) and extended it regarding CanMEDS roles. When building the MSF questionnaire, its transferability to training in other, non-surgical specialties was also taken into consideration. In our setting, participants included residents in paediatric surgery as well as residents in paediatrics. The use of CanMEDS roles as a basis, the generic formulation of the items, and the interdisciplinary composition of the expert group should ensure that the instrument can be used in residency training in various specialist areas. At least in our setting with residents from paediatric surgery and paediatrics, who stem from the same hospital and worked in the same department during the time of this study, the implementation of the questionnaire was successful. This idea is in line with research by van der Meulen et al. and Mackillop et al. (23, 44), who found that one generic MSF can be used for various

specialties, under the condition that the number of raters and their mix, as well as the content of items, is suitable for the respective purpose.

*(ii) Response process validity* was supported by the think-aloud study, as well as the analysis of narrative comments and analysis of “unable to comment” ratings, which indicate that overall, the focus of every item was understood as intended and that the instrument could be used as expected. Furthermore, comparison of data from the response process for the two groups of residents (paediatric surgeons compared to paediatricians) shows that the percentage of items answered on the scale is similar for both groups. Again, this finding, in line with the literature (23, 44), supports the notion that this generic MSF questionnaire can be utilised for both groups of residents. Data from evaluations confirmed the good usability and acceptance of the questionnaire.

*(iii) Internal structure:* The exploratory factor analysis indicated that a one-factor model fits the data and accounted for 53.5% of total variance in the first run and 62% of total variance in the second run. This suggests that the scale does not differentiate as well as expected or that competence cannot be defined as the sum of separated skills but rather as their combination (45). It has to be discussed, if the scale-based quantitative rating is biased by something which hinders a proper differentiation between competences. In this regard, Wood et al. outlined several cases of multi-rater assessment for which they identified an “overwhelming halo effect” (15). Therefore, we must put into question, whether scoring should be omitted. On the one hand, based on the factor analysis, we would tend to promote this idea of dropping scale-based “numbers”. We have observed that, for the formative purpose of the instrument, narrative comments are of much greater importance than scale-based ratings, in line with the literature (15, 32). On the other hand, supervisors and residents reported in focus group interviews within another study (data not shown) that the ratings for each scale served as a kind of “screening” parameter to obtain a quick overview of the current performance, compare easily between runs and facilitate the comparison of self-assessment with MSF ratings. Taken together, even if narrative comments are the core of the instrument, feedback of supervisors and residents indicates that there is extra value in the quantitative ratings and therefore the use of the scale seems justified, too.

With respect to the higher inter-rater reliability (G-study) of .797 for the second run compared to .604 for the first run, we conclude that experience with the instrument is important to achieve an acceptable level of inter-rater reliability. This finding was similarly described by Moonen-van Loon et al. (46), who reached higher reliabilities by combining the results of several occasions of MSF over a prolonged period of time.

The finding that the scores are valid and reliable implies that data collected with 12 raters, composed as described, can be used to rate a doctor’s competency in order to provide formative feedback based on this questionnaire. This number of raters is consistent with previous literature reporting that between five and 20 raters are necessary for an accurate rating, depending on raters’ occupations, on the roles assessed and on the training of raters (15).

*(iv) The consequences* of our instrument were demonstrated by the learning goals which were formulated and by the investigation of progress between the first and second run of MSF. We did not find a significant difference in ratings between the first and second run, which indicates that residents developed further their competencies as expected, as raters were asked to “take into account the level of training”. Seven residents (of nine who responded to the survey on self-reported change, reported an improvement due to MSF in one or more items. Since they also provided a narrative explanation of how MSF supported their learning, we can begin to understand their experience in greater depth. Their examples reflect the causal relation between MSF and self-reported changes. Though it would be desirable to have more data on consequences, our results contribute to the knowledge on MSF, as the consequential validity of MSF instruments is rarely reported in the literature (16, 34, 46). Further investigation of this aspect of validity is planned by including more participants and investigating long term consequences.

The main strength of our study is that, to the best of our knowledge, MSF-RG is the first competency-based MSF instrument in the German language for which different sources of validity evidence have been investigated. As we chose to draw on the widely used CanMEDS framework and piloted our MSF instrument for surgical as well as non-surgical residents, we assume that its use should be transferable to other specialties.

The results of our study are limited by the fact that all participants, although having different training goals (paediatric surgery, paediatrics), worked in one department. Additional research on the validity of the instrument is needed and will be feasible as soon as more data with more participants from diverse institutions will have been collected.

It was not possible to investigate the “relation to other variables”, which is the fifth source of validity evidence according to Cook et al. (26), as this institution does not currently use any other measurement which also rates the complete construct of a physician’s competency at several time points during training.

Also, the perspective of patients and their parents was left out during this study. As their view on a physician’s competence is highly important to gain a more comprehensive picture, we propose, that an additional questionnaire for this group of raters should be developed. Then, it should also be investigated, if this perspective might influence the process of MSF and its validity evidence.

Future research should have a closer look at the consequences of the MSF for the learning goals of residents and its impact on performance of all participants which could help to further foster the understanding of MSF.

Since the validity of an instrument depends on its use, we recommend that the extensive literature on the best possible implementation of MSF should be considered (13–16, 30–35) when planning to implement MSF.

## **Conclusion**

We developed a German-language competency-based questionnaire for the implementation of multisource feedback in postgraduate medical training, and examined four sources of validity evidence with 47 residents on 81 occasions of MSF. We found evidence for the validity of this MSF questionnaire regarding content, response processes, internal structure and consequences. This suggests that this MSF questionnaire in German (MSF-RG) is suitable for MSF to support residency training. Further studies will be needed to investigate the long-term consequences of the instrument as well as the correlation with scores from other assessments.

## **List Of Abbreviations**

MSF Multisource Feedback

## **Declarations**

## **Ethics approval and consent to participate**

A motion for a vote on ethics was submitted to the Association of Swiss Ethics Committees on research involving humans. The regional committee (Kantonale Ethikkommission Zürich) deemed, based on the detailed study protocol, that no further approval was necessary (reference number Req–2016–00001). All participants provided consent after receiving information about the study.

## **Consent for publication**

All participants provided informed consent for the use of their data for publication in pseudonymised or anonymised form.

## **Availability of data and materials**

The datasets generated and analysed during the current study are not publicly available as this might endanger the anonymity of participants, but are available from the corresponding author upon reasonable request.

## **Competing interests**

SHa is section editor and SHu is associate editor to BMC Medical Education. The other authors EH, US, CB, DS declare that they have no competing interests.

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# Authors' contributions

EH, US, CB, and SHu designed the study. EH and SHu coordinated the study. US recruited the participants and coordinated the data acquisition. DS performed the statistical analysis and interpreted the results with EH, CB and SHu. EH and SHu drafted the manuscript. CB and SHa commented on the design of the study, revised the manuscript, and contributed to the discussion. All authors read and approved the final manuscript.

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## Tables

Table 1 MSF questionnaire for residency training in German language (MSF-RG)

Original item	English translation	CanMEDS role
<i>Items 1-16 are rated on a 5-point scale from "Unter meinen Erwartungen" (below my expectations), "Erfüllt meine Erwartungen grenzwertig" (marginally fulfils my expectations), "Erfüllt meine Erwartungen" (fulfils my expectations), "Über meinen Erwartungen" (above my expectations), to "Weit über meinen Erwartungen" (far above my expectations), and alternatively «Nicht beurteilbar» (unable to comment), with space provided for narrative comments directly after each item.</i>		
Wie beurteilen Sie die Ärztin/den Arzt im Hinblick auf die folgenden Aspekte unter Berücksichtigung des Weiterbildungsstandes?	How do you assess the physician with regard to the following aspects, taking into account the level of training?	
1 Die Ärztin/ der Arzt... ... stellt korrekte Diagnosen.	The doctor... ... diagnoses patient problems correctly.	Medical Expert
2 ... entwickelt angemessene Behandlungspläne.	... formulates appropriate management plans.	Medical Expert
3 ... ist sich seiner eigenen Grenzen bewusst und bittet in der entsprechenden Situation um Hilfe.	... is aware of her/his own limitations and asks for help in that situation.	Medical Expert
4 ... ordnet medizinische Maßnahmen im Bewusstsein der Kosten an.	... orders investigations in awareness of costs.	Manager
5 ... hat ein gutes Zeitmanagement und setzt Prioritäten.	... manages time effectively and prioritises.	Manager
6 ... verfügt über gute manuelle/technische Fähigkeiten.	... has good manual and technical skills.	Medical Expert
7 ... führt die Krankengeschichte und Berichte zeitgerecht und präzise.	... keeps records in a timely and accurate manner.	Communicator
8 ... kommuniziert adäquat mit Patienten und Angehörigen.	... communicates adequately with patients and family members.	Communicator
9 ... bezieht psychosoziale Aspekte mit ein.	... involves psychosocial aspects.	Communicator
10 ... behält die Patientensicherheit im Blick.	... keeps an eye on patient safety.	Health Advocate
11 ... kommuniziert adäquat mit Kollegen.	... communicates adequately with colleagues.	Collaborator
12 ... ist erreichbar und zuverlässig.	... is accessible and reliable.	Collaborator
13 ... gibt gern Wissen an junge Kollegen weiter.	... likes to teach younger colleagues.	Scholar
14 ... ist offen für Feedback und setzt es um.	... is open to feedback and implements it.	Scholar
15 ... ist initiativ und übernimmt Verantwortung.	... shows initiative and assumes responsibility.	Manager
16 Wie bewerten Sie im Gesamteindruck diese Ärztin/ diesen Arzt?	How do you rate this doctor overall?	
<i>Questions 17 and 18 can be answered with narrative comments.</i>		
17 Was sind die besonderen Stärken der Ärztin/des Arztes?	What are the individual strengths of this doctor?	
18 In welchen Bereichen sollte die Ärztin/der Arzt sich insbesondere noch verbessern?	In which areas do you see a need for improvement?	
<i>Questions 19-21 can be answered with yes or no, and ask for narrative comments in the case of a "yes".</i>		
19 Sehen Sie äußere Einflüsse, die die Leistung der Ärztin/des Arztes beeinträchtigen oder befördern?	Are there hindering or facilitating influences on this doctor's work?	
20 Haben Sie Vorschläge zur Veränderung der Arbeitsbedingungen der Ärztin/des Arztes?	Can you suggest changes in this doctor's working conditions?	
21 Haben Sie irgendwelche Zweifel an der Integrität oder Gesundheit der Ärztin/ des Arztes? Falls ja, nennen Sie Ihre Bedenken:	Do you have any doubts about this doctor's probity or health? If yes, please state your concerns:	Professional

Table 2 Analysis of "unable to comment" ratings as an aspect of the response process

keywords of items	A: resident's specialty		B: rater's occupation					C	
	paediatrics	paediatric surgery	consultant paediatric surgeons	nurses from ward	nurses from theatre	consultant anaesthesiologists	residents paediatric surgery	residents paediatrics	self-assessment
1 ... diagnoses	75	72	92	69	10	43	94	89	100
2 ... management plans	73	74	91	78	8	37	95	85	96
3 ... aware of own limitations	87	90	94	86	75	79	98	89	100
4 ... awareness of costs	46	46	51	56	24	5	58	59	94
5 ... manages time	84	86	83	92	72	62	95	93	100
6 ... manual and technical skills	38	57	64	40	63	73	42	54	94
7 ... keeps records	68	65	84	60	0	16	95	89	100
8 ... communication with patients	76	76	82	95	9	54	89	84	100
9 ... psychosocial aspects	67	61	70	77	7	24	85	72	100
10 ... patient safety	77	80	80	87	57	76	87	84	100
11 ... communication with colleagues	91	93	94	85	88	92	98	98	99
12 ... accessible and reliable	92	94	94	94	87	78	97	98	100
13 ... teaching	41	46	38	28	37	30	67	74	100
14 ... open to feedback	82	86	87	86	73	68	90	87	100
15 ... initiative and responsibility	86	87	93	89	62	60	96	93	100
16 overall rating	92	95	97	96	79	86	99	100	100

Percentage of scale-based ratings of - column A: resident's specialty, B: rater's occupation, or C: self-assessment - each as a function of the items 1-16. Colours of boxes emphasise the percentage of ratings: black: answered by 75% of raters or more, dark grey: 50-75%, light grey: 25-50%, white: less than 25%. Example: item 2 was answered in 73% of MSF for paediatric residents and in 8% of cases by nurses from theatre.

Table 3 G-study and D-study on inter-rater reliability

		Estimated variance components		N	G-coefficient	SEM
		Inter-resident variance	Rater variance within resident			
Run 1	G-study	0.032	0.021	11.85	0.60	0.38
Run 2	G-study	0.093	0.024	12.03	0.80	0.28
	D-study	0.093	0.026	11	0.78	0.29
			0.028	10	0.77	0.30
			0.032	9	0.75	0.31
			0.035	8	0.72	0.32
			0.041	7	0.70	0.34
			0.047	6	0.66	0.36

Estimated variance components for the variance associated with residents and raters and the generalisability coefficient (G-coefficient) and standard error of measurement (SEM) for the first and second run (G-study). G-coefficient and SEM as a function of the number of rater ratings (N) for the second run (D-study).

## Figures

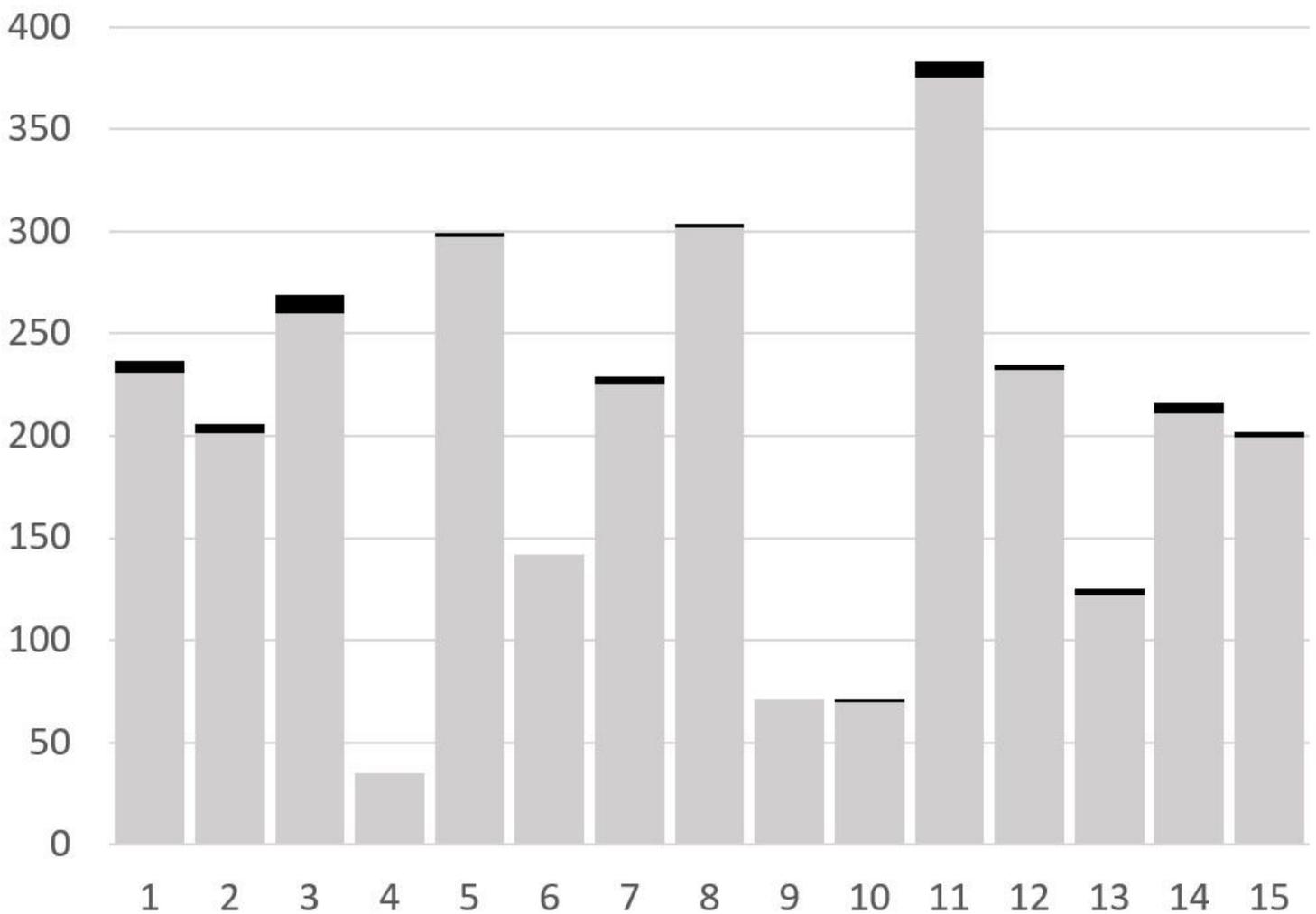
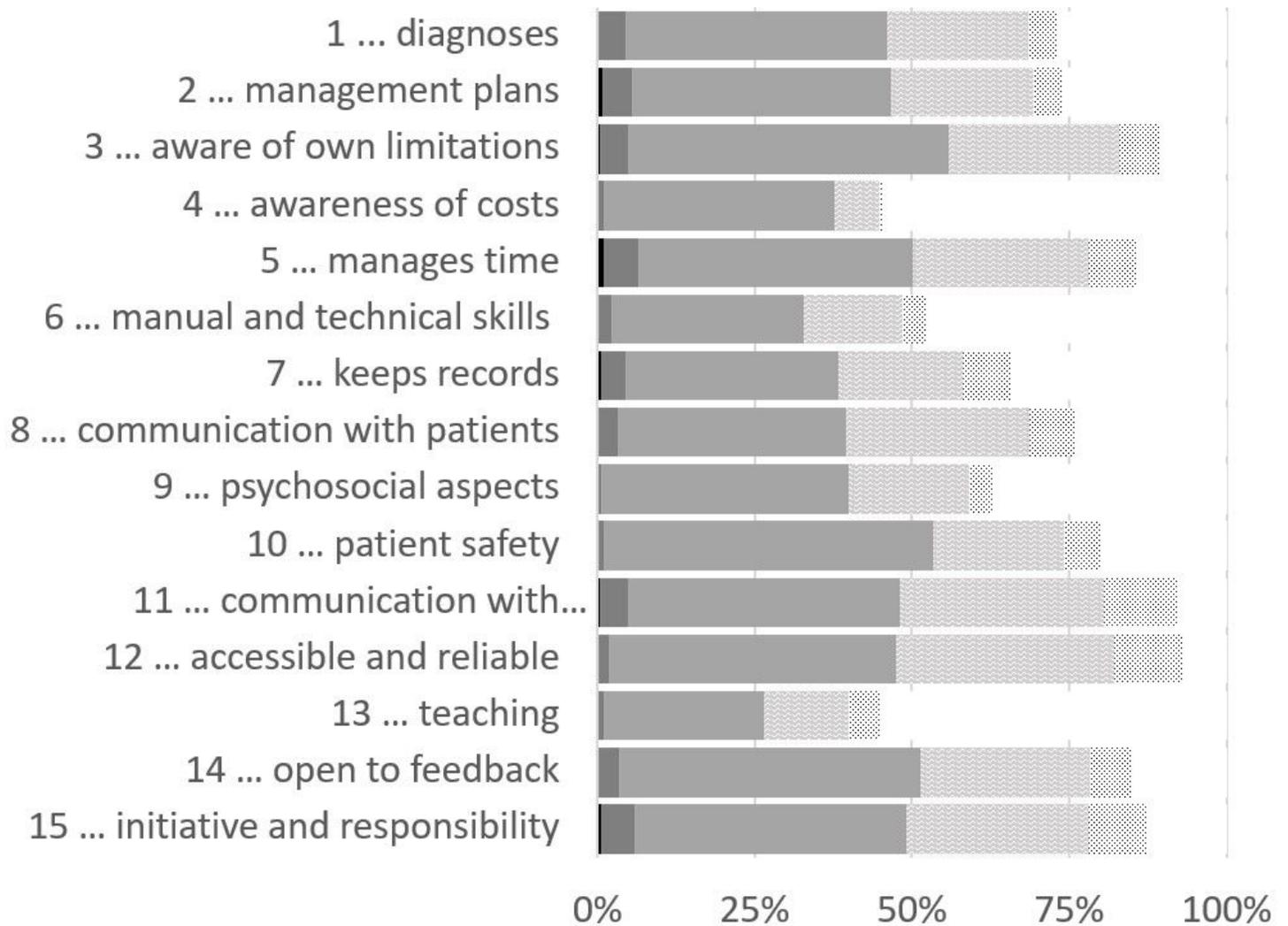


Figure 1

Analysis of narrative comments. Absolute number of answers which focus on the item as intended (grey) and the number of answers which focus on another topic (black) as a function of the items 1-15.



**Figure 2**

Answer patterns as a function of the items 1 to 16. For each item 1-16, the figure shows the relative amount of ratings per each point of the 5-point scale. Legend: from left to right: black: below my expectations, dark grey: fulfils my expectations marginally, medium grey: fulfils my expectations, grey-waved: above my expectations, white dotted: far above my expectations. Missing to 100% are "unable to comment" ratings.