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On the Role of Role-Theoretical Concepts: Determining Dimensionality or Difficulty in Cross-Occupational Collaboration

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Abstract

In vocational education and training, it can be assumed that the digital transformation increases the relevance of individuals' cross-occupational collaboration competency (COCC) across vocational and professional sectors, thus improving and reorganizing processes across time and domains on the basis of available information. This poses a challenge to instruction and diagnostics in VET, which can be supported by thorough, empirically grounded theoretical modeling. In Striković and Wittmann (2022), we suggested a role-theoretical approach to modeling COCC involving five role-theoretical dimensions: knowing one's own occupational role, knowing the occupational role of one's collaboration partners, latent processes of role distance, role-taking, and object-oriented role coordination. In the present study, we evaluate this role-theoretical model empirically using the example of nursing, specifying and operationalizing the model with a computer-based situational judgment test and using a data set of 328 nursing students to carry out an in-depth analysis of (1) dimensionality and (2) role-related task features thought to influence item difficulty. While model comparisons showed the superiority of a unidimensional vector compared to five- and two-dimensional structures, linear additive regression analysis revealed that the role-related task features on the basis of the five dimensions showed significant effects, as did the number of collaboration partners and the test subjects' subject-matter competence, which can also be linked to the nurses' situational role. These findings are in line with our theoretical reasoning in the COCC model. We discuss their limitations as well as their theoretical and educational significance, outlining needs for further research—also in other professional and vocational domains.

Keywords Role Coordination · Vocational Education and Training · Interprofessional Collaboration Competency · Computer-Based Testing · Item Response Theory · Situational Judgment Test

Extended author information available on the last page of the article

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Introduction

Cross-occupational and interdisciplinary collaboration—that is, working together with representatives of other occupations or professions—is becoming increasingly important in the field of vocational education and training (VET) both in general (Paeßens & Winther, 2024; Spliethoff et al., 2021; Zlatanovic et al., 2017) and in particular through the digitally driven transformation of work (e.g., Striković & Wittmann, 2022; Micheli et al., 2019; Paeßens et al., 2023). One major reason has been that beyond providing new digital tools, integrated electronic documentation systems enable improved availability and analysis of information, which in turn allows for process reorganization across time and space but also requires new collaboration to make sense of information from the perspective of the participating domains, as well as to reorganize processes. In social and care professions such as nursing, cross-occupational collaboration within the social and health sector has been studied for decades under the designation “interprofessional collaboration” (e.g., Berghout, 2021; Dogba et al., 2016; Reeves et al., 2017). But here as well, networked digital technologies in the field of nursing, such as electronic health records or telemedical and telecare technology, have been assumed to make it an even more important if not a dominant form of nurses’ work (see Delaney et al., 2022; Kaufhold & Heinze, 2022; Wittmann et al., 2024a): Information technology such as electronic health and care records as well as telemedicine enhance information distribution and quality, changing the intersection between (health)care institutions but also creating new requirements in terms of the collaborative grounding of data in the patients’ complex histories on behalf of the adequate provision of care (Flemming & Hübner, 2013; Flemming et al., 2014).

Consequently, how to foster a corresponding cross-occupational collaboration competency (COCC) in VET is becoming increasingly important. Yet, enhancing COCC through instruction requires making students’ competencies accessible to diagnostics (see Abele et al., 2021; Blömeke et al., 2015; Pellegrino, 2012; Seeber & Wittmann, 2017; Shavelson et al., 2012) and subsequently to interventions. However, even in nursing, where both academic and VET curricula have reflected the growing demand for competence (e.g., Herath et al., 2017), deficiencies in international research concerning consistent models persist, as do instruments for assessing interprofessional collaboration competencies (IPCC). In addition to falling short of measuring these competencies in a standardized and objective manner (see Marion-Martins & Pinho, 2020), relevant testing measures are often based on frameworks like CIHC (2010), IPEC (2011; 2016), and WHO (2010), whose generic competency terms (e.g., teams, communication, values and ethics, etc.) have rarely been elaborated theoretically (see Striković & Wittmann, 2020).

To address these deficiencies, we developed a general model of COCC based on role-theoretical assumptions (Striković & Wittmann, 2022) and provided examples on how to specify it for social and technological roles in the digital transformation but left open the question of its empirical viability. The theoretical model suggests five possible dimensions (knowing one’s own occupational role, knowing the occupational role of one’s collaboration partners, latent processes of role distance, role-taking, and object-oriented role coordination) and also lends itself to a one- and

two-dimensional interpretation (role knowledge and role-related abilities). Generally, the instructional idea behind multiple dimensions is that they can be assessed separately, and instruction can be based upon such assessment.

Most importantly, it seems likely from the perspective of the theoretical model that the five role-related components could have a difficulty-determining character, alongside other role-theoretical concepts, specifically hierarchy and number of collaboration partners. This raises the issue that our modeling of COCC, due to a lack of available studies and plausibility assumptions, can be conceived either as a feature of cognitive elements or a developmental pattern, aspects that are traditionally separated in empirical VET research but do not fundamentally contradict each other and can even appear together (see Klotz et al., 2015; Wilson 2009; 2023).

The examination of theoretically derived item characteristics holds theoretical significance with respect to difficulty assumptions, as it serves as a source of validation of a theoretically developed model (see Borsboom et al., 2004; Messick, 1989, 1994, 1995). Hartig (2007; see also Hartig & Jude, 2007) conceives of task features thought to account for higher or lower demands on persons as item characteristics constituting empirically testable hypotheses about “variations in the attribute [that] causally produce variation in the measurement outcomes” (Borsboom et al., 2004, p. 1061). They should therefore be defined prior to operationalization and subsequently open up the possibility of empirically determining proficiency levels and developing new items more purposefully. Besides the purpose of validation, observed difficulty-determining characteristics can then be interpreted and used for the conceptualization of more effective educational processes, as the systematic variation of task difficulties plays a crucial role in both the identification of available or insufficiently developed competencies and the instructional support for their development. Hence, with respect to instruction, the results could be used to create (manageable) barriers in teaching–learning processes for promoting competencies systematically (see Hartig et al., 2012; Klotz et al., 2015; Nickolaus, 2016). Therefore, Hartig’s method is preferred in VET (e.g., Behrendt et al., 2017; Klotz et al., 2015; Schumann & Eberle, 2011) in contrast to post hoc task analyses (Beaton & Allen, 1992).

As a first step in empirically validating our model of COCC, a data set available from the research project *Extended Competence Assessment Systems in the Health Sector* (EKGe)¹ in German nursing education is suitable for testing our theoretical model empirically. It contains data (Wittmann et al., 2024a) from the computer-based situational judgment test *Interprofessional Collaboration Competency Instrument for Nursing* (ICCI-N), on the basis of which we address the following research questions.

RQ1: Which model empirically best represents dimensionality, specifically the five-, two- and one-dimensional structure?

RQ2: To what extent do role-based task features contribute to item difficulty when assessing COCC?

This manuscript is structured as follows: We begin by briefly outlining how the digital transformation leads to the increasing significance of cross-occupational collaboration, with special regard for interprofessional collaboration within

¹ The project was part of the research initiative ASCOT+, funded by the German Federal Ministry of Education and Research.

the healthcare sector, thus illustrating the importance of enhancing and modeling COCC for VET and asking what can be drawn from the available tradition and state of IPCC research. The second section exemplifies such a theoretical modeling of COCC for the case of IPCC in nursing. Consequently, we outline the test design, sample ($N=328$ nursing students), data collection, test instruments, and the procedure underlying the analyses of dimensionality, as well as the influence of task features on item difficulty. Subsequently, we present our findings and discuss their limitations as well as their educational and theoretical value, thereby revealing topics for further research—also in other professional or vocational domains.

Cross-occupational Collaboration: A Brief Overview

Cross-occupational collaboration, under the designation of interprofessional collaboration, has been a central concept across the healthcare sector, but also in other social professions, such as education and social work (e.g., Crawford, 2011; Friedman et al., 2023; Ross et al., 2024; Timperi et al., 2024). With the rise of the digital transformation, it has been increasingly debated in other contexts as well, specifically in economic or technical domains (e.g. Micheli et al., 2019; Spliethoff et al., 2021). A major reason is the integration of technology and data and, as a result, the availability and the quality of information across occupational and organizational boundaries, allowing for the reorganization of processes, ideally with the recipients—clients, customers, or patients—at the center. Leveling these potentials requires enhancing COCC. This is the case for healthcare and nursing as well, where new arrangements like telemedicine or electronic health records lead to new requirements but also to opportunities for establishing common ground and targeting interventions across considerable distances and organizational boundaries as well as for cross-occupational collaboration. In our research, we used Engeström's (2019) conceptualization of an activity system to model affordances of cross-occupational collaboration between non-technological and technological professions and occupations, with a specific focus on the digital transformation (see Striković & Wittmann, 2022).²

In the specific context of nursing, the *object*—a problem related to a care recipient (client, patient, etc.)—is addressed by nurses and other relevant health professionals (*subjects*) in order to help improve the care recipient's well-being or autonomy in terms of an *outcome*. This is achieved by means of *instruments* such as electronic care documentation or electronic wound reports; such digital tools enable nurses to connect with representatives of their own or other professional groups across spatial boundaries with less effort to exchange care recipient-related information. Digital tools can, however, themselves become the object of labor activity: "As digitalisation initiatives become more ambitious and aim at wider service reorganisation, the implications for professionals are not limited to their technology use. Increasingly,

² Here, for the sake of argumentation, we only briefly lay out our activity-theoretical modeling of cross-occupational collaboration affordances with respect to the digital transformation of healthcare in order to illustrate the importance of instructional support and the theoretically grounded, empirical modeling of COCC for VET. Further aspects are discussed by Wittmann et al. (2024a).

professionals from nontechnical domains are involved in designing technologies and developing work routines for their field of practice” (Sadorge et al., 2024, p. 102). This indicates that the community of occupational and professional groups included in the activity system is changing in the course of the digital transformation. In the health sector, reorganization in support of collaboration may be expected if the potential of networked digital tools and resulting opportunities is to be exploited. One conceivable consequence of this is that the existing role expectations constituting the *division of labor* and *rules* in terms of guidelines, conventions, and standards will be irritated as well. Likewise, the digital transformation leads to the emergence of new contexts, for which no negotiated role expectations and rules yet exist, such as collaboration between health professionals and IT developers aimed at designing a digital technology for the registration and sharing of patient information (see Sadorge et al., 2024). Such vague or yet-to-be-negotiated role expectations and rules can then become the object themselves, jointly addressed by different occupations and professions involved in the activity.

As a huge amount of empirical research has been conducted on IPCC specifically in the healthcare and nursing domains, it should provide a good starting point for elaborating requirements and avenues for support in other domains as well. However, this research often lacks a theoretical underpinning, particularly one that might be transferable across domains. This may be illustrated by the empirical weakness of the instruments used to assess IPCC in international research (Marion-Martins & Pinho, 2020). For instance, existing questionnaires primarily measure attitudes or self-efficacy toward interprofessional collaboration (e.g., Berduzco-Torres et al., 2020; Itzhaki et al., 2023; Sigalet et al., 2015) with partly unknown or insufficient psychometric quality (see Mahler et al., 2015; Reeves et al., 2017; Schmitz & Brandt, 2015). Moreover, the theoretical considerations underlying the operationalization are either not provided or only hinted at; insofar as theoretical underpinnings do exist, a high degree of heterogeneity in the theoretical approaches is evident (see Reeves et al., 2016; Thistlethwaite, 2016). This may be because the instruments typically developed fall back on generic terms such as “teams” and “communication” within curricular frameworks (e.g., CIHC, 2010; Marion-Martins & Pinho, 2020).³

One major shortcoming of these kinds of approaches is that collaboration across occupational boundaries only seems relevant in contexts where collaborative routines already exist, rather than having to be initiated by the professional role-bearer. This seems insufficient in general, but even more so with respect to the affordances of the digital transformation. As a result of this lack of conceptual basis and weak operationalization, a systematic review and meta-analysis of the empirical research landscape suggests that nurses’ IPCC can be significantly enhanced through randomly constructed and situated team experiences of 60 to 90 min (Marion-Martins & Pinho, 2020), a result that seems *prima facie* questionable regarding the complexities of interprofessional collaboration. Notwithstanding the absence of consistent

³ Further theoretical and psychometric deficiencies in the existing operationalizations of nursing students’ competencies are described extensively in Kaspar et al. (2016) and Wittmann et al. (2022a); they persist for the IPCC (Wittmann et al., 2022b).

models of IPCC, a role-theoretical approach appears to be the most applicable in light of the interprofessional collaboration research, as it features prominently albeit rather arbitrarily and inconsistently in IPCC research (Marion-Martins & Pinho, 2020; Wittmann et al., 2024a). For COCC in the broader sense, specifically in the context of the digital transformation, role-theoretical approaches allow us to conceptualize COCC as rooted in vocational, professional, and occupational responsibilities, while also open to being actively shaped by the role-bearer to improve results for recipients in the course of the rapidly changing context.

In sum, the arguments on the importance of COCC due to the digital transformation and the research shortcomings constitute our interest in the role-theoretical modeling of COCC as well as in providing avenues for its systematic task-related diagnostics. We contend that our model of COCC, as laid out below for the case of nursing, is more consistent and precise and lends itself to empirical research as well as, subsequently, to the elaboration of concrete suggestions for improvement in VET. While we laid out the theoretical foundations extensively in Striković and Wittmann (2022), the following sections illustrate our model both theoretically and empirically for the case of IPCC in nursing.

Heuristic Modeling of Interprofessional Collaboration Competency: Role-related Dimensionality and Difficulty Parameters

In line with a role-theoretical approach, we defined IPCC for the purposes of nursing education as the ability to use knowledge about one's own nursing role and that of other healthcare professionals to assess the healthcare needs of care recipients (Striković & Wittmann, 2022; Wittmann et al., 2022b). In order to model IPCC, we used our generic modeling of COCC as elaborated in Striković and Wittmann (2022), containing role-theoretical concepts of individual dispositions based on structural symbolic interactionism. According to this framework, the (professional or occupational) role—in line with our activity-theoretical considerations—is a scheme that is both conducive to orientation and subject to negotiation and redefinition processes according to professional or vocational values. Importantly, in our model of COCC we connected the role-theoretical concepts following a fundamental assumption of a difficulty alignment (Striković & Wittmann, 2022): Some of the concepts are preconditions for other concepts, which should therefore be more difficult to master. This also means that the model provides a theoretical argument for increasing the task difficulty in relation to a given concept.

By analyzing the nursing domain, we transferred the COCC model to a heuristic *student model* of IPCC (Striković & Wittmann, 2022; see also Wittmann et al., 2024a). Following the definition of IPCC, it focuses especially on knowledge about roles, that is, norms and socially consensual expectations directed at an individual who acts in a particular societal position. The *knowledge about occupational roles* is twofold:

1. For *knowledge about one's own nursing role*, which includes the nurses' legal and professional responsibilities and obligations, such as enhancing clients' autonomy,

it is assumed that the corresponding items are the easiest, since one's own occupational or professional role is learned through both participation and intentional education.

2. Furthermore, situations of cross-occupational collaboration also involve professionals performing other occupational or professional roles, which—compared to one's own nursing role—are likely to be less adequately cognitively represented in terms of *knowledge about the occupational roles of the collaboration partners*.

Beyond role knowledge, we additionally considered three *individual abilities in relation to roles*:

3. The first is *latent role distance*, conceptualized as distancing oneself from the norms and expectations of the situational role to critically reflect on and interpret them. As it takes effort to do so without “falling out of one's own role” or changing the roles within the situation, role knowledge is required as a prerequisite for role distance; this role ability is indicated, for example, by the asking of critical questions appropriate to the role or acceptance of the role limits.
4. The ability to detach oneself from one's own role is assumed to be a prerequisite for the second ability, *role-taking*—the ability to understand or anticipate the behavior of other healthcare professionals by viewing it in the context of an imputed role; for instance, it is indicated by the fact that test subjects are able to understand possible reasons for the situational actions of collaboration partners from other healthcare professions.
5. In the third ability, *care recipient-oriented role coordination*, the roles of the collaboration partners, their role expectations, and the results of role-taking are related to each other as a means of addressing the care recipients' needs in the most constructive way possible. The manifestation of this ability is called role-making, understood as negotiating, developing, or shaping role expectations, indicated, for example, through the selection of contradictory positions in role conflicts or the suggestion of changes for interactive action.

As outlined (extensively in Striković & Wittmann, 2022), the five role-theoretical dispositions may not only be reflected in test dimensionality but rather represent task characteristics affecting difficulty—from knowing one's own nursing role as the least demanding prerequisite to care recipient-oriented role coordination as the most demanding prerequisite.

Besides assigning difficulty on the basis of these role-theoretical dispositions, we also considered two other role-related features thought to account for differences in difficulty: (i) number of collaboration partners and (ii) hierarchy (e.g., Bradley et al., 2009; Finch & Stryker, 2020; Krappmann, 2021; Reeves et al., 2016; Robertson, 2011; Stryker, 1981). Regarding the former, we trivially assumed that the difficulty increases with the number N of healthcare professionals or roles the nurse has to collaborate with, as this is accompanied by more received role expectations that have to be dealt with (e.g., Stryker, 1981). We conceptualized the third feature—the hierarchical structure in which the focal person is situated—as twofold, following our domain analysis. On

the one hand, the nursing domain includes situations where collaboration with doctors as medical professionals is necessary; historically, these situations tend to be *upward*-directed. On the other hand, the nursing domain also includes *lateral* collaborations, such as those between nurses and physiotherapists (e.g., Bradley et al., 2009; Foronda et al., 2016; O'Daniel & Rosenstein, 2008; Pfaff et al., 2014; Yukl & Tracey, 1992). On the basis of role-theoretical considerations, which suggest that a more substantial hierarchical disparity implies a higher degree of repression for the subordinate individual, it is reasonable to assume that upward collaboration entails higher demands than lateral collaboration (Finch & Stryker, 2020; Krappmann, 2021; Robertson, 2011). All three difficulty parameters and the assumed relationship between parameter value labels and difficulty are depicted in Fig. 1.

For reasons of psychometric validity, with the aim of limiting test stimuli to domain-specific requirements of collaboration with other health professions, situations should be modeled in such a way that care recipient-related care requirements may be assumed to have been clear to the test subjects, either through extensive prior coverage in the educational and practice-based curricula or through explicit specification of the requirements in the presentation of the situations. Nevertheless, it is conceivable that individuals' subject-matter competence may influence item difficulty (see Brandl et al., 2024; Nickolaus, 2018; Seeber & Wittmann, 2017), the premise being that the individual can contribute better to collaboration when the healthcare needs concerning their own nursing role are well understood (e.g., Gülich & Lindemann, 2020; Korpajaakko-Huuhka & Klippi, 2008). Such affinities between subject-matter competencies and socially interactive behavior might be assumed in particular for domains where occupational professionalism is less technological and more socially interactive (Nickolaus, 2018), as in social and healthcare work (see Cowan et al., 2005; Meretoja et al., 2004; Monnier et al., 2016; Kaspar et al., 2016, in contrast to industrial-technical professions (see Nickolaus, 2018; Nickolaus et al., 2018) and even sales and services (Seeber & Wittmann, 2017). Furthermore, it is conceivable that the operationalized task characteristics exhibit a certain range of difficulties, depending on the familiarity with the situational requirements (see Nickolaus, 2016; Klotz et al., 2015).

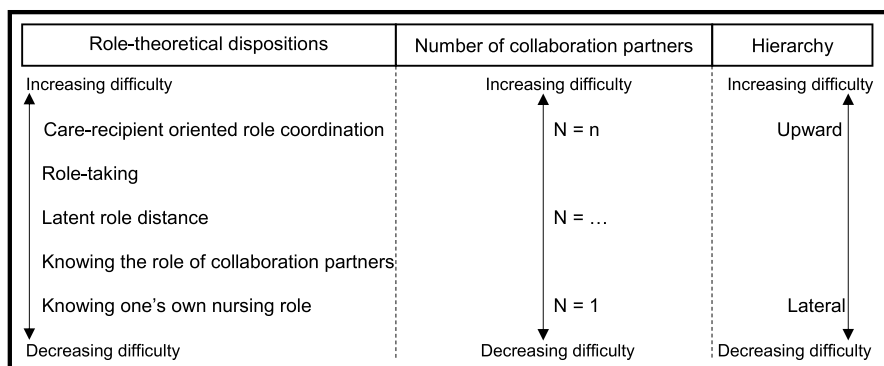


Fig. 1 Characteristics Thought to Account for Differences in Item Difficulty

Method

Instrument Design

Technology-based measurement techniques seem particularly suitable for the large-scale assessment of competencies in VET (see Winther & Klotz, 2013; Wu et al., 2015), because they allow occupational situations to be presented in a standardized manner (Seeber & Wittmann, 2017). Therefore, we provided the measurement instrument (ICCI-N) based on the previously outlined theoretical underpinning as a computer-based situational judgment test (SJT; e.g., Cabrera & Nguyen, 2001; Chan & Schmitt, 2005; Metcalfe & Dev, 2018). It contained scripted video vignettes (e.g., Hillen et al., 2013) showing authentic situations in which effective interprofessional collaboration can lead to improved fulfillment of objective nursing requirements, including situations related to the digital transformation.

In line with an evidence-centered design approach (ECD; see Mislevy, 2013; Mislevy et al., 2017), we conducted a *domain analysis* prior to modeling these situations and individual dispositions for mastering them (i.e., *domain modeling*). This allowed us to identify situations requiring interprofessional collaboration as well as competency demands placed upon students. This was accomplished in several studies (see Wittmann et al., 2024a): First, (1) we carried out a systematic literature review of existing empirical studies to clarify the state of research on the conceptualization and operationalization of nurses' or nursing students' IPCC (Striković & Wittmann, 2020). In addition, (2) we conducted analyses of the curricula for nursing education in German vocational schools and practice settings to identify interprofessional collaboration situations for ensuring curricular validity of the ICCI-N. Alongside the curricular analyses, (3) we chose a group Delphi interview study with ten representatives from nursing and educational sciences, schools, nursing practice, and regulatory policy as a further approach for developing typical collaboration situations of nurses and other health professions, as group dynamic processes can stimulate meaningful content-related aspects (de Meyrick, 2003; Niederberger & Renn, 2023).

We then used the findings from these studies to model the tasks of the ICCI-N. Following Haertel and Wiley (1993, p. 361), Mislevy et al. (1999) defines a task as a "goal-directed human activity to be pursued in a specified manner, context, or circumstance" (p. 5). In this sense, *task modeling* includes the framework for situations where subjects act, as well as considerations regarding item design, which should be based on theoretical and conceptual foundations (Mislevy et al., 1999; see also Seeber & Wittmann, 2017). Therefore, we based the situation modeling on assumptions about generalizable and interrelated characteristics oriented toward Hundenborn (2007): that is, care processes, institutional contexts, interaction structures, and objective nursing demands, as well as individual experience and processing (for an in-depth discussion, see Wittmann et al., 2024a).⁴ Taking these aspects

⁴ Some aspects of the ICCI-N addressed in this section have been published by Wittmann et al. (2024a), but in the German language. We include these for purposes of transparency and comprehensibility.

Table 1 Overview of the Institutional Fields of Practice and Situations in the ICCI-N

Field of practice 1: <i>Outpatient care</i>	Field of practice 2: <i>Nursing home</i>	Field of practice 3: <i>Hospital care</i>
1. Promoting needs-based care in the case of decubitus 2. Compensating staff absence through collaboration (duty scheduling) 3. Meeting care recipients' needs collaboratively using telemedicine	1. Promoting collaboration in case of client-oriented collaboration requirements 2. Considering care recipients' needs when handing them over to physiotherapy 3. Working toward a needs-based approach regarding nursing-induced risk assessment 4. Dealing with missing information concerning medication	1. Structured communication about care recipients' needs during admission 2. Communicating during the ward round while taking into account the care recipients' perspective 3. Effectively asserting the need for medical care in a life-threatening situation 4. Asserting the need for interprofessional care in the hospital context 5. Improving patient care through an interprofessional case review on the admission of a patient (with chronic pain)

into account, we developed scripts and had them checked by experts from science and practice (e.g., stereotyping and undue exaggeration) to ensure authenticity and validity before shooting the video vignettes with professional actors.⁵

In consideration of curricular validity, all situations were embedded in three typical institutional fields of care: (1) outpatient care, (2) nursing home for elderly individuals, and (3) hospital. Table 1 provides an overview of the curriculum- and content-validated institutional fields and situations (see Wittmann et al., 2024a). To balance the instrument in the context of traditional versus upcoming challenges of the digital transformation in nursing, two of the twelve situations were explicitly developed to consider the changing institutional and interactive context of nurses' work resulting from the digital transformation. Beyond the characteristics of the situation modeling, both situations are rooted in the digital transformation of the healthcare sector. The first situation, "Meeting care recipients' needs collaboratively using telemedicine" within the institutional context of outpatient care, deals with diabetes mellitus in conjunction with suspected alcohol abuse. Here, the inter-organizational division of labor in a general practice has changed due to a digital telemonitoring system and the use of a medical video consultation. This results in new interaction structures: On the one hand, the general practice presumably has automatically analyzed information that would not be available in non-digitalized settings. On the other hand, relevant additional information sensitive to the client is available only to the nurse, which should be communicated as effectively as possible in a new, jointly established communication arrangement, taking into account the information already available, both electronically in writing between the nurse and doctor and in virtual synchronous communication involving the patient. The second situation, "Dealing with missing information concerning medication," is located in an inter-organizational context and involves a phone call between a nurse working in a nursing home and a medical assistant working in a medical practice. Here, the correct medication is required, for which the nurse must receive a written medical order. The interaction structure is characterized by the need to carry out the care process in compliance with data protection regulations. Digital technology is included here in the form of classic digital practice information systems infrastructure.

To support the nursing students' immersion in the institutional fields, we presented each of them with a short introductory video portraying the work context, collaboration partners, and further relevant aspects of the test stimuli to follow. Three to five videotaped care situations, each approximately 70 s long, were then presented for each institutional field as stimuli for a set of adjoining test items (see Fig. 2). To identify items of the original version with low psychometric qualities, we conducted a pilot study asking 109 nursing students to respond to the computer-based test. We scaled the performance data using a one-dimensional partial credit model to iteratively select items on the basis of common and probabilistic fit indices, particularly item-total correlation (for the detailed procedure, see Wittmann et al., 2022a). In another validation study, eight nurses were involved in using thinking aloud and cognitive interviews administered at a

⁵ The video production was supervised by Ulrike Weyland and Larissa Wilczek at the University of Münster. The final video vignettes are available as an *open educational resource* at <https://videos.ekge.de/ipkk>.

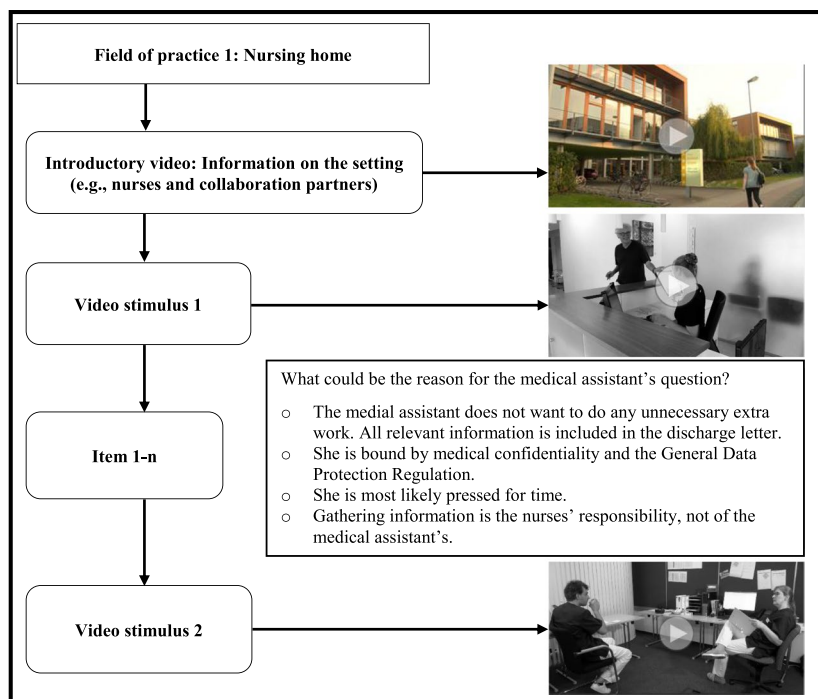


Fig. 2 Basic Test Flow and Exemplary Item Task

group level (see Wolcott & Lobczowski, 2021). This round included testing of the clarity of the items, linguistic comprehensibility, cognitive processes while responding, and so on. The feedback led to modest changes.

Congruent with typical nursing activities (Fichtmüller & Walter, 2007), the items include the selection of one of several possible situational or state appraisals (e.g., What is X's responsibility in this situation?), behaviors and action plans (e.g., How could nurse X respond to ...? How should nurse X, in your opinion, proceed/prioritize ...?), or interpretations and evaluations of observed behavior (e.g., What could be the reason ...?). To provide for standardized *scoring*, we designed item responses according to the guidelines of Haladyna et al. (2002) in closed format—either single-choice or true–false. The latter response format was used for items capturing multiple facets of IPCC.

Sample and Procedure of Data Collection

In order to conduct an in-depth analysis of the dimensionality and the influence of role-related task features on item difficulty, we used the data collected during the research project EKGe. The data were gathered from April to July 2021. The test takers used tablets and headphones, allowing them to watch the videos and complete the tasks at their own pace. Furthermore, we assembled various test booklets, each with different query sequences.

The test was taken by a total of 328 nursing students, most of them in their second year (see Table 2). While the “clinical nursing” and “nursing specialist” subsamples show a ratio that is identical to the national nursing student population, the whole sample skews toward “geriatric nursing” (55.5%, as opposed to 39.5% in national nursing student population data; Federal Statistical Office of Germany, 2021). With regard to the overall nursing student population, male student nurses were slightly underrepresented (25.1% in the overall nursing student population; Federal Statistical Office of Germany, 2021), and the youngest age group (< 21) was underrepresented (38.0% in the overall nursing student population; Federal Statistical Office of Germany, 2022), reflecting the comparatively older geriatric nursing subsample.

Overall, the respondents achieved an average of 19.9 points on the test out of a maximum of 45.0 possible points, which means that the test was rather difficult. A comparison of test results among the different specializations in nursing education indicates a better performance by students in clinical nursing: While they achieved an average of 22.8 points on the test, the geriatric nursing students (2nd year of nursing education: 19.3 points; 3rd year of nursing education: 20.1 points) and nursing specialists attained 19.4 and 17.6 points respectively, with the comparably lower test performance of the nursing specialist students likely being due to a shorter training period of this group at the time of the testing, as their training began 6 to 8 months later than training for geriatric nursing and clinical nursing.

Test Materials

The ICCI-N is comprised of 36 items, after the exclusion of six items due to an item-total correlation under 0.1. The remaining items with an EAP/PV reliability of 0.81 show satisfactory wMNSQ values ($0.86 < \text{wMNSQ} < 1.14$; see Gnamb & Nusser, 2019), largely acceptable t-values ($< |2.6|$; see Bond et al., 2020), and largely satisfactory item-total correlations (> 0.12) (for a comparable procedure for excluding items, see Wittmann et al., 2024a; 2022a). Of the remaining items, 28 were scored dichotomously (0 = incorrect, 1 = correct). Another four items offered a more differentiated estimation of IPCC, distinguishing between two different subdimensions

Table 2 Specializations in Nursing Education By Years of Nursing Education, Gender, Age Group, and Country of Birth (in Percentage)

Specializations in nursing education	Year of nursing education		Gender		Age group			Country of birth Germany	Total
	2nd	3rd	f	m	< 21	21–25	> 25		
Geriatric nursing	79.1	20.9	75.4	23.4	18.0	34.7	47.3	76.6	182
Clinical nursing	100.0	0.0	78.0	18.3	50.0	31.7	18.3	93.9	83
Nursing specialist	100.0	0.0	84.9	11.3	28.3	45.3	26.4	86.8	63
Total	88.4	11.6	77.8	19.9	28.5	35.8	35.8	83.1	328 ^a

Nursing specialist training began approximately six to eight months after the start of training in geriatric nursing and clinical nursing

^aFor $n = 26$ students, data on gender, age, and country of birth are missing

after theory-driven scoring (i.e., polytomous items). For the latter, local stochastic independence can be assumed, as the correlations under the control of the person's ability parameters are not significant (e.g., Christensen et al., 2017). Consequently, we separated the polytomous items of the ICCI-N by subdimension for the analyses of dimensionality and difficulty-generating features.

To estimate the influence of test subjects' subject-matter competence on item difficulty within the ICCI-N, we also used data from the sensitive TEMA-L for measurement of care recipient-oriented nursing competence; the structure and test implementation of the TEMA-L were similar to the ICCI-N (for details, see Kaspar et al., 2016; Wittmann et al., 2022a). After the exclusion of one item from the TEMA-L instrument due to its low item-total correlation, it was comprised of 35 items with an EAP/PV reliability of 0.63, which is unsuitable for individual diagnostic purposes but still useful for correlational analyses at the group level. The remaining items show satisfactory wMNSQ values ($0.91 < \text{wMNSQ} < 1.19$), largely acceptable t-values ($< |2.7|$), and largely acceptable item-total correlations (> 0.15). The TEMA-L consists of 26 dichotomous tasks and nine polytomous items, offering a more differentiated estimation of care recipient-oriented nursing competence.

Procedure of Data Analysis

To address our research questions, we used item response theory (IRT) modeling as a means of deriving estimates of student proficiency and item difficulty, which are linked on a unified interval (logit) scale (Wright & Stone, 1979). In this context, we scaled the performance data of the sample⁶ within the framework of a partial credit model (Masters, 1982, 1988) by using weighted likelihood estimation (WLE; Warm, 1989) in the IRT software ConQuest (Adams et al., 2020). Subsequently, we conducted model comparisons to examine whether a multidimensional structure of IPCC could be empirically reproduced (RQ1). Our role-theoretical model classifies the items of the test instrument into five dimensions: (1) knowledge about one's own nursing role, (2) knowledge about the occupational roles of the collaboration partners, (3) latent processes of role distance, (4) role-taking, and (5) care recipient-oriented role coordination. As the first two dimensions constitute knowledge about occupational roles and the last three dimensions represent individual abilities concerning occupational roles (Striković & Wittmann, 2022; see also Kanning, 2009), we additionally assume a two-dimensional model to be reasonable, particularly as evidence on subject-matter competence in different VET domains often supports a discrimination of knowledge and ability (see, e.g., Norwig et al., 2017; Nickolaus et al., 2010). We examined dimensionality by comparing the fit indices of the five-dimensional model (see Fig. 3, right panel) and the two-dimensional model (see middle in Fig. 3) with a one-dimensional model (see Fig. 3, left panel) that is also in line with our role-theoretical model, in which some of the concepts presuppose other concepts. The deviance is used to evaluate model fit.

⁶ The dataset is available at https://doi.org/10.5159/IQB_EKGe_v1 (Wittmann et al., 2024b).

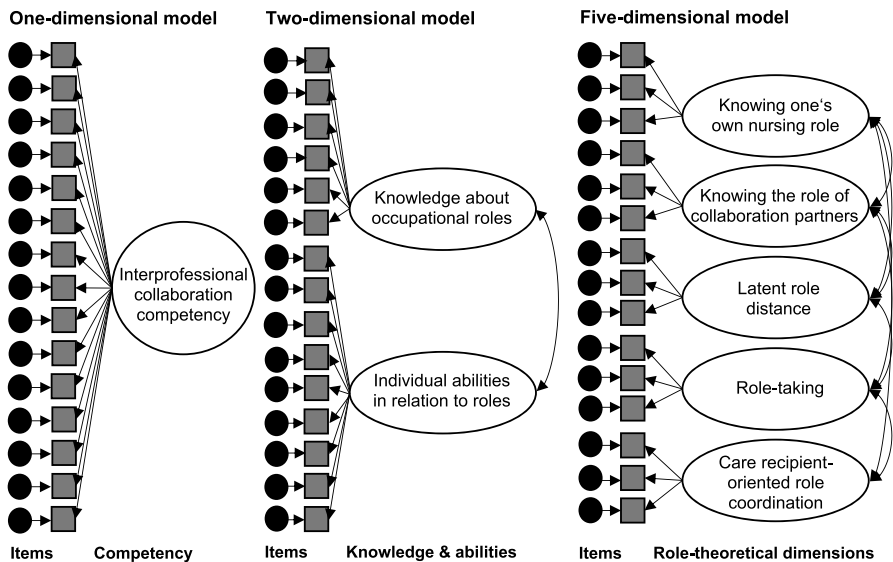


Fig. 3 One-, Two-, and Five-dimensional Models of IPCC

For the model of preference, we then used Rasch scaling to determine the difficulty parameter σ_j for each item j , which defines the items' location on the logit scale. On this basis, we examined through Hartig's (2007) procedure to what extent our task features contributed to item difficulty (RQ2). For this purpose, all items were scored according to their task characteristics. Here, the levels of the task characteristics are expressed in such a way that the numerical coding is assumed to have a positive correlation with task difficulty. If a task characteristic has two levels (e.g., hierarchy), the one that is assumed to be more difficult is coded as 1 (e.g., upward hierarchy), and the easier one is coded as 0 (e.g., lateral hierarchy). For characteristics with more than two levels, the respective levels are transferred to dummy variables, which take values of 0 and 1. For instance, a three-level task characteristic such as the number of collaboration partners N is divided into two dummy variables, one for the (non)existence of the presumable medium level of difficulty ($N=2$) and one for the (non)existence of the most difficult level ($N>2$).

We used an additive and linear regression model to predict empirical item difficulties (dependent variable) as a linear function of item characteristics (independent variables). As standardized regression weights offer better comparability, we drew upon them to determine whether the theoretically derived gradations regarding the prediction of item difficulty by the task characteristics can be empirically supported

(e.g., Behrendt et al., 2015; Ehninger et al., 2022).⁷ Consistent with the IRT scaling, the item difficulty values used were those on the competence scale at which the nursing students had a 50% probability of solving the respective task (e.g., Klotz, 2015; Wiethe-Körprich & Bley, 2017). Furthermore, we checked whether the independent variables show multicollinearity. The variance inflation factor had to be smaller than 5.

For further elaboration of our method, we refer to the descriptive statistics in Table 7 (see Appendix), showing the logit means, item ranges, and the standard deviations of subscales differentiated according to our task features (see Fig. 1). While the central tendencies (logit means) of the subscales all lie within the item ranges—that is, the differences in the subscale difficulties are not due to floor or ceiling effects—it also becomes apparent that the nursing students showed an unexpected proficiency level on some subscales. For instance, the nursing students have a higher proficiency level on the subscale “Care-recipient oriented role coordination” than on the remaining role-based subscales, except for “Knowing one’s own nursing role.” In light of this, it seems reasonable to measure/code further variables in addition to the task features.

One variable thought to account for the effect of task features on item difficulty within the ICCI-N is subject-matter competence. Given that the WLE person ability parameters derived from the TEMA-L measuring care recipient-oriented nursing competence and the ICCI-N are strongly and significantly correlated ($r=0.52$; $p<0.001$), the two competencies indeed appear to be intertwined (see Seeber & Wittmann, 2017). To operationalize the role of care recipient-oriented nursing competence in solving the respective ICCI-N items, we coded the correlations between the WLE person ability parameters in TEMA-L and the solutions for each ICCI-N item as follows: n.s. = 0; $r<0.2=1$; $0.2\leq r\leq 0.3=2$; $r>0.3=3$ (see Gignac & Szodorai, 2016).

Beyond solutions based on intended dispositions, task features irrelevant to the construct could also affect item difficulty; in particular, this may be the case when the individual prerequisites for solving the task *lege artis* are (largely) lacking (Abele, 2018; Förster et al., 2017; Heinrichs, 2016; Nickolaus, 2016). For instance, in our think-aloud validation study, participants used intuition, guessing (see also Förster et al., 2017; Harteis & Billett, 2013; Heinrichs, 2016), or (mis)inferences based on daily life experiences from professional practice (see Abele, 2016; Nuthall & Alton-Lee, 1995; Miller et al., 1968). As these solution approaches can hardly be influenced by task modeling, nor can they be coded or controlled for the quantitative analysis of difficulty-generating features, they are beyond the examination’s scope. However, two participants reported during the cognitive interviews that they chose the longest response option if intended dispositions were unavailable. Such a response pattern for items where the longest

⁷ Alternatively, modeling through a linear logistic test model (LLTM) is possible, where, simultaneously with Rasch modeling, task difficulty is estimated as a linear combination of task features (Embretson, 1998). However, the LLTM assumes that task features can almost perfectly explain item difficulties (Hartig et al., 2012). This seems unlikely in most cases—especially with regard to the relatively less advanced empirical research on features influencing difficulties of items for assessing social competence.

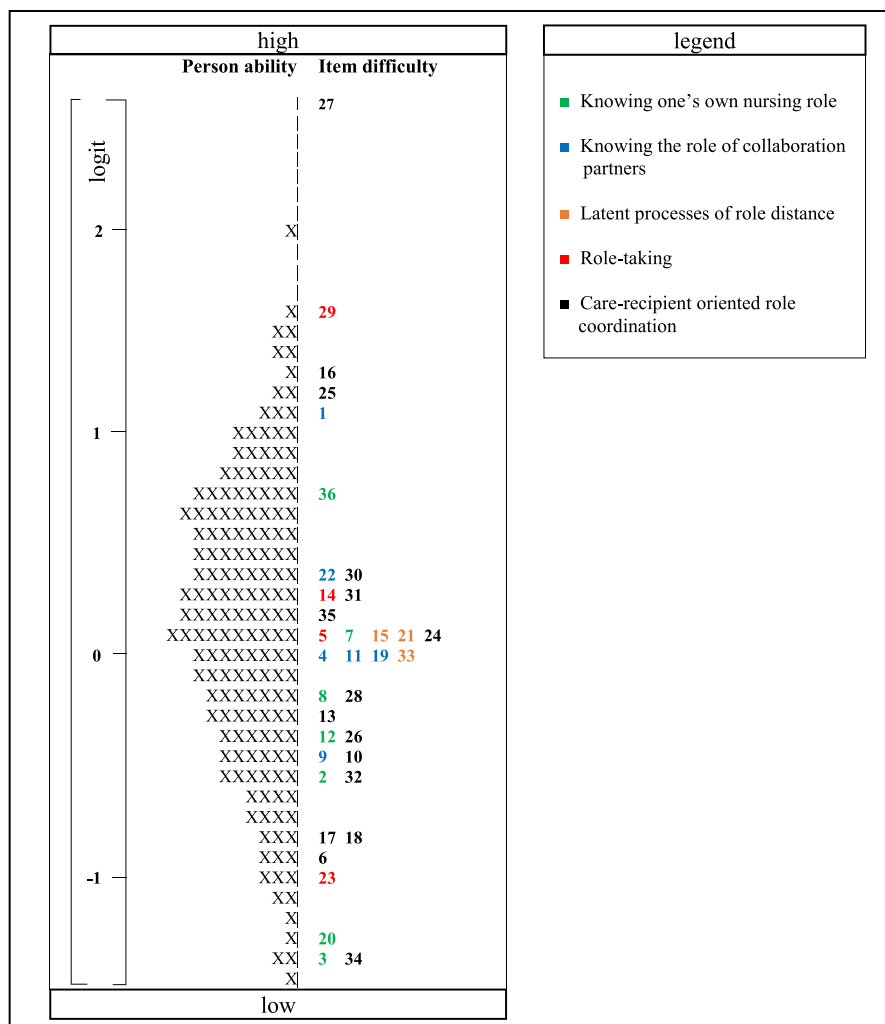


Fig. 4 Wright Map (Note: Each X Represents 1.9 Cases.)

response option is correct can decrease the item difficulty. For instance, items 10, 13, 17, 18, and 34, targeting care recipient-oriented role coordination, exhibit unexpectedly low positions on the logit scale (see Wright map in Fig. 4) and have correct response options with at least five words more than the longest incorrect response option. We used this figure to code the ICCI-N items (text length difference between correct and longest incorrect response option ≥ 5 words = 1; otherwise = 0), in addition to the role-theoretical requirements, the number of collaboration partners, hierarchy, and the influence of care recipient-oriented nursing competence. Codings of the items with regard to the independent variables are presented in Table 8 (see [Appendix](#)).

Table 3 Number of Items, Intercorrelations, and Reliabilities for the Subdimensions of the Role-theoretical Model (5-dimensional)

Subdimensions	1	2	3	4	n items	Reliability (EAP/PV)
1. Knowing one's own nursing role	–				7	0.64
2. Knowing the role of collaboration partners	0.85	–			6	0.69
3. Latent processes of role distance	0.80	0.84	–		3	0.66
4. Role-taking	0.67	0.80	0.73	–	4	0.60
5. Care recipient-oriented role coordination	0.88	0.92	0.84	0.82	16	0.74

Results

Dimensional Structure

We ran model comparisons to examine whether the role-theoretically assumed multidimensional models could be empirically represented with the data. Table 3 provides information on the number of items in each subdimension, the subtest reliabilities, and the intercorrelations of the five subdimensions. Most subtest reliabilities of the ICCI-N are questionable—except for care recipient-oriented role coordination, which achieved an acceptable EAP/PV reliability. This could partially be due to the relatively low number of items of these four test components. Additionally, in the dimensions “Knowing one’s own nursing role,” “Knowing the role of collaboration partners,” and “Role-taking,” one item each has a lower item total correlation than 0.2 but was retained for reasons of curricular and content validity. While the predominantly low subtest reliabilities argue against treating the subdimensions as separate test components (Striković et al., 2022), the intercorrelations are also high, especially for “Care recipient-oriented role coordination” and “Knowing the role of collaboration partners.”

Table 4 provides information on the number of items, the subtest reliabilities, and the intercorrelations in the two-dimensional model. Again, both dimensions achieve questionable to acceptable EAP/PV reliabilities. Their high intercorrelation of 0.93 indicates that separation hardly provides any additional insights into the test takers’ existing or deficient capabilities. Hence, our analyses favor the one-dimensional model.

Table 1 shows the results of model comparisons. The deviances of the two- and five-dimensional models are slightly lower than that of the one-dimensional model.

Table 4 Number of Items, Intercorrelations, and Reliabilities for the Subdimensions of the Model Differentiating Knowledge and Abilities Related to Roles (2-dimensional)

Subdimensions	1	2	n items	Reliability (EAP/PV)
1. Knowledge about occupational roles	–		13	0.66
2. Individual abilities in relation to roles	0.93	–	23	0.74

Fit Indices of Dimensional Analyses to the ICCI-N

	1-dimensional	2-dimensional	5-dimensional
Reliability (EAP/PV)	0.81	0.66/0.74	0.64/0.69/0.66/0.60/0.74
Deviance	13581.22	13576.86	13573.09
Estimated number of parameters	38	40	52
Difference (from the 1-dimensional model)		4.36 at 2 df; $p = 0.11$	8.13 at 14 df; $p = 0.88$

However, the differences between the one-dimensional and the multidimensional models are not significant; neither the two-dimensional ($p=0.11$) nor the five-dimensional model ($p=0.88$) provides a superior representation of the empirical data. Concerning the fit indices and the limitations presented, the more parsimonious one-dimensional model, showing a good EAP/PV reliability of 0.81, is empirically preferable.

Hence, the empirical model does not allow for differentiating IPCC profiles with respect to the theoretically assumed multidimensional structures. Theoretically, however, high intercorrelations seem plausible with regard to the underlying inclusive relations between the role-theoretical concepts in our modeling, where, for example, care recipient-oriented role coordination requires knowledge of the occupational role of collaboration partners, meaning that the one-dimensional model seems in line with our theoretical assumptions. The question then arises as to what role role-related concepts could play within a one-dimensional model, potentially underlining the relevance of the model and its concepts for usage in instruction. Subsequently, we investigate this question with regard to the influence of role-related task features on item difficulty.

Role-related Task Features Determining Item Difficulty

Table 5 shows the estimation of the predictive power of all task features (i.e., adjusted R^2) and the effects of each task feature on item difficulty on the basis of a linear additive regression analysis. All four dummy variables of the role-based requirements are significant at least at $p < 0.05$, with care recipient-oriented role

Table 5 Regression weights for predictors of item difficulty in the ICCI-N

Adj. $R^2=0.315$	b	SE	β	p
Constant	-0.334	0.370		.38
Role-based requirements				
Knowing the occupational roles of the collaboration partners	0.835	0.394	.376	< .05
Latent processes of role distance	1.248	0.539	.417	< .05
Role-taking	1.111	0.455	.422	< .05
Care recipient-oriented role coordination	1.021	0.348	.613	< .01
Hierarchy	-0.420	0.253	-.252	.11
Number of collaboration partners N				
$N=2$	0.460	0.258	.278	.09
$N>2$	1.506	0.452	.572	< .01
Subject-matter competence	-0.432	0.152	-.444	< .01
CV: Difference in text length between correct and longest incorrect answer option ≥ 5 words	-0.481	0.285	-.260	.10

b represents unstandardized regression weights, β indicates the standardized regression weights. Standardized regression weights in bold font style are significant at least at $p < .10$. This cutoff is typical of comparable studies on difficulty-determining variables of competence assessments (e.g., Behrendt et al., 2015; Klemenz et al., 2019; Klotz et al., 2015; Wiethe-Körprich & Bley, 2017)

coordination being the strongest predictor ($\beta=0.613$), followed by role-taking ($\beta=0.422$), latent processes of role distance ($\beta=0.417$), and knowledge about occupational roles of the collaboration partners ($\beta=0.376$). The number of collaboration partners N proves to be explanatory as well ($\beta=0.278$ for $N=2$; $\beta=0.572$ for $N>2$). In the case that the nurse has to collaborate with two healthcare professionals ($p=0.09$), the value is significant only at the level of 10%. The influence of the hierarchy variable unexpectedly shows a negative figure ($\beta=-0.252$); however, it is above the 10% level of marginal significance ($p=0.11$). Moreover, items of the ICCI- N were easier to solve for test subjects with high subject-matter competence ($\beta=-0.444$). The effect is significant at $p<0.01$. With regard to the control variable ($\beta=-0.260$), we found that item difficulty decreased when the correct answer option contained at least five more words than the most extended incorrect answer option—though slightly above the alpha level of 10% ($p=0.104$).

The specified model explains 31.5% of the total variance ($F=2.79$; $p=0.02$). While this constitutes a relatively low value compared to other studies on competence measurement in VET (adj. R^2 between 0.28 and 0.77), the comparison should be interpreted with caution, because these studies neither address social competencies nor focus on the domain of nursing (e.g., Nold et al., 2008; Norwig et al., 2017; Seeber, 2005; Winther, 2010). Furthermore, our model meets the assumption of non-multicollinearity, as the variance inflation factor (1.18–2.22) indices for all predictors do not show critical values.

Discussion of Findings and Limitations

In our empirical study, we confronted 328 nursing students with a computer-based SJT to assess their IPCC. With the role-theoretical foundation of COCC as its basis, our operationalization takes into account the state of research, while at the same time addressing the research gap of missing consistent conceptual development and operationalization. On the one hand, we used the performance data to analyze whether a five-, two-, or one-dimensional structure should be empirically preferred (RQ1). On the other hand, we examined to what extent our operationalized task features—that is, role-based requirements, hierarchy, and number of collaboration partners—contribute to item difficulty (RQ2). This section discusses the empirical findings.

Dimensional Structure (RQ1)

Regarding the first research question, the paper presented here provides an evaluation not only of the role-theoretically derived five-dimensional structure but also of a role-theoretically plausible two-dimensional structure categorizing the five subdimensions according to (1) knowledge about occupational roles and (2) individual abilities in relation to roles (Striković & Wittmann, 2022). A distinction between knowledge and ability such as that made here is often found in the evidence on subject-matter competence in different VET domains (see, e.g., Norwig et al., 2017; Nickolaus et al., 2010). However, the model comparisons of the five-, two-, and

one-dimensional models suggest that IPCC can be considered a unidimensional vector score with a good EAP/PV reliability of 0.81.

Indeed, we already argued that it remains unclear how multidimensional modeling holds empirically, as this might also depend on the extent to which this kind of role construct-related knowledge is actively taught in VET (Striković & Wittmann, 2022). Against this background, future studies could investigate whether a multidimensional structure would be empirically tractable if the students first participated in an instruction program aligned with the role-theoretical subdimensions. Furthermore, it cannot be ruled out that the dimensionality found in our study is an artifact of the way the test was provided and its design factors, even though different test booklets with varied sequences and local stochastic independence were ensured. However, it was not possible to consider associated individual item response patterns due to the limited sample size, consisting of nursing students predominantly in their second year of training (see Kaspar et al., 2016). It should be noted that five items showed a rather low item total correlation between 0.12 and 0.20; they were not removed for ensuring curricular and content validity. Against this background, reliability optimizations could produce a different empirically preferred dimensionality. The reliability of the findings would also benefit from analyses of the diagnostic quality of the items at different points of training during nursing education.

If the one-dimensional solution is preferable even in these cases, one reason could be that the subdimensions are intermingled in nurses' real-life actions and therefore cannot be represented as separate test components or analytically separated in the empirical data, an assumption that would be fully in line with our theoretical assumptions about how the role-related concepts are hierarchically aligned in determining task difficulties (see Striković & Wittmann, 2022). However, the question arises as to what role role-related concepts could play within a one-dimensional model, potentially underlining the relevance of the model and its concepts for usage in instruction.

Role-related Task Features Determining Item Difficulty (RQ2)

Therefore, concerning the second research question, we used a multiple linear regression analysis to determine the effect of task features on item difficulty. It was possible to specify predictors of item difficulty in line with most of our theoretical assumptions. Our findings show that two kinds of the role-theoretical task features—"role-based requirements" and "number of collaboration partners"—predict differences in item difficulty. A theoretically significant result concerns the task characteristics of the first aspect, whose standardized regression weights show a difficulty alignment in line with our theoretical reasoning; the same applies to the number of collaboration partners.

However, the range of item solutions related to the respective role-based requirements is broad. One explanation we consider likely for this is that items vary in difficulty depending on familiarity with the requirement, even when referring to identical role-related concepts. Although it is not deliberately operationalized, this

task characteristic can be illustrated by two items targeting care recipient-oriented role coordination, both related to the same situation of missing information on medication: Item 26 asks for a presumably familiar course of action in order to obtain a missing discharge report for a specific patient in a manner compliant with data protection and legal requirements. As expected, this item shows a lower difficulty for the nursing students. In contrast, item 27 shows the highest difficulty, contributing substantially to the high difficulty range of care recipient-oriented role coordination (see Wright map in Fig. 4). Contextualized in the digital transformation, this item involves the complete identification of the solution space, including inter-organizational approaches for changing nursing home standards to enable improved collaboration under the General Data Protection Regulation. We assume that nursing students would tend to be unfamiliar with this requirement (see Wittmann et al., 2024a).

The task feature “hierarchy” shows a negative regression weight. This is surprising, as we expected a positive figure. This contradictory result could be an artifact of the test design, because real collaborative situations with an “actual” person cannot be represented in a SJT (see Hartmann et al., 2023). Moreover, lateral collaboration may not be given the same curricular importance as collaboration and communication with physicians. However, it should be noted that the effect of the variable on item difficulty is not significant.

Furthermore, our regression model included subject-matter competence, focusing on an often neglected aspect: the relationship between IPCC as a social competency of nursing professionals and care recipient-oriented nursing competence as an approximation to subject-matter competence. The results show that this variable had a significant confounding effect, indicating that items tended to be easier to solve by persons with higher care recipient-oriented nursing competence. This corresponds to Seeber and Wittmann’s (2017) argument that adjusting to and interacting competently in different social situations in healthcare requires nurses to thoroughly understand care needs.

Furthermore, it is conceivable that nursing students may also draw upon unintended individual resources. As an outcome of cognitive interviews, we included the formal task characteristic “Difference in text length between correct and longest incorrect answer option” as a control variable. Despite barely missing the level of marginal significance, this draws attention to an at least potentially relevant task feature that should be considered in future test designs—even beyond the domain and competency focused on in this study.

As the variance explained by the task characteristics included in the present study remains rather low ($\text{adj. } R^2 = 0.315$), future studies might search for additional predictors that might allow for the identification of proficiency levels (i.e., scale anchoring).

In addition to the specific limitations with regard to our two research questions, there are also more general issues that limit the generalizability of our findings and hence indicate a necessity for future research within the field of nursing. It must be emphasized that the predictive power of task features and dimensionality is linked to the (1)

sample and (2) test material of the study (see Hartig, 2007; Schumann & Eberle, 2011). With this in mind, replications seem unavoidable: (1) As our sample is restricted predominantly to the second year of training, further studies with different samples will need to stabilize (or modify) our findings. Furthermore, (2) a higher number of items, especially for latent role distance and role-taking processes, would have been preferable. Moreover, the single-choice and true-false item formats only require a selection—that is, no real acting. In order to achieve a more authentic assessment, open answers would be suitable. We decided against such a format on behalf of test economy and reliability, the objectivity of the results, and the heterogeneous language skills in German nursing education. Nevertheless, it would be desirable for further studies with an extended or new item pool to evaluate the generalizability of our findings.

However, the present study facilitates communication about the difficulty-determining features in diagnosing COCC for the field of nursing and should be seen as the first approach in this field. Besides this, alternative modeling would also be conceivable: Although COCC in our model is cognitive in the narrow sense, its role-theoretical concepts offer the potential for integrating moral and emotional concepts in future research—such as emotion-related role-taking, role-related ambiguity tolerance, or role-related self-efficacy (see Striković & Wittmann, 2022).

Significance Regarding Cross-occupational Collaboration and Instruction

As the digital transformation enhances the importance of cross-occupational collaboration beyond the healthcare sector, future studies should possibly also focus on other professional and vocational domains. While this may primarily concern other professions in the social and healthcare field, we argue that this should also be the case in business and technical areas, where authentic workplace requirements include situations of collaboration with actors less related to one's own vocational, professional, or occupational fields. This may also be expected to uncover further task characteristics determining difficulty (Nickolaus, 2016). Specifically, familiarity with situational requirements could be relevant across professional and vocational domains, while unfamiliarity might be a considerable feature of the digital transformation.

Moreover, aspects influencing difficulty are significant for education and instruction, as it is possible to create potential barriers in the educational process by varying the task characteristics in a targeted manner, allowing COCC to be both evaluated and promoted more systematically. Instructionally, empirical investigations into item difficulty could provide significant evidence as to which situational requirements are particularly suitable for creating barriers that can still be mastered by students in the context of VET and professional education. Despite certain limitations, we suggest that the value of the present analysis lies in its focus on COCC as a social but subject-matter-related competency—implying substantial knowledge of roles—for which the evidence has been relatively weak so far. The results provide insights into difficulty-determining task characteristics that could be relevant for assessing COCC in other professional and vocational domains as well.

Conclusions

In the digital transformation, cross-occupational and interdisciplinary collaboration has become increasingly important for VET. This is also true of the healthcare sector, where discussions on interprofessional collaboration already have a long tradition. How related competencies of COCC can be modeled, operationalized, and facilitated is therefore significant to VET. We proposed and tested a role-theoretical model in non-academic nursing education, using data from a situational judgment test on IPCC. While our results favor a unidimensional approach to modeling the overall competency, they support the theoretical consideration that the five role-theoretical components outlined in our model of COCC exhibit an influence on item difficulty. The identified task characteristics can be crucial both in developing future tests or further items and subsequently in considering instructional task design. While our results should be viewed as a first approach to empirically modeling difficulty-determining task features in the area of COCC, they also provide support for the value of the role-theoretical model and open up lines of further investigation, such as the use of the findings on difficulty-determining task features for instructional purposes or the empirical application of the model in other vocational and professional domains.

Appendix

Table 7 Logit Means, Item Ranges, and Standard Deviations of the Role-theoretical Task Features

Subscales	Logit mean	Item range	Standard deviation
Role-based requirements			
Knowing one's own nursing role	0.544	$-0.973 \leq x \leq 1.188$	1.053
Knowing the role of collaboration partners	0.001	$-0.593 \leq x \leq 0.941$	1.024
Latent processes of role distance	0.073	$-0.090 \leq x \leq 0.080$	1.187
Role-taking	-0.057	$-1.255 \leq x \leq 1.356$	1.210
Care recipient-oriented role coordination	0.126	$-1.441 \leq x \leq 2.654$	0.993
Number of collaboration partners			
$N=1$	0.525	$-1.013 \leq x \leq 1.601$	1.018
$N=2$	0.006	$-1.043 \leq x \leq 2.446$	0.863
$N>2$	-0.357	$-0.440 \leq x \leq 0.590$	0.986
Hierarchy			
Lateral	0.074	$-1.420 \leq x \leq 2.495$	0.808
Upward	0.216	$-1.291 \leq x \leq 1.735$	0.951

Table 8 Codings of Items Concerning All Task Features

Item	Knowing the occupational roles of the col-laboration partners	Latent processes of role distance	Role-taking	Care recipient-oriented role coordination	Hierarchy	N col-laboration partners		Difference in text length between correct and longest false response ≥ 5 words	Correlations with care-recipient oriented nursing competence
						$N=2$	$N \geq 2$		
01	1	0	0	0	1	0	1	0	2
02	0	0	0	0	1	1	0	0	0
03	0	0	0	0	0	0	0	0	2
04	1	0	0	0	0	0	0	0	1
05	0	0	1	0	0	0	0	1	1
06	0	0	0	1	1	1	0	0	1
07	0	0	0	0	0	0	1	0	2
08	0	0	0	0	0	1	0	0	2
09	1	0	0	0	0	1	0	0	2
10	0	0	0	1	1	1	0	1	0
11	1	0	0	0	0	1	0	0	0
12	0	0	0	0	0	1	0	1	0
13	0	0	0	1	0	1	0	1	1
14	0	0	1	0	0	1	0	0	2
15	0	1	0	0	0	1	0	0	2
16	0	0	0	1	0	1	0	1	1
17	0	0	0	1	0	0	0	1	2
18	0	0	0	1	1	0	0	1	2
19	1	0	0	0	1	1	0	1	1
20	0	0	0	0	1	0	0	0	1
21	0	1	0	0	1	0	0	0	2
22	1	0	0	0	0	0	0	0	2
23	0	0	1	0	0	0	0	0	2
24	0	0	0	1	0	0	0	0	0
25	0	0	0	1	0	0	0	0	1
26	0	0	0	1	0	0	0	0	2
27	0	0	0	1	0	1	0	0	0
28	0	0	0	1	0	0	0	0	2
29	0	0	1	0	1	1	0	0	0
30	0	0	0	1	1	1	0	0	2
31	0	0	0	1	1	1	0	0	2
32	0	0	0	1	1	1	0	1	2
33	0	1	0	0	1	1	0	0	2
34	0	0	0	1	1	0	0	1	1
35	0	0	0	1	1	0	1	0	3
36	0	0	0	0	1	0	1	0	0

Code availability Not applicable.

Authors' Contributions Aldin Striković conceptualized the study, initiated the analyses, wrote the manuscript, and contributed substantially to interpreting the data. Philine Krebs performed the statistical analyses with the assistance of Aldin Striković. Eveline Wittmann suggested the analyses, provided guidance throughout, and revised the manuscript. All authors read and approved the final manuscript.

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Data Availability The dataset used and analysed are available at https://doi.org/10.5159/IQB_EKGe_v1.

Declarations

Ethics Approval and Consent to Participate The study has been approved by the Ethics Commission of the University of Göttingen.

All participants provided consent.

Competing Interests The funding body did not interfere with the study's design, collection, analysis, and interpretation of data or writing of the manuscript.

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