

Acquisition and Promotion of Critical Online Reasoning Skills –  
Analyses among Students in Professional/Practical Year/Studies in Medicine, Law,  
and Teaching

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ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING

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## ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING

**Dedication**

I dedicate this thesis to Lucy, my most loyal little companion. You've been by my side day and night, listening to me and giving me comfort when I needed it most. Thank you for your unconditional love. I will love you forever, until we meet again.

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Firstly, I want to thank my wonderful parents. Ever since I was little, you've provided me with support to achieve my personal best. You've given me the opportunity to select my educational path, and I am truly grateful for this privilege and for having such a loving home. I thank my two older brothers, who taught me resilience and always believed in me. In particular, my brother Niko, a physician who inspired me to write this dissertation and with whom I can share my enthusiasm for science. I would like to express my profound gratitude to my partner Kiru, my most dedicated cheerleader. The patience, affirmation, love, and guidance you provide are beyond measure. Thank you also to your loving family, who are always there for me.

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### Summary

**English:** This dissertation explores the development and promotion of critical online reasoning (COR) skills among medical students in their clinical year, as well as law and teacher education trainees in Germany. Given the challenges posed by digitalization and the accompanying increase in online information, the ability to identify and critically evaluate trustworthy information is deemed essential for evidence-based practice in these professions. Through four sub-studies, the current state of COR competencies, as well as the need and feasibility of targeted digital training interventions, are examined. The findings highlight the necessity for better integration of COR into academic curricula and indicate that targeted digital training programs can be promising approaches to enhancing these skills.

**Deutsch:** Diese Dissertation untersucht die Entwicklung und Förderung von Kompetenzen im kritischen Umgang mit Online-Informationen (Critical Online Reasoning, COR) unter Medizinstudierenden im praktischen Jahr sowie Studierenden der Rechtswissenschaft und Lehramtsstudierenden in Deutschland. Angesichts der Herausforderungen, die die Digitalisierung und der damit einhergehende Anstieg an Online-Informationen mit sich bringen, wird die Fähigkeit, vertrauenswürdige Informationen zu identifizieren und kritisch zu bewerten, als essentielle Kompetenz für das evidenzbasierte Arbeiten in diesen Berufsfeldern angesehen. In vier Teilstudien wird der gegenwärtige Stand der COR-Kompetenzen sowie der Bedarf und die Machbarkeit gezielter digitaler Trainingsmaßnahmen untersucht. Die Ergebnisse unterstreichen die Notwendigkeit einer besseren Integration von COR in die Studiencurricula und zeigen, dass gezielte digitale Trainingsprogramme vielversprechende Ansätze zur Förderung dieser Kompetenzen bieten können.

## ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING

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## List of Abbreviations

ÄApprO	Approbationsordnung für Ärzte <i>(Licensing Regulations for Physicians)</i>
AI	Artificial Intelligence
BRIDGE	Berufspraktische Bildungsprozesse im Recht- und Lehramtsreferendariat sowie der Medizin unter Nutzung digitaler Medien <i>(Practical Educational Processes in Medicine, Law, and Teaching Using Digital Media)</i>
COR	Critical Online Reasoning
CR	Clinical Reasoning
EbM	Evidence-based Medicine
EPA	Entrustable Professional Activity
GUI	Graphical User Interface
ICT	Information and Communication Technology
NKLM	Nationaler Kompetenzbasierter Lernzielkatalog <i>(National Competence-Based Catalog of Learning Objectives)</i>
PJ	Praktisches Jahr <i>(Final Year)</i>
SERP	Search Engine Results Page
QCA	Qualitative Content Analysis
WBT	Web-based Training

## **1 Introduction**

### **1.1 Relevance and Challenges in Dealing with Online Media and Internet Use in Medical Practice**

The digitalization process of recent decades has integrated the Internet and digital technologies into everyday life, significantly influencing learning and professional processes (Hans & Crasta, 2019). This transformation has led to an ever-expanding information landscape, facilitating convenient, rapid, and location-independent access to a vast number of online resources (Szymkowiak et al., 2021). Notably, the Internet has become a predominant source of information for students and young professionals in both formal and informal learning environments (Grothaus, 2021; Ugur, 2020), gradually surpassing traditional university resources such as textbooks (Maurer, 2020; Newman and Beetham, 2017; Zlatkin-Troitschanskaia et al., 2021a).

While the abundance of online media provides immediate access to diverse information at minimal expense (Braasch, 2018), it also presents significant challenges. The substantial volume of low-quality information poses risks and obstacles to decision-making and acting when utilizing Internet sources (Batista et al., 2022; Walton et al., 2020; Maurer et al., 2018). This is compounded by the frequent lack of trustworthiness, completeness, accuracy, or objectivity in online information (Zhang & Ghorbani, 2019; Carbonell et al., 2018). As a result, users commonly encounter challenges in evaluating the quality of online content, often experiencing a sense of overwhelm attributed to ‘information overload,’ which can negatively affect their professional judgement and actions (Feroz et al., 2022; Schoor et al., 2020; Hahnel, 2019). The capacity to assess the credibility of online media has thus become a crucial ‘cultural-technical skill’ in the 21st century, which is indispensable for success in several professions (Osborne et al., 2023; Machete & Turpin, 2020; Redecker, 2017). This accounts especially for professions in which evidence-based decision-making and acting are essential in practice, such as medicine, law, and teaching (Kuhn et al., 2020; Drapezo et al., 2022; Vaskov et al., 2021).

At the same time, higher Internet use does not automatically imply higher competency in successfully managing online information (Wineburg et al., 2018; Weber et al., 2019). Despite being labeled as ‘digital natives’ due to their regular use

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING of digital devices and Internet browsing from a young age (Taylor, 2012; Osborne et al., 2022), today's university graduates and young professionals often demonstrate inadequate skills in evaluating the credibility of online media (McGrew & Chinoi, 2022; Breakstone et al., 2021; Ziv & Bene, 2022; McGrew et al., 2018; Wineburg & McGrew, 2018; Zlatkin-Troitschanskaia et al., 2021a). For example, they fail to examine the source's authorship, misinterpret the underlying intentions, or rely on irrelevant factors such as website design or search engine authority (Wineburg & McGrew, 2019; Klawitter & Hargittai, 2018). The competent handling of online information is imperative for effective decision-making and acting using Internet sources (McGrew & Byrne, 2020; McGrew et al., 2017). Achieving proficiency in these underlying skills requires systematic training in searching for, critically evaluating, and reasoning with high-quality information (McGrew & Kohlen, 2024; Axelsson et al., 2021). In the following dissertation, this skill set is defined as 'critical online reasoning' (COR; Molerov et al., 2020; Nagel et al., 2022; the COR framework will be further elaborated in Section 2.3).

Especially for students and young professionals in (human) medicine, COR-related skills are progressively gaining significance (Mesko & Györfly, 2019). Since the medical field is characterized by a constantly and rapidly changing information environment (O'Carroll et al., 2015), physicians increasingly use the Internet to remain informed about current clinical studies and research findings (Zhou et al., 2020; Rott, 2014). Online information is thus relevant for physicians as they need up-to-date research results to draw up high-quality diagnoses and treatment plans (Kuhn et al., 2020). However, the integration of online information into clinical decision-making processes presents challenges, including adeptly navigating search engines and online databases for diagnostic investigations and processing the abundance of medical data online (Jorzig & Sarangi, 2020). These challenges mirror broader digital transformations currently taking place in healthcare, which demand an augmented skill set from today's medical workforce (Menvielle et al., 2018). Consequently, high-quality patient care requires (prospective) physicians to be able to access, select, and evaluate relevant online information for the diagnostic procedure based on given symptoms while simultaneously integrating new research findings into their considerations (Mesko & Györfly, 2019; Frank et al., 2010).

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Physicians frequently encounter difficulties in staying updated on current diagnostic and treatment guidelines and publications, citing information overload as a primary impediment (Hawinks et al., 2021). These difficulties are often linked to a perceived deficiency in relevant skills within medical education curricula (Haag et al., 2018; O'Carroll et al., 2015), which consequently leads to students and young medical professionals to express feeling inadequately prepared for the digital demands of modern medical practice (Hawkins et al., 2021; Zlatkin-Troitschnanskaia et al., 2021b). Considering the challenges posed by the digitalization of health care, the development of a skill set enabling physicians to critically reason and argue based on online information is regarded as fundamental (Obermeyer & Lee, 2017). Accordingly, targeted educational interventions within medical faculties are imperative to equip graduates with the essential competencies for evidence-based decision-making (Timmer et al., 2021) in the digital age.

### **1.2 Research Objective and Dissertation Structure**

Given that COR-related skills constitute a central aspect of practical relevance in medicine, it prompts inquiry into whether and to what extent these skills can be and are currently being fostered through professional education and practice (Zlatkin-Troitschanskaia et al., 2021b). Recent studies have indicated the possibility of cultivating such skills within higher education (McGrew et al., 2019; Weber et al., 2018; 2019). Despite efforts to integrate such skills into medical education, however, deficiencies persist, leaving graduates unprepared for the complexities of contemporary medical practice (Jünger, 2023; Haag et al., 2018; Watson & Burr, 2018; O'Carroll et al., 2015). In addition, despite their high practical relevance, there is limited evidence concerning the utilization of online media and information among young (medical) professionals, as well as the development of corresponding competencies throughout their educational journey and how these competencies can be effectively promoted within post-university professional training processes (Steffens et al., 2017; for an overview, see Zlatkin-Troitschanskaia et al., 2021b).

To address this research gap, this dissertation aims to provide answers to the following overarching research question (RQ):

***RQ: To what extent are the skills of competently dealing with online media acquired and promoted among students in clinical professional year/studies in Germany?***

To answer RQ, several procedural steps are required, dividing the dissertation into five chapters. In the introduction, the significance of the topic and its relevance for medical practice (see Section 1.1), the research desideratum, and the objective of the thesis were presented, alongside an overview of the thesis structure (see Section 1.2).

Chapter 2 serves to establish the conceptual and theoretical groundwork. Thereby it contains an overview of the impact of digitalization on current students and graduates (see Section 2.1) followed by an elaboration of the significance of evidence-based practice in clinical decision-making (see Section 2.2). Subsequently, the COR construct, intending to operationalize the skills of competently dealing with online media within the context of this dissertation, is defined in detail (see Section 2.3). Section 2.4 outlines potentials of enhancing COR skills in medicine to further identify the research gap. In Section 2.5, structuring research questions are derived from the theoretical foundation to systematically address RQ.

Following this, in Chapter 3, a general overview of the research project in which this dissertation was embedded in is provided, along with a brief summary of data collection methods and sampling techniques. The chapter 3 concludes with a description of the underlying structure of the forthcoming analyses (see Section 3.3).

Comprising the main part of the thesis, Chapter 4 is further divided into four sub-studies, each dedicated to addressing one of the structuring research questions derived in Section 2.5. Finally, the discussion in Chapter 5 elaborates on the extent to which COR skills are acquired and can be promoted among students and graduates in clinical professional year/studies in medicine, deriving implications for educational and professional practice (see Section 5.1). The last chapter presents a critical reflection on the limitations of this research (see Section 5.2) and an outlook on future research directions (see Section 5.3).

## **2 Conceptual and Theoretical Foundations**

### **2.1 Digitalization and its Impact on Contemporary Professional Environments**

The digitalization of recent decades has initiated significant advancements across numerous facets of society, fundamentally reshaping how individuals acquire information and engage in learning processes (Redecker, 2017). Especially following the COVID-19 pandemic, there has been a notable surge in the willingness to pursue knowledge through online means among students and graduates in higher education (Xie et al., 2020; Thakur et al., 2022). Emphasizing fast and convenient methods of information retrieval, mobile applications and online content are favored over traditional media (Szymkowiak et al., 2021). The Internet has thus fully integrated into our daily lives, with around 4.80 billion people (60.9% of the world's population) accessing it for on average 6.9 hours per day (Nguyen & Phung 2023).

These advancements also influence the working environment. The rapid assimilation of information and communication technologies (ICTs) has led to an ongoing development of digital skills essential for professional practice (van Laar, 2019). Individuals now encounter increasingly complex tasks and copious amounts of available information, requiring them to efficiently select and apply knowledge in both their professional and personal lives (ebd., 2020). The “skills and practices necessary for becoming a confident and agile adopter of various technologies for personal, academic, and professional purposes,” commonly referred to as ‘digital literacy’ (Beetham & Sharpe, 2011, p.1), have now become indispensable in higher education across all levels (Vodà et al., 2022). The contemporary workforce requires individuals who can effectively search for relevant information, justify their decisions, generate innovative ideas applicable to their fields, and devise solutions to problems within digital contexts (Erstad & Voogt, 2018; Yang, 2014). This illustrates that critical thinking and problem-solving have developed into main cognitive competences for the 21<sup>st</sup> century (Wechsler et al., 2018), which are regarded as fundamental in achieving successful professionalization (van Laar, 2020).

This accounts especially for professions relying on evidence-based decision-making and acting, referring to the conscientious use of multiple sources of evidence in organizational decisions with the purpose of enhancing decision quality under realist conditions (Rousseau, 2020). These professions notably include the domains of

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING *medicine, law, and teaching* (Zlatkin-Troitschanskaia et al., 2021b). Despite differences in their respective working environments, these three fields exhibit significant similarities in the context of digitalization. All three domains are currently experiencing fundamental transformations due to digitalization, as evidenced by the integration of various digital technologies into professional practice, gradually replacing conventional methods (Mesko & Györfy, 2019; Enkova et al., 2021; Arnold, 2020). Consequently, trainees and professionals in these fields must acquire the requisite skills to adapt to and effectively utilize these digital technologies, often through education and training (Akour & Alenezi, 2022; Parviainen et al., 2022).

Moreover, professionals in all three domains rely on remaining updated with the latest knowledge, necessitating the ability to navigate the vast array of available information to identify relevant and accurate resources (Zlatkin-Troitschanskaia et al., 2021b). Further, the societal importance of these domains is highlighted by the crucial role professionals undertake in addressing the needs of individuals, including patients, clients, or students, with the quality of their work directly influencing the well-being and outcomes of these individuals (Turabian, 2019; McGinniss, 2018; Endedijk et al., 2022). In this context, especially trainees and young professionals in these domains, particularly those with limited professional experience, depend significantly on acquiring (professional) information as a foundation for their practical endeavors. In Germany, this pertains to medical students in their final year<sup>1</sup>, legal trainees, and teacher trainees during the transition from university study to professional practice (Zlatkin-Troitschanskaia et al., 2021b).

Additionally, today's young professionals are considered 'digital natives,' having grown up with digital technologies and the Internet, typically relying on these tools for information retrieval (Tombul, 2019; Osborne et al., 2022). Consequently, this target group is of notable interest for the forthcoming research investigations. This dissertation is primarily centered on medical students in their final year in human medicine in Germany. However, it will also provide some comparative insights into the fields of law and teaching (see Section 4.3). The primary focus on the medical

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<sup>1</sup> The final year (*Praktisches Jahr; PJ*) is the third and final phase of the degree in human medicine in Germany. It focuses on applying theoretical and practical knowledge to the patient as well as experiencing the processes in everyday hospital life (Hamburg Medical School, 2023).

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING target group arises from the study design of the BRIDGE research project, from which the data pertinent to this dissertation originates (the BRIDGE project will be presented in more detail in Section 3.1).

## **2.2 Evidence-Based Practice in Clinical Decision-Making**

### **2.2.1 Clinical Reasoning (CR)**

As this thesis focuses on the skill set required to competently deal with online media among students in the domain of (human) medicine (RQ), it is important to further elaborate on the relevance of employing an evidence-based approach and utilizing the Internet for information retrieval in medical practice.

One of the fundamental objectives of medical education is to equip future physicians with the skills and knowledge necessary to navigate the complexities of everyday professional life. A key aspect of this preparation is the development of diagnostic skills, which are vital for accurately assessing and identifying a patient's condition through comprehensive symptom analysis and examination (Norman, 2006; Yunus, 2021). This systematic process of handling medical data and algorithms to determine the best course of action for a patient is commonly referred to as 'clinical decision-making' (Bermann, 2011; Patton, 2010). Effective clinical decision-making relies on a physician's cognitive abilities to gather relevant information and take appropriate actions for the specific patient, at the right time, and for the appropriate reasons (Linn et al., 2012). These cognitive abilities, which enable physicians to "observe, collect, and analyze information, resulting in decisions and actions that seek to improve patients' well-being," are defined as 'Clinical Reasoning' (CR; Gordon et al., 2022, p. 8).

CR is closely linked to the research strands of critical thinking (Facione, 1990) and critical reasoning (Cook et al., 1966). It is a fundamental skill set that facilitates medical professionals to distinguish between pertinent and irrelevant information in critical situations, reason and make judgments about patient problems, formulate appropriate diagnoses, and initiate effective therapies (Sharifinia & Shakurnia, 2022). In addition to these abilities, CR requires analytical thinking and reasoning, metacognition, and reflection (Young et al., 2020).

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The framework of Levett-Jones et al. (2010, p. 516) identifies eight stages of CR, including:

- 1) Consider the patient's situation
- 2) Collect new patient information
- 3) Process information
- 4) Identify problems/issues
- 5) Establish goals
- 6) Take action
- 7) Evaluate outcomes
- 8) Reflect on process and new learning

The first three stages of the process are concerned with the acquisition, verification, and analysis of pertinent information. To obtain the relevant information, handover reports, medical records, patient charts, results of examinations, and previously performed medical assessments can be consulted. In addition, new information can be collected (e.g., through a current assessment of the patient) and knowledge can be retrieved (e.g., from hospital information systems, medical databases, publications, and guidelines) (ebd., 2010; Daei et al., 2020; Yazdani et al., 2017; Corazza et al., 2020).

These stages further involve distinguishing between relevant and irrelevant information, recognizing inconsistencies and gaps in the collected data, and situating the information within its appropriate context. In the subsequent stage, 'Identify problems/issues,' the collected information is synthesized to derive conclusions, thereby facilitating the formulation of a diagnosis for the patient's problem. In the ensuing 'Establish Goals' stage, the physician delineates the (measurable) outcomes to be attained within an appropriate timeframe. Afterwards, the resulting actions to achieve these goals are undertaken ('Take action') and evaluated ('Evaluate outcomes'). The evaluation mainly focuses on assessing the effectiveness and results of the interventions, i.e., whether the situation has improved. In the final stage ('Reflect'), the physician reflects on the insights gained from the overall process and considers alternative courses of action (Levett-Jones et al., 2010; Gruppen, 2016). Although CR is divided into eight successive stages, it is characterized as a continuous process. Physicians frequently navigate between these stages iteratively until they

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attain an accurate evaluation of a patient's health status (Hege et al., 2018; Yazdani et al., 2017).

This CR framework highlights the complexity of acquiring, evaluating, and implementing information in the context of clinical decision-making. Throughout the entire CR process, physicians must simultaneously apply their own knowledge to correctly categorize and evaluate the available information, as well as to perform further examinations in an appropriate and competent manner (Andersson et al., 2019; Gruppen, 2016).

### ***2.2.2 Evidence based Medicine (EbM)***

The process of clinical decision-making is of crucial importance in medical practice, yet it is simultaneously subject to several risks. Given that students and young medical professionals have limited understanding of CR concepts, they tend to rely on the first piece of information they find (*anchor bias*), information that is readily available (*availability bias*), or make quick diagnoses without considering reasonable alternatives (*premature closure*), which can lead to diagnostic inaccuracies and suboptimal therapeutic measures (for details, see Choi et al., 2022; Saposnik et al., 2016; Kumar et al., 2011). To ensure optimal and scientifically sound patient care, it is imperative to consistently seek out and apply the best available evidence. This practice is commonly referred to as 'Evidence-based Medicine' (EbM; Imorde et al. 2020).

Several models of EbM have been developed for use in clinical contexts. The typical stages of the process include identifying a clinical problem and deriving questions, accessing the requisite literature, applying critical appraisal skills to pertinent studies, and assessing the reliability and clinical relevance of the evidence to inform decision-making, while considering both the physician's expertise and the patient's expectations (Djulbegovic & Guyatt, 2017; Kang, 2016).

The practice of EbM entails the integration of individual clinical expertise and external evidence derived from systematic research to inform decision-making for individual patients (Ziegler et al., 2020; Montori & Guyatt, 2002). Individual expertise refers to the skills and judgment that an individual physician develops over time

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING through clinical experience and practice (Petty, 2015). Augmented expertise manifests in enhanced diagnostic efficacy and efficiency, as well as by the discerning recognition and empathetic consideration of individual patients' circumstances, rights, and preferences when making clinical decisions regarding their treatment (Croskerry, 2018). External evidence encompasses clinically relevant research, particularly patient-centered studies, which evaluate the accuracy of diagnostic tests, prognostic markers, and the effectiveness of treatments. It serves to invalidate outdated practices and introduce more potent, precise, and safer alternatives (Klemme et al., 2015).

Physicians who are competent in their field integrate both their individual clinical expertise, and the most current external evidence. They recognize that neither alone is sufficient. In the absence of clinical expertise, there is a risk that external evidence will prevail in practice, as it may not always be relevant or applicable to individual patients. In turn, a lack of external evidence can lead to outdated practices, which may ultimately result in harm to patients (Knottnerus et al., 2016; Sackett & Sackett, 1997).

In theory, the external evidence considered, such as a study or medical guideline, would encompass all individuals affected by the underlying disease. However, this is not a realistic scenario in practice. Consequently, the optimal approach for addressing this question is to seek the most suitable, currently available evidence through methods derived from EbM (Zou et al., 2004). These methods involve a systematic approach to accessing and reviewing research studies, frequently employing meta-analysis, with a particular focus on a comprehensive overview of clinical trials (Grummich et al., 2012; Bertelsmann et al., 2007).

Further, frameworks derived from EbM, such as the PICO (*Population, Intervention, Comparison, Outcome*) scheme for defining essential elements of a review question (for details, see Cooke et al., 2012), facilitate the formulation of the initial research questions necessary for conducting accurate searches for scientific information (Schardt et al., 2007). Once a clear clinical research question has been formulated, a focused search for relevant information can be conducted. Identifying problems and formulating appropriate questions thus represents a crucial aspect of EbM, since without a clearly structured clinical question, further stages in the overall process cannot be effectively implemented (Kunz et al., 2007).

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The Internet has become an important tool for EbM by providing a vast array of information, facilitating systematic reviews, and improving communication among collaborators (Coleman & McDowell, 2012). This presents both opportunities and risks. On the one hand, the electronic storage of an ever-expanding volume of medical data has the potential to enhance patient care by facilitating the systematic utilization of empirical knowledge (Maggio et al., 2019). On the other hand, the chronic shortage of time and the exponential growth of medical information pose significant challenges for physicians in maintaining an up-to-date understanding of the current state of medical research within their respective specialties (O'Carroll et al., 2015). For example, the annual quantity of scientific articles authored by individuals within the neurological/psychiatric field has surged approximately sixfold, rising from 16,495 publications in 2000 to 97,610 publications in 2020 (Hüll, 2022).

Today, physicians have a plethora of resources at their disposal to gain access to stored data, including a vast array of national and international databases (e.g., PubMed, Embase, UpToDate), and medical guidelines (Ko & Turner, 2018; Maggio et al., 2019; Jünger, 2023). Databases represent a valuable resource for physicians by providing access to numerous scientific articles and other specialized literature (Yu et al., 2020). Moreover, medical guidelines offer evidence-based recommendations for clinical practice, thereby serving as structured decision-making aids to enhance medical care (Ruhl & Siegal, 2017). In the context of EbM in clinical decision-making, the integration of both types of resources is undoubtedly beneficial (Meybohm et al., 2023).

In conclusion, the continuous incorporation of new, credible, and valid scientific findings is paramount for providing high-quality patient care. However, this process presents difficulties in everyday medical practice, as it requires certain fundamental skills (Imorde et al., 2020). One such skill is clinical expertise, which develops gradually over time through practical experience (Petty, 2015; Croskerry, 2018). It is consequently less developed at the time of entering the profession (Ziegler et al., 2020). Accordingly, students and young physicians are particularly reliant on external evidence during this stage (Nicholson et al., 2020; Gopalakrishnan & Ganeshkumar, 2013). The acquisition of skills in EbM through systematic training enables medical graduates to integrate evidence with patient preferences and clinical

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING expertise, thereby enhancing decision-making for individual patients (Welink et al., 2020). This underscores the necessity for students and young medical professionals to receive systematic instruction in the effective navigation, evaluation, and competent use of online (medical) information. From these findings, the following specification of the overarching research question can be derived:

***RQ: To what extent are the skills of competently dealing with online media acquired and promoted among medical students in clinical professional year/studies in Germany in the context of evidence-based clinical decision-making using online sources?***

## **2.3 Framework of Critical Online Reasoning (COR)**

### **2.3.1 Construct Definition**

To address RQ, it is necessary to refine the definition of the underlying skills considered essential to competently deal with online media. This study uses the framework of ‘critical online reasoning’ (COR) as a conceptual foundation to elucidate the skill set required for the critical-reflective utilization of online media (for details, see Molerov et al., 2020; Nagel et al., 2022). This framework was developed based on the systematic analysis and synthesis of relevant and related constructs, such as critical thinking (Facione, 1990), digital literacy (Ainley et al., 2016), media literacy (Abreu et al., 2017), information literacy (Taylor & Dalal, 2014), critical argumentation (Walton, 2006), scientific reasoning and argumentation (Fischer et al., 2018), and information problem-solving (Brand-Gruwel et al., 2017).

COR is defined as the ability to effectively “search, select, access, process and use online information to solve a given problem or build knowledge from this online information while critically distinguishing trustworthy from untrustworthy information and reasoning argumentatively based on trustworthy and relevant information from the online environment” (Molerov et al., 2020, p. 7). According to this definition, COR consists of the following three main interconnecting facets:

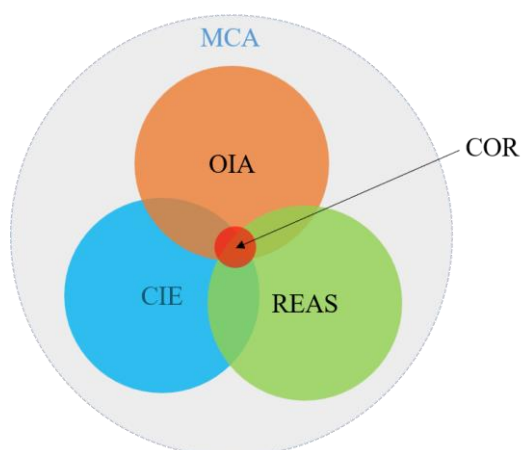
- (i) Online Information Acquisition (OIA skills): OIA concentrates on searching and accessing online information, e.g., using search queries on search engines and databases or visiting websites.

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- (ii) Critical Information Evaluation (CIE skills): CIE focuses on the selection and evaluation of information sources based on website features and cues (e.g., graphics, text, audio-visuals). CIE ability is necessary to evaluate sources e.g., in terms of credibility and trustworthiness.
- (iii) Reasoning based on Evidence, Argumentation, and Synthesis (REAS skills): REAS focuses on the integrative evaluation of collected information as well as on the consideration of different (possibly contradictory) perspectives in an argumentatively coherent manner.

Further, Molerov et al. (2020) assume that the activation of these COR facets requires metacognitive skills, referred to as Metacognitive Activation (MCA), which include decisions such as when to initiate and terminate which part of the overall search process. As depicted in Figure 1, the COR construct emerges from the intersection of the central facets described above. This suggests that the proficient navigation of databases or the adept formulation of search queries on websites, while important, do not alone constitute the entire ability to critically engage with online information. Instead, these are essential sub-skills within the broader COR skill set.

**Figure 1.** Framework of COR (based on Molerov et al., 2020, p. 8).



This framework was comprehensively validated according to testing standards by AERA et al. (2020) in higher education across different domains including medicine (Schmidt et al., 2020; Zlatkin-Troitschanskaia et al., 2021a). Based on the construct definition of COR, the overarching research question is specified as follows:

***RQ: To what extent are COR skills acquired and promoted among medical students in clinical professional year/studies in Germany in the context of evidence-based clinical decision-making using online sources?***

### **2.3.2 Generic and Domain-Specific COR**

Building on the COR validation, the (meta)cognitive requirements were conceptually further differentiated into generic and domain-specific contexts (i.e., GEN-COR and DOM-COR; Zlatkin-Troitschanskaia et al., 2021b), depending on the topic and degree of domain-specificity of an underlying task. The term ‘GEN-COR’ is applicable to generic tasks and websites that do not require domain-specific expertise (Molerov et al., 2020). Consequently, they represent domain-independent skills in the realm of critically handling online information. Such abilities may include general online problem-solving strategies or the verification specific publications on the Internet (Brand-Gruwel et al., 2009). Further, the COR construct can also be tailored to specific domains, which are referred to as ‘DOM-COR.’ In contrast to GEN-COR, DOM-COR encompasses skills that are inherently linked to specialized knowledge within a specific domain (Molerov et al., 2020; Zlatkin-Troitschanskaia et al., 2021b).

One important reason for this differentiation is that research indicates a significant impact of domain-specific knowledge and expertise on search behavior (Liu & Zhang, 2019; Lucassen & Schraagen, 2011; White et al., 2009). Experts within a specific field rely on their previous knowledge and, as a consequence, use more complex and precise search queries in comparison to novices without domain-specific knowledge. For instance, experts reformulate and recombine search queries instead of entering random search terms (Coşkunserçe & Aydoğdu, 2022; Dinet et al., 2010). In particular, the information processing behavior of ‘experts’ provide useful insights with regard to the successful handling of online information.

Based on prior research, it is assumed that the main COR facets are consistent across both generic and domain-specific contexts. However, their specific combination and application can lead to different profiles and developmental trajectories within and between domains (Zlatkin-Troitschanskaia et al., 2021b).

### 2.3.3 The relationship between CR and DOM-COR skills in Medicine

Given the focus of this dissertation on the effective and competent use of online media in evidence-based clinical decision-making, DOM-COR skills are particularly relevant for subsequent analyses. To further distinguish between GEN-COR and DOM-COR and gain a deeper understanding of DOM-COR in medicine, the upcoming section will elucidate the relationship between the introduced frameworks CR and COR. A schematic comparison of both frameworks and related actions and skills is presented in Table 1 (for details, see Schmidt, 2023).

Today, the importance of online sources in clinical decision-making is steadily increasing (Bullock & Webb, 2015; Kuhn et al., 2020; Laidlaw et al., 2012; Zhou et al., 2020). In accordance with the principles of EbM, the most reliable evidence should be utilized whenever possible. In this context, well-developed DOM-COR skills, integrating both COR and CR, play a central role in the advancement of EbM practices. These skills empower physicians to access high-quality, trustworthy, and pertinent material from online sources and to utilize it effectively in clinical decision-making.

**Table 1.** Comparison of CR and COR.

<b>Clinical Reasoning (CR)</b>		<b>Critical Online Reasoning (COR)</b>	
<i>Conceptual Framework of CR (Levett-Jones et al., 2010)</i>	<i>Actions and Related Skills of CR</i>	<i>Conceptual Framework of COR (Molerov et al., 2020)</i>	<i>Actions and Related Skills of COR</i>
1) Consider the patient's situation	- Data collection (medical history interview; physical examination) - Data collection/information retrieval from the patient	Online Information Acquisition (OIA)	- Confident technical handling of ICTs - Identification of information problem - Development of an effective search strategy - Ability to conduct effective research
2) Collect new patient information	- Ability to work with existing patient information - Identification of patient's problem		- Precise formulation of a search query - Determining keywords
3) Process information	- Ability to make differential diagnoses based on available patient information	Critical Information Evaluation (CIE)	- Use of search engines and databases - Searching, selecting, and evaluating search results / online information regarding relevance, usefulness,
4) Identify problems/issues	- Ability to develop hypotheses regarding diagnoses		

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5) Establish goals	<ul style="list-style-type: none"> <li>- Ability to gain scientific knowledge</li> <li>- Ability to apply acquired knowledge to individual patients</li> </ul>		<ul style="list-style-type: none"> <li>trustworthiness, and accessibility</li> <li>- Analysis and critical evaluation of online sources based on the quality criteria</li> </ul>
6) Take action	<ul style="list-style-type: none"> <li>- Skills in scientific analysis, collection and evaluation of data and facts</li> </ul>		<ul style="list-style-type: none"> <li>- Consideration of possible biases and misinformation</li> </ul>
7) Evaluate outcomes	<ul style="list-style-type: none"> <li>- Ability to draw up treatment plans based on guidelines</li> </ul>	Reasoning based on Evidence, Argumentation, and Synthesis (REAS)	<ul style="list-style-type: none"> <li>- Making judgments regarding the reliability of the information</li> </ul>
8) Reflect on process and new learning	<ul style="list-style-type: none"> <li>- Ability to apply clinical knowledge</li> <li>- Critical evaluation and application of scientific information and sources</li> <li>- Problem solving skills</li> <li>- Clinical reasoning skills</li> <li>- Clinical reasoning and decision-making skills</li> <li>- Scientific reasoning skills</li> <li>- Self-reflection</li> </ul>		<ul style="list-style-type: none"> <li>- Knowledge of (online) credibility cues</li> <li>- Comparison of various online sources (cross-checking)</li> <li>- Synthesis of the evaluated information</li> <li>- Ability to make decisions</li> <li>- Ability to form judgments</li> <li>- Reasoning based on evidence</li> <li>- Self-reflection</li> </ul>

Already in the initial three stages of CR ('Consider the patient's situation,' 'Collect new patient information,' and 'Process information'), COR skills prove advantageous. These abilities facilitate the identification of unknown or unusual symptoms, which can then be further investigated, for example, by consulting medical databases or guidelines. This systematic approach leads to more precise diagnoses and enhanced patient care (Graham et al., 2011). Further, certain anamnesis and examination algorithms accessible via the Internet can be utilized (Davies et al., 2007), ensuring thoroughness in information retrieval and thereby improving its quality.

In the following two stages of CR ('Identify problems/issues,' 'Establish goals'), credible online information provides helpful support for physicians. For instance, physicians can conduct further investigations of clinical presentations in order to establish achievable objectives for the patient. Moreover, online resources facilitate the determination of the urgency of addressing specific symptoms,

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considering that treatment prioritization for similar symptoms may differ significantly across diverse clinical contexts (van der Voort, 2017).

In stages six ('Take action') and seven ('Evaluate outcomes'), COR skills remain valuable. On occasion, physicians may be required to administer medications for which they lack the requisite knowledge or experience. In such scenarios, the Internet offers a convenient resource for refreshing knowledge, reducing the risk of incorrect medication application or dosage (Clarke et al., 2013). It is of the utmost importance to consult only reliable, up-to-date sources and tailor information to each patient's individual needs, rather than applying a universal approach (Laidlaw et al., 2012). In the event that the patient's condition does not improve as anticipated, the Internet can provide supplementary insights into their clinical situation. This can positively impact the treatment plan through a revised clinical reasoning process, ultimately leading to improved outcomes (Davies, 2007).

Expanding upon this, the COR skills are also beneficial in the final stage of CR ('Reflect on process and new learning'). The process of researching and reasoning from detailed information about clinical presentations, diagnosis, and therapy allows for reflection on an underlying patient case and contributes to enhancing future patient care. In addition, it empowers physicians to integrate newly acquired clinical expertise with external evidence (Durning et al., 2013).

To summarize, the value of DOM-COR for evidence-based clinical decision-making becomes apparent as well-developed COR skills demonstrate their value across all stages of CR.

Additionally, COR and CR share several similarities. Both frameworks emphasize the importance of conducting comprehensive research in order to achieve optimal outcomes. They both involve accessing, selecting, and evaluating information, discerning between relevant and trustworthy data and irrelevant and untrustworthy sources. Subsequently, this information evaluation should result in the formulation of a valid argument or an appropriate diagnostic plan, depending on the context (Molerov et al., 2020; Levett-Jones et al., 2010). As a result, the effective integration of DOM-COR skills in evidence-based clinical decision-making necessitates the possession of both CR and COR abilities. This dissertation is particularly concerned with the skills

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING derived from the three facets of the COR construct and its valid assessing and promoting among medical studies in clinical year.

#### **2.4 Potentials of Enhancing COR skills in Medicine**

In general, medical decision-making and CR have become increasingly complex, mirroring the shifts in both healthcare systems and medical science (Obermeyer & Lee, 2017). The role of online sources in EbM is becoming more significant (Kuhn et al., 2020; Zhou et al., 2020; Bullock & Webb, 2015; Laidlaw et al., 2012). In this context, a well-developed COR skill set might greatly enhance the effective implementation of evidence-based clinical decision-making, particularly by utilizing trustworthy sources as external evidence.

Despite its relevance, research has demonstrated a significant need for support in COR skills necessary for evidence-based clinical decision-making utilizing online sources (Zlatkin-Troitschanskaia et al., 2021a; Yazdani et al., 2017). Students and graduates in higher education exhibit deficiencies in COR skills and perform poorly in correctly evaluating the credibility of online media (McGrew & Chinoi, 2022; Breakstone et al., 2021; McGrew et al., 2018; for an overview, see Zlatkin-Troitschanskaia et al., 2021a). For example, students are susceptible to the deceptive features of websites, such as official-looking logos and domain names, without verifying the authority behind the online source (Wineburg & McGrew, 2019). Additionally, they tend to justify their selection of sources based on their perceived relevance and accessibility, rather than on epistemic factors (Ziv & Bene, 2022; List et al., 2016).

In the medical field, while physicians frequently encounter clinical questions that can often be addressed using digital search tools, persistent barriers to effective information-seeking still prevent these tools from fully meeting physicians' needs (Vallo-Hult et al., 2023). A lack of time, limited information-seeking skills, and a deficient awareness of accessible sources are common barriers that impede young physicians from obtaining the desired clinical online information (Daei et al., 2020). This could potentially lead to flaws in data collection, integration, and verification, which could result in premature closure and diagnostic errors (Nendaz & Perrier,

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING 2012). Indeed, premature closure, in conjunction with deficiencies in diagnostic skills and knowledge, has been linked to diagnostic errors among medical students (Braun et al., 2019). These deficiencies, in addition to unfamiliar surroundings, the challenge of transferring knowledge into practice, and an overload of information in CR, have been identified as contributing to feelings of unpreparedness among medical graduates for clinical practice (BurrIDGE et al., 2020; Monrouxe et al., 2017; Rencic et al., 2017). Medical graduates attribute these weaknesses to the insufficient integration of necessary skills into the study curricula of medical education (Dornan et al., 2019; Kuhn et al., 2020). This raises the question *of the extent to which COR skills relevant for clinical decision-making can be and are currently being fostered effectively among young medical professionals (see Section 4.1).*

Initial intervention studies indicate that COR-related skills can be improved through training (Breakstone et al., 2024; McGrew & Chinoy, 2022; McGrew et al., 2019). The methods employed include video tutorials (Roozenbeek et al., 2022), game-based simulations (Basol et al., 2021; Maertens et al., 2021), and teacher-led interventions (Pavlounis et al., 2022; Wineburg et al., 2022). However, training methods that assess individuals' skills and strategies to critically use online media remain underdeveloped (Breakstone et al., 2024). Further, existing training approaches address only partial COR-related facets and hardly focus on domain-specific contexts (Shah et al., 2015; Breakstone et al., 2018; Taylor & Dalal, 2014).

Similarly, research in the field of medicine has demonstrated that the search skills relevant for CR and EbM can be enhanced through various training methods, including interactive teaching sessions, clinical clerkships, and web-based certification trainings (Hasan et al., 2019; Maggio & Kung, 2014; Lin et al., 2013). Nevertheless, despite the implementation of training programs, it has been observed that young medical professionals continue to encounter difficulties in effectively transferring and applying the knowledge they have acquired to clinical practice (Ahmadi et al., 2015). In a study conducted by Stefanescu et al. (2018), 35 surgeons were surveyed at the beginning of their clinical residency. The results indicated that 71% of respondents reported deficits in linking knowledge to CR, 54% to decision-making, and 51% to therapy planning. Key challenges of implementing EbM include information overload and the necessity for medical professionals to utilize evidence within the context of

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING patient care (Nagtegaal et al., 2019). Notwithstanding the efforts made to promote such skills, which are evident in the new licensing regulations for physicians (*Approbationsordnung für Ärzte; ÄApprO*)<sup>2</sup>, there still seems to be a lack of integration of these skills into medical curricula (Haag et al., 2018; O’Carroll et al., 2015). For instance, although the use of guidelines for EbM offers numerous advantages, guideline competence has not yet been systematically taught or assessed in medical education (Jünger, 2023).

Additionally, while medical students and graduates recognize the importance of EbM and CR for their future careers (Kumaravel, 2020; Ilić & Forbes, 2010), time management presents a significant barrier in successfully completing supplementary EbM courses, especially among young medical professionals facing high workloads (McCall et al., 2020; Raspe et al., 2020).

Considering the current state of research, there is a growing need for structured training in medical education, on-the-job adaptation, and guided professional development to enhance COR-related skills within clinical practice. Further research is necessary to investigate the proficiency of COR skills among medical students and young medical professionals utilizing online sources for clinical decision-making. A more thorough understanding of this complex process will facilitate the derivation of valuable insights that can inform improvements in medical education and professional practice.

This dissertation is intended to address the identified research desideratum. The initial objective is to ascertain the need for the promotion of COR skills among young medical professionals (in Germany). To this end, an analysis of the extent to which there is, indeed, a lack of integration of COR skills into medical curricula is required (see Section 4.1). Further, based on the preceding considerations and the current state of research, it is necessary to examine the current level of development of COR skills among young medical professionals and their performance in corresponding tasks (see Section 4.2). In response to the identified need for and potential for promoting COR-

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<sup>2</sup> In Germany, medical studies are governed by specific licensing regulations for physicians (*Approbationsordnung für Ärzte; ÄApprO*), which predefine binding standards for education in human medicine (ÄApprO, 2002)

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING related skills, this dissertation further aims to elaborate on a suitable, comprehensive training method for GEN-COR skills (see Section 4.3) and for DOM-COR skills explicitly for prospective physicians in clinical decision-making (see Section 4.4). Additionally, it will address the feasibility of the proposed training methods.

## **2.5 Structuring Research Questions**

To systematically address the overarching specified research question (RQ), a set of structuring research questions is derived from the elaborated state of research and theoretical foundations. These research questions have been investigated in this thesis individually in four distinct sub-studies, which constitute the main part of the dissertation.

The initial two sub-studies represent a comprehensive needs analysis regarding the acquisition and promotion of COR skills among young medical professionals (in Germany). Despite their high relevance, COR-related skills pertinent to clinical practice are perceived to be inadequately anchored in the medical study curricula (Fuerhozer et al., 2019; Haag et al., 2018). More specifically, there appears to be a shortage of systematic instruction on the utilization of medical databases and guidelines for clinical decision-making in an online context (Jünger, 2023). This perception is supported by the fact that young medical professionals report feeling unprepared for professional practice (Raspe et al., 2020). In response, there arises a demand for the further promotion of such skills in medical education (Ratte et al., 2018; Leventi & Yanakieva, 2018). Moreover, medical students view EbM as a valuable tool for their clinical training and future practice (Ilić & Forbes, 2010). However, they encounter difficulties when attempting to apply this knowledge in their clinical work and are also unable to obtain the desired clinical online information (Burridge et al., 2020; Daei et al., 2020), which prompts an investigation into whether these deficits are due to inadequate training. This raises the question of the extent to which COR skills relevant for clinical decision-making are currently integrated into the curricula of medical faculties in Germany. These findings yield the first research question (RQ1), which seeks to determine the necessity of promoting COR skills in medical education:

***RQ1: To what extent are the individual facets of COR anchored in the curricula of medical study programs?***

In order to make an empirically grounded assertion regarding the necessity of promoting COR skills among young medical professionals (in Germany), it is imperative to conduct a subsequent investigation that assesses the existing level of development of these skills among them. As demonstrated by research, especially young physicians tend to rely on external sources of evidence in clinical decision-making, as they lack both clinical expertise and experience (Ziegler et al., 2020; Gopalakrishnan & Ganeshkumar, 2013). The use of Internet sources is becoming increasingly prevalent in this regard (Maggio et al., 2019; Coleman & McDowell, 2012). Nevertheless, the utilization of online media and information among young (medical) professionals, as well as the development of corresponding skills throughout their educational journey remains largely unexplored (Steffens et al., 2017; for an overview, see Zlatkin-Troitschanskaia et al., 2021b). Existing studies indicate that a lack of information searching skills and the unawareness of accessible sources are frequent barriers in physicians' access to high-quality evidence-based information during patient care (Daei et al., 2020). Further, (young) physicians seem to have difficulties in reading and interpreting medical research, leading to overgeneralization and incorrect application in clinical practice (Moore, 2011). This raises the question of how young medical professionals utilize online sources when tasked with solving a diagnostic case, and to what extent they are able to perform effectively. From this, the second research question (RQ2) emerges, which aims to ascertain the extent to which COR skills are currently developed among German medical students in their final clinical year of studies. This leads to the following research question:

***RQ2: How well-developed are COR skills among medical students in the transition from study to professional practice?***

Following the previous sub-studies that aim at identifying the necessity of cultivating COR skills among young medical professionals, the question now arises as to the methods by which these skills can be systematically promoted through targeted intervention. Existing studies indicate that it is possible to foster COR skills (McGrew & Chinoi, 2022; McGrew et al., 2019). In this context, two critical areas require further investigation. Firstly, there remains a scarcity of training methods aimed at fostering

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING individual competencies in critically navigating online media throughout an entire process of information problem-solving using the Internet (i.e., all three COR facets) among young professionals in higher and post-university professional education (Zlatkin-Troitschanskaia et al., 2021b; Breakstone et al., 2024). This research gap pertains to the acquisition and promotion of COR skills as a whole (i.e., both GEN-COR and DOM-COR skills), which gives rise to the following research question (RQ3):

***RQ3: Based on established didactic principles and learning models, how must a training for the acquisition and promotion of COR in higher and post-university professional education be conceptualized and designed?***

Secondly, existing research has also identified a lack of training methods for domain-specific COR skills (Shah et al., 2015; Breakstone et al., 2018; Taylor & Dalal, 2014). With respect to this dissertation, this encompasses the skills necessary for evidence-based clinical decision-making using online media, pertinent to the field of DOM-COR in medicine. As stated previously, there is a growing demand for the advancement of COR-related skills in medical education (Ratte et al., 2018; Leventi & Yanakieva, 2018). This research gap is intended to be addressed with the fourth study, which leads to the following research question (RQ4):

***RQ4: Based on established instructional and learning models as well as principles of EBM, how feasible is a cross-location digital training for the acquisition and promotion of DOM-COR skills in medicine among medical students in the clinical studies/year?***

Finally, the principal findings of the four preceding research questions will be summarized and interpreted. The objective here is to present concrete recommendations for medical education and professional practice. In conclusion, the fifth research question can be formulated as follows:

***RQ5: Which implications for educational and professional practice can be derived from the results of the analyses pertaining to RQ1-4?***

### 3 Method

#### 3.1 Project Background

In light of the increasing reliance on online media for information retrieval among young professionals and the growing importance of critical online media use, especially in professions that require evidence-based decision-making and acting, the project “Practical Educational Processes in Medicine, Law, and Teaching Using Digital Media” (*Berufspraktische Bildungsprozesse im Recht- und Lehramtsreferendariat sowie der Medizin unter Nutzung digitaler Medien; BRIDGE*) was founded by the German Federal Ministry of Education and Research (BMBF) in 2020, with a scheduled duration of three years (2020-2023). This dissertation was realized in the context of the BRIDGE project.

The BRIDGE project is an interdisciplinary research collaborative<sup>3</sup> that examined the development of COR skills among young professionals in the fields of medicine, law, and teaching, since these skills are essential for the effective utilization of online resources in professional practice. The objective of the BRIDGE project was to investigate the potential for fostering the critical-reflective use of online information in professional education contexts and to examine the role of digital training in supporting professional decision-making and acting. The project encompasses the development and implementation of both a novel online performance assessment of COR skills and a corresponding digital training concept in the post-academic professional training phase in these three domains (Zlatkin-Troitschanskaia et al., 2021b).

A longitudinal assessment was conducted to analyze changes in the professional use of digital media by the participants from the three domains during the transition from university study to professional practice. The data collection occurred at various points in time from 2020 to 2023. Young professionals were accompanied for approximately one year from the commencement of their practical phase. They

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<sup>3</sup> The BRIDGE project was conducted in cooperation with researchers at the University of Frankfurt as well as numerous cooperation partners. For more information, see the project’s homepage <https://eng.bridge.uni-mainz.de/>. (BMBF funding reference: 01JD1906)

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING participated in pre- and post-surveys and a training program designed to enhance their GEN-COR and DOM-COR skills (see Figure 2).

**Figure 2.** Study Design of the BRIDGE Project.



The tasks utilized to assess the GEN-COR and DOM-COR skills consisted of brief context/scenario descriptions and subtasks to be answered. Participants were asked to conduct a free Internet search, evaluate the online information they found, and write an answer for each subtask within a limited time frame. The training to promote GEN- and DOM-COR skills was employed between the assessments. In addition to measuring the COR skills using the COR assessment, an online questionnaire was employed in the initial and concluding stages of the study to obtain further information, including socio-demographic data, media usage patterns, and the perceived importance of COR for training. For their participation, the participants received an expense allowance for each survey date and were able to view their results in comparison to their peers via their individual participant data on an online feedback platform, accompanied by additional explanations (Zlatkin-Troitschanskaia et al., 2021b).

### 3.2 Data Collection and Sampling

The underlying data of the dissertation was primarily derived from the BRIDGE project, with a particular emphasis on the medical domain.

The data of sub-study 1 is based on the module manuals and examination regulations of all 43 state-maintained human medicine programs in Germany from 2022 (see Section 4.1). The material presented here has been gathered from the websites of the individual medical faculties and was not part of the BRIDGE project. The data from sub-study 2 was derived from the pre-assessments conducted on GEN-COR and DOM-COR skills in medicine, focusing exclusively on the respondents from the medical domain (see Section 4.2). Sub-study 3 is concerned with the theory- and evidence-based conceptualization and implementation of a training program aiming to enhance COR skills. It takes well-established approaches to instructional design and

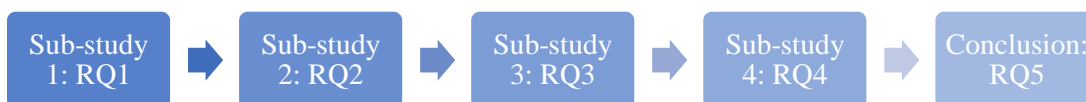
ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING existing training methods designed to foster the critical handling of online media into account (see Section 4.3). Sub-study 4 is specific to the training method for fostering DOM-COR skills in medicine. The analyzed data was identified from the data set of the BRIDGE project, which included all medical students who had successfully completed the DOM-COR module of the training (see Section 4.4).

In total, 129 students and young professionals from three German federal states participated in the BRIDGE study. Of these participants, approximately 30% (39 respondents) were employed in the field of teacher education. Just under half (64 respondents, 49.61%) were engaged in medical practice, while a fifth (26 respondents, 20.16%) were situated in the field of law. Of the 64 respondents in the medical field, 58 (90.62%) completed the GEN-COR and DOM-COR pre-assessments, while 29 (45.31%) completed the DOM-COR training. The subsamples in question are presented in detail in sub-studies 2 and 4.

### 3.3 Research Conceptualization

The main part of this dissertation is comprised of four sub-studies, each of which addresses one of the structuring research questions (see Figure 3).

**Figure 3.** Research Conceptualization.



In sub-study 1, the extent to which the individual facets of COR are anchored in the curricula of German medical study programs is examined (RQ1). To this end, the module manuals and examination regulations of all 43 state-maintained human medicine programs in Germany are subjected to analysis. A qualitative content analysis was conducted to compare regular and model curricula and assess potential differences in the promotion of COR skills in medical education. This sub-study focuses on the comparison of regular and model curricula to assess possible differences in the promotion of COR skills in medical education. This analysis study will provide initial insights into the curricular-anchored promotion of COR at German medical faculties and serves as a referential basis for reform processes currently taking place in German medical education.

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Sub-study 2 investigates the extent to which COR skills are developed among German medical students in their final year of studies (RQ2). For this purpose, the performance of young medical professionals participating in the GEN-COR and DOM-COR pre-assessments of the BRIDGE project is evaluated and analyzed in relation to certain sociodemographic variables and personality traits. The results will provide an impression of how well students and young physicians perform in the context of clinical decision-making when creating a realistic diagnostic plan using online information. Conversely, the results may indicate whether there is a correlation between COR skills and certain sociodemographic variables (e.g., gender, age) or personality traits (e.g., need for cognition) as well as media usage behavior.

Sub-study 3 is concerned with the development of a training program for the acquisition and promotion of COR in higher and post-university professional education. The training program is based on established didactic principles and learning models (RQ3). In contrast to previous approaches that focused on only a few aspects of COR, this training method intends to provide comprehensive instruction on an entire process of information problem-solving using the Internet and related strategies. As a result, this sub-study is anticipated to make a significant contribution to the fostering of this highly relevant skill among students within and across different domains. Sub-study 3 represents the theoretical and empirical conceptualization and implementation of the COR training, which was subsequently applied in the BRIDGE project.

Sub-study 4 addresses the feasibility of a cross-location digital training program for the acquisition and promotion of DOM-COR skills in medicine based on learning models and principles of EbM (RQ4). The target group is comprised of medical students in the final clinical year at three German medical faculties as part of the BRIDGE project. The objective of this study is to assess the perceived relevance and utility of such training in clinical practice, as well as its acceptance among young medical professionals (despite their high workload). The results of this study may assist in reducing the perceived unpreparedness of young physicians when entering the workforce.

Finally, the results of all four studies are summarized in the conclusion, which derives implications for educational and professional practice (RQ5).

## 4 Results

### 4.1 Curricular Analysis of the Promotion of Critical Online Reasoning in University Studies in Human Medicine in Germany<sup>4</sup>

#### 4.1.1 Research Question

Due to digitalization, the information landscape is continuously expanding, providing easy, fast, and location-independent access to a large amount of online information. The Internet is predominantly used as an information source in everyday practice among students and young professionals in formal and informal learning contexts (Grothaus et al., 2021; Maurer et al., 2020). The competent handling of online information in a rapidly changing digital environment thus represents an essential skill in several professions in the 21st century (Osborne et al., 2023; Redecker, 2017). This accounts especially for professions, in which evidence-based decision-making and acting are required, including medicine (Kuhn et al., 2020; Roeper et al., 2022). Since the medical field is characterized by constant progress in knowledge, physicians increasingly use the Internet to remain informed about current clinical studies and research findings (Zhou et al., 2020). The consultation of search engines and online databases for diagnostic investigations and electronic medical records are only two of many examples of digital change processes in healthcare that impose new challenges on today's medical workforce (Jorzig & Sarangi, 2020; Menvielle et al., 2018).

Current research indicates the increasing relevance of Internet skills for medical practice, as physicians daily need up-to-date evidence to develop high-quality diagnostic and treatment plans (Mesko & Györfy, 2019). Consequently, high-quality patient care requires physicians to be able to access, select, and evaluate relevant online information for the diagnostic procedure based on given symptoms and, at the same time, to continuously integrate new research findings into their considerations (Frank et al., 2010). Simultaneously, physicians report having difficulties in staying up to date on current diagnostic and treatment guidelines and publications, i.e. due to information overload (Hawkins et al., 2021), and criticize that respective skills are not

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<sup>4</sup> This chapter is planned to be published in O. Zlatkin-Troitschanskaia, M. Theres-Nagel, V. Klose & A. Mehler (Eds.), *Students', Graduates' and Young Professionals' Critical Use of Online Information: Digital Performance Assessment and Training within and across Domains*. Springer.

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING sufficiently anchored in the study curricula of medical education (Haag et al., 2018; O’Carroll et al., 2015). Overall, young physicians often state feeling unprepared for today’s professional practice in a digital age (Zlatkin-Troitschanskaia et al., 2021b).

To counteract the challenges resulting from the digitalized health era, the skill set for physicians to critically reason and argue based on online information is regarded as fundamental (Obermeyer & Lee, 2017). Graduates and young medical professionals also stress that a specific skill set for the critical use of online media plays a central role in their practice and needs to be adequately fostered in medical university studies. To investigate the (intended) promotion of such skill set that is described as critical online reasoning (COR, see Section 2.3), this study focuses on the analysis of respective skills within the curricula of all 43 state-run medical faculties in human-medicine in Germany and aims at answering the central research question (RQ1):

***RQ1: To what extent are the individual facets of COR anchored in the curricula of medical study programs?***

#### ***4.1.2 Conceptual Background***

##### ***4.1.2.1 Current Developments in German Medical Education***

To answer RQ1, it is first necessary to outline the current situation of medical education in Germany. Overall, clinical reasoning and medical decision making have largely become more complex, reflecting the changes in the healthcare system and medical science (Obermeyer & Lee, 2017). This development has led to a fundamental (inter-)national reform process of traditionally knowledge-focused medical degree programs over the past years (Frank et al., 2010). Competency-based medical education is regarded as a prerequisite to adequately prepare medical students for their prospective working life and serves as a foundation for the corresponding redesign of the curriculum (Carraccio et al., 2016). In this context, diagnostic and scientific skills are coming more into focus.

In Germany, medical studies are governed by specific licensing regulations for physicians (*Approbationsordnung für Ärzte; ÄApprO*), which predefine binding standards for education in human medicine (ÄApprO, 2002). In 2017, German authorities passed the Masterplan for Medical Studies 2020 (Masterplan

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING Medizinstudium 2020), an agenda comprising 37 reforming measures of medical education in Germany, including changes to the ÄApprO (BMBF, 2017). The objectives of this reform include providing more practice-oriented undergraduate training, and also, ensuring that the competencies of next generations' medical professionals can meet new challenges, such as those resulting from digitalization (Wulf, 2017). The corresponding content to achieve the reform objectives is elaborated in the National Competence-Based Catalog of Learning Objectives (*Nationaler Kompetenzbasierter Lernzielkatalog, NKLM*), which is a mandatory professional qualification framework describing the skills that medical students should acquire as part of a core curriculum (NKLM, 2015). After three years of nationwide development, an evolved yet nonbinding version of the National Competence-Based Catalog of Learning Objectives (NKLM 2.0) was issued in 2021. As part of the currently ongoing revision, which is taking place in cooperation with medical faculties, this version of the NKLM is being further developed to obtain an obligatory final version 3.0 by 2025 (Siech et al., 2021).

Regarding its content, the revision of the NKLM calls for a stronger emphasis on and promotion of higher-level reasoning skills in medical education, including scientific work and corresponding skills, i.e. the ability to use relevant information technologies in a critical and patient-oriented manner and formulate and conduct literature searches for the best available evidence for these problems based on precise, scientific questions in the professional databases (Richter-Kuhlmann, 2020). Finally, physicians need to incorporate evident information, such as current results of clinical studies and guideline recommendations, into their decision-making and acting (Timmer, 2021). Within this context, the critical handling of online media becomes inevitable in medical practice. To derive how the promotion of these specific competencies, as described in the NKLM 2.0, has been implemented so far and to identify potentials for improvement of medical education, the status quo of medical curricula needs to be systematically analyzed in the first place, which is the focus of this study.

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*4.1.2.2 Structure of Human Medicine Programs at German Medical Faculties*

The resource-demanding programs of human medicine have been state-funded for a long time (Gillissen, 2014). Today, 43 of in total 48 medical education programs in Germany are state-funded (Schwörer & Wissing, 2017). Since the curricula of three of these 43 faculties offer joint and identical courses, the curricular analysis in this study includes 40 unique degree programs in human medicine in Germany.

Essentially, these programs can be subdivided into two types of medical studies: regular curricula and model curricula (Kiessling et al., 2019). The 40 degree programs to be considered in this study are spread over a total of 37 locations. At 27 of these locations, only regular curricula are offered. At three locations, both regular and model curricula can be chosen by students. The remaining seven locations implement model curricula exclusively. The differentiation and examination of both variants of medical studies are highly relevant for the sound assessment of the current promotion of COR in German medical studies. Further, it allows for the initial evaluation of previous reforms towards more competency-based medical education. Therefore, the research question needs to be specified as follows:

***RQ1: To what extent are the individual facets of COR anchored in regular curricula compared to model curricula at German medical faculties?***

While most medical faculties implement a regular curriculum, in rare instances mixed curricula are used, i.e. the integrated reform course at the University of Bochum. The structure of regular curricula can be regarded as the original approach to medical studies and is based on the licensing regulations (ÄApprO) from 2002. Regular curricula are clearly subdivided into foundation and main courses (pre-clinic and clinic). The first four pre-clinical semesters of study focus on the structured teaching of basic subjects in preparation for the upcoming six semesters of clinical subjects and the final practical year of studies (*Praktisches Jahr; PJ*), in which student training revolves around working with patients (Haage, 2002). Regular curricula are thus characterized by a strict, rather rigid, and time-consuming study structure (Jagow & Lohölter, 2006). In recent years, regular curricula have seen more innovative and practical elements included in the clinical component of medical education, i.e. standardized simulated patients and sessions focusing on communication skills. Overall, there is a growing emphasis on problem-based and computer-based learning

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING within faculties (Nikendei et al., 2009). Scientific competencies, which are particularly relevant for COR, however, are still not sufficiently taught, although they are partially included in the ÄApprO (Jünger, 2023; Baum et al., 2022). §1 (ÄApprO, 2002) states “the training to become a physician is carried out on a scientific basis and is practice- and patient-oriented”. Furthermore, §27 predefines the subjects, interdisciplinary areas to be taught and the total number of teaching hours, whilst learning objectives regarding scientific competencies, i.e. evidence-based medicine, are not mentioned. The actual implementation and distribution of available teaching is the responsibility of the medical faculties (Wieking, 2005). This description leads to the first assumption (A1) of the study:

***A1: The study regulations of regular curricula regarding COR facets differ only slightly from each other.***

Since the traditional syllabus of regular curricula often lacked practical applications, medical education has undergone a fundamental reform with a paradigm shift towards competency-based training in recent decades (Gillissen, 2014). To significantly improve medical education through more innovative study designs, teaching methods, and curricula tailored to different purposes, the opportunity to develop model curricula was added to the ÄApprO in 1999. Model curricula aim counteract recent challenges in medicine, science, and society as a whole, and should also solidify students’ lifelong learning (Fabry & Fischer, 2014). There is a close link between basic medical, clinical-theoretical, and clinical content, and various compulsory elective modules, i.e. on scientific work, which allow students to set their own priorities (Hitzblech et al., 2014). Compared to the structure of regular curricula, model curricula incorporate e.g., early contact with patients (patient-based curriculum), a stronger focus on practical skills, as well as interdisciplinary teaching formats, which enable knowledge transfer and problem-oriented learning (Hitzblech et al., 2019). The incorporation of scientific competencies varies according location, with explicit instruction occurring at some sites (Hitzblech et al., 2014; Fabry & Fischer, 2014). For example, the integrated medical degree program in medicine (iMED) at the university of Hamburg is defined by the founding principle of ‘scientific orientation,’ which intends to promote critical thinking and consistent interaction with

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING evidence-based science among the students (Rheingans et al., 2019). These characteristics lead to the second research assumption (A2):

***A2: COR facets (in particular the REAS facet) are more prevalent in model curricula compared to regular curricula.***

### ***4.1.3 Methodology of the Curricular Analysis***

#### ***4.1.3.1 Process Model of the Qualitative Content Analysis***

To answer RQ1 and examine the research assumptions (A1, A2), a qualitative content analysis (QCA) based on the methodological foundations of Mayring (2003) was conducted. QCA is a structured, qualitative method for analyzing text-based data, e.g., transcripts of interviews or documents to identify latent meaning structures. QCA enables the analysis of large amounts of text and is therefore suitable for analyzing the module manuals and examination regulations of the 43 state-run human medicine programs in Germany (Mayring & Fenzl, 2019). In QCA, the text-based data is examined for structural features based on a systematic category system, that contains predefined criteria (codes) which are assigned to corresponding text passages. This process is denoted as coding. Finally, the codings, i.e., the allocations of the codes to specific expressions and text passages, are statistically analyzed and evaluated in terms of their frequency (Mayring, 2003). As the codings are formed deductively, i.e., the establishment and definition of the category system precede the analysis of the text-based data, the procedure is also referred to as “deductive category application” (Mayring & Fenzl, 2019). The procedure of QCA is strictly rule-based and initially requires the specification of the material, direction, research questions, and process model of the analysis as follows to make it comprehensible and intersubjectively verifiable (ebd., 2019):

*1) Determination of the Material of Analysis:* This study uses as data basis the module manuals and examination regulations, subsequently referred to as study regulations, of 40 human medicine programs in Germany. Although there exist 43 state-run human medicine programs overall, three locations (Mannheim, Siegen, and Nuremberg) are rejected as they share joint curricula with the other three locations

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING (Heidelberg, Bonn, and Erlangen) already considered in the analysis (see Section 4.1.2.2).

2) *Analysis of the Development Situation*: The material of analysis consists of study regulations. These are first elaborated internally by the universities and then submitted to the Ministry of Education of the respective federal state for approval. In this process, the medical faculties are guided by the current version of the ÄApprO, which can be regarded as a binding standard for training in human medicine (see Section 4.1.2.1; Siech et al., 2021). However, the individual medical faculties have extensive leeway in the design of their curricula (Nikendei et al., 2009).

3) *Formal Characteristics of the Material*: The study regulations are available in text form and freely accessible on the university websites of each location, whereby the scope and transparency of provided content vary greatly. While most universities offering regular curricula only publish study regulations without further information on their specific teaching content, universities offering model curricula grant access to module handbooks in which the course content is described in detail. Since comparing the coding frequencies from study regulations to those of module handbooks would lead to biases in the results, only study regulations were considered in the analysis. Notably, some study regulations do not include the list of potential elective courses. In such cases, reference was usually made to the university website.

4) *Direction of the Analysis*: This study investigates the (intended) promotion of COR skills in state-run human medicine programs across Germany.

5) *Theory-based Differentiation of the Research Question*: The analysis investigates RQ1, to what extent the individual facets of COR are anchored in the curricula of regular curricula compared to the curricula of model curricula. Further, the research assumptions A1 and A2 (see Section 4.1.2.2) were analyzed.

#### 4.1.3.2 Elaboration of the Category System

The development of the category system undergoes three subsequent steps: the category definition, the specification of anchor examples, and the development of coding rules (Mayring & Fenzl, 2019). The category definition comprises a detailed presentation of the features that characterize an individual category of the QCA (Table

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2). Within this study, the categories were represented by the three COR facets OIA, CIE, and REAS (see Section 2.3). In the category system, these categories were broken down into meaningful attributes that determine the specific text passages of a study regulation to which the respective categories are to be assigned. The definition and attributes of the COR facets were derived from the construct definition of COR (see Section 2.3.1; Molerov et al., 2020; Nagel et al., 2022).

**Table 2.** Category Definition of the COR Facets.

<b>COR-facet</b>	<b>Online Information Acquisition (OIA)</b>	<b>Critical Information Evaluation (CIE)</b>	<b>Reasoning based on Evidence, Argumentation, and Synthesis (REAS)</b>
<b>Definition</b>	Searching and accessing online information	Evaluation of information sources based on website features and cues	Reasoning based on selected information and its syntheses considering different (possibly contradictory) perspectives in an argumentatively coherent manner
<b>Attributes (Examples)</b>	<ul style="list-style-type: none"> <li>- Use of search engines</li> <li>- Use of databases</li> <li>- Use of precise search terms and operators</li> </ul>	<ul style="list-style-type: none"> <li>- Evaluation of websites and their parts in terms of quality criteria like accessibility, usefulness, relevance and trustworthiness</li> <li>- Selection of relevant text passages</li> <li>- Verification of content, supporting documents, etc. using different sources</li> <li>- Recognition of latent frames and biases</li> </ul>	<ul style="list-style-type: none"> <li>- Reasoning based on selected information/evidence and its synthesis</li> <li>- Recognition of different (possibly contradictory) perspectives and/or uncertainties</li> <li>- Weighing and balancing the pro and contra arguments</li> <li>- Creating own arguments and decision-making in a coherent and consistent manner</li> </ul>

To ensure that the coding is as precise as possible, initially, the course content of two selected locations, Augsburg and Bielefeld, was viewed (Universität Augsburg, 2019; Universität Bielefeld, 2021). The selection was mainly due to the fact that both locations represent the most recent medical faculties to have developed competence-oriented curricula from the beginning that further provide access to detailed module handbooks (Härtl et al., 2017). This should serve to develop an idea of which keywords and course descriptions indicate a particular COR facet and to filter out so-called

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING anchor examples (Mayring & Fenzl, 2019). The concept of anchor examples follows the ‘prototype theory’ which is based on the idea that every category has an inner structure that can be briefly expressed with the concept of typicality (Coseriu, 2000; Poitou, 2004). The coding in the QCA, i.e., the process of assigning these categories comprising certain characteristics to text passages, is based solely on sufficient, not necessary, conditions of similarity; i.e., it is regarded as sufficient that an element A has a certain similarity to an already categorized element B to be categorized as B (‘principle of sufficient similarity;’ Poitou, 2004). The definition of the category, in this case, the COR facets, is clarified by specific excerpts from the selection of module handbooks from the universities of Augsburg and Bielefeld (Table 2). These are to be regarded as exemplary for the respective COR facets and allow for the deduction of a prototype course name for the latter QCA.

Finally, to counteract differentiation problems between the categories the coding rules were developed (Table 3). These follow the ‘theory of decision boundaries,’ which addresses the problem that characteristics within a single category are subject to a certain variance and aims at constructing a ‘boundary’ that is as precise as possible (Waldmann, 2017). If the similarity comparison of an analyzed text passage with a prototype is not sufficient since there are overlaps between different categories, the coding rules defined by the analyst were used to decide which category a particular text passage falls into (ebd., 2017). These rules thus aim at achieving the most accurate distinction possible of the categories and finally allow the category system to be applied in the QCA (Mayring & Fenzl, 2019; for detailed coding guidelines, see Appendix A).

**Table 3.** Coding Rules and Corresponding Anchor Examples of the COR Facets.

<b>COR-facet</b>	<b>Online Information Acquisition (OIA)</b>	<b>Critical Information Evaluation (CIE)</b>	<b>Reasoning based on Evidence, Argumentation, and Synthesis (REAS)</b>
<b>Coding Rules</b>	This category is assigned to each module that:  - requires the independent acquisition of information (outside the lecture slides)	This category is assigned to each module that:  - trains critical and systematic evaluation, assessment.	This category is assigned to each module that  - relates to evidence-based medicine, science literacy training, scientific competence  - promotes argumentation skills

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	<ul style="list-style-type: none"> <li>- trains (heuristic and systematic) strategies for searching for information, literature research</li> <li>- includes literature research as required in scientific work.</li> </ul>	<ul style="list-style-type: none"> <li>- teaches how to recognize with cognitive heuristics, biases, perceptual errors</li> <li>- includes the analysis of existing scientific work and underlying quality criteria, rules, basic principles</li> <li>- includes scientific work focusing on the selection of trustworthy sources</li> </ul>	<ul style="list-style-type: none"> <li>- requires students to form their own judgment regarding a subject matter</li> <li>trains the ability to think scientifically</li> <li>- includes scientific work focusing on answering a given research question</li> </ul>
<b>Exemplary Module Handbook</b>	(Bielefeld University, 2021b)	(University of Augsburg, 2019)	(University of Augsburg, 2019)
<b>Anchor Examples</b>	<ul style="list-style-type: none"> <li>- "Students carry out initial academic activities such as literature research" (p. 22)</li> <li>- "Preparation of a literature list..." (p. 205)</li> <li>- The module examination consists of [...] a literature-based planning of ... (p. 231)</li> <li>- "They [...] expand their skills in researching the state of research (also in international literature)" (p. 236)</li> </ul>	<ul style="list-style-type: none"> <li>- "... you will be able to name quality criteria for scientific work and explain the methods used to determine them" (p. 24)</li> <li>- "...you will be able to explain the principles of good scientific practice" (p. 25)</li> <li>- "They can distinguish between heuristic and analytical cognitive processing [...] and consciously use these methods" (p. 37)</li> </ul>	<ul style="list-style-type: none"> <li>- "You will learn [...] to understand scientific findings/articles [and] critically reflect on them" (p. 25)</li> <li>- "... you will be familiar with the specific justification procedures in science (p. 31)</li> <li>- "... you will be able to explain the different types of argumentation, criteria of valid arguments and typical fallacies" (p. 47)</li> <li>- "... you will be able to [...] deal with uncertainties in deal with uncertainties in diagnostics" (p. 25)</li> </ul>
<b>Prototype Course Name</b>	„Scientific thinking and acting“	"Scientific longitudinal course"; "Theory of science"	"Argumentation theory, logic & rhetoric"; "Writing workshop"

## 4.1.3.3 Curricula Analysis of Study Regulations

For the QCA, the material, i.e. the study regulations of the 40 study programs, was first entered into the qualitative analysis software program MAXQDA. Subsequently, the text passages of the study regulations containing information on the

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING objectives of the degree program as well as the purpose of the examination types, the course of study, the timetable, and the type of courses were analyzed and coded based on the category system. While coding, a distinction was made between mentions of unspecified keywords within text passages relevant to a COR facet and explicitly mentioned content within a module relevant to a COR facet. For this purpose, six codes were created (Table 4).

**Table 4.** Codes Assigned to COR facets.

<b>COR-facet</b>	<b>Online Information Acquisition (OIA)</b>	<b>Critical Information Evaluation (CIE)</b>	<b>Reasoning based on Evidence, Argumentation, and Synthesis (REAS)</b>
<b>Codes</b>	OIA Module	CIE Module	REAS Module
	OIA Keyword	CIE Keyword	REAS Keyword

The number of mentions was used to make qualitative-interpretative statements about the importance attributed to the teaching of COR skills in the respective degree program. The corresponding code was OIA-/CIE-/REAS-Keyword. Following the principle of sufficient similarity (see Section 4.1.3.2), keywords and text passages that have similarities to attributes of the category definition or the anchor examples, were understood as mentions and accordingly assigned to one of the six codes. The coding rules (Table 3) were considered. The coding of the appropriate module names was used to identify the number of modules per degree program that could teach skills of one of the COR facets. For this purpose, anchor examples were used to derive prototypical module names for each facet (Table 3). The corresponding code was the OIA/CIE/REAS module. Again, the principle of sufficient similarity was applied. Each study regulation therefore has two key figures per facet.

#### **4.1.4 Results of the Curricular Analysis**

##### **4.1.4.1 Regular Curricula**

To investigate RQ1 and the resulting research assumptions, it was examined how often the codes derived from the COR facets (see Section 4.1.3.2) occur in the study regulations of the 30 locations offering regular curricula in Germany. The results

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING are presented in Table 5. For each of the study locations, the number of assigned codes is listed. Further, the total number of codes as well as the mean for each category were analyzed.

**Table 5.** Coding Frequencies in the Study Regulations of Regular Curricula.

	<i>Study Location</i>	<i>OIA Module</i>	<i>OIA Keyword</i>	<i>CIE Module</i>	<i>CIE Keyword</i>	<i>REAS Module</i>	<i>REAS Keyword</i>	<i>Total</i>
1	Bonn	1	0	3	0	1	0	5
2	Cologne	0	0	2	0	0	0	2
3	Dresden	0	0	2	0	1	0	3
4	Duisburg	1	2	3	3	1	2	12
5	Düsseldorf	0	0	2	0	0	0	2
6	Erlangen	0	0	2	0	0	0	2
7	Frankfurt (Hesse)	0	0	2	1	1	1	5
8	Freiburg	1	1	2	2	1	4	11
9	Gießen	0	0	0	0	0	0	0
10	Göttingen	0	0	2	0	1	1	4
11	Greifswald	0	0	4	1	0	0	5
12	Halle-Wittenberg	0	1	2	1	0	3	7
13	Hamburg	0	0	2	0	0	0	2
13	Homburg	0	0	2	0	1	0	3
15	Heidelberg	0	0	2	0	0	1	3
16	Jena	0	1	2	1	0	2	6
17	Kiel	0	1	1	1	0	1	4
18	Leipzig	0	0	3	0	0	1	4
19	Lübeck	0	0	3	0	0	0	3
20	Magdeburg	1	0	2	0	1	3	7

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21	Mainz	1	1	3	1	1	2	9
22	Marburg	0	1	2	1	0	3	7
23	Munich (LMU)	0	1	2	1	0	1	5
24	Munich (TUM)	0	1	0	1	1	1	4
25	Münster	0	0	2	1	0	3	6
26	Regensburg	0	0	1	0	0	0	1
27	Rostock	0	2	2	2	0	3	9
28	Tübingen	0	1	2	1	0	6	10
29	Ulm	1	1	3	1	2	2	10
30	Würzburg	0	0	2	0	0	0	2
<b>Total</b>		6	14	62	19	11	40	152
<b>Mean</b>		0.2	0.47	2.07	0.63	0.37	1.33	5.07
<b>Median</b>		0	0	2	0.5	0	1	4.5

A total number of 152 codings relevant for COR were identified in the study regulations of regular curricula for all 30 locations. On average, this leads to 5.07 codings for the three COR facets per location, which is comparably low.

Considering the individual COR facets, on average, there were only 0.2 OIA modules coded per university. With an average number of 0.47 OIA mentions per study regulation, the number of coded keywords is not substantially higher. Only at six locations, a suitable module was identified for coding. While most of the underlying names of those modules, i.e. “Methodology of Scientific Work,” referred to teaching fundamentals of scientific work suggesting aspects relevant to OIA, explicit relevant course descriptions were hardly found. More specifically is the introductory course “Scientific Bibliography and Effective Search of Medical Literature” at one university (JGU, 2011). This course aims to teach how to elaborate a research question and use databases for research, including the correct citation of literature. However, this course is merely a “strongly recommended” elective subject (JGU, 2011). TUM (2011) also

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING refers to OIA by mentioning that the overall learning objective of medical education includes the integration of modern information technologies to enable students to continuously access new information alongside their work.

In contrast, the number of coded CIE-promoting modules with an average of 2.07 CIE modules per study program is greater. However, an average number of 0.63 CIE mentions of keywords per study regulation was rather moderate. Modules similar to “Fundamentals of Medical Psychology and Medical Sociology” were coded here since they usually teach content on cognitive heuristics, biases, or errors of perception. Nevertheless, access to more detailed content descriptions is necessary to provide further evidence in terms of promoting the CIE facet. Additional keywords were coded with relation to the terms “evaluation” and “assessment.”

On average, the number of coded REAS modules (0.37) and keyword mentions (1.33) is the highest for all three COR facets. Regarding the overall promotion of REAS, however, these results are comparably low, especially since eight locations have no mentions in the underlying study regulations. Modules promoting the REAS facet predominantly correspond to course descriptions referring to “scientific work” suggesting aspects relevant to this facet. More specifically, three courses entitled “Evidence-based Medicine” were identified, which were nonetheless offered as elective, rather than compulsory, courses.

Examination formats that could (indirectly) regard the categories (i.e., presentation, term paper, essay, review, etc.) rarely appear within the study regulations and mainly serve to define the type of examination of a module but provide few indications regarding the promotion of skills related to COR.

Based on the QCA of the study regulations, it can be concluded that the promotion of COR in the regular medical curricula is attributed little importance within the majority of locations only slightly differing from each other. Therefore, research assumption A1 can be confirmed. Exceptions, such as the course on scientific bibliography and courses on Evidence-based Medicine, exist but are merely offered as electives. As has been mentioned initially (see Section 4.1.2), these courses are not anchored as obligatory content in the ÄApprO and the corresponding study curricula.

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## 4.1.4.2 Model Curricula

The QCA of model curricula follows the same structure as applied to regular curricula. The results are presented in Table 6.

**Table 6.** Coding Frequencies in the Study Regulations of Model Curricula.

	<i>Study Location</i>	<i>OIA Module</i>	<i>OIA Keyword</i>	<i>CIE Module</i>	<i>CIE Keyword</i>	<i>REAS Module</i>	<i>REAS Keyword</i>	<i>Total</i>
1	Aachen	1	0	2	1	2	8	14
2	Augsburg <sup>5</sup>	3	2	5	2	5	3	20
3	Berlin	3	2	3	4	3	7	22
4	Bielefeld	5	4	6	6	7	6	34
5	Bochum	2	2	4	3	2	4	17
6	Cologne	3	4	3	6	3	12	31
7	Düsseldorf	0	2	2	5	0	7	16
8	Hamburg	2	1	4	2	2	5	16
9	Hannover	1	1	1	0	1	3	7
10	Oldenburg	1	3	3	4	3	7	21
	<b>Total</b>	21	21	33	33	28	62	198
	<b>Mean</b>	2.1	2.1	3.3	3.3	2.8	6.2	19.8
	<b>Median</b>	2	2	3	3.5	2.5	6.5	18.5

Overall, 21 module names as well as 21 keywords indicating the teaching of the OIA facet were found in the study regulations of model curricula. With an average of 2.1 codings per location, these results are substantially higher in comparison to regular curricula. However, similar to regular study curricula, the coded modules and

<sup>5</sup> The study regulations of the University of Augsburg do not contain a list of modules offered and in this case the module handbook was used to examine the module names in this case.

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING keywords primarily relate to the teaching of fundamentals of scientific work, focusing on the OIA facet.

Modules related to the promotion of CIE skills averaged 3.3 codings per location. The number of mentions of keywords referring to CIE, which often concerned the expressions ‘evaluation and assessment,’ e.g., in relation to "technical and digital developments in medicine" (Bielefeld University, 2021) counts to an average of 3.3 codings per location.

The highest values were observed in the columns assigned to the REAS facet. On average, 2.8 modules and 6.2 keywords were coded. This includes e.g. some electives on evidence-based medicine or scientific writing workshops. REAS keywords were often found in overarching learning content and learning objectives which emphasize the teaching of scientific literacy and the importance of sound, research-oriented medicine.

Overall, these findings confirm the research assumption A2 stating that COR facets (in particular the REAS facet) are more prevalent in the curricula of model curricula compared to regular curricula. This QIA indicates that the teaching of COR skills is more prevalent in model curricula.

#### 4.1.4.3 Intergroup Comparison

To systematically compare the results of regular to model curricula, the average values of coding frequencies per location were contrasted to the factors by which the key figures of the regular curricula must be multiplied to correspond to those of the model curricula (Table 7).

**Table 7.** Comparison of the Average Coding Frequencies of Regular and Model Curricula.

<i>Study Program</i>	<i>OIA Module</i>	<i>OIA Keyword</i>	<i>CIE Module</i>	<i>CIE Keyword</i>	<i>REAS Module</i>	<i>REAS Keyword</i>
Regular Ø	0.2	0.47	2.07	0.63	0.37	1.33
Model Ø	2.1	2.1	3.3	3.3	2.8	6.2
<b>Factor</b>	10.5	4.57	1.6	5.24	7.57	4.7

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While the average values of model curricula were overall moderate, however, they were substantially higher than the average values of regular curricula. Except for the CIE modules, the average key figures of the model curriculum differ between four to eleven times higher coding frequencies compared to regular curricula. The results indicate that the introduction of model curricula (see Section 4.1.2.2) increased COR promotion, especially of skills related to the REAS facet, suggesting A2.

Regarding the content structure, the study regulations of the 30 regular curricula, were extremely similar. Thus, the category indicators within this group vary only slightly, suggesting assumption A1. Greater intra-group differences were found in the results of model curricula, where the first study section was individual for each location. However, throughout model curricula, both compulsory and elective general science modules progressively increase in number. This trend is observed across all locations where such programs are offered. Furthermore, there are overall substantially more modules offered for acquiring interdisciplinary and competency-oriented skills than in regular curricula.

The overarching content and objectives of the study programs, which were usually listed in the first paragraphs of the study regulations, undermine these findings. In the regular curricula, the focus lies primarily on e.g. "the basic scientific knowledge necessary for the independent and autonomous practice of medicine", in particular "[the] structure and [the] function of the human body, the teaching of diseases, their recognition, treatment and prevention" (Friedrich Schiller-University Jena, 2015). In contrast, the study regulations of the model curricula emphasize the importance of e.g. "sound knowledge and understanding of scientific principles and methods", the "special consideration of evidence-based medicine and the empirical and critical foundations of scientific thinking" (Charité - Universitätsmedizin Berlin, 2018). The reforms (see Section 4.1.2.2), which were aimed at establishing the model degree program, became evident in the study regulations and indicated the shift towards competency-based learning.

#### **4.1.5 Conclusion**

##### *4.1.5.1 Discussion*

In recent years, rapid digital transformation has led to fundamental changes and new challenges in the medical profession, which require evidence-based decision-making and acting (Kuhn et al., 2020; Roeper et al., 2022). Physicians need to increasingly use the Internet to remain in-formed about current clinical studies and research findings and incorporate search engines and online databases into their daily working practice (Zhou et al., 2020; Mesko & Györfy, 2019; Jorzig & Sarangi, 2020; Menvielle et al., 2018). Physicians report having difficulties in staying up to date on current diagnostic and treatment guidelines and publications, i.e. due to information overload (Hawkins et al., 2021), and criticize that respective skills are not sufficiently anchored in the study curricula of medical education (Haag et al., 2018; O’Carroll et al., 2015). Although the intention to develop scientific competencies is already contained in the current *ÄApprO*, the lack of operationalization of the overarching goals has led to a lack of binding integration of such skills, i.e. evidence-based medicine, and guideline competence, into the medical curricula (Jünger, 2023).

To counteract the challenges resulting from the digitalized health era, the skill set for physicians to critically reason and argue based on online information is regarded as fundamental and needs to be fostered in medical university studies adequately (Obermeyer & Lee, 2017). To investigate the (intended) promotion of such a skill set, defined as critical online reasoning (COR), this study addressed the central research question, to what extent the individual facets of COR are anchored in the study curricula of all 43 state-run regular and model curricula of human-medicine in Germany.

For this purpose, the study regulations of 40 study locations were systematically examined using a qualitative content analysis (QCA) based on a deductive category application (see Section 4.1.4). The results indicate that the promotion of COR-related skills is only partially anchored in curricula in both variants of medical studies. In comparison, the average values of model curricula are slightly higher compared to the results of regular curricula. This finding indicates, that the implementation of the intended reforms in medical studies, which are primarily characterized by a stronger evidence-based and scientific focus and the teaching of

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING interdisciplinary skills, is (at least partially) accompanied by an increased (intended) pro-motion of COR-related skills in the model curricula.

This result may be due to two decisive factors. First, the study regulations were created at different times. Model curricula, such as those in Augsburg and Bielefeld, are significantly more recent than the majority of regular curricula and consequently more competence-oriented. Furthermore, a new *ÄApprO* is expected to be published in 2025 upon completion of the NKLM 3.0. The medical faculties are therefore waiting to revise their curricula, which is leading to a backlog of reforms. In this context, the study results can serve as basis for future analyses to examine how best to anchor COR-related skills in prospective curricula.

#### *4.1.5.2 Limitations and Implications*

Providing first insights into the curricular-anchored promotion of COR in medical studies, the study also has some limitations that need to be considered. Firstly, the study material was narrowed down to state-run universities, disregarding private study programs. Since private universities differentiate substantially from state-run study programs, i.e. in terms of smaller class sizes, innovative teaching methods, and technologies (Schwörer & Wissing, 2017), it would be interesting to investigate whether COR-related skills are more prevalent in the underlying study curricula compared to state-run universities.

Secondly, the codings in the QCA of study regulations were limited due to this ambiguous text material. Although the category system aimed at counteracting the difficulties of assigning underlying keywords and text passages, many assumptions had to be made due to partly very short and limited descriptions. In some cases, a precise assignment to the individual COR facets was difficult or hardly possible. The additional difficulty resulted from the limited scope of information provided by the module names in the study regulations. More detailed descriptions of course content and teaching methods would be necessary to make well-founded inferences on the intended promotion of COR-related skills in the underlying curricula. Notably, there are other elective courses available that cover important skills related to COR, such as evidence-based medicine. Although these courses are listed on the university websites,

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they were not included in the study regulations and therefore were not considered in the QCA. To obtain more comprehensive and accurate results, future studies should take these additional sources into account when analyzing the relevant material.

Thirdly, study regulations only provide insight into the intended perspective of teaching. To gain deeper insights into the actual implementation of the analyzed study curricula regarding the promotion of the COR facets in medical studies, it would be important to conduct profound needs analyses, e.g., via interviews with teachers and students of medicine. Considering recent research results which indicate that students have substantial deficits in COR skills, i.e., when evaluating the credibility of online media (Deutsch & Kuhn, 2019; Kuhn et al., 2020; McGrew et al., 2017), it would also be of great interest to analyze the COR-performance of medical students when solving Internet-based information-problems (see Section 4.2). Moreover, since COR skills can be fostered in professional education and training (Zlatkin-Troitschanskaia et al., 2021b), an elaboration of a training method promoting COR-related skills for medical students, as embedded in the NKLM 2.0 (see Section 4.1.2.1), could contribute significantly to improving medical studies in the digital age (see Section 4.4).

## 4.2 Domain-specific Critical Online Reasoning of Medical Students in Final Year of Studies<sup>6</sup>

### 4.2.1 Research Question

In the digital age, the acquisition and use of information among students and graduates have undergone a significant transformation (Banerjee et al., 2020; Brooks, 2016). The Internet has become a primary source of information for students, offering a vast array of knowledge and learning resources (Rak et al., 2022; Maurer et al., 2020; McGrew et al., 2018). On the one hand, the pervasive accessibility of the Internet facilitates the rapid dissemination of knowledge (Giegerich, 2019; Braasch et al., 2018). Conversely, the intricate nature of the Internet as a learning environment is accompanied by a multitude of challenges and potential risks (Ciampaglia, 2018). These challenges emerge primarily due to the fact that content on the Internet can be freely distributed and thus frequently comprises unstructured, unreliable, inaccurate, or biased information (Wineburg et al., 2018; Kiili et al., 2022). Moreover, the vast quantity of accessible information can result in an ‘information overload,’ which has a negative impact on learning processes (Hahnel et al., 2019).

Digitalization has led to a similar trend in the medical field, which is characterized by a constantly and rapidly changing information environment (O’Carroll et al., 2015). Physicians are increasingly using the Internet to keep themselves regularly informed about new therapeutic measures and incorporate current research in their medical decisions (Rott, 2014). Online information is thus relevant for physicians as they need up-to-date research results to draw up high-quality diagnosis and treatment plans (Zhou et al., 2020; Kuhn et al., 2020).

At the same time, higher Internet use does not automatically imply higher competency in successfully managing online information (Wineburg et al., 2018; Weber et al., 2019). Both students and graduates have difficulties in critically assessing the credibility of online sources (McGrew et al., 2017; Wineburg & McGrew, 2018;

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<sup>6</sup> This chapter is planned to be published in O. Zlatkin-Troitschanskaia, M. Theres-Nagel, V. Klose & A. Mehler (Eds.), *Students’, Graduates’ and Young Professionals’ Critical Use of Online Information: Digital Performance Assessment and Training within and across Domains*. Springer.

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING 2016; Wineburg et al., 2016). Despite being of central relevance in professional practice, such competence deficits were also observed in the medical field (Watson & Burr, 2018). Physicians express having difficulties staying up to date on the growing variety of guidelines and clinical studies and further criticize that the necessary skills are not sufficiently anchored in the study curricula of medical schools (Haag et al., 2018; O'Carroll et al., 2015). In contrast to the increased demands, prospective physicians feel inadequately prepared for their professional future (Schwarzer & Fabian, 2012). The ability to critically deal with online information is highly necessary in medical practice, especially for young physicians, as they do not have substantial prior professional experience available (Ziegler et al., 2020). The successful handling of online media can only be achieved, if young professionals systematically learn to search for, critically evaluate, and use high-quality information for evidence-based decision-making and acting (Mason et al., 2010). In this study, this skill set is defined as 'critical online reasoning' (COR; see Section 2.3).

Despite the pivotal role that COR skills play in the education of young professionals, they remain a relatively under-researched area, particularly within the medical field (Kuhn et al., 2020; Zlatkin-Troitschanskaia et al., 2021b). There is a lack of valid domain-specific assessments for the competent use of online information in practice, in particular regarding young professionals in the transition from medical school to starting their career (Nagel et al., 2022; Zlatkin-Troitschanskaia et al., 2021a; Molerov et al., 2020). To close this research gap and develop a deeper understanding of COR skills among prospective medical professionals, this study aims to answer the following central research question (RQ2):

***RQ2: How well-developed are the COR skills among medical students in the transition from study to professional practice?***

#### ***4.2.2 Conceptual Background and Research Assumptions***

As depicted in Section 2.3.2, based on the validation of COR (Molerov et al., 2020; Nagel et al., 2020; 2022; Schmidt et al., 2020), the framework is further differentiated between generic (GEN) and domain-specific (DOM) COR (i.e., GEN-COR and DOM-COR). The distinction is primarily based on the subject and the level

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING of specificity of the task scenarios and the online information employed in the assessments. In contrast to GEN-COR tasks, DOM-COR task prompts concentrate on information problems specific to a certain domain, such as medicine. These problems require young professionals to reason from specialized online information or to identify domain-specific cues (Molerov et al., 2020). Further, based on prior research (Alexander et al., 2016; Toplak & Stanovich, 2002; Sá et al., 1999), it is assumed that the main COR facets are consistent across both generic and domain-specific contexts. However, their specific combination and application can lead to different profiles and developmental trajectories within and between domains (Zlatkin-Troitschanskaia et al., 2021b).

Consequently, GEN-COR and DOM-COR skills are interrelated but empirically separable, and thus, can each be assessed differently. From these results the first assumption (A1) of this study:

***A1: There is no (necessary) relationship between GEN-COR and DOM-COR performances.***

Since this study intends to analyze COR skills among young professionals in medicine, the main focus of the analyses lies on DOM-COR skills respectively. Moreover, to gain a deeper understanding of how well these skills are pronounced among the target group, it is of particular interest to examine if their development can be related to sociodemographic variables, i.e. gender and age (Zlatkin-Troitschanskaia et al., 2021a). The aspect of gender is particularly relevant to medical studies as an increasingly high number of female students has been observed in the study intakes of human medicine over the past ten years (Hege et al., 2022). In previous studies, no differences in COR-related skills were found concerning gender on general research topics (Breakstone et al., 2021; Nagel et al., 2022). According to the construct definition of COR, similarly, no gender effects are expected to occur in research on domain-specific topics either, which leads to the second assumption (A2) of this study:

***A2: There are no differences in DOM-COR performances with respect to gender.***

In addition to sociodemographic variables, DOM-COR skills can also be related to personality traits, i.e., domain-specific knowledge, figural intelligence/visual perception (Liepmann et al., 2007), social media efficacy (Hocevar et al., 2014), and

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING critical reflection (Frederick, 2005), which are controlled for in the BMBF-funded BRIDGE project, in which this study was embedded (for details, see Zlatkin-Troitschanskaia et al., 2021b). Since research indicates that certain personality characteristics impact research behavior in specific domains (Wildemuth, 2004; Brand-Gruwel et al., 2005), similar results are expected in this study, as postulated in the third assumption (A3):

***A3: There are differences in DOM-COR performances with respect to (certain) personality traits.***

### **4.2.3 Method**

#### *4.2.3.1 Study Design*

As the study aims to analyze COR skills among young professionals in medicine in the transition from medical school to starting their career (RQ2), the analyses are based on the data of 58 medical students in their final year<sup>7</sup> of studies during the transition from university study to professional practice. The data was collected in 3 time-shifted cohorts (2020-2023) at two German universities as part of the BRIDGE project. Participation in the study was voluntary. As an inducement to participate, students received an expense allowance and the opportunity to view their test results online after the assessments and receive individualized feedback on their performance. The assessments were all conducted online. The sample of 58 medical students analyzed in this study is a subset of the 64 medical respondents involved in the BRIDGE project. Six participants were excluded from the following analyses due to incomplete data.

#### *4.2.3.2 Test Instruments*

To answer RQ2 and test the research assumptions (see Section 4.2.2), performance in a generic (GEN-COR) and a domain-specific (DOM-COR) task as well as sociodemographic data (e.g., gender, age) and a diverse range of personality

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<sup>7</sup> The final year (*Praktisches Jahr; PJ*) is the third and final phase of the degree in human medicine in Germany. It focuses on applying theoretical and practical knowledge to the patient as well as experiencing the processes in everyday hospital life (Hamburg Medical School, 2023)

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING traits were collected in this online study (for details, see Appendix B). The socio-demographic data and personality traits were controlled for and assessed via initial online surveys. The implementations of the GEN-COR and DOM-COR tasks was based on the assessment of COR performance (CORA) in an evidence-based design (Mislevy, 2018). CORA was designed to capture the research, evaluation, and use of online information in a realistic Internet environment. This included the usage of unrestricted web searches and actual websites. Process data (i.e., log data) and performance data (i.e., written answers) were collected for all COR tasks and evaluated subsequently (for details, see Zlatkin-Troitschanskaia et al., 2021b).

Each task (GEN-COR and DOM-COR) consisted of a brief description of an authentic information problem accompanied by an assignment to solve the problem through an open web search, an evaluation of the pertinent online information, and the formulation of an open response (for details, see Appendix C):

- 1) *GEN-COR Task*: No specific expertise was required to complete the newly developed GEN-COR task. Within a timeframe of 20 minutes, the participants were asked to research if e-bikes are beneficial for health. Further, they should insert the online sources used to answer this question and state whether and why they consider it credible. Finally, they should write a reasoned statement about the information problem (for details, see Zlatkin-Troitschanskaia et al., 2021b).
- 2) *DOM-COR Task*: The DOM-COR task was also newly developed for this study and should reflect a realistic research situation, as would be expected in the working practice of medical students in their final year. The task contained a hypothetical patient case for which an evidence-based diagnostic plan had to be elaborated within 20 minutes. Again, the task assignment called for an open web search. In addition, the DOM-COR task includes a second assignment of 30 minutes in which a search for primary literature on relevant studies referring to the patient case presented in the first assignment was requested.

Subsequently, the performance in the respective COR tasks was analyzed (i.e., the log data and written responses). The rating scheme used for analyzing the GEN-COR task was developed based on the COR construct and takes into account participants' recognition of biases, decisions, justifications, and sources in 6 facets,

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING each with different weights in the overall score (for scoring details, see Molerov et al., 2020; Nagel et al., 2020; 2022; an excerpt of the rating scheme is depicted in Appendix C). The task performances were scored by at least two independent, trained human raters and combined into a mean score (for details, see Zlatkin-Troitschanskaia et al., 2021b). The rating scheme for the DOM-COR task was further developed based on the GEN-COR rating scheme and comprises 9 facets, which were also weighted differently in the overall score (Zlatkin-Troitschanskaia et al., 2021b). The DOM-COR tasks were evaluated by a rater who had received extensive training. A second rater analyzed approximately 20% of the participants, resulting in a high interrater correlation ( $r = .825$ ;  $p = .002$ ).

The following section describes in detail the scales used to assess personality traits:

- 1) *Media Use*: To assess media use behavior, students were asked on a six-point Likert scale (1 = several times a day; 6 = never) how often they had used certain media in the past semester for learning as part of their studies on average per week (Maurer et al., 2020). Eleven types of media were listed.
- 2) *Critical Thinking*: The critical handling of information was assessed on a six-point Likert scale (1 = does not apply at all; 6 = fully applies) with six items (adapted from Dormann et al., 2018) from which a mean value was calculated.
- 3) *Need for Cognition*: Participants' need to find an answer or to understand the background of underlying information was examined based on a six-point Likert scale from Beißert et al. (2014) (1 = does not apply at all; 6 = fully applies) with four items, from which a mean value was calculated.
- 4) *Information Overload*: Media overload, i.e., the extent to which students feel overwhelmed by the amount of available media, was assessed on a six-point Likert scale (1 = does not apply at all; 6 = fully applies) with three items (adapted from Karr-Wisniewski & Lu, 2010). A mean value was calculated based on the three items.
- 5) *Cognitive Reflection Test (CRT)*: A test to analyze the predisposition to reflective, analytical thinking consisting of three questions that had to be answered within three minutes was carried out (Frederick, 2005). The number of correct answers was summed to produce a score.

#### 4.2.3.3 Sample Description

The total sample consists of 58 participants from two German universities (Frankfurt: n=23; Göttingen: n=35), who were collected in three time-shifted cohorts. Given that the three cohorts do not differ significantly in their performance on the DOM-COR task ( $p=.056$ ), the GEN-COR task ( $p=.637$ ), socio-demographic data (i.e., university entrance grade ( $p=.418$ )), or personality traits (i.e., information overload ( $p=.149$ )), they were treated as a single group (n=58) (Tables 8 and 9).

**Table 8.** Descriptive Statistics for the Sample – I (n=58).

<b>Sociodemographic Variables</b>	
Gender / Female, n (%)	41 (70.7)
Age, mean ( $\pm$ S.E.M.)	25.7 (0.31)
Medicine-related Vocational Training, n (%)	7 (12.1)
Grade UEQ*, mean ( $\pm$ S.E.M.)	1.3 (0.04)
Grade M1** in Writing, mean ( $\pm$ S.E.M.)	2.4 (0.12)
Grade M1** Oral, mean ( $\pm$ S.E.M.)	2.2 (0.12)
Grade M2***, mean ( $\pm$ S.E.M.)	2.7 (0.08)

\* University Entrance Qualification, \*\* First State Examination, \*\*\*Second State Examination

#### 4.2.3.4 Data Analysis

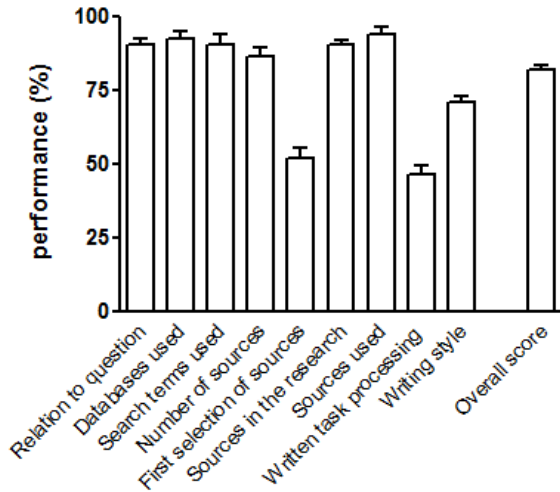
The analyses were performed using SPSS (IBM SPSS Statistics 28.0) and were based on an anonymous code assigned to each participant. Although the data is not normally distributed, a one-way ANOVA was conducted to test for mean differences between more than two groups (e.g., the three time-shifted cohorts), as the one-way ANOVA is relatively robust to the failure to conform to the normal distribution assumption (Blanca et al., 2017; Lix et al., 1996; Schmider et al., 2010). If a post hoc test was required, the Scheffé test was applied. The Mann-Whitney-U test was employed to compare the mean values between two groups (i.e., gender, students with and without prior medical vocational training). Furthermore, Spearman's correlation coefficient was used to relate COR task performance to sociodemographic data and personality traits. All p-values are two-tailed, and a result is regarded as significant when  $p < 0.05$ .

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**4.2.4 Results***4.2.4.1 DOM-COR Performance*

To answer the RQ2 (see Section 4.2.1), the performance in the DOM-COR task was analyzed in detail. In general, the participants demonstrated satisfactory performance in the DOM-COR task, with an overall score of 81.9% (Figure 4 and Table 9). Two facets of the DOM-COR task, namely ‘*First selection of sources*’ and ‘*Written task processing*,’ were rated as only adequate. This discrepancy is likely attributable to the nature of the assessment. For example, the rating of the facet ‘*Written task processing*’ included an element of self-reflection on the part of the participants, although this was not explicitly requested in the task. Furthermore, a diagnostic plan may not necessarily include a written reflection. In contrast, the participants performed very well in the facets ‘*Sources in the research*’ and ‘*Sources used.*’ The detailed rating (results of the individual facets) is presented in Figure 4.

**Figure 4.** Detailed Scoring of the DOM-COR Performance (n=58).

*4.2.4.2 Relations of the DOM-COR Performance with Other Variables*

In addition to sociodemographic data (see Section 4.2.3.3) and DOM-COR performance (see Section 4.2.4.1), GEN-COR performance and several personality traits were also assessed (Table 9). The relationship between these variables and

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DOM-COR performance was analyzed to test the research assumptions (see Section 4.2.2).

**Table 9.** Descriptive Statistics for the Sample - II (n=58).

<b>Variables regarding Task Performance, mean (<math>\pm</math>S.E.M.)</b>	
Performance in GEN-COR task, points 1 to 4	3.3 (0.07)
Performance in DOM-COR task, in %	81.9 (1.38)
<b>Variables regarding Personality Traits, mean (<math>\pm</math>S.E.M.)</b>	
Media use, extracts, scale 1 to 6	
AMBOSS	5.1 (0.12)
Journals	2.4 (0.14)
Newspaper	1.6 (0.14)
TV / Radio	1.6 (0.15)
Critical Thinking, scale 1 to 6	4.2 (0.11)
Need for Cognition, scale 1 to 6	4.2 (0.10)
Information Overload, scale 1 to 6	3.3 (0.15)
Cognitive Reflection Test, correct answers from a possible 3	2.0 (0.13)

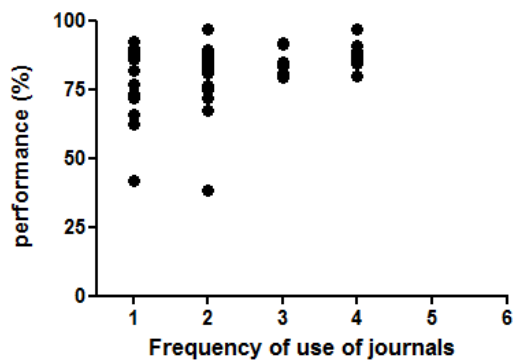
Regarding A1, it was assumed, based on the construct definition of COR, that there is no necessary relationship between GEN-COR and DOM-COR performance (see Section 4.2.2). In alignment with previous findings, no significant correlation was found between performance on GEN-COR and DOM-COR tasks ( $r=-0.085$ ,  $p= .527$ ). Therefore, A1 can be confirmed.

With respect to A2, no significant differences were observed in DOM-COR performance with regard to gender ( $p=.062$ ), thereby confirming A2. Moreover, no significant correlation was observed between DOM-COR performance and either the age of the participants ( $r=-.291$ ,  $p=.098$ ) or the grades surveyed (university admission grade:  $r=-.175$ ,  $p=.188$ ; grade M1 in writing:  $r=-.249$ ,  $p=.60$ ; grade M1 oral:  $r=-.064$ ,  $p=.631$ ; grade M2:  $r=-.142$ ,  $p=.287$ ).

With regard to A3, the correlation between DOM-COR performance and several personality traits was examined in detail below. There was a positive correlation between performance in the DOM-COR task and the frequency of certain media used (journals:  $r=.274$ ,  $p=.038$  (Figure 5); daily newspaper:  $r=.259$ ,  $p=.050$ ;

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING TV/radio:  $r=.282$ ,  $p=.032$ ), but not in the use of other media such as the medical knowledge platform AMBOSS ( $r=.123$ ,  $p=.359$ ), which was the most frequently used information source among the participants (Table 9). Such correlations were not found in connection with the performance in the GEN-COR task (daily newspaper:  $r=.148$ ,  $p=.268$ ; TV/radio:  $r=.245$ ,  $p=.064$ ; journals:  $r=.159$ ,  $p=.235$ ).

**Figure 5.** Correlation between DOM-COR Performance and the Frequency of Using Journals (scale of 1 = several times a day to 6 = never) ( $r=.274$ ,  $p=.038$ ).

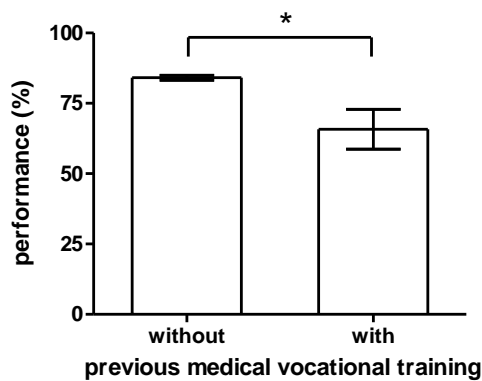


Furthermore, no correlations were identified between performance in the DOM-COR task and personality traits such as critical thinking ( $r=.134$ ,  $p=.316$ ), need for cognition ( $r=.058$ ,  $p=.667$ ), or information overload ( $r=-.113$ ,  $p=.399$ ). However, a significant correlation does exist between DOM-COR performance and the number of correct answers in the cognitive reflection test ( $r=.358$ ,  $p=.006$ ). Nevertheless, no significant correlation was observed between GEN-COR performance and the cognitive reflection test ( $r=-.002$ ,  $p=.986$ ).

Moreover, a correlation was found between previous medical experience and performance on the DOM-COR task. As part of the sociodemographic data collection, the participants were asked to provide information regarding any vocational qualifications they had completed prior to their university studies. A total of ten participants (17%) had already completed vocational training prior to commencing their degree program. Of the ten students, seven (12%) had completed medical-related vocational training (in nursing or emergency services). When comparing the mean values of DOM-COR performance between the three subgroups (*no training, medical training, non-medical training*), there was a significant difference between these subgroups ( $p < 0.001$ ). This difference exists between the subgroups ‘without training’

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING and ‘with medical training’ ( $p < 0.001$ ) as well as between the subgroups ‘non-medical training’ and ‘medical training’ ( $p = .023$ ); however, not between the subgroups ‘without training’ and ‘with non-medical training’ ( $p = .972$ ). Combining the subgroups, ‘no training’ and ‘non-medical training,’ and comparing this mean value with the mean value of the subgroup ‘with medical training’ using a non-parametric test, the relationship between prior domain-specific experience (medical vocational training) and performance in the DOM task was confirmed ( $p = .001$ , Figure 6,  $r = -.408$ ). Performance in the GEN-COR task was independent of prior medical vocational training ( $p = .096$ ).

**Figure 6.** DOM-COR Performance between Students with and without Prior Domain-specific Experience (Medical Vocational Training) (\* $p = 0.001$ ).



The following section takes a closer look at the subgroup of the seven students with medical vocational training in comparison to the overall cohort. There were five females (71.4%) and two males (28.6%). This corresponds to the overall cohort, in which 70.7% of the participants were female. The participants with previous medical training had a mean age of 28.1 years. They are therefore 2.4 years older than the students in the overall cohort (25.7 years,  $p = .015$ ). With regard to personality traits, the average scale scores were as follows: critical thinking 4.4 (overall cohort 4.2,  $p = .342$ ); need of cognition 4.1 (overall cohort 4.2,  $p = .949$ ); information overload 3.3 (overall cohort 3.3,  $p = .939$ ). The cohort demonstrated a mean university admission grade of 1.8 (overall cohort 1.3,  $p < .001$ ), an M1 grade in the written of 2.7 (overall cohort 2.4,  $p = .337$ ), an M1 grade in the oral exam of 2.3 (overall cohort 2.2,  $p = .902$ ), and an M2 grade of 2.7 (overall cohort 2.7,  $p = .897$ ). In the cognitive reflection test, they achieved 1.7 correct answers (total cohort 2.0,  $p = .271$ ). The frequency of using the following media resulted in the respective scale values: knowledge platform

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING AMBOSS 4.8 (total cohort 5.1,  $p=.889$ ), journals 2.1 (total cohort 2.4,  $p=.552$ ), daily newspaper 1.4 (total cohort 1.6,  $p=.319$ ), TV/radio 1.3 (total cohort 1.6,  $p=.786$ ). They attained an average performance of 3.0 points in the GEN task (overall cohort 3.3,  $p=.096$ ). The performance in the DOM task showed the clear difference described above: 65.8% performance (overall cohort 81.9%,  $p=.001$ ).

Overall, there were differences in DOM-COR performances in relation to certain personality traits, confirming A3.

#### **4.2.5 Conclusion**

##### *4.2.5.1 Discussion*

In this study, the focus was placed on assessing and analyzing the domain-specific COR skills of medical students during the transition from medical studies to professional practice (RQ2). It is imperative for young medical professionals, in particular, to determine which sources are scientifically reliable and sufficiently up-to-date as they progressively utilize the Internet as an integral component of digitalization and the resulting transformation in research processes (Ziegler et al., 2020). Additionally, it is of paramount importance for young medical professionals to disseminate themselves about current medical research results and treatment options with the utmost care. Further, it is crucial that young medical professionals are equipped with the ability to conduct critical and reflective online research, given that they have not yet had the opportunity to accumulate substantial experience in the field.

The participants exhibited satisfactory overall performance in the DOM-COR task set. It must be acknowledged, however, that this is merely an initial observation of students' DOM-COR performance, given that only one DOM-COR task was administered. The diagnosis for the patient case used might have been easy to provide if this clinical scenario had been covered in detail during the study. In this case, the DOM-COR service would not have been provided in detail during the assessment. Therefore, curricular analysis would be helpful for the development of further appropriate tasks (see Section 4.1).

The research assumptions could be confirmed. No correlation was identified between performance in the GEN-COR and DOM-COR tasks (A1) or an influence of

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING gender on DOM-COR performance (A2). Differences in DOM-COR performance were found in relation to the following personality traits: media use, score in the cognitive reflection test, and previous medical experience (medical vocational training) (A3).

Since the Cognitive Reflection Test (CRT) measures a person's ability or disposition to think about a question rather than give the first intuitive answer, that is, the tendency to reflective, analytical thinking, it was expected to correlate with DOM-COR skills (Zlatkin-Troitschanskaia et al., 2021).

It is conclusive that more frequent use of original literature was correlated with higher DOM-COR performance. Schäfer (2022) demonstrates that the type of media utilized influences the extent of knowledge acquisition. The findings indicated that the consumption of brief, "snack news" did not result in any discernible increase in knowledge. Conversely, the reading of a comprehensive online article was associated with a notable enhancement in knowledge. The capacity for knowledge growth is contingent upon the ability to adapt to one's environment. This process is underpinned by changes in synaptic connections and the connectivity of neuronal networks. The manner and intensity of activation are pivotal determinants in this regard (Flor, 2019). Furthermore, differentiated cognitive processing (e.g., thinking about the information and creating links with existing information) is also crucial for consolidating the information learned. This indicates that different media are differently qualified for learning (Schäfer, 2022). Comprehensive and structured information that establishes connections (like original literature) therefore creates good learning conditions. It is conceivable that these correlations between media use and knowledge gain can also be applied to COR skills. The fact that there was no correlation between DOM-COR performance and the most frequently used medium (AMBOSS) was possibly since all participants used AMBOSS.

The correlation between domain-specific experience (medical vocational training) and performance on the DOM task is remarkable and important to understand in order to better support this important group of students. A similar relationship has also been shown for performance on a domain-specific knowledge test in medicine (exam questions) by Roeper et al. (2022). Medical students with prior medical vocational training were not able to markedly increase their domain-specific knowledge during the course of the seminar, while confidence increased clearly in this

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING group. This fits with the findings by Schäfer (2022), who also observed an opposite effect of knowledge growth and confidence. Snack news tended to make people believe they were better informed than they were while reading an online article counteracted an overestimation of knowledge. The interesting question is also what caused the group with previous medical experience to perform worse in the DOM-COR task. In fact, this group has a significantly lower university admission grade (1.8 compared to the overall cohort 1.3;  $p < 0.001$ ). This could explain why they first completed vocational medical training (e.g., N.C. was 1.5 for medicine in Frankfurt in 2015/16). However, the university admission grade did not correlate with the DOM-COR performance in this study. The reason for the worse DOM-COR performance in this study may also be due to confidence (Roeper et al., 2022; Schäfer, 2022). In future research, it would therefore be useful to include the assessment of confidence when solving a task.

#### *4.2.5.2 Limitations and Implications*

The overall number of participants (and especially participants with previous medical experience) is one of the significantly limiting factors. The characteristics and correlations found among the DOM-COR skills of medical students needs to be further investigated in a longitudinal design, for instance, to find out when DOM-COR skills develop over the course of their studies. For example, previous studies, in which the COR-related construct, Civic Online Reasoning, was examined for middle school, high school, and college students, showed a positive correlation between COR-related skills and study progress (McGrew et al., 2018). Recent studies also concluded that these skills improved with increasing expertise and higher grade levels (Nygren et al., 2020; Breakstone et al., 2021; Guath & Nygren, 2022). Also related to the COR construct, which, according to the definition, can be enhanced by corresponding training, students' COR skills should improve due to increasing experience with online research and the writing of scientifically argumentative texts over the course of studies (Molerov et al., 2020; see Section 4.3). Thus, in terms of convergent validity, students who are further along in their studies should perform better in COR tasks than students at the beginning of their studies.

### **4.3 Design, Implementation, and Evaluation of a Digital Training to Improve Students' Generic and Domain-Specific Critical Online Reasoning in Post-University Professional/Practical Training<sup>8</sup>**

#### **4.3.1 Research Questions**

In the course of digitalization, the Internet has developed into one of the main information sources of university graduates (Grothaus, 2021; Ugur, 2020; Newman and Beetham, 2017; for a literature review, see Zlatkin-Troitschanskaia et al., 2021a). Online sources are often used more frequently to access information than university sources, such as textbooks (Mauer et al., 2020). While the immediate availability and variety of online media offer information resources at low effort and expense (Braasch, 2018), the vast quantity of low-quality information imposes several risks and challenges for decision-making and acting using Internet sources (Walton et al., 2020; Maurer et al., 2018; Batista et al., 2022). Online information is oftentimes untrustworthy, incomplete, erroneous, or biased, challenging users in their judgment of the quality of the content they find on the Internet (Zhang & Ghorbani, 2019; Carbonell et al., 2018). For instance, they feel overwhelmed by the amount of information they encounter online ('information overload'), which can negatively impact their professional decisions and actions (Feroz et al., 2022; Schoor et al., 2020; Hahnel, 2019).

The ability to judge the credibility of online media is an essential 'cultural-technical skill' for several study domains and professions in the 21st century (Redecker, 2017; Machete & Turpin, 2020). Although today's university graduates and young professionals, also described as a generation of 'digital natives,' have grown up using digital devices and browsing the Internet regularly (Taylor, 2012; Osborne et al., 2022), they often perform poorly when it comes to correctly evaluating the credibility of online media (McGrew & Chinoi, 2022; Breakstone et al., 2021; Ziv & Bene, 2022; McGrew et al., 2018; Wineburg & McGrew, 2018). For example, they fail to question the author of a source, do not recognize the real intention, or base their judgement on irrelevant criteria, such as the design of a website or the authority of a search engine

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<sup>8</sup> The shortened version of this chapter is planned to be published in the Journal of *International Journal of Training and Development*.

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING (Wineburg & McGrew, 2019; Klawitter & Hargittai, 2018). The ability to competently deal with online sources and information is required for appropriate decision-making and acting using Internet-based sources (McGrew & Byrne, 2020; McGrew et al., 2017). Competent handling of online information can only be achieved if graduates and young professionals systematically learn to search for, critically evaluate, and reason using high-quality information (McGrew & Kohnen, 2024; Axelsson et al., 2022).

In this study, this skill set is defined as ‘critical online reasoning’ (COR; Molerov et al., 2020; Nagel et al., 2022). COR plays an increasingly important role in the demands of several professions for which evidence-based decision-making and acting is essential in practice. This accounts in particular for practical training of medical, legal, and teaching trainees, since (young) professionals in these domains increasingly use online media for every-day work purposes (Kuhn et al., 2020; Drapezo et al., 2022; Vaskov et al., 2021) (for examples, see Section 4.3.3.1). Despite the high importance of COR skills in these three domains, previous studies indicate substantial deficits among young professionals (Zlatkin-Troitschanskaia et al., 2021a), leading to the question whether and to what extent the ability to critically deal with online information can be effectively fostered in professional/practical training (phase). Generally, COR-related skills can be improved with training (McGrew & Chinoi, 2022; Jahn and Kenner, 2018; Weber et al., 2018; Benjes-Small et al., 2013). However, existing training approaches only address partial COR-related facets and hardly focus on domain-specific contexts (see Section 4.3.2.1). To address this limitation, this study aims at the theory- and evidence-based conceptualization and implementation of a training to equally foster all COR facets within and across the three domains. Accordingly, the study is guided by the central research question (RQ3):

***RQ3: Based on established didactic principles and learning models, how must a training for the acquisition and promotion of COR in higher and post-university professional education be conceptualized and designed?***

To address RQ3, the training design follows the principles of the ADDIE instructional design model, which describes the five phases ‘Analysis’, ‘Design’, ‘Development’, ‘Implementation’, and ‘Evaluation’ that are progressively performed

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING in the development of digital teaching arrangements (Shelton & Saltsman, 2008; Branch, 2009) (see Section, 4.3.2.2). The primary structure of this study is based on the five phases of the ADDIE model (see Section 4.3.3).

In alignment with the aforementioned model, the study is structured around five research questions (RQ3.1-3.5) that address the five phases:

***RQ3.1 ‘Analysis’: What are the main training objectives needed for a training in the target population, i.e., which particular skills in development does a training need to foster across the three professional domains?***

To investigate RQ3.1 an analysis was first undertaken of the special COR-related requirements within and across the three domains. Next, interviews were conducted with experts from the three domains. Finally, the data from the survey on prior COR-related training experiences and expectations on online training in professional practice were analyzed (see Section 4.3.3.1). The results of RQ3.1 informed the subsequent phase of the study, which addressed the following:

***RQ3.2 ‘Design’: How does a training have to be designed to effectively meet needs, demands, and expectations on the acquisition and promotion of COR skills in post-university professional training within and across the three domains?***

To explore RQ3.2 and thus to derive the general structure and create a template for the learning modules and content of the training, the study relied upon established didactic principles and digital learning models drawn from pertinent research (see Section 4.3.2.1). Furthermore, these prior research findings and training methods were connected to the construct definition of COR and its facets, which describe the individual skills to be fostered (Molerov et al., 2020). Building on this, detailed learning objectives for each learning module were formulated and operationalized.

Since the COR training seeks to improve the critical handling of online media accessed via digital devices, established concepts from the field of e-learning, including computer-based trainings (CBT), are most appropriate for the format of the training. CBTs are courses of instruction that are delivered via software products, an intranet, or directly over the Internet as web-based trainings (WBT) (Khan, 2001). WBTs offer the potential for direct integration of online media relevant to the training, independent pursuit of training courses by students, and the ability for developers to

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING save and evaluate user data, which provides insights into users' learning processes (Aora et al., 2018; Garrison, 2011). Therefore, this format has been selected for this project.

In the next phase, Development, the WBT needs to be theoretically and content-wise conceptualized based on established didactic principles and learning models. Accordingly, the following RQ was investigated:

***RQ3.3 'Development': How should the training materials be developed, considering technological, didactic, and content-oriented criteria?***

In addressing RQ3.3, initially, the design of the Graphical User Interface (GUI) for the WBT was conceived, with careful consideration given to media didactic design elements (Lee & Owens, 2004). Subsequently, training methods were derived from the predefined learning objectives (see Section 4.3.3.5). These methods incorporated practices suitable for e-learning and traditional design elements of WBT such as text, video, and images (Balaban, 2011). Additionally, they were informed by established principles of multimedia learning (Mayer, 2017) to enhance instructional effectiveness in the multimedia learning environment.

Upon entering the Implementation phase, the designed learning content undergoes practical testing, facilitating the practical application of the instructional design. This process gives rise to the following RQ:

***RQ3.4 'Implementation': How was this training technically implemented in the context of this project?***

Regarding RQ3.4, in this study, the WBT was implemented in the open-source learning management system 'Moodle' (Costello, 2013). It was tested among medical, law, and teaching trainees in their practical training phase of studies in Germany (see Section 4.3.3.6).

During the final phase, Evaluation, both summative and formative assessments are conducted on the developed learning content. This comprehensive evaluation aims to ensure its effectiveness and to identify areas for improvement (Niegemann et al., 2013).

***RQ3.5 ‘Evaluation’: How was this training tested and analyzed in this study? What claims or conclusions can be derived in terms of its effectivity?***

To investigate RQ3.5, evidence from the pre-post-assessments of COR skills was utilized, along with data collected during the training, and feedback from participants across the three domains. The initial evaluation findings indicate that the COR training can enhance graduates’ COR skills in the three domains (see Section 4.3.3.6). Concurrently, certain limitations were identified, prompting critical discussions regarding further development and the transferability of the training to professional contexts.

This study concentrates on the theoretical and didactic conceptualization of the training. Consequently, the first three phases ‘Analysis’, ‘Design’, and ‘Development’ are elaborated in detail while the subsequent phases, ‘Implementation’ and ‘Evaluation,’ are briefly addressed within the context of the BRIDGE project, given the comprehensiveness of the ADDIE model. In the following section, the relevant prior state of research and theoretical-conceptual background of this study are described, before findings to the five research questions are presented following the structure of the five main phases of the ADDIE model (see Section 4.3.2.2). Finally, conclusions are drawn regarding the transferability of the training to professional contexts (see Section 4.3.4).

### ***4.3.2 Prior Research and Conceptual Background***

#### ***4.3.2.1 Previous Training Methods of COR-Related Skills***

Research and practical experiences consistently emphasize the relevance of the critical handling of online media in post-university professional training (Zlatkin-Troitschanskaia et al., 2021b). However, while various training methods exist to foster single COR-related facets, no comprehensive approach covers all relevant skills across different professional domains.

The most prevalent training approach is the usage of checklists, where users systematically assess website credibility using predefined criteria (Shah et al., 2015; Walraven et al., 2008; Flanagin & Metzger, 2007; Shanahan, 2008; for details, see Appendix E). For example, the ‘RAD CAB’ method by Christenson (2006), includes

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING

the criteria Relevance, Appropriateness, Detail, Currency, Authority, and Bias. Similarly, the ‘CRAAP’ test by Blakeslee (2004) assesses Currency, Relevance, Authority, Accuracy, and Purpose. The more criteria apply, the more credible the corresponding source. While these checklists outline the relevant evaluation criteria, their practical implementation and prioritization are not clearly explained (Breakstone et al., 2018; Meola, 2004). Additionally, the criteria application varies across media types and professional contexts (Grimes & Boening, 2001), and, the simplistic ‘right-or-wrong’ approach overlooks the complexity of online media (Currie et al., 2010; Gross & Latham, 2011). With regard to COR, the checklist approach connects with CIE skills, since this facet requires the evaluation of credibility cues similar to the abovementioned criteria; however, it lacks emphasis on OIA and REAS.

Another approach involves presenting exemplary online media that exhibit highly incredible, extremist, or disinformation features (Mathson & Lorenzen, 2008). First, preselected online media containing obviously dubious features are presented to the students. Subsequently, they receive further examples from various fields in which the credibility cues are harder to detect. While this approach is extremely illustrative, the preselected media are always topic-related (Meola, 2004). Moreover, identifying disinformation is oftentimes harder in reality than in the selected examples. Consequently, students are sensitized to untrustworthy sources in the presented topics but fail to evaluate sources in other fields (Mathson & Lorenzen, 2008). Although this approach especially addresses the CIE facet by examining specific cues and the evidential value of online sources, it also neglects the OIA and REAS facets, since it does not practice accessing and selecting online sources for decision-making purposes.

Meola’s (2004) ‘context approach’ highlights that the Internet contains both erroneous and credible information (e.g., in verified databases of libraries), which students must learn to access and use effectively. Instead of simply analyzing predefined criteria, such as accuracy or relevance, students are encouraged to first access credible information sources and second compare them with at least two additional sources. The comparison strategy is vital to verifying information with proof and evidence (Dahlen, 2012; Taylor & Dalal, 2014). Identifying similarities and differences between sources activates a (meta)cognitive process, aiding to detect biases and misleading statements. In contrast to the checklist and example approaches,

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING students are finally asked to freely navigate the Internet and search for data and facts from credible sources to proof the initial online source (Meola, 2004). This approach specifically addresses the OIA and CIE facets, and highlights that the competent use of online sources entails a multistep process aligning with the COR definition (Molerov et al., 2020). However, the REAS facet is hardly considered.

Another approach, rooted in cognitive development theory (Black & Allen, 2017; Jackson, 2007), aligns with the ‘Perry scheme’ (Perry, 1970), which posits nine cognitive stages that university students progress through during their studies. Consequently, training approaches should cater to students’ cognitive stages, offering tasks of varying difficulty levels that foster the students’ in-dividual strengths and weaknesses (Jackson, 2007). The recognition of students’ cognitive stages informs a constructivist approach of web evaluation (Benjes-Small et al., 2013), where learners actively construct their knowledge instead of passively absorbing information (Booth, 2011). Instead of presenting preselected media and checklists, tasks following this approach encourage students to freely navigate the Internet and evaluate sources based on their own criteria. Feedback is essential to ensure students’ learning successes, allowing students to reflect their solutions and internalize the necessary skills more effectively (Benjes-Small et al., 2013). Although this approach requires complex development and implementation, it promises the highest knowledge gain, as its learner-centered strategy adapts tasks to students’ cognitive stages (Jackson, 2007).

All previous approaches and findings have significantly contributed to the conceptualization of the COR training in this study (see Section 4.3.4). Additionally, prior research emphasizes the relevance of autonomous training in real-world scenarios (Gross & Latham, 2011; Taylor & Dalal, 2014; Flanagin & Metzger, 2008). This entails students learning to utilize search and evaluation strategies in decision-making and action in varying professional contexts, facilitating successful transfer of such strategies and skills across specific contexts.

#### *4.3.2.2 ADDIE Model of Instructional Design for Web-based Trainings (WBT)*

Before the actual content of the training can be conceptualized, its technological and didactic format and structure need to be determined (RQ3). As the training seeks

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING to improve online skills, the technical WBT format is selected (Khan, 2001). WBTs can be accessed directly via web browsers and do not require the installation of specific software. Further advantages are the time- and location-independence and the adjustability to individual learning speed. Accordingly, users are free to decide when and where to complete the training in their daily lives (Driscoll, 2002). Training modules can be completed, interrupted, and repeated simultaneously by several users (i.e., by creating individual online accounts), without hampering the overall learning process. WBTs allow for storing and evaluating data, which provide valuable insights about the individual learning progress to users as well as to training developers. For instance, user data enables the revision and improvement of the training modules (Caballé et al., 2014). Feedback is essential for the consequent orientation towards the training objectives (Latham, 2012; Brown, 2017). The Internet environment of a WBT facilitates reciprocal feedback, since users can easily fill in and send contact forms communicating criticism and suggestions for improvement as well as receive corrective feedback regarding their training results (Mora et al., 2015; Gupta and Bostrom, 2009; Wang & Wu, 2008).

This technical format is compatible with a variety of media designs (i.e., videos, interactive applications, direct integrations of online media via links), and modules can be flexibly complemented and adapted (Drigas, & Karyotaki, 2016). Apart from potential costs of a WBT, a critical factor is the dependence on a stable Internet connection and technical infrastructure, which should ideally be the same for all users. In university contexts, the technical format of a WBT is most suitable for the targeted training purpose (Arkorful, & Abaidoo, 2015).

In accordance with the technical WBT format, its didactic format and structure rely on the most prevalent learning theory in this field: Instructional Design (ID; Branch, 2009). Smith and Ragan (2005, p.8) define ID as “the systematic and reflective process of translating principles of learning and instruction into plans for instructional materials, activities, information resources, and evaluation.” ID thus aims at the best possible learning environment for a given training purpose and its underlying conditions. Several theoretical ID models exist that focus on the implementation of didactic and psychological principles for the conception of teaching-and-learning assessments and which serve as frameworks for the design of e-learning methods. A

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING model predominantly used for the conceptualization of digital teaching assessments is the ADDIE model of ID (Branch, 2009). The acronym ADDIE describes the five phases ‘Analysis’, ‘Design,’ ‘Development,’ ‘Implementation,’ and ‘Evaluation,’ which are progressively performed in the development process (Shelton & Saltsman, 2008; Gustafson & Branch, 1997).

In the first phase, ‘Analysis,’ the needs of the training and learning offer, the overarching guidelines, as well as the training objectives and content are determined. Additionally, the requirements of the target group are analyzed, which are essential for developing a competence profile and derive purposeful learning strategies (Branch, 2009). The analyses form the basis of the actual learning modules and content (Hodell, 2007).

In the second phase, ‘Design,’ the external structure of the training is established, in which the content is grouped and sequenced into modules by determining their order and duration (Welty, 2007).

In the third phase, ‘Development,’ the actual learning material is created and designed by developing single tasks, audio recordings, or videos (Hodell, 2007).

In the ‘Implementation’ phase, the conceptualized learning tool is tested in practice (Shelton & Saltsman, 2008).

The final ‘Evaluation’ phase, which entails a summative and formative evaluation of the learning tool, usually leads to a revision and improvement of the concept (ebd., 2008).

Despite criticism of its rigid structure, this model provides a linear development process and facilitates a logical and transparent conceptualization. The entire process is usually carried out in iterative loops. For the initial development, however, the focus lies upon the linear structure of the model. This study primarily concentrates on the theoretical and didactic conceptualization of the training and thus the first three phases (‘Analysis,’ ‘Design,’ and ‘Development’).

### ***4.3.3 Analysis, Design, Development, Implementation and Evaluation***

#### *4.3.3.1 Requirement Analysis of the Target Group (RQ3.1)*

In the first phase of the ADDIE model, ‘Analysis,’ the requirements towards the training are determined. Through the increasing digitalization, the competent use of online information has developed into an essential skill in the 21<sup>st</sup> century for several professions (Redecker, 2017). This accounts especially for the education and training of medical, legal, and teaching professionals, since these fields require evidence-based decision-making and acting in practice (Kuhn et al., 2020). However, undergraduate and graduate students often lack the necessary skills, e.g., to critically evaluate online information (McGrew & Chinoy, 2022; Breakstone et al., 2021; McGrew et al., 2017). Although the existing deficit is widely known, there exists no training approach fostering all relevant skills needed for critically dealing with online information. Based on the COR construct (see Section 2.3) and previous training approaches (see Section 4.3.2.1), this study aims to fill this research gap through the conceptualization of a training in the WBT format (see Section 4.3.2.2). Drawing from previous research, the overarching training objectives are the following:

- Secure technical handling of the World Wide Web (WWW)
- Critically access and evaluate information on the WWW
- Apply evidence-based argumentation methods
- Metacognitively reflect on the learning process

The intention of the training is therefore not only to foster (deficient) COR skills but also to reflect the individual learning process in order to contribute to lifelong learning (Dahlen, 2012), i.e., the participating students and young professionals shall acquire transferrable knowledge and skills, which are applicable to both their professional practices and private lives (Cropley & Knapper, 2021).

Next, the target group of the training is defined and analyzed in terms of their learning requirements. To derive a meaningful learning strategy, demographic data as well as the current state of knowledge need to be determined. A requirement is characterized by a gap between the current state of (deficient) COR skills and the target state of COR skills after completion of the training. The requirement analysis thus serves as basis for developing a competence profile, which contains all relevant COR

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skills that participants should possess after completing the training. This analysis is essential to define the content and focus of the training (Shelton & Saltsman, 2008) and also serves to infer the training benefit and expected learning motivation of the target group (Dahlen, 2012).

The target group of the COR training are medical, legal, and teaching trainees in their practical training phase in Germany who participated in the BRIDGE project (Zlatkin-Troitschanskaia et al., 2021b). The requirement analysis was conducted via participants' surveys as well as interviews with experts from teacher education, law, and medicine (for details, see Gonzales-Ringer 2021, Scherbaum 2021, Kohmer 2020). Table 10 shows a comparison of the respective descriptive characteristics.

**Table 10.** Comparison of the General Characteristics of the Target Group in Medicine, Law, and Teacher Education.

<b>Domain</b>	<b>(Human) Medicine</b>	<b>Law</b>	<b>Teaching</b>
Average Age	26.2	24.4	24.8
Gender Distribution	Female: 63.3% Male: 36.7%	Female: 55.9% Male: 44.1%	Female: 61.6% Male 38.4%
Stage of Studies During WBT Participation	Practical training phase (as preparation for prospective professional career)		
Time Span of Practical Training Phase	12 months (4 months each in the areas of internal medicine, surgery, general medicine, or a further clinical-practical domain)	2 years (min. of three months each at a civil or criminal court, prosecution, administrative authority, and electoral station)	18 months (Hesse: 21 months; Bavaria: 24 months) in the respective subject of teaching (here, economics)
Objective of Practical Training Phase	Deepening and expansion of knowledge and skills acquired during university studies as well as application to concrete cases of illness	Familiarization with legal professional practice and its social foundations as well as deepening and expansion of knowledge and skills acquired during university studies	Preparation for professional practice through increasing responsibility, the autonomous preparation of lessons and the intensive training of action-related teaching skills
Required (Written) Reports during Practical Training Phase	Logbook documenting observed/applied work techniques, clinical cases etc.	No central logbook, but assisting in preparing documents required in practical legal contexts (e.g., composition of a plea)	No central logbook, but various written elaborations (e.g., observative reports, teaching concepts, class materials etc.)

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With an average age of 25.1 years, the target group falls among the main users of the Internet, who have grown up in an environment dominated by the Internet ('Google Generation'; Rowlands et al., 2008). All participants have completed their university studies and are currently completing their practical training phase before entering their professional career. Considering the theory of cognitive stages, it can thus be assumed that the target group has at least achieved the stage of *relativistic thinking* (Black & Allen, 2017). All participants are adult learners who, in contrast to children and adolescents, are characterized by higher self-motivation, goal orientation, and the ability to build upon existing knowledge (Conde-Gafaro, 2022). These characteristics are considered in designing the learning tools in the subsequent phases.

In all three domains, the practical training phase aims at the deepening and expansion of previous knowledge and skills, which are essential for later everyday working life. Medical students are required to keep a logbook, whereas students from law and teacher education are asked to prepare regular written documents focusing on tasks of the respective professional practice. Therefore, the target group is confronted with new tasks and content in their practical phase and thus has a high need for information acquisition (e.g., with regard to preparing clinical cases, court decisions, or lesson plans). Inferring from previous study results, they are likely to use the Internet, especially when quickly accessing information (Grothaus et al., 2021; Ugur, 2020) Therefore, the target group can expect a practical benefit from participating in the WBT. To further define this benefit, a closer look at the COR skill levels within the three domains is taken.

*Medicine:* Online media are becoming increasingly important for professional practice in medicine (Mesko and Györffy, 2019; Inman et al., 2019); the Internet has turned into a significant research tool for disease patterns and diagnostics (Menvielle et al., 2017). Apart from consulting databases, search engines are commonly used in medical practice nowadays, e.g., to access medical guidelines and survey articles (O'Carroll et al., 2015). The study curriculum in Germany has not yet been adapted to digitalization nor does it contain a unified schedule for the instruction of COR skills (; Jünger, 2023; Haag et al., 2018). Nonetheless, about 60% of medical students rated their search engine skills as good to very good; about 35% as moderate and 5.5% as poor (Rott, 2014). In using online databases, 50% rated their skills as good to very

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*Law:* A similar picture emerges in law, which requires a self-organized and critical examination of underlying factual circumstances and cases in professional practice (Drapezo et al., 2022). The increased offer of digital media and expert literature on the Internet leads to a complex environment of juridical research instruments, demanding legal professionals to access and deal critically with online information (Enkova et al., 2021; Vogel, 2020). The curriculum of law studies in Germany is also lacking courses focusing on COR, which has effects on the study results of law students, i.e., the repeated usage of unreliable online sources in term papers (Braunheim et al., 2023). According to Schimmel (2011), the underlying problem is that law students are generally taught to search for judgements and legislative texts but not evidence-based online-information. Law graduates who participated in this study also report a high importance of COR skills for their study and professional success, with REAS being considered the most relevant COR facet. Compared with the medical students, they evaluate the extent to which COR has been promoted throughout their university studies as lower. They also preferably use legal online databases (e.g., Beck-online and Juris), followed by textbooks and lecturers' slides. They assess databases and textbooks as the most reliable types of sources.

In addition, in the context of this project, interviews were conducted with experts in the field of law education. These experts reported that COR is a necessary

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skill for legal professionals, yet it is not sufficiently promoted during university studies. The experts state that it is crucial for law trainees to understand the initial research problem and connect it to expert knowledge to be able to differentiate between relevant and unnecessary information. The metacognitive facet thus plays a substantial role in the overall research process in law. Moreover, law students should be instructed to use precise search terms and operators in search engines and databases, which imply the necessity to promote OIA. Both experts regard the usage of search engines as more complex and critical in contrast to databases (for details, see Scherbaum, 2021).

*Teaching:* COR is also essential in teaching, since teachers are not only required to critically deal with online information in their professional practice but also ‘transmit’ relevant skills to their students. Although e-learning and technical facilities have recently been promoted in higher education (similar to medicine and law), there exists no unified curriculum for COR skills in teacher education. Student teachers learn how to technically administer online media but rarely how to deal with such in a critical-reflexive manner (Arnold, 2020; Mindt and Meister, 2020). Again, this corresponds with the findings in this study in which the surveyed student teachers regard COR and especially REAS as a necessary facet for their study and professional success but criticize that the respective skill set has only moderately been promoted during their university studies. As the Internet is increasingly used as resource for planning and designing lessons, a deficit in COR can have substantially negative effects on the quality of teaching and learning. For instance, illustrative and interesting learning materials can easily be retrieved, however, the vast amount of freely accessible content that exists needs to be examined. Student teachers regard their abilities in searching and processing online information as high and their abilities in analyzing, reflecting, and solving information problems as low (Brinkmann et al., 2018; Herzig and Martin, 2017).

Furthermore, interviews with experts in teacher education were conducted in the scope of this study in order to substantiate the above-mentioned findings. Experts state that the importance of COR for teaching has increased over the past decade and that a high risk to adopt technically and didactically wrong information exists. The experts criticize that COR is only treated superficially or casually mentioned when writing

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING essays and lesson plans (for details, see Gonzales-Ringer, 2021). A targeted training of COR skills is thus essential for prospective teachers as well.

Overall, the results of the requirement analysis correspond with previous study results, indicating that prospective medical, legal, and teaching professionals have deficits in critically examining online media, even though this skill set is crucial in all three domains. A lack of instructional measures for COR in the study curricula in higher education exists. For instance, while search engines and databases are predominantly used to access online information, students have deficits in competently dealing with these types of media. Overall, there is a substantial need for the COR training for all three domains.

#### *4.3.3.2 Targeted Competence Profiles*

The requirement analysis subsequently includes the elaboration of a competence profile describing the target state of skills after training completion. The required COR skills can be tied to specific activities on the Internet, which are defined in the information problem-solving model (IPS-I) by Brand-Gruwel and Wopereis (2006). The competence profile of COR is therefore based on this model. Defining the information problem constitutes the first step. This step is central to gain an insight into the given problem, activate previous knowledge, and develop a goal-oriented strategy. This strategy is then applied, e.g., by using search engines to access the intended information. Afterwards, the presented information is skimmed, selected, and examined. Finally, the evaluated results are summarized and presented. To address the entire COR process in the training, the structure of the IPS-I model was transferred and extended to the COR concept, as shown in the resulting competence profile (Table 11). The left columns contain the activities of the IPS-I model transferred to the facets of COR. The right columns describe all skills to be fostered through the training. For instance, to obtain credible information from the WWW, users need to technically navigate the Internet and develop, implement, and adjust their research strategy until they find the required information. Therefore, they have to orient themselves in the overall COR process and reflect the respective stage of information processing.

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Following the IPS-I model, the COR process begins with the definition of an information problem, i.e., users can specify the goal and intention of a research problem to derive a suitable and applicable strategy. When subsequently searching for information, users need to select an appropriate platform, e.g., a search engine, to access information. They further need to recognize, select, and understand relevant terms and text passages and correctly evaluate the credibility cues of the underlying sources. Users are expected to access and compare multiple external sources and simultaneously skim texts, and identify and evaluate credibility cues in iterative loops. Subsequently, users need to examine the argumentative structure of a given source. Finally, the previously collected information needs to be summarized, structured, and prioritized to pass a concluding judgement. This step acquires users to bundle the respective content and construct a valid, sound argument, e.g., regarding the credibility of an online source. All these skills should therefore be instructed in the COR training.

**Table 11.** Competence Profile of COR.

IPS-I Model	Conceptual Framework of COR	Actions and Related Competences of COR
	Meta-Cognitive Activation (MCA)	Activation of and orientation throughout the research process and reflection of the status of information acquisition
		Development of a research strategy to solve the underlying information problem, e.g., in terms of finding information, organizing sources, extracting content etc. in iterative loops until the required information is found / underlying information problem is solved
		Recognition of information problem: Intention and objective of information acquisition, examination of the initial situation
Define Information Problem	Online Information Acquisition (OIA)	Definition of information problem (Intention and objective of information acquisition, examination of the initial situation)
		Development of a research strategy for the underlying information problem
Search for Information		Selection of a point of access/platform/source for information acquisition (search engine, database, etc.)
		Implementation of research strategy on the respective point of access/platform/source (entering precise search terms and URLs, following links, etc.)
	Identification, selection, reading and understanding of relevant text passages and entries	
		Accessing and comparing multiple (external) online sources
Scan / Process Information	Critical Information	Identification and evaluation of credibility cues

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	Evaluation (CIE)	Examination regarding evidential value, objectivity, validity, and stringency
Organize and Present Information	Reasoning based on Evidence, Argumentation, and Synthesis (REAS)	Identification of arguments and their specific components in an online source Collation, structuring and weighing of information collected in previous steps
		Passing a correct, evaluative judgement regarding the credibility of an online source / Concluding synthesis of the underlying information problem
		Constructing and phrasing a convincing, evidence-based solution to the underlying information problem, e.g., an argument in favor of/against the credibility of sources used, etc.

#### 4.3.3.3 Training Goals

The competence profile of COR allows deriving the learning objectives of the training, which then serve as basis to construct learning units in the subsequent phases (see Section 4.3.3.4). A successful learning process should address all three groups of educational activities and their respective taxonomies. These are cognitive activities, focusing on the mental skills and knowledge; affective activities, regarding the attitudes and emotions; and psychomotor activities, comprising manual and physical skills (for details, see Bloom et al., 1956; Krathwohl et al., 1984). The classification of learning objectives according to educational activities allows ordering and operationalizing the latter training activities and are therefore considered in the following conceptualizations.

The initial content of the training constitutes the secure technical handling of the WWW. Although the target group is expected to be familiar with the overall functioning of the Internet, specific COR-relevant terms (e.g., browser, URL) ought to be defined more precisely. This secures a unified basic vocabulary and understanding throughout the training and also enables more accurate feedback. The resulting learning goal is:

1. *Users name all COR-relevant technical terms and demonstrate a secure technical handling of the WWW.*

Second, the recognition and definition of the underlying information problem is crucial. This step is necessary to derive a goal-oriented, efficient search strategy and avoid wasting time browsing the WWW; users need to specify the intention and requirements of the information problem, i.e., university or everyday purposes, as basis

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for all subsequent research steps (Eisenberg, 2016). As the training focuses on the improvement of students' generic and domain-specific COR, it comprises content dealing with general, e.g., political issues as well as relevant aspects of the three domains medicine, law, and teaching. As soon as the information problem is defined, users need to develop a research strategy which usually involves the comparison of multiple sources to select the most suitable one(s). The resulting learning goal is:

2. *Users define an underlying information problem and derive a goal-oriented research strategy.*

Next, the practical implementation of the research strategy follows, in which users initially select a platform to access information, i.e., search engines and/or databases, depending on the requirement. Databases and online libraries are usually designed for academic purposes, whereas search engines serve rather general research objectives. As search engines are increasingly used when accessing information in university studies and professional practice, the training seeks to improve the handling of the most used search engine on the WWW, Google (Halavais, 2017; Taylor and Dalal, 2014; Rowlands et al., 2008). Google is not only the most popular search engine but also the most comprehensive one, enabling access to, e.g., websites, pictures, digitalized books as well as scientific articles. The training thus focuses on the functioning and utilization of Google and its search options, leading to the following learning goal:

3. *Users define and purposefully apply the functions of the search engine Google.*

The search results are presented in rankings on search engine results pages (SERPs), containing the title, summary of the content, and link to the respective result. Users consequently have to horizontally and vertically read through the SERPs to detect relevant passages within a short time span. This activity is defined as 'skimming' or 'scanning' (Jalbout and Taleb, 2019). Skimming is an efficient methodology to quickly recognize suitable information, and thus essential for the COR training. The resulting learning goal is:

4. *Users quickly identify and highlight relevant passages within search results and linked online sources.*

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Since the SERPs could also contain unreliable or erroneous information (Lewandowski, 2012), users need to examine the presented content regarding specific credibility cues, i.e., brand logos, advertisement, and vocabulary (McGrew & Chinoy, 2022; Unkel & Haas, 2017; ). This learning content serves to sensitize users to recognize cues which speak in favor of or against the credibility of an online source (Choi, 2015; Sundar, 2015; Fogg et al., 2013). The subsequent learning goal is:

5. *Users identify and classify credibility cues of search results and online sources.*

Next, it is crucial for the users to access and compare multiple sources simultaneously (Taylor & Dalal, 2014; Meola, 2004). Cross-checking online sources provides an essential reference base to detect erroneous information but also to verify credible content (Choi, 2015). Accordingly, a further learning goal is:

6. *Users cross-check multiple online sources and critically compare the presented content.*

For the comprehension of online sources, users need to identify arguments and their components. Based on the Toulmin model (1958), which subdivides arguments into five components (claim, reason, evidence, warrant, and response), users are taught to recognize these elements and examine the quality of argumentative structures within online sources regarding their evidential value, objectivity, validity, and stringency, leading to the following learning goal:

7. *Users identify and examine the components and quality criteria of an argument.*

REAS also comprises the passing of an evaluative judgement, e.g., regarding the credibility of an online source, and constructing a concluding synthesis of the underlying information. Collected information needs to be structured and summarized to construct a convincing, evidence-based solution. This step relies on the learning content of examining argumentative structures, which can now be used for the phrasing of one's own comprehensive argument. The related learning goal is:

8. *Users structure and connect the information collected throughout the research process and derive and construct a concluding, explicit, evaluative judgement.*

As the training intends to foster generic as well as domain-specific COR, a further content includes the effective usage of research tools for students in the

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING practical training phase in medicine, law, and teacher education (see Section 4.2.4.1). The usage of specialized databases is highly relevant for prospective law and medical professionals, whereas prospective teachers search the WWW for methods and media to plan and design their lessons. The COR training consequently aims to introduce the most prevalent types of domain-specific online media for research. The penultimate learning goal is:

9. *Users effectively utilize the most prevalent research tools in their respective professional domain (medicine, law, or teaching).*

Finally, the training does not only seek to improve users' COR skills but also the reflection of their overall learning process. Reflecting enables the connection of the learning content with the user's mental processing. Users should therefore think about their newly acquired skills to recognize their achieved learning progress, which in turn will motivate them to further improve their abilities (Dahlen, 2012). This step contains analyses of the users' expectancies towards the training, arising difficulties, as well as learning results and successes. The results do not only provide useful insights for the users but also for the revision and improvement of the training. The related learning goal is:

10. *Users define learning objectives for themselves as well as analyze and reflect on their learning process.*

These content and learning objectives are subsequently formed into concrete modules in the next phases of training conceptualization.

#### 4.3.3.4 Training Design (RQ3.2)

In the following, the focus lies on the second and third phases of the ADDIE model, 'Design' and 'Development.' In the 'Design' phase, the external structure, order, and duration of the training are defined. The 'Development' phase then deals with the actual creation of single learning units and their material (Shelton & Saltsman, 2008; Hodell, 2007; for excerpts of the training material, see Appendix E).

First, the defined learning objectives (see Section 4.3.3.3) are narrowed down to determine the external structure, order, and modules of the training. Accordingly, the content is grouped into nine coherent modules (Table 12). The first module

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“Preparation and Planning of a Goal-Oriented Information Acquisition,” contains two learning units, focusing on the technical terms, and handling of the WWW, as well as the definition of the research problem and strategy. Units 3 to 6 are part of the module “Efficient Research with the Search Engine Google” in which the search functions, effective use of search terms, and operators are explained. Units 7 and 8 focus on the “Skimming and Scanning of Information” of search engine results and linked websites. Units 9–11 form the module “Credibility Cues” teach structural and textual indicators of the credibility of online sources. Unit 12, “Cross-Checking”, focuses on the simultaneous comparison of multiple external sources. The subsequent module “Argumentation Analysis,” which consists of units 13 and 14, instructs the components and quality criteria of a valid argument. Units 15 and 16, which form part of the module “Judgement Formation and Research Synthesis”, comprise the passing of a final evaluative judgement as well as the construction and phrasing of an evidence-based solution to the information problem. Units 17–19 of the module “Effective Research in Law, Medicine, and Teaching” concentrate on the usage of the most used and reliable domain-specific research methods in the respective fields. Finally, the units “Pre- and Post-Assessment Survey” as well as “Feedback and Reflection” form the module “Self-Reflection,” which serves the reflection of the overall learning process at the beginning, throughout, and at the end of the COR training.

Based on the principle of sequencing an action process by the IPS-I model, the structure of the training modules follows the order of an entire COR process (see Table 11, Section 4.3.3.2); i.e., users undergo and internalize the interrelated steps of solving an information problem from beginning to end. This structure allows for the construction of progressive learning material that is embedded into a unified context, i.e., one authentic information problem that is solved in the training. As each module constitutes a relevant step of the overall COR process, all learning units are mandatory. The feedback and reflection units are to be inserted after the completion of a module.

The duration of the training is flexible and determined by the available time and attention span of users, i.e., the amount of time during which a person is able to focus on a task without getting distracted. On average, adults have an attention span of 20 minutes (Converged, 2016). After that, instructional methods should be changed to effectively use the available time of a learning unit and achieve the predefined learning

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING objectives. Accordingly, the training consists of short micro-learning units approximately 15 minutes in length after which users receive direct, corrective feedback. In two units, the training requires 30 minutes (per day). In this manner, the training modules remain connected, except for units 11 and 12. Since unit 12 requires the application of all skills, there is no interruption of the overall learning process. The pre- and post-assessment surveys are processed independently and take approximately 10 minutes. The overall training duration, including two reflection units (20 minutes), is 285 minutes (4.75 hours). As the WBT allows the users to process the training individually, depending on their individual learning speed, deviations could occur.

**Table 12.** Structure of the COR Training.

Modules	Units	
Self-Reflection	Pre-Assessment Survey	↘
Preparation and Planning of a Goal-Oriented Information Acquisition	1. Technical Terms and Handling of the WWW	Feedback + Reflection
	2. Information Problem and Research Strategy	
Efficient Research with the Search Engine Google	3. Google Functions I	Feedback + Reflection
	4. Google Functions II	
	5. Effective Search Terms	
	6. Google Operators	
Skimming and Scanning of Information	7. Skimming and Scanning of Search Engine Results	Feedback + Reflection
	8. Skimming and Scanning of Online Sources	
Credibility Cues	9. Source Cues	Feedback + Reflection
	10. Author Cues	
	11. Text Cues	
Cross-Checking	12. Cross-Checking of Online Sources	Feedback + Reflection
Argumentation Analysis	13. Components and Variants of an Argument	Feedback + Reflection
	14. Quality Criteria of an Argument	
Judgment Formation and Research Synthesis	15. Summarizing Information / Passing a Judgment	Feedback + Reflection
	16. Construction of an Evidence-Based Argument	
Effective Research in Law, Medicine, and Teaching	17. Effective Research in Teacher Education	Feedback + Reflection
	18. Effective Research in Medicine	
	19. Effective Research in Law	
Self-Reflection	Post-Assessment Survey	↙

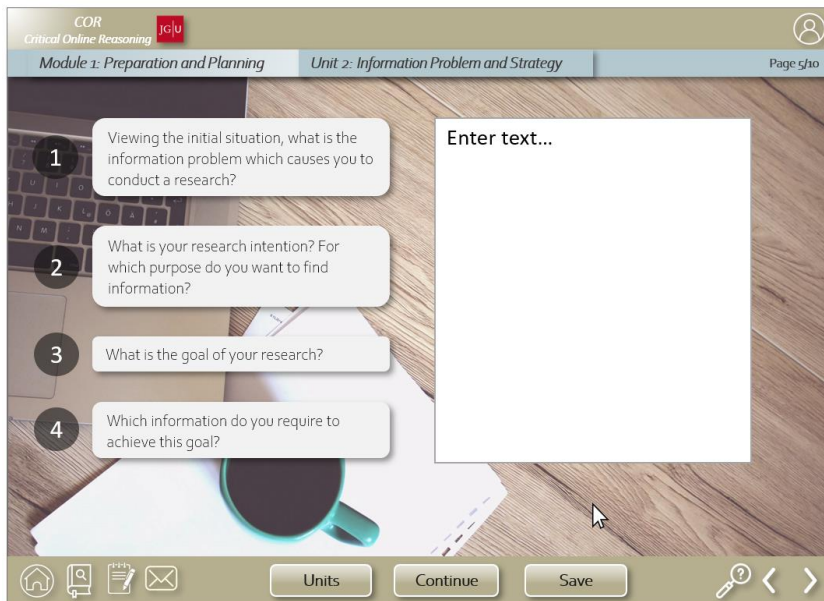
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Based on this external structure, the internal structure of the training, i.e., the visual representation and individual learning units, are conceptualized next.

#### *4.3.3.5 Training Development (RQ3.3)*

In the first step of the ‘Development’ phase, the graphical user interface (GUI) is specified. Since this study focuses on the theoretical elaboration of the training, excluding the actual technical implementation, only the main GUI used to navigate and process individual tasks is described here. The GUI delivers the first impression of the training and should thus be aesthetic but also functional, as its design also has a strong motivational impact (Lee & Owens, 2004). The GUI consists of three main elements. The ‘marking area’ shows the users which training module they are currently processing. In the ‘learning and working area,’ the actual tasks are presented and solved. The ‘control area’ contains all navigation functions. Fixed control elements should be presented horizontally as they follow the natural viewing angle and eye movements when reading (Pettersson, 2014). Additionally, control elements which need to be accessed repeatedly, i.e., notepads or glossaries, are found more easily. Overall, the functional division of the GUI should be well structured and clearly visible (Johnson, 2014).

A schematic representation of the GUI is presented In Figure 7 (for further excerpts of the developed GUI, see Appendix E). The marking area is situated at the top of the GUI, signaling the respective training module, unit, and page number. Underneath follows the learning and working area, which is metaphorically designed as a desk surface, since realistic analogies have a positive impact on working motivation and efficiency (ebd., 2014). The control area is located at the bottom, which allows users to navigate through the training, save their progress but also write down notes on a virtual notepad, look up technical terms in a glossary, and contact the training developers for feedback. Further, users can jump back and forward between pages and call a help function in case of difficulties.

**Figure 7.** Schematic Presentation of the GUI.

In addition to GUI, further didactical considerations are important. The target group of the training are university graduates in the practical phase, who possess previous knowledge and who are characterized by a goal-oriented, self-motivated working behavior (Crowley & Knapper, 2021). Tasks should thus be designed to motivate the users intrinsically, which is implemented through constructive feedback and reflective tasks after each module. To avoid demotivation and confusion, it is essential for the users to recognize an actual training benefit. This is best achieved if users implement the acquired knowledge directly (Dahlen, 2012). Previous knowledge is activated by using introductory pages listing the learning intentions at the beginning of each module as well as through the pre-assessment survey at the beginning of the training. The tasks are designed using authentic and realistic examples, which facilitates the transfer of knowledge to daily and professional life later on.

Subsequently, the description of the single learning units is derived from the preceding structure and learning objectives. The theoretical-didactical conceptualization is mainly based on constructivist learning theory, as this approach has shown to be successful in fostering COR related skills (see Section 4.3.2.1). Further, the 12 principles of multimedia learning according to Mayer (2017) are taken into account when employing e-learning methodologies typical for the design of WBTs, i.e., videos and interactive elements (for detailed material, see Kohmer 2020).

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As soon as the users log into the WBT via a web browser, they are presented with a welcome page introducing them to the training and listing its intentions to clarify the training benefit and initiate motivation. Moreover, the most important navigation functions are explained, and users are asked to start the training.

*Pre-Assessment Survey:* At the beginning of the training, users are asked to complete a pre-assessment survey which specifies the training objectives and activates previous knowledge. Based on the study by Dahlen (2012), the survey asks the users about their study domain (medicine, law, or teaching) and previous COR skills. The questions are based on the competence profile of COR (Table 11) and are designed in a closed format, which allows the training developers to assess and compare COR deficits among all users. Users are also asked about their expectations towards the training. The results can be used to revise or complement the training.

*Post-Assessment Survey:* The COR training is finally concluded with a post-assessment survey which serves to evaluate the learning success of the overall learning process. It enables users an overview of their own progress. The results are also important to revise the training. The survey is constructed similarly to the pre-assessment survey and asks the users about their acquired skills throughout the training. Afterwards, the users are asked in how far their expectations towards the training have been met and which improvements they suggest.

#### 4.3.3.6 Training Implementation (RQ3.4) and Evaluation (RQ3.5)

As this study focuses on the theoretical and didactic conceptualization of the training, the two final phases 'Implementation' and 'Evaluation' are only briefly outlined. In the 'Implementation' phase, the designed learning content is tested and applied practically. The WBT was deployed via the open-source learning management system 'Moodle,' selected for its extensive capabilities in creating multimedia learning materials and integrating content from diverse sources into a digital training environment (Costello, 2013). Moodle helped trainees to access the WBT autonomously using a laptop/computer from home. The WBT was available for a duration of approximately 6 weeks, during which the study participants were notified of the specific time frame allocated for the training. While the GEN-COR modules of

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the WBT had to be completed by all participants, the DOM-COR modules were assigned to the participants of each domain respectively. Due to their similar training structures and characteristics identified in the requirement analysis, they were considered suitable for comparative analysis. All trainees participated in the WBT on a part-time and voluntary basis.

In the Evaluation phase, pre- and post-assessments were carried out to gather feedback from participants and evaluate their overall learning experience, and also to investigate the effectiveness and transferability of the WBT training and identify areas for improvement.

**Pre-Assessment Survey:** Before the training, users were asked to complete a pre-assessment survey which specifies the training objectives and activates previous knowledge. Based on Dahlen (2012), the survey asks the trainees about their study domain (medicine, law, or teaching) and previous COR skills. The questions are based on the competence profile of COR (Table 11) and are designed in a closed format, which allows the training developers to assess and compare COR levels among all trainees. Trainees were also asked about their expectations for the training. The results were used to revise the training.

**Post-Assessment Survey:** The COR training concluded with a post-assessment survey which evaluates the learning success of the overall learning process. It enables users an overview of their own progress. The results were also important when revising the training. The survey is constructed similarly to the pre-assessment survey and asks the users about skills acquired throughout the training. Afterwards, the users were asked to what extent their expectations for training have been met. The survey included questions concerning perceived usefulness, difficulty, and familiarity with the training content, and the overall perceived improvement of COR skills. Additionally, participants were encouraged to provide comments and suggestions for enhancing the WBT experience through open-ended questions.

Overall, the WBT was regarded as useful by all participants, some of whom were already familiar with certain aspects of the training content. Furthermore, participants reported an improvement in their COR skills as a result of the training. The difficulty of the tasks was considered appropriate. Participants provided suggestions for improvement, including extending the training content, particularly in

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING the DOM-COR modules, and offering additional exercises. Participants expressed a need for more college courses focusing on COR-related skills before beginning practical training, deeming them crucial for professional practice. Finally, participants requested that training content be accessible for future reference, emphasizing its practical utility in the three domains.

Finally, while the implementation and evaluation results indicate successful transferability of this newly developed WBT training across the three different professional domains, participants' results in the various generic and domain-specific tasks show most had difficulties applying and successfully transferring their skills in different contexts.

#### ***4.3.4 Discussion and Conclusion***

Research on university students shows substantial deficits in their COR-related skills, i.e., in consulting search engines and databases to retrieve information and evaluating the credibility of online-sources. These skills are substantial for professions in which evidence-based decision-making and acting is required in practice, which includes medicine, law, and teacher education. Although this deficit is known to experts from the professional fields as well as to university practitioners, no training approach fostering all COR facets has existed to date. Therefore, based on the ADDIE model, a training program was theoretically-didactically conceptualized and technically implemented to effectively improve the generic and domain-specific COR skills of prospective professionals in medicine, law, and teacher education. The study focused on the first three phases of the ADDIE model.

In the first phase, 'Analysis,' the needs, intentions, resources, and the target group of the training were determined and analyzed. The requirement analysis shows that despite its necessity for professional practice, the teaching of COR skills is currently barely included in university curricula of medical, legal, and teaching professionals. At the same time, the experts interviewed and the target group of the training report on (1) the high importance of COR for their professional practice, as they predominantly access and use online sources; and on (2) their deficits when solving information problems using the Internet. These deficits reinforce the necessity

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING of the COR training. Based on the conceptual framework of COR following the IPS-I model, a competence profile was developed describing the relevant COR skills. This profile served as the basis for deriving the learning content and goals of the training.

In the next phases, ‘Design’ and ‘Development,’ the content of the training was sequenced and grouped into coherent modules; and its structure, order, and duration were defined. One main advantage of the training is its format as a WBT with short micro-learning units of 15 minutes. Since no physical presence is required, this allows for the training to be completed from any location and to be easily integrated into the schedules of the participants’ daily lives. A further benefit is the adjustability of the content of the WBT, so that necessary revisions can be conducted in the practice. For this purpose, the option of sending feedback to the training developers in the ‘Development’ phase was implemented; and pre- and post-assessment surveys as well as reflection tasks were included, which serve to demonstrate to the participants and test developers to what extent the training goals were achieved successfully.

The newly developed COR training seeks to contribute significantly to the fostering of the highly relevant critical handling of online media among students within and across different do-mains. Compared to previous approaches in which only partial aspects of COR were fostered (e.g., merely the evaluation of credibility criteria), the uniqueness of the underlying training lies in the teaching of an entire process of information problem-solving using the Internet and related strategies. The training modules are therefore logically linked together and the participants subsequently internalize the required steps of the overall COR process. The tasks comprise realistic generic and domain-specific information problems and encourage the users to freely navigating the Internet, constituting an authentic training environment.

Despite these advantages, a few limitations need to be critically discussed. First, a central deficit is the exclusive focus on the search engine Google. Although it represents the most prevalent form of accessing information on the Internet, and additional functions of the platform, such as ‘Books’ and ‘Scholar,’ are also addressed in the training, the requirement analysis showed that graduate students also have difficulties when dealing with (professional) databases and online libraries (see Section 4.3.3.1). While the usage of professional databases in medicine, law, and teacher training is taught in the three respective units of the training, general online

libraries and platforms to access verified information should be included in further developments.

Second, the training is embedded into an authentic information problem environment, which serves to motivate the participants as well as to thematically frame the learning process. Nevertheless, similar to the approach by Mathson and Lorenzen (2008), the scope of the training is thus limited to a selected exemplary information problem. Another, e.g., less-restricted information problem might be more meaningful and feasible. Third, although the training is intended to be interactive and stimulating, it should be reconsidered whether single topics or the feedback are rather to be taught via instructions in an audio format instead of texts to achieve a better learning effect (Mayer, 2017). These reflections should be reviewed with experts from the respective domains, such as medicine, law, and teacher education.

An additional central aspect is the implementation of feedback, which is fundamental for the constructivist design of the training. Participants need to receive auditory feedback on their personal performance to achieve their learning objectives and to ensure a successful and measurable learning outcome (Benjes-Small et al., 2013). Tutors could provide manual feedback to the modules, though this solution would be extremely complex and time consuming since participants solve the training asynchronously. An intelligent and adaptive learning system providing automatized feedback and learning assistance would thus be the most convenient solution (Brown, 2017; Wang & Wu, 2008), however, its technical feasibility needs to be further examined.

#### 4.4 Promotion of the Critical-reflective Use of Online Media among Medical Students in Final Clinical Year<sup>9</sup>

##### 4.4.1 Research Question

To optimize patient outcomes, physicians need to adeptly navigate the Internet, incorporating the latest research results and medical guidelines in their clinical reasoning and decision-making and acting (Zhou et al., 2020; Menvielle et al., 2017). However, the ubiquity and inaccuracy of online information pose significant challenges, particularly in evaluating credibility of content, thus complicating the clinical decision-making process (Obermeyer & Lee, 2017; Kiili et al., 2022; Andreassen & Bråten, 2012). As the medical field constantly advances, staying updated on diagnostic and treatment guidelines becomes increasingly challenging due to information overload, affecting both practicing physicians and recent graduates (Hawkins et al., 2021; Inman et al., 2019). Current research on students and graduates indicates substantial deficits in critically handling online information (Zlatkin-Troitschanskaia et al., 2021a; McGrew et al., 2018; Wineburg & McGrew, 2018). In particular, medical graduates state having problems in clinical decision-making, which is partially due to a lack of skills to incorporate evidence-based clinical guidelines (Norman et al., 2017; Bijani et al., 2021; Stefanescu et al., 2018). The strengthening of scientific skills within medical education and the relevance of digitalization for teaching and patient care all show the increasing importance of these topics in medical education (Timmer et al., 2021).

While efforts to promote scientific skills are evident in the new licensing regulations for physicians (*Approbationsordnung für Ärzte; ÄApprO*), such a skill set still appears to be insufficiently integrated into medical curricula (Jünger, 2023; Haag et al., 2018; O'Carroll et al., 2015). Accordingly, medical students report feeling unprepared for professional practice in this regard (Hawkins et al., 2021). Proficiency in competent navigating online sources is crucial to overcome the challenges of medical practice in a digital age. As a consequence, recent graduates in medicine

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<sup>9</sup> This chapter is planned to be published in O. Zlatkin-Troitschanskaia, M. Theres-Nagel, V. Klose & A. Mehler (Eds.), *Students', Graduates' and Young Professionals' Critical Use of Online Information: Digital Performance Assessment and Training within and across Domains*. Springer. Modeling and analyses in this study were conducted solely and independently by A. Kohmer.

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING require systematic training to search for, critically evaluate, and utilize high-quality information for evidence-based decision-making and acting (Zlatkin-Troitschanskaia et al., 2021b; Obermeyer & Lee, 2017).

In this study, this skill set is defined as ‘critical online reasoning’ (COR; Molerov et al., 2020; see Section 2.3). Training has shown to improve COR-related skills (Breakstone et al., 2024; Benjes-Small et al., 2013; McGrew et al., 2019). Moreover, such skill set is particularly relevant for medical students during the transition from university study to professional practice in their final year, in which they face real patient situations (McKenzie et al., 2020). However, an accompanying training in the field of scientific skills and guideline integration in clinical treatment currently only takes place occasionally (Jünger, 2023). Further, existing training approaches on COR-related skills are fragmented and hardly focus on domain-specific contexts (Metzger, 2007; Shanahan, 2008; Gross & Latham, 2011; McGrew et al., 2019). To address this limitation, this study aims at the theory- and evidence-based conceptualization and implementation of a cross-location digital training which fosters domain-specific COR skills among medical students in the transition from university study to professional practice. Consequently, the focus lies on the research question (RQ4):

***RQ4: Based on established instructional and learning models as well as principles of EBM, how feasible is a cross-location digital training for the acquisition and promotion of DOM-COR skills in medicine among medical students in the clinical studies/year?***

#### ***4.4.2 Conceptual Background***

##### ***4.4.2.1 Scientific Skills in Medical Education in Germany***

Competency-based medical education is considered an essential requirement to equip medical students for their future professional lives (Caraccio et al., 2016). In medical education, the promotion of critical thinking and clinical reasoning skills are considered fundamental goals (Gavgani et al., 2015). The training of medical students should therefore aim to enable them to classify the individual case of illness in the existing system of medical science and to derive appropriate medical action (Hahn &

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Fischer, 2009; Hasegawa et al., 2007). To act correctly in clinical situations and to ensure the best possible and scientifically valid diagnosis and treatment for patients, according to the principles of 'Evidence-based Medicine,' physicians should search for and apply the best available evidence, i.e. research information (Imorde et al., 2020; Masic et al., 2008; Kunz et al., 2007). For this purpose, the clinical experience that medical students gain in hospitals and increasingly in outpatient care can only provide a limited foundation for medical practice (Jünger, 2023). Therefore, especially due to the advancing digitization of the healthcare system, it is necessary to teach DOM-COR skills to enable young professionals in medicine to find and incorporate current research findings, i.e. diagnostic and treatment guidelines, and publications from the Internet, in the clinical reasoning and decision-making and acting (Frank et al., 2010).

The application of such skills is particularly relevant to medical students in during the transition from university study to professional practice, since they enter the clinical work environment assisting in the treatment of real patients (McKenzie et al., 2019). This phase serves to deepen and expand the medical knowledge and abilities acquired during their academic studies in practice, i.e. in clinical reasoning and decision-making (ÄApprO, 2002; Baum et al., 2022). As many medical graduates in Germany report feeling unprepared for work (Ochsmann et al., 2011), having to deal with everyday practices, including treatment and therapy planning and a high workload, often causes enormous stress and self-doubts among students in their final year (Raspe et al., 2020; Brennan et al., 2010). One primary factor contributing to this issue is the widely debated inadequacy of supervision and feedback during practical training (Rüsseler et al., 2017; Nikendei et al., 2012). In this context, the first research assumption (A1) of this study can be defined as follows:

***A1: The digital training of DOM-COR skills including feedback will be regarded as useful among graduate medical students in the transition to postgraduate education and students will show a high engagement in the digital training (despite the high workload).***

Recent studies indicate that scientific and empirical grounded methods of working are considered one of the most fundamental skills in medical practice among physician educators and young physicians (Wijnen-Meijer et al., 2013; Fürstenberg et al., 2017). The promotion of such skills within the curricula of medical faculties in

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Germany is consequently an increasingly relevant aspect of shaping well-rounded and competent healthcare professionals (Haag et al., 2018; Stallmach & Jünger, 2020). Despite this relevance, however, scientific skills are currently not sufficiently anchored in medical curricula (Jünger, 2023). While certain medical faculties encompass modernized curricula with scientific orientation or elective modules on evidence-based medicine (Rheingans et al., 2019; Weberschock et al., 2008), overall, the incorporation of scientific skills varies across locations (see Section 4.1).

The need for a systematic promotion of scientific skills is also reflected in the ongoing national reform process in Germany, the Masterplan for Medical Studies 2020 (*Masterplan Medizinstudium 2020*) (BMBF, 2017). It aims at a systematic teaching of scientific concepts and methods which shall enable prospective physicians to “effectively deal with current research findings and apply them in everyday healthcare practice” (BMBF, 2017, p.3). To achieve the desired reform goals, it is imperative to have access to the appropriate content. The latest iteration of the National Competence-Based Catalog of Learning Objectives (NKLM), Version 2.0, was recently ratified in 2021 (NKLM, 2021) and provides a comprehensive outline of the necessary learning objectives. The NKLM 2.0 features a dedicated chapter on scientific skills, i.e. principles of Evidence-based Medicine, which delineates the corresponding levels of competencies according to Bloom’s taxonomy (Adams, 2015), along with guidance regarding the timeline for accomplishing these learning objectives throughout the medical degree program (see Section 4.4.3).

All enumerated skills in this chapter ought to be acquired by the time of the final year (NKLM, 2021). While this advancement represents a significant progression in cultivating scientific skills within medical education, it predominantly encompasses theoretical and didactic content with implementation scheduled for 2025 (Timmer et al., 2021). In this study, this chapter provides a comprehensive understanding of DOM-COR skills among medical students, which are expected to be mastered at the end of their studies. Since the participants in this study are presumed to have attained (at minimum) fundamental scientific skills pertinent to evidence-based medicine by their final year, the second research assumption (A2) of this study is:

***A2: Graduate medical students (in the transition to postgraduate education) are expected to perform well in the DOM-COR tasks of digital training.***

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*4.4.2.2 ADDIE-Model of Instructional Design for Web-based Training (WBT)*

Since the digital training of this study intends to improve online skills, the technical format of web-based training (WBT) was selected (Khan, 2001). WBTs, accessible through web browsers without requiring specific software, offer flexible, individualized, learning experiences independent of time and place (Schneider, 2014). Users can engage at their own pace, with the freedom to choose when and where to participate. This is particularly relevant for this study as medical students face a high workload in the transition from graduate to postgraduate education and immediately before their final exams (i.e., second state exam, see Section 4.4.2.1). Further, WBTs enable the storing and evaluation of user data, providing essential insights, e.g., into performances and feedback, supporting continuous evaluation and improvement of the training (Kraemer & Müller, 2013).

The elaboration of the WBT is based on the ADDIE model of instructional design, a framework for designing and developing effective e-learning materials and programs (Branch, 2009). This model delineates the five systematic phases ‘Analysis’, ‘Design’, ‘Development’, ‘Implementation’, and ‘Evaluation’, which are sequentially executed during the creation of digital teaching arrangements (Niegemann et al., 2013) (see Table 13 on the ADDIE-model in the context of a WBT on DOM-COR skills in medicine).

In the initial phase, ‘Analysis,’ the focus lies on identifying the need for training, the target audience, and the overarching learning objective (Branch, 2009). These elements collectively serve as the foundation for shaping both the learning content and task formats (Hodell, 2007). This study identifies the need for training due to the rising importance of DOM-COR skills in medical practice and the lack of systematic scientific skills instruction in medical education (see Section 4.4.2.1). So far, no comprehensive, cross-location, and accompanying WBT on DOM-COR skills in medicine exists (Zlatkin-Troitschanskaia et al., 2021b; Jünger, 2023). Additionally, graduate medical students transitioning to postgraduate education express a specific need for these skills, often reporting feeling unprepared for work (Raspe et al., 2020; Ochsmann et al., 2011), making them the target audience. Overall, the training intends to promote DOM-COR skills to search for, critically evaluate, and utilize high-quality

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING information for evidence-based decision-making and acting (Zlatkin-Troitschanskaia et al., 2021b).

In the 'Design' phase, the focus shifts to establishing the timeframe and structural framework of the learning content. This entails organizing content into modules, sequencing them appropriately, and defining detailed learning objectives (Branch, 2009). Considering the intended use of the WBT as accompanying training for medical graduates in their daily practice, microlearning units spanning 15-30 minutes were adopted to facilitate integration in their daily routines (Mittelmann, 2011). Further, recent research highlights two central aspects concerning clinical reasoning and decision-making with Internet incorporation (see Section 4.4.2.1). Firstly, medical professionals need to effectively navigate the vast online information landscape, employing search engines and medical databases to address patient-related clinical problems. Secondly, grounded in evidence-based medicine, medical professionals need to integrate guidelines into their practice (Jünger, 2023; Hawkins et al., 2021; Inman et al., 2019). These aspects form the central modules of the WBT. The detailed learning objectives of the WBT are based on Chapter VIII.1 on 'medical scientific skills' in the NKLM 2.0 (2021) (see Section 4.4.3).

In the subsequent phase, 'Development,' the actual learning materials are created for each module (Niegemann & Weinberger, 2020). In this study, all learning materials for the WBT were produced using the open-source learning management system 'Moodle,' which offers a variety of interactive tasks (Costello, 2013). For a detailed depiction of the implemented training, see Section 4.4.3.

Upon reaching the 'Implementation' phase, the designed learning content undergoes practical testing. This phase serves as a practical application of the instructional design (Niegemann et al., 2013). In this study, the WBT was tested among graduate medical students in the transition to postgraduate education at two medical faculties (Frankfurt and Göttingen) with three cohorts (see Section 4.4.4.2).

In the 'Evaluation' phase, both summative and formative assessments are carried out on the developed learning content, to ensure its effectiveness and identify areas for improvement (Niegemann et al., 2013). In this study, a post-assessment survey was conducted as part of the WBT to gather feedback from participants and evaluate their overall learning experience (see Section 4.4.4.3).

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Despite criticism of its rigidity, the ADDIE model provides a systematic and linear approach to instructional design, ensuring a logical and coherent development process (Branch, 2009). While iterative loops are common in the overall process, this study primarily focuses on the linear structure for initial development and testing purposes.

**Table 13.** The ADDIE-Model in the Context of a WBT for DOM-COR Skills in Medicine.

Phases of the ADDIE-Model	Aspects to be identified/carried out	Application to WBT in DOM-COR Medicine
1) <i>Analysis</i>	Need for training	- Increasing relevance of DOM-COR skills in medical practice - Lack of comprehensive, systematic training in medical education - Lack of accompanying, cross-location training
	Target audience	- Graduate medical students in the transition to postgraduate education
	Overarching learning content	- Promotion of DOM-COR skills for evidence-based decision-making and acting
2) <i>Design</i>	Timeframe	- Microlearning units (15-30 min)
	Module content	- Adeptly conducting online research based on the principles of evidence-based medicine - Integrating medical guidelines into clinical practice
	Detailed learning objectives	- NKLM 2.0, Chapter VIII.1 on ‘medical scientific skills’
3) <i>Development</i>	Creation of learning material	- Interactive tasks in ‘Moodle’
4) <i>Implementation</i>	Practical testing	- Two medical faculties (Frankfurt, Göttingen) - Three cohorts
	5) <i>Evaluation</i>	Formative and summative feedback

#### 4.4.3 *Implemented Training*

The overall WBT, which was part of the research project “*Practical Educational Processes in Medicine, Law, and Teaching Using Digital Media*” (BRIDGE) (Zlatkin-Troitschanskaia et al., 2021b), consisted of five GEN-COR modules and one module for each domain assessed in the project, i.e. medicine, law, and teacher training. All modules addressed different COR facets. While the GEN-COR modules covered the structure of an entire COR process, i.e. all three COR facets,

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING the DOM-COR modules focused on COR-related skills relevant to each domain exclusively. The training was structured as follows:

**Table 14.** COR-Training Modules in the BRIDGE Project.

<b>GEN-COR Modules</b>					
<i>Technical Terms and Research Strategies</i>	<i>How to: Google</i>	<i>Assessing the Credibility of Online-Information</i>	<i>Skimming and Scanning of Online-Information</i>	<i>Argumentation, Judgement Formation, and Research Synthesis</i>	
Online Information Acquisition (OIA)		Critical Information Evaluation (CIE)		Reasoning based on Evidence, Argumentation, and Synthesis (REAS)	
<b>DOM-COR Modules</b>					
<i>Effective Research in Law</i>		<i>Effective Research in Teacher Training</i>		<i>Effective Research in Medicine</i>	
Use of Legal Databases	Research of Online Sources	Methods and Tools	Researching teaching materials and content	Online Literature Research	Medical Guidelines

The WBT on DOM-COR skills in medicine focused on effective (online) research for evidence-based decision-making and acting and consisted of two consecutive modules ‘Online Literature Search’ and ‘Medical Guidelines’ (Table 14). The skills intended to be fostered in these two modules are based on the learning objectives stated in Chapter VIII.1 on ‘medical scientific skills’ in the NKLM 2.0 (2021) (Table 15). The learning objectives subsequently served to derive the actual learning content, i.e. the knowledge input and tasks for both modules.

**Table 15.** Skills fostered in the WBT based on the NKLM 2.0.

<b>Skills fostered in the WBT</b>	<b>Section in the NKLM 2.0</b>	<b>Learning Objectives Medical graduates can...</b>
PICO scheme Name keywords Name synonyms	VIII.1-03.1.2 (Final Year: 3b)	... translate patient-related clinical problems into precise scientific questions that can be researched in specialist and literature databases.
Formulate search terms (Operators)	VIII.1-03.1.4 (Final Year: 3b)	... formulate and conduct literature research for the best available evidence for these problems based on precise, scientific questions in the databases relevant to their own profession.

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Apply search strategies	VIII.1-02.1.4	... research, select, and interpret relevant (secondary and tertiary) literature and other sources of information using suitable research systems and effective search strategies.
Use databases	VIII.1-03.1.4	...formulate and conduct literature research for the best available evidence for these problems based on the precise, scientific questions in the databases relevant to their own profession.
Use medical guidelines	VIII.1-03.5.3	... discuss the characteristics and requirements of guidelines for clinical application.
Answer a scientific question based on literature research	VIII.1-03.3.3 (Final Year: 3b) and VIII.1-03.3.4 (Final Year: 3b)	... carry out the examination of therapeutic and prognostic studies with regard to their validity for clinical application. ...“-“ with regard to their relevance for clinical application.

The WBT primarily focused on enhancing DOM-COR skills in medicine within the COR framework. This emphasis was driven by the recognition of the crucial role of domain-specific knowledge and expertise in research conduct (Wildemuth, 2004; Lucassen & Schraagen, 2011). Research has shown that domain-specific experts have better search query skills than non-experts (Brand-Gruwel et al., 2005; Hembrooke et al., 2005). With this in mind, Module 1, titled ‘Online Literature Research,’ focuses on teaching effective search strategies using suitable search terms and Boolean operators across various search engines and medical databases. Moreover, a primary challenge encountered when utilizing the Internet for information retrieval in the medical domain pertains to managing the vast volume of online information (Obermeyer & Lee, 2017; Hawkins et al., 2021). To promote targeted access to expert information, prominent databases commonly employed in clinical practice (e.g., PubMed, Embase, Cochrane Library, LIVIVO, TRIP, and CINAHL) were introduced, accompanied by links to instructional materials and video tutorials. Further, medical graduates report feeling unprepared for professional practice due to the complexity of clinical reasoning and decision-making and the high workload they are facing (Raspe et al., 2020). In this context, medical guidelines can help to reduce uncertainty, as they condense evidence-based, interdisciplinary knowledge for everyday practice and evaluate it according to defined criteria (Jünger, 2023). Given their essential function in translating scientific findings into clinical practice and offering valuable support, especially to early-career physicians, the utilization of medical guidelines was instructed in the second module.

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Each training module included an initial unit of knowledge input and a subsequent task. The knowledge input comprised concise micro-learning units of approximately 15 minutes each, thus demanding approximately 30 minutes in total. The tasks should be completed immediately afterward. The training duration was adaptable, contingent on users' available time and attention span. The WBT was accessible to medical students for 4-6 weeks, during which the participants were notified of the specific time frame allocated for the training. The WBT was launched from the online learning management system 'Moodle' accessible from home using a computer/laptop (for details, see Zlatkin-Troitschanskaia et al., 2021b).

Overall, the knowledge presented in both modules was complemented by detailed explanations and visual aids. Each method introduced, such as the PICO scheme, utilized for formulating well-structured clinical questions (Schmucker et al., 2013), was accompanied by practical application examples. Regarding the tasks, the responses for the first module task, 'Effective Research in Medical Databases,' had to be entered into designated text fields. This task necessitated the direct application of previously discussed knowledge, using the example of the medication effects of Remdesivir on the mortality rate of COVID-19 patients. Since no solutions were provided, the task relied on the participants' cognitive efforts. In contrast, in module 2, 'Medical Guidelines,' participants were required to select prescribed terms and predetermined items in the cloze text and cloze table (see Section 4.4.4.1; excerpts of the WBT are depicted in Appendix F).

#### **4.4.4 Methodology**

##### *4.4.4.1 Study Design*

This study aims to assess the feasibility of a pilot implementation of a WBT with cross-location applicability, designed to acquire and enhance DOM-COR skills in medicine relevant to evidence-based decision-making and acting among medical students in the transition from graduate to postgraduate education (RQ). The WBT presented in this paper was elaborated and tested in three time-shifted cohorts (2021-2022) of 29 medical students at two German medical faculties as part of the research project BRIDGE (see Section 3.1). The analysis in this study is based on a subset of

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29 medical students selected from a total of 64 medical respondents participating in the BRIDGE project. Initially, half of the medical respondents were assigned exclusively to the GEN-COR modules of the WBT, while the other half were assigned to the DOM-COR modules specific to medicine. Due to incomplete task data, additional participants had to be excluded, resulting in a final subsample of 29 students. The WBT was conducted online. Participation in the study was voluntary. As an inducement to participate, students received an expense allowance and the opportunity to view their test results online after completing the training. The training modules were structured as follows:

1) *Module 1 'Online Literature Research'*: For knowledge input, an overview of literature research with links to medical databases, manuals, articles, and additional relevant information was presented on a total of 14 slides. Further, the procedure for researching medical databases was explained step-by-step with supporting visual material. The corresponding task consisted of answering a clinical question in sub-steps (see Figure 8).

**Figure 8.** Task of the Module 'Online Literature Research'.

<b><u>Task – Effective Research in Medical Databases</u></b>	
<b>Clinical question: Does treatment with Remdesivir reduce the mortality rate of patients suffering from COVID-19?</b>	
<b>I.</b>	Classify the question into the PICO scheme (Patient; Intervention; Comparison; Outcome; Study Design).
<b>II.</b>	a) Determine five search terms you will use for your research. b) Find synonyms for these search terms.
<b>III.</b>	Now combine the selected search terms using Boolean operators and search PubMed for relevant publications.
<b>IV.</b>	Provide an answer to the clinical question.

2) *Module 2 'Medical Guidelines'*: The instructional material comprised a presentation of 14 slides that elaborated on the concept of guidelines, the evolutionary phases of development, various levels of evidence, degrees of recommendation pertaining to treatment guidelines, research advice, and the practical application of these guidelines in patient care. The corresponding task contained a cloze text with eight selectable, prescribed terms on the definition and meaning of medical guidelines and a cloze table on levels of evidence and degrees of recommendation of treatment

recommendations, with an overall eight predetermined items to be assigned via drag and drop.

#### 4.4.4.2 Sample Description

The total sample consists of 29 medical students from two German universities (Frankfurt:  $n = 18$ ; Göttingen:  $n=11$ ), who took part in the training in three time-shifted cohorts from December 2021 to April 2022 during and immediately after their final year. Prior to training, the students had completed a standard medical curriculum and had participated in a mandatory course on evidence-based medicine in the second semester (Göttingen) or second and third semesters (Frankfurt) of their clinical studies. While the GEN-COR modules had to be completed by all participants of the BRIDGE project, the DOM-COR modules were assigned to the participants of each domain respectively. Within the analyzed sample, participants from cohort 2 (Göttingen) underwent the GEN-COR modules before engaging in DOM-COR training. Cohorts 1 and 3 (Frankfurt), first participated in the DOM-COR training, followed by the completion of the GEN-COR modules.

**Table 16.** Descriptive Statistics for the Sample ( $n=29$ ).

Cohort	Sociodemographic Variables					
	N	Gender		Ø Age	Ø UEQ grade*	Ø Grade M2**
		Male	Female			
1) Frankfurt	13	5	8	25.21	1.20	2.43
2) Göttingen	11	2	8	24.8	1.21	2.6
3) Frankfurt	5	1	4	28.2	1.64	2.8
<b>Total</b>	<b>29</b>	<b>8</b>	<b>21</b>	<b>25.59</b>	<b>1.28</b>	<b>2.55</b>

\* University Entrance Qualification; \*\* Second State Examination

#### 4.4.4.3 Data Analysis

To answer RQ4 and investigate the research assumptions (see Section 4.4.2.1), a WBT on DOM-COR skills in medicine was elaborated and tested, collecting process data (i.e., log data), performance data (i.e., training results) as well as sociodemographic data (e.g., gender, age), and evaluation data (i.e., survey to

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evaluate the training). The socio-demographic data was controlled for and assessed via initial online surveys.

Subsequently, to test the research assumptions, the collected data (i.e., log data, performance data, and evaluation data) were analyzed. The log data included the total duration of training participation for both modules (see Section 4.4.5.1, Table 17). The performance data, i.e. task results, were scored by two independent trained human raters and combined into a mean score. The underlying rating scheme was theoretically elaborated, using examples for each task. Points for each module were awarded for each task (see Section 4.4.5.1, Table 18).

At the end of the training, an evaluation of the WBT was conducted through a post-assessment survey. Participants were asked the questions listed in Table 19 and mean values were computed for each. Additionally, students were invited to offer comments and suggestions for enhancing the WBT experience through open-ended questions (see Section 4.4.5.2). Responses underwent qualitative content analysis (QCA) (Mayring, 2003) for further examination.

### **4.4.5 Results**

#### *4.4.5.1 Process and Performance Results*

To answer the RQ3 (see Section 4.4.2) and investigate the assumptions (see Section 4.4.2.1), the process data (i.e. log data) and performance data (i.e. training results) were analyzed in detail. The log data included the total duration of training participation comprising the time spent on knowledge input for modules 1 and 2 and the completion of corresponding exercises. The time spent on knowledge input was determined from the difference between the total duration of training participation and the duration of the exercises. The reason for this is that participants kept switching back and forth between the knowledge input of both modules. The individual time for each knowledge input could therefore not be separated. The results are presented in Table 17.

**Table 17.** Average Processing Time.

	Ø Days of Training Access	Ø Time spent on Knowledge Input*	Ø Time spent on Task 1 'Remdesivir'	Ø Time spent on Task 2 'Guidelines'	Ø Total Duration of WBT	
Cohorts	N	Mean (Median)				
<i>1 - Frankfurt</i>	13	1 (1)	25 (21) min	21 (21) min	4 (4) min	50 (47) min
<i>2 - Göttingen</i>	11	1 (1)	12 (12) min	12 (13) min	4 (4) min	28 (32) min
<i>3 - Frankfurt</i>	5	1.6 (1)	46 (29) min	39 (33) min	6 (5) min	1h 31min (1h 13min)
<b>Total</b>	29	1.10 (1)	21 (17) min	23 (17) min	4 (4) min	49 (36) min

\* For both modules ('Online Literature Research' and 'Medical Guidelines')

Overall, participants accessed and completed the WBT within one day without interruptions. These results support A1, assuming that final-year medical students engaged them in the training despite their high workload. As intended with the implementation of micro-learning units, the average time spent on knowledge input in total was 21 minutes. Notably, there is considerable variation in the time spent between cohorts, with Cohort 2 allocating the least amount of time and Cohort 3 dedicating the most time to knowledge acquisition. Comparable outcomes became evident regarding the processing duration of the first task, 'Remdesivir,' averaging at 21 minutes. Once more, Cohort 2 exhibited the shortest completion time, while Cohort 3 demonstrated the longest duration. In contrast to Task 1, the time spent to complete Task 2 'Guidelines' was much shorter and only averaged 4 minutes. This variance is likely attributable to the task design. Task 1 involved multiple subtasks where participants were required to formulate their responses independently and input them into open-text fields, whereas in Task 2, answer options were provided and participants had to accurately assign them to the cloze text and cloze table.

Regarding the total duration of the training, the average was 49 minutes. Once more, Cohort 2 devoted the shortest amount of time, while Cohort 3 allocated the longest duration to the training. Remarkably, within the third cohort, two outliers required notably more time for all parts of the training. The reason could be that these participants left their browsers open while concurrently engaging with other programs on their laptops/PCs, which is not discernible from the log data. Additionally, it can

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be inferred that the shorter processing time observed in the second cohort may be attributable to the completion of the DOM-COR training subsequent to the GEN-COR training modules at the end of the study. Consequently, their motivation may not have been as pronounced as in the beginning.

The performance data, i.e. task results, were scored by two independent trained human raters and combined into a mean score. Mean values and standard deviation were calculated for all mean scores achieved, and minimum and maximum values were given for each score (Table 18).

**Table 18.** Average Scores in the Training Tasks (n=29).

Module	Task	Min.	Max.	Mean (SD)	Attainable Scores
1) 'Online Literature Research'	1. PICO Scheme	1	4	3.8 (.6)	4
	2. a) Naming of Search Terms	2.5	5	3.8 (.7)	5
	2. b) Naming of Synonyms	1.5	3	2.1 (.3)	3
	3. Boolean Operators	0	3	1.1 (.9)	3
	4. Answer to Clinical Question	0	1	.6 (.5)	1
2) 'Medical Guidelines'	1. Cloze Text on Medical Guidelines	4.5	8	6.7 (.9)	8
	2. Cloze Table on Medical Guidelines	5	8	7.4 (1.1)	8
<b>Total Score</b>		21	30	25.3 (2.2)	32

Regarding A2, 29 participants (97%) successfully completed the WBT, obtaining an average score of 25.3 points (79%). Notably, in Module 1 'Online Literature Research', participants attained the highest scores in the initial sub-task concerning the PICO scheme, averaging 3.8 points (95%). An interesting observation is the decline in DOM-COR performance as task complexity rises. On average, participants scored 3.8 points (76%) for sub-task two, whereas they attained merely 0.6 points (60%) for sub-task five, which demanded a conclusive response regarding the impact of Remdesivir on the mortality rate of COVID-19 patients. The greatest difficulties were found in dealing with Boolean operators in sub-task 4, for which the participants only achieved an average of 1.3 points (37%). In contrast, the participants overall performed better in the tasks of Module 2 'Medical Guidelines'. They achieved an average of 6.7 points (84%) for the cloze text and 7.4 points (83%).

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The different results between module tasks 1 and 2 could be partly due to the differences in the task formats, as the tasks in Module 2, i.e. the cloze text and table, provided answers to choose from. However, task results for Module 1 reveal a diminishing DOM-COR performance as task complexity increases, requiring greater independent transfer of knowledge. Overall, the results support A2 stating that graduate medical students (in the transition to postgraduate education) are expected to perform well in the DOM-COR tasks of the training.

#### 4.4.5.2 Training Evaluation

To evaluate the WBT and further investigate the research assumption (A1), participants answered a post-assessment survey at the end of the training. The results are presented in Table 19.

**Table 19.** Training Evaluation and Self-Assessment (n=15).

Assessment Criteria	Question	Scale from 1 to 4 *		
		Min	Max	Mean (SD)
Usefulness	Did you regard the training as useful?	2	4	3 (.65)
Prior Knowledge	Were you already familiar with the content of the training from your studies?	1	4	2.6 (.83)
Perceived COR Skills Improvement	Have your online skills improved because of the training?	2	4	2.8 (.56)
		Scale from 1 to 3 **		
Perceived Difficulty	How did you perceive task difficulty?	1	3	1.33 (.72)

\*\* 1 = does not apply at all, 4 = fully applies; \*\* 1 = appropriate, 3 = too difficult

Overall, 15 out of 28 participants who completed the WBT (54%) responded to the post-assessment survey. With an average of 3, the WBT was regarded as (rather) useful, supporting A1. The perceived value of the WBT became also apparent in participants' assessment of whether their online skills have improved as a result of the training, which also (rather) applies. Interestingly, the training content was already partially familiar to the students, who have participated in mandatory courses on

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING evidence-based medicine in the course of their university studies. The difficulty of the tasks was on average considered appropriate.

Further, students were asked open-ended questions for comments and suggestions for improvement on the WBT. The responses were examined through qualitative content analysis (QCA) (Mayring, 2003), leading to the following results:

**Table 20.** Open Responses for Training Evaluation.

Category	Excerpts from Answers
1) Desire to expand the training	-“... more detailed instructions on how to solve the tasks.”- “...expand the content on MeSH search terms.”
2) Subjective learning effect	-“...I learned a lot out of the training.”
3) DOM-COR skill acquisition during studies	-“...unfortunately, I didn't learn much about research during my studies at university.” -“...I would like to see this content integrated into medical studies, as research and studies make up a very large part of our later work and we are not given enough tools in this regard.”
4) Request for learning material	-“...could you provide the knowledge input for later use?”

The responses provided can be categorized into four groups. Firstly, participants expressed a desire to enhance the training content. They sought more comprehensive instructions for task solutions and requested additional information on the utilization of Medical Subject Headings (MeSH), which function as an extensive controlled vocabulary utilized for indexing journal articles within medical databases. Secondly, participants reported a substantial learning effect they perceived. Thirdly, the acquisition and enhancement of DOM-COR skills during their university studies suggested, consistent with prior research, that these skills are not adequately integrated into the study curricula. Despite being in their final year of studies, participants expressed a need for additional courses focusing on COR-related skills, deeming them essential for professional practice. Lastly, participants requested that the training content be made available for future reference, underscoring the practical utility of the training. Overall, these responses emphasize the acceptability of the WBT thus suggesting A1.

#### **4.4.6 Conclusion**

##### *4.4.6.1 Discussion*

Physicians need to adeptly navigate the Internet to optimize patient outcomes by incorporating the latest research and medical guidelines into their clinical decision-making and acting (Zhou et al., 2020; Menvielle et al., 2017). However, challenges arise due to the abundance and unreliability of online information, impacting clinical choices (Obermeyer & Lee, 2017). To address this, systematic training in domain-specific COR skills is essential for medical graduates, especially during the transition to professional practice (Zlatkin-Troitschanskaia et al., 2021b; Jünger, 2023). This study assessed the feasibility of a digital training program designed to enhance these skills among medical students transitioning from graduate to postgraduate education. The training was developed as a Web-Based Training (WBT) using the ADDIE model of instructional design and principles of evidence-based medicine. It was tested across three time-shifted cohorts at two German medical faculties.

This study demonstrates the feasibility of implementing a cross-location WBT on DOM-COR skills in medical education. The presented results support research assumptions (A1 & A2). The analysis of log data on training duration together with the high level of acceptance among final-year students (despite their high workload) shown in the evaluation data, supports the efficacy of the WBT (A1). In addition, the results and open-text responses from the post-assessment survey underscore the perceived relevance and utility of the training content in clinical practice (A1). As anticipated, participants demonstrated proficient performance in executing DOM-COR tasks (A2). Remarkably, as task complexity increased, the performance exhibited a diminishing trend, notably evident in the first task concerning 'Remdesivir. However, the observed disparities in performance might also be attributable to the diverse task formats employed, leading to the limitations of this study.

##### *4.4.6.2 Limitations and Implications*

The tasks presented in the two modules exhibited varying levels of difficulty. The exercise pertaining to 'Medical Guidelines' primarily constituted a review of knowledge, evidenced by the employment of cloze text and a cloze table, rather than

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING direct application to clinical cases. Conversely, the task on 'Remdesivir' demanded a higher degree of knowledge transfer. Overall, the scope of skills addressed within the exercises is insufficient given their complexity. Consequently, an expansion of training tasks is required. Moreover, a deeper analysis of DOM-COR skills operationalization, aligned with NKLM 2.0 and Bloom's Taxonomy, is needed (NKLM 2.0, 2021; Adams, 2015).

Another limitation of the study is the variation in data collection times, which complicates comparisons between cohorts. Furthermore, participation was voluntary, potentially influencing participant motivation, as indicated by the sample size and processing time of the third cohort (see Section 4.4.5.1). Additionally, the study was confined to only two medical faculties, limiting the generalizability of the findings. To increase the validity of the results, it is essential to implement the training in other locations.

Finally, the results are limited to the tasks conducted exclusively on the 'Moodle' platform. To gain a deeper understanding of participants' DOM-COR processes, it would be advantageous to collect log data on online searches conducted during task completion. To further assess DOM-COR performances, the utilization of diagnostic case vignettes would additionally prove beneficial (see Section 4.2).

While students acknowledged the importance of integrating DOM-COR skills into medical education and the curriculum, there was less emphasis on its integration into the workplace. This suggests a potential disconnect between the perceived relevance of DOM-COR skills and its application in practice, as indicated in several studies (Kahlke et al., 2020; Gassas, 2021; DeLuca et al., 2016). Therefore, it is imperative to integrate scientific and guideline skills into the curricula, but also second state and final state examinations. This integration would not only ensure the alignment of training objectives but also enhance the overall educational value.

Furthermore, integrating the WBT into the state examination would facilitate constructive alignment and ensure accessibility for all students, including those in outpatient settings where independent training may be challenging (Demmer et al., 2023; 2021). It is recommended to incorporate this WBT alongside workplace-based training in scientific skills to comprehensively prepare medical students for clinical practice. Possibilities would be the integration of the WBT into Entrustable

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Professional Activities (EPAs), or the assessment of DOM-COR skills within Open-Book Exam formats like the competence-based simulation of the first day of residency (Prediger et al., 2020; Harendza et al., 2020).

## 5 General Discussion

### 5.1 Summary of the Central Results (RQ1-RQ4)

This dissertation examines *the extent to which COR skills are acquired and can be promoted among medical students in clinical professional year/studies in Germany in the context of evidence-based clinical decision-making using online sources* (RQ).

To systematically address RQ, a set of structuring research questions (RQ1-RQ4) was derived from the current state of research and theoretical foundations. These research questions have been investigated in this thesis individually in four distinct sub-studies, each dedicated to addressing one of the structuring research questions. This section will provide an overview of the primary findings of the studies. This will enable the derivation of implications for educational and professional practice, as well as the answering of the final research question (RQ5; see Section 5.2). The dissertation concludes with an examination of the limitations inherent to the research project (see Section 5.3) and a discussion of potential subject areas for further research (see Section 5.4).

The initial two sub-studies were conducted with the objective of providing a comprehensive needs analysis regarding the acquisition and promotion of COR skills among young medical professionals in Germany. In consideration of a potential deficiency in the instruction of COR-related skills in medical education (Haag et al., 2018; Jünger et al., 2023), sub-study 1 dealt with the question *to what extent the individual facets of COR are anchored in the curricula of medical study programs* (RQ1). A qualitative content analysis (QCA) was performed to assess the promotion of this skill set within the module manuals and examination regulations of all 43 state-maintained human medicine programs in Germany. By systematically comparing regular and model curricula, specific differences in the promotion of underlying skills could be identified. The results of the QCA indicated that the overall level of promotion of COR was moderate, revealing deficits in promoting COR skills and at the same time providing guidance for ongoing revisions of the NKLM in medical higher education. Regarding the study structure, the mean scores for the model curricula were substantially higher than those for the regular curricula, particularly in the REAS domain. Furthermore, the findings demonstrated that within the model curricula, the

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number of compulsory and elective courses in the general sciences that encompass COR-related skills is gradually increasing in the more recent study regulations.

As a subsequent investigation to sub-study 1, which focused on the intended teaching of COR skills, the objective of sub-study 2 was to *evaluate the extent to which COR skills are developed among medical students in the transition from academic to professional practice* (RQ2). To this end, the performance of young medical professionals participating in the GEN-COR and DOM-COR pre-assessments of the BRIDGE project was evaluated and analyzed in relation to certain sociodemographic variables (e.g., gender, age) and personality traits (e.g., information overload, need for cognition). Overall, the participants performed well in the presented tasks. Moreover, no correlation was identified between GEN-COR and DOM-COR performance, which lends support to the notion that both skills are interrelated but empirically separable. In addition, no significant differences in performance were observed based on gender. It is noteworthy that there appear to be correlations between COR performance and the type of media used (e.g., journals) as well as previous medical training (e.g., vocational training). These findings suggest the need for further investigation.

Sub-studies 1 and 2 were conducted to ascertain the necessity of cultivating COR skills among young medical professionals. Sub-studies 3 and 4 then focused on the methods by which these skills can be systematically promoted through targeted intervention. Taking established didactic principles and learning models into account, sub-study 3 dealt with the *conceptualization and design of a training for the acquisition and promotion of COR in higher and post-university professional education* (RQ3). As no training program to date has incorporated all three COR facets, a new, comprehensive training program was developed based on the ADDIE model of instructional design. In order to facilitate convenient access to the training directly via the Internet, the technical format of a web-based training (WBT) was selected (Khan, 2001). The elaborated WBT comprises short micro-learning units of 15 minutes, which makes it easier to integrate the training into everyday working life. The WBT was designed to improve the GEN-COR and DOM-COR skills within and across different domains in the context of an entire process of information-problem solving using the Internet. The training modules are therefore structured in a logical sequence, enabling participants to internalize the requisite steps of the COR process as a whole. The tasks

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING encompass realistic generic and domain-specific information problems, encouraging users to navigate the Internet with autonomy, thereby creating an authentic training environment. In this regard, the WBT constitutes a significant contribution to this highly pertinent field of research. Moreover, the findings of this study's needs analysis, which included interviews with experts, indicated that the capacity to access, evaluate, and utilize information effectively is of paramount importance for professionals in all three domains of medicine, law, and teaching. This underscores the necessity of cultivating the development of COR skills among young professionals, especially in professions requiring evidence-based decision-making and acting.

Ultimately, sub-study 4 was concerned with the lack of training methods for domain-specific COR skills (i.e., DOM-COR skills; Shah et al., 2015; Breakstone et al., 2018; Taylor & Dalal, 2014). Considering the context of this dissertation on the skills required for evidence-based clinical decision-making using online media, this sub-study sought to address, *based on established instructional and learning models as well as principles of EbM, the feasibility of a cross-location digital training program for the acquisition and promotion of DOM-COR skills in medicine among medical students in their clinical studies/year* (RQ4). Building upon the findings of sub-study 3, this investigation was thus centered on the DOM-COR training modules in medicine. The skills intended to be fostered and learning content of the underlying modules were derived from the learning objectives outlined in Chapter VIII.1 on 'medical scientific skills' in the NKLM 2.0 (2021). Similarly to sub-study 3, the presented training method was implemented as a WBT. It was tested across three time-shifted cohorts at two German medical faculties. The results demonstrated feasibility of implementing a cross-location WBT on DOM-COR skills in medical education. This was evidenced by the results of the log data on training duration, as well as the high level of acceptance in the evaluation data among final-year students, despite the considerable demands on their time. Furthermore, the results demonstrated that students acknowledged the importance of incorporating DOM-COR skills into medical education and the curriculum. However, they placed less emphasis on their integration into the workplace, which suggests a potential discrepancy between the perceived relevance of DOM-COR skills and their practical application, as indicated by several previous studies (Kahlke et al., 2020; Gassas, 2021; DeLuca et al., 2016).

The findings of the presented sub-studies indicate the necessity and potential for the cultivation of COR-related skills pertinent to clinical decision-making using online sources among young medical professionals. These results permit the derivation of implications for (medical) educational and professional practice.

## **5.2 Implications for Educational and Professional Practice (RQ 5)**

### ***5.2.1 Implementation of NKLM 3.0 and Revision of Study Regulations***

As previously stated, the release of a new ÄApprO is anticipated in 2025, subsequent to the conclusion of the NKLM 3.0. Consequently, medical faculties are predicted to implement revisions to their curricula, including modifications to study regulations and module handbooks. This presents a number of implications for educational practice.

A first aspect to be considered in this regard is the limited scope of information provided by the module names in the current study regulations (see Section 4.1). In the course of revising the study regulations upon completion of the NKLM 3.0, it would be advisable to include more detailed descriptions of course content and teaching methods. Additionally, the curricular analysis in sub-study 1 has shown that elective courses exist that cover important skills related to COR. These encompass modules on EbM, which are listed on university websites but not yet included in the study regulations. It is thus recommended that future study regulations be more comprehensive and transparent, and that they also ensure the completeness of the courses offered at each location.

Further implications pertain primarily to the prospective practical implementation of the NKLM 3.0. To guarantee the successful implementation of courses on scientific skills in the future, it is recommended that medical faculties engage in an ongoing exchange of ideas to develop effective teaching strategies. (Lammerding-Koeppel et al., 2017). Such discussions would be useful not only between faculties with older and newer curricula, but also between representatives of locations with regular and model curricula (Lehmann et al., 2018). In addition, it might be useful to consider course models from private universities for possible inspiration. This exchange is already occurring in various working groups of medical faculties, in

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING which representatives from basic research, clinical practice, biomathematics, public health, medical didactics, and students are engaged in joint discussions concerning the scientific skills requisite to the practice of medicine (e.g., *Arbeitsgruppe Wissenschaftsstrang Manheim*<sup>10</sup>, *Arbeitsgruppe EbM Frankfurt a.M.*<sup>11</sup>). The further expansion and exchange between such working groups would be beneficial.

Throughout this exchange, it is of the utmost importance to develop concrete teaching and learning methods, not only to establish clear learning objectives, but also to elaborate their operationalization (Ahmadi et al., 2015). In sub-study 4 (see Section 4.4.3), the skills intended to be fostered and the learning content of the underlying modules of the DOM-COR WBT were derived from the learning objectives outlined in Chapter VIII.1 on ‘medical scientific skills’ in the NKLM 2.0 (2021). This ought to ensure that the training program effectively cultivates the relevant skills set among young medical professionals. The purpose of the NKLM (and the upcoming NKLM 3.0) is to provide a mandatory professional qualification framework describing the skills that medical students should acquire as part of a core curriculum (NKLM, 2015). The contents and learning objectives outlined in the document must therefore be utilized in the future to align corresponding learning materials. This ensures that all faculties are able to understand which skills need to be acquired by specific points in time and thus assure these skills to be fully addressed. Consequently, the NKLM serves as an important reference point for future curriculum design and implementation. With regard to the actual implementation, however, further operationalization, aligned with Bloom's Taxonomy, is required (NKLM 2.0, 2021; Adams, 2015)

### **5.2.2 Extended Assessments on DOM-COR Performance**

In addition to recommendations for the (future) revisions of study regulations and the implementation of the NKLM 3.0, the findings of the DOM-COR tasks utilized in the pre-assessment (sub-study 2) as well as the DOM-COR WBT (sub-study 4) offer valuable implications for the assessment and advancement of DOM-COR tasks (in the context of clinical decision-making in medicine). As was demonstrated in sub-study 2

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<sup>10</sup> <https://www.umm.uni-heidelberg.de/studium/abteilung-medizinische-ausbildungsforschung/>

<sup>11</sup> <https://www.ebmfrankfurt.de/>

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING (see Section 4.2.4), participants showed overall satisfactory performance results in the DOM-COR task, which might be attributed to two factors: familiarity with the presented diagnostic case and the perceived ease of the task. Consequently, while the incorporation of realistic patient cases in the educational process is vital for the advancement of CR and EbM abilities (Stylianou et al., 2020), it is essential to provide a diverse range of tasks with increasing complexity and in alignment with the respective academic year. As already mentioned, The NKLM, can serve as a valuable reference point for the development of appropriate tasks and training methods in this regard.

Further, the findings from sub-study 2 have indicated that participants with prior medical experience demonstrated inferior performance on the DOM-COR task. As no correlation was identified between their lower university admission grade and DOM-COR performance, it may be postulated that this effect was due to overestimation (Roepert et al., 2022). These results also have implications for medical education and professional practice. It would be erroneous to assume that medical students who have completed vocational medical training prior to their studies will necessarily demonstrate a higher level of COR performance. It is therefore recommended that all medical students receive training in COR-related skills, regardless of their prior working experience. Furthermore, it is recommended that confidence be considered in future tasks, as physician overconfidence contributes to diagnostic errors (Berner & Graber, 2008).

### ***5.2.3 Training Methods to Promote COR skills***

Ultimately, implications can be drawn from the WBT on GEN-COR and DOM-COR skills developed and tested as part of this dissertation (sub-studies 3 and 4). To begin with, the findings of the needs analysis conducted in sub-study 3 (see Section 4.3.3.1), which included interviews with experts from medicine, law, and teaching, indicated that the capacity to access, evaluate, and utilize information effectively is of paramount importance for professionals in all three domains. This is due to the fact that professionals in these domains predominantly access and utilize online sources, and further have deficits in solving information problems using the Internet. This underscores the necessity for COR training and leads to the implication that systematic

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training is necessary in education as well as on the job. In this regard, WBTs have been shown to be an efficacious methodology.

In developing and implementing future COR-training methods, it is essential to consider an approach that encompasses an entire process of information problem-solving using the Internet and related strategies, i.e., all three COR facets, rather than focusing on individual phases (Brand-Gruwel & Wopereits, 2006). On this basis, the research process and the associated competencies will be better internalized (Breakstone, 2024). Additionally, the learning modules should be embedded in scenarios that closely mimic real-life situations, which are relevant to the users' professional practice, thereby facilitating practical transfer (Dahlen, 2012). In this context, constructivist learning theory has been demonstrated to be an effective approach for fostering COR-related skills (Jackson, 2007). Further, feedback is essential for the consequent orientation towards the learning objectives and the evaluation of individual learning processes (Brown, 2017; Benjes-Small et al., 2013). Moreover, the temporal aspect should be considered (Converged, 2016), ensuring that the learning units are easily integrated into the daily work routine. In this regard, the results of the log data on training duration, as well as the high level of acceptance in the evaluation data in sub-study 4 (see Section 4.4.5), have demonstrated that a digital training program consisting of short micro-learning units is indeed feasible.

Additionally, further implications can be derived explicitly for the training of DOM-COR skills in medicine. The results of sub-study 4 (see Section 4.4.5) indicated that students recognized the significance of integrating DOM-COR skills into medical education and the curriculum. However, they placed less emphasis on their integration into the workplace, which suggests a potential discrepancy between the perceived relevance of DOM-COR skills and their practical application, as evidenced by several studies (Kahlke et al., 2020; Gassas, 2021; DeLuca et al., 2016). It is thus recommended that training methods be made increasingly available, not only during university study but also throughout the transition to postgraduate practical education when entering clinical work. Given the numerous challenges that young medical professionals face during this phase, including unfamiliar surroundings, information overload, and difficulties in transferring knowledge into practice (BurrIDGE et al., 2020; Monrouxe et al., 2017; Rencic et al., 2017), a digital and easily accessible training

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING method, as presented in this study, could positively impact the expressed feelings of unpreparedness and improve outcomes, including diagnosis (Braun et al., 2019; Dornan et al., 2019). Consequently, it is of paramount importance to integrate scientific and guideline skills not only into the curricula, but also second state and final state examinations. This integration would not only ensure the alignment of training objectives but also enhance the overall educational value.

### **5.3 Limitations**

#### **5.3.1 Construct Definition of DOM-COR in Medicine**

The research project presented in this dissertation also exhibits certain limitations and constraints. This section addresses the overall theoretical and methodological limitations of the research project. Further limitations concerning the specific analyses can be found within the individual research studies (see Section 4).

Given the focus of this dissertation on the effective use of online media in evidence-based clinical decision-making, DOM-COR skills are particularly relevant in the conducted analyses. Although DOM-COR was deliberately differentiated from GEN-COR for this purpose (see Section 2.3.2), the COR construct requires further theoretical derivation for the domain of medicine. As has become apparent, both CR and EbM, are of pivotal importance in the implementation of DOM-COR in clinical decision-making utilizing the Internet. In this context, additional domain-specific skills not represented by the three COR facets are relevant. Despite the demonstrated overlap between COR and CR, a further comparison of the constructs is required to develop a comprehensive competence profile for DOM-COR medicine (in clinical decision-making) and to clarify the necessary competences.

This results in a further limitation of the curricular analysis presented in sub-study 1. The scientific competencies of critically handling online media were operationalized and examined based on the COR construct. However, as previously mentioned, CR skills are also important in the context of clinical decision-making using online sources. It is thus recommended that, in order to gain deeper insight into the teaching of DOM-COR skills in medicine, an analysis analogous to Study 1 for clinical reasoning should be carried out. It is also important to note that curricular

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING analyses based on study regulations and module handbooks are based on very brief descriptions that only reflect the intended perspective of teaching. The actual practical implementation of teaching is therefore not taken into account. To gain deeper insights into the actual implementation of the promotion of the COR-related skills in medical education, it would be important to conduct a profound needs analysis. This could be achieved through interviews with teachers and students of medicine from different study locations, subject areas (e.g., general medicine, clinical practice, medical didactics), hierarchies (e.g., professors, lecturers, instructors), and study times (e.g., at the beginning, middle, and end of the studies).

### ***5.3.2 Evaluation and Revision of the WBT***

In light of the training methods developed in sub-studies 3 and 4, several further constraints need to be addressed. Although both training approaches offer significant added value and have proven to be feasible, they represent only the initial version of the COR training developed throughout the BRIDGE project. Consequently, the content of the training is focused on a limited number of subject areas. The GEN-COR training program is exclusively focused on the search engine ‘Google,’ with no mention of the use of general literature databases and platforms. Similarly, the DOM-COR training in medicine is limited to two tasks, with the first task focusing exclusively on ‘Remdesivir.’ The incorporation of additional tasks, particularly those designed to facilitate the practical implementation of CR, is recommended. Consequently, it would be advantageous to integrate realistic case vignettes into the training program. Furthermore, the incorporation of interactive elements into the training would enable the adaptation to diverse learning styles and enhance the emphasis on the practical application of knowledge, as opposed to mere knowledge recall.

Eventually, it would be beneficial to test the training at multiple locations, in addition to the two included in the present study. This also applies to the COR assessments, which must be tested at additional locations.

### **5.3.3 *Sample Size and Study Design***

In addition to the limitation of the study focusing solely on two German medical faculties, the sample size within the sub-studies is a crucial point of consideration. The sample sizes vary significantly and, with  $n=29$  and  $n=58$  participants, are not representative of the entire country. This is attributable to a combination of factors, including both a decline in the number of participants and the presence of erroneous data. Furthermore, the DOM-COR training module in medicine was not tested in a uniform manner across all locations, which is why the number of test subjects who underwent training was significantly lower than that of the GEN-COR and DOM-COR pre-assessments.

Moreover, the presented study does not allow for any conclusions to be drawn regarding the actual increase in learning outcomes associated with COR skills through WBT. This is due to the fact that the study was not designed as a pre-post study with a training intervention, and there is no control group for the cohorts being examined. In future investigations, it would be advisable to take this into account in order to verify the extent of the learning increase and the effectiveness of the training method in question.

In addition to employing extended instruments of the BRIDGE study at more locations and with larger samples, it would also be advisable to analyze COR skills in longitudinal studies. Such an approach would facilitate a comprehensive understanding of the acquisition and development of these skills among young medical students throughout the course of their studies.

## **5.4 Outlook and Future Directions**

In the context of this dissertation, it has been demonstrated that the critical use of online media in evidence-based clinical decision-making utilizing the Internet represents a highly relevant skill set for young medical professionals. It is therefore necessary to implement a systematic program of promotion of such skill set in medical education. Despite the implementation of initiatives to integrate COR-related competencies into academic curricula and to enhance them through training, the current approaches remain insufficiently developed. In particular, during the transition

ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING transitioning from university study to medical practice, young medical professionals require adequate training and support in applying COR to evidence-based clinical decision-making. The underlying studies have demonstrated that these skills and the corresponding training approaches are perceived as relevant and valuable for professional practice. Consequently, further research will be required on this topic in the future, thereby expanding the results of this dissertation.

Firstly, it is essential that further needs analyses are conducted (e.g., curricular analyses, expert interviews, surveys; for details, see Long, 2018) to further elaborate on the relevance of cultivating COR-related skills in medicine, both in the immediate term and once the NKLM 3.0 will be finalized in 2025. Given the potential for medical faculties to subsequently revise their curricula, it is of considerable interest to analyze how the status quo of developing and enhancing COR-related skills in medical education presented in this research project will have changed and whether improvements can be observed. It will be particularly interesting to examine how the learning objectives embedded in the NKLM 3.0 will be operationalized in educational practice and to what extent these learning methods and derived teaching methods prove to be practicable. In this regard, the extensive scope of the core curriculum is perceived as a significant challenge for faculty members, as it limits their design options (Timmer et al., 2021). Recent studies on effective teaching methods of COR-related scientific skills (i.e., competencies in EbM) among undergraduate medical students suggest that the incorporation of diverse didactic approaches, including self-study time and the vertical integration of such skills in undergraduate medical curricula along with clinical aspects, is an effective strategy for enhancing respective skills (Vonneilich & Kurth, 2020; Albarqouni et al., 2018). Given the fact that young physicians encounter particular difficulties in effectively transferring and applying their acquired knowledge to clinical practice (Ahmadi et al., 2015), an integration of COR-related skills (and associated training methods) in the clinical context appears to be a potentially fruitful avenue of inquiry.

In this regard, the integration of the COR-WBT presented in this dissertation into the state examination would facilitate constructive alignment and ensure accessibility for all students, including those in outpatient settings where independent training may be challenging (Demmer et al., 2023; 2021). Integrating this WBT with

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on-the-job scientific skills training is recommended to comprehensively prepare medical students for clinical practice. Possibilities include incorporating the WBT into Entrustable Professional Activities (EPAs) or assessing DOM-COR skills within open-book examination formats, such as the competency-based simulation of the first day of residency (Prediger et al., 2020; Harendza et al., 2020).

The transition towards a competency-based approach to medical education is likely to have implications not only for the teaching of COR-related scientific skills, but also for the further adaptation of CR training methods. Young medical professionals need real-world, on-the-job experience with patients to develop their skills and professionalism (Ziegler et al., 2020). Technology is an adjunct to such experience, not a replacement, and should not be judged as if it were a substitute for that contact (Bullock & Webb, 2015). Therefore, it is expected that workplace-based assessments, which test real-world performance and are therefore particularly important for teaching clinical decision-making, will be enhanced by meaningful technologies and nonworkplace-based methods (e.g., clinical vignettes with explanatory responses and alternatives, essays with clinical vignettes followed by free-text responses, digitalized concept maps; Daniel et al., 2019). For example, Gouzi et al. (2019) have introduced the use of interactive whiteboards in CR courses among third-year medical students. The whiteboards provide access to digital material, including diagnostic tests. The underlying material may be annotated, thereby enabling the construction and development of decision trees throughout the various stages of CR (Levett-Jones et al., 2010). The interactive training method had a positive impact on the learning of undergraduate medical students in the areas of diagnostic test ordering and interpretation (Gouzi et al., 2019).

In addition to potentials of enhancing COR-related skills in medical education, it is of further interest to analyze how (young) medical professionals actually use the Internet as an information source in clinical decision-making. In this regard, it is of particular importance to examine which search engines and databases they rely on and which website elements they pay attention to (Farnood et al., 2020; Tranter et al., 2022). For example, a recent study by Vallo Hult et al. (2023) demonstrated that physicians utilize search engines such as Google for medical information, even during patient consultations. In an additional study conducted by Tranter et al., (2022), access

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to information via search engines at the point of care was considered a valuable chance to educate patients on where to access reliable and current information. The application of the Internet in clinical practice appears to be becoming increasingly normalized and integrated, which gives rise to a number of interesting questions, e.g., regarding the potential impact on patients' perceived trust (Vallo Hult et al., 2023).

In addition to examining how (young) medical professionals utilize the Internet in clinical decision-making, it is also crucial to investigate this phenomenon in other domains, including law and teaching. This entails a comprehensive analysis of the behaviors exhibited by individuals in processing and selecting information, as well as the underlying factors that influence these actions. In this context, the interdisciplinary and international research unit "Critical Online Reasoning in Higher Education (CORE)," which is funded by the German Research Foundation (DFG) for an initial period of four years (2023-2027) seeks to provide additional insights. CORE aims to understand how students in higher education actively and purposefully acquire, discern, and use accurate information from reliable online sources on the Internet to build warranted knowledge, complete course-related tasks, and study successfully. For this purpose, the COR development is analyzed in a longitudinal study design applying mix-methods approaches and analysis from 16 disciplines. These methods include, among others, the collection and evaluation of log-data, eye-tracking analysis, think-aloud protocols, as well as QCA regarding narrative structures and linguistic properties of underlying online sources<sup>12</sup>. The target group constitutes university students in economics and medicine (including social sciences and physics as comparison disciplines) at three German universities. This interdisciplinary and multidimensional approach allows for an integrative analysis of relationship between the level development of students' COR skills, the features of the online information landscape students use for their learning, and students' learning success in higher education. In consideration of the research approaches presented in this dissertation, a more comprehensive understanding can be obtained regarding the process through which COR skills evolve over the course of medical studies, the specific stages at which this occurs, and the extent to which DOM-COR skills manifest in relation to the

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<sup>12</sup> For details, see <https://www.uni-mainz.de/>

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established curricular structures. Furthermore, it is possible to investigate whether the ability to utilize medical databases and medical guidelines, for example, improves in conjunction with the acquisition of domain-specific knowledge over time..

While further research is essential to gain a deeper understanding of the development COR skills among students and young professionals, it is also crucial to acknowledge the constant and rapid evolution of information and communication technologies (ICTs) and the Internet. One illustrative example is that of Artificial Intelligence (AI), which should be considered in the context of digitization in medicine. AI plays an increasing role in the critical handling of online media. In particular, the use of generative AI (i.e., deep learning models capable of generating high-quality text, such as ChatGPT) in medical education is an emerging trend that is welcomed by many medical students, professionals, and educators as it opens up entirely new possibilities (Moritz et al., 2023; Mah et al., 2021). With regard to CR, students can, for example, use generative AI to practice asking the right questions, a core competency in EbM. The chatbot helps refine research questions, suggests different methods and study designs, and efficiently paraphrases text. Thus, generative AIs can improve problem-solving skills relevant for clinical decision making by expanding perspectives on problems and suggesting additional differential diagnoses. Thus, generative AI is likely to be adopted as an interactive reference tool, with its use in wards becoming standardized through an evidence-based approach (e.g., GPT-4). As a result, their integration into physician competence training is assumed to become necessary (Moritz et al., 2023).

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**Appendix A: Coding Guidelines of the Curricular Analysis****Table A1.** Coding Guideline OIA.

Online Information Acquisition	
Definition	<p><i>Suche von und Zugriff auf Online-Informationen:</i></p> <ul style="list-style-type: none"> <li>- Nutzung von Suchmaschinen</li> <li>- Nutzung von Datenbanken</li> <li>- Entwicklung präziser Suchbegriffe und Operatoren</li> <li>- Auswahl passender Websites in Bezug auf Zugänglichkeit, Nützlichkeit, Relevanz und Vertrauenswürdigkeit</li> <li>- Auswahl relevanter Textpassagen</li> </ul>
Ankerbeispiel	<ul style="list-style-type: none"> <li>- <i>„Die Studierenden führen erste wissenschaftliche Tätigkeiten wie eine Literaturrecherche durch“</i> (Universität Bielefeld, 2021b, S. 22)</li> <li>- <i>„Anfertigen einer Literaturliste oder eines Thesenpapiers“</i> (Universität Bielefeld, 2021b, S. 205)</li> <li>- <i>„Sie sind in der Lage, eine wissenschaftliche Arbeit zu planen, zu recherchieren und zu strukturieren“</i> (Modulhandbuch Bielefeld, S. 220)</li> <li>- <i>„Sie [...] können Ergebnisse wissenschaftlicher Studien recherchieren“</i> (Universität Bielefeld, 2021b, S. 223)</li> <li>- <i>Die Modulprüfung besteht aus [...] einer literaturbasierten Planung einer klinischen Studie“</i> (Universität Bielefeld, 2021b, S. 231)</li> <li>- <i>„Sie [...] erweitern ihre Fähigkeiten zur Recherche des Stands der Forschung (auch in internationaler Literatur)“</i> (Universität Bielefeld, 2021b, S. 236)</li> </ul> <p style="text-align: center;">↓</p> <p style="text-align: center;"><u>Prototypischer Modulname:</u> „Wissenschaftliches Denken und Handeln“</p>
Kodierregeln	<ol style="list-style-type: none"> <li>1. Das Merkmal eines digitalen Veranstaltungsformats führt nicht zu einer Kodierung.</li> <li>2. Der Vergleich und die Bewertung von Quellen wird im Rahmen der Analyse zu Gunsten einer besseren Trennschärfe ausschließlich der Facette CIE zugeordnet.</li> <li>3. Diese Kategorie wird jedem Modul zugeordnet, das: <ul style="list-style-type: none"> <li>- die eigenständige Beschaffung von Informationen (außerhalb der Vorlesungsfolien) fordert</li> <li>- (heuristische und systematische) Strategien der Informationssuche/Literaturrecherche schult</li> <li>- wissenschaftliches Arbeiten beinhaltet, da dieses stets literaturbasiert ist bzw. mit dem Zugriff auf fremdes Gedankengut einhergeht</li> </ul> </li> <li>4. Keywörter zu Prüfungsformaten, die OIA indirekt fördern, werden nicht kodiert.</li> </ol>

**Table A2.** Coding Guideline CIE.

Critical Information Evaluation	
Definition	<p><i>Analyse und Bewertung von Online-Quellen:</i>            Untersuchung von URL, Design der Website, Titel der Textquelle, Struktur, verwendeten Grafiken, verwendeten audiovisuellen Medien, Inhalt, Autor, Herausgeber, Veröffentlichungsdatum, Belegen/Quellenangaben            Vergleich verschiedener Quellen            Identifikation von Verzerrungen oder Manipulationsversuchen            Bewertung angesichts grundlegender Gütekriterien            Kritische Reflexion und Beurteilung der Vertrauenswürdigkeit der Quelle</p>
Ankerbeispiel	<ul style="list-style-type: none"> <li>- <i>“Nach Abschluss von Modulteil 2 können Sie Gütekriterien wissenschaftlichen Arbeitens benennen und Methoden erläutern, mit denen diese bestimmt werden“ (Universität Augsburg, 2019, S. 24)</i></li> <li>- <i>„Sie lernen, [...] wissenschaftliche Befunde/Artikel zu verstehen [und] kritisch zu reflektieren“ (Universität Augsburg, 2019, S. 25)</i></li> <li>- <i>„Nach Abschluss von Modulteil 4 können Sie die Grundsätze guter wissenschaftlicher Praxis erläutern“ (Universität Augsburg, 2019, S. 25)</i></li> <li>- <i>„Sie können zwischen heuristischer und analytischer kognitiver Verarbeitung [...] unterscheiden und diese Methoden bewusst einsetzen“ (Universität Augsburg, 2019, S. 37)</i></li> </ul> <p style="text-align: center;">↓</p> <p style="text-align: center;"><u>Prototypische Modulnamen:</u></p> <ul style="list-style-type: none"> <li>- „Wissenschaftliches Denken und Handeln“/ „Wissenschaftlicher Longitudinalkurs“/ „Wissenschaftstheorie“</li> <li>- Jene, welche auf die Vermittlung psychologischer Grundlagen hindeuten</li> </ul>
Kodierregeln	<ol style="list-style-type: none"> <li>1. Das Merkmal eines digitalen Veranstaltungsformats führt nicht zu einer Kodierung.</li> <li>2. Diese Kategorie wird jedem Modul zugeordnet, das:           <ul style="list-style-type: none"> <li>- das kritische und systematische Reflektieren/Hinterfragen/Evaluieren/Bewerten trainiert</li> <li>- die Fähigkeit zu wissenschaftlichem Denken schult</li> <li>- den Umgang mit kognitiven Heuristiken/Verzerrungen/Wahrnehmungsfehlern lehren könnte</li> <li>- die Analyse bestehender wissenschaftlichen Arbeiten oder deren Gütekriterien/Regeln/grundlegenden Prinzipien beinhaltet</li> <li>- wissenschaftliches Arbeiten beinhaltet, da dieses stets die Auswahl vertrauenswürdiger Quellen fordert</li> </ul> </li> <li>3. Keywörter zu Prüfungsformaten, die CIE indirekt fördern, werden nicht kodiert.</li> </ol>

**Table A3.** Coding Guideline REAS.

Reasoning with Evidence, Argumentation & Synthesis	
Definition	<p><i>Schlussfolgerung und Argumentation auf Basis von Online-Informationen:</i></p> <ul style="list-style-type: none"> <li>- Belegen von Informationen durch Quellenangaben/Evidenzen</li> <li>- Zusammenfassen von Informationen</li> <li>- Diskussion der die Forschungsfrage betreffenden Pro- und Kontra-Argumenten</li> <li>- Gewichten und Abwägen der Argumente</li> <li>- Solider Umgang mit Unsicherheiten</li> <li>- Urteilsbildung</li> <li>- Strukturierte Aufbereitung der Ergebnisse</li> <li>- Schriftliche/Mündliche Präsentation der Ergebnisse</li> </ul>
Ankerbeispiel	<ul style="list-style-type: none"> <li>- „Nach Abschluss von Modulteil 2 können Sie die Aussagekraft wissenschaftlicher Untersuchungen hinsichtlich methodischer Gesichtspunkte kritisch diskutieren“ (Universität Augsburg, 2019, S. 24)</li> <li>- „Nach Abschluss des Moduls sind Sie mit den spezifischen Begründungsverfahren in der Wissenschaft vertraut (Universität Augsburg, 2019, S. 31)</li> <li>- „Nach Abschluss des Moduls können Sie die unterschiedlichen Argumentationstypen, Kriterien gültiger Argumente und typische Fehlschlüsse erklären“ (Universität Augsburg, 2019, S. 47)</li> <li>- „Nach Abschluss von Modulteil 3 können Sie [...] mit Unsicherheiten in der Diagnostik umgehen“ (Universität Augsburg, 2019, S. 25)</li> </ul> <p style="text-align: center;">↓</p> <p style="text-align: center;"><u>Prototypische Modulnamen:</u></p> <ul style="list-style-type: none"> <li>- „Wissenschaftliches Denken und Handeln“/ „Wissenschaftlicher Longitudinalkurs“/ „Wissenschaftstheorie“...</li> <li>- „Argumentationstheorie, Logik &amp; Rhetorik“</li> <li>- „Schreibwerkstatt“</li> </ul>
Kodierregeln	<ol style="list-style-type: none"> <li>1. Das Merkmal eines digitalen Veranstaltungsformats führt nicht zu einer Kodierung.</li> <li>2. Der Schritt der Identifikation von Heuristiken und Wahrnehmungsfehlern wird im Rahmen der Analyse zu Gunsten einer besseren Trennschärfe ausschließlich der Facette CIE zugeordnet.</li> <li>3. Diese Kategorie wird jedem Modul zugeordnet, das <ul style="list-style-type: none"> <li>- sich auf die evidenzbasierte Medizin/Wissenschaftsorientierung/Schulung von Wissenschaftskompetenz bezieht</li> <li>- die Strukturierungs- und Argumentationsfähigkeiten fördert</li> <li>- die eigene Urteilsbildung bezüglich eines Sachverhalts erfordert</li> <li>- wissenschaftliches Arbeiten — insbesondere die Beantwortung einer vorgegebenen oder selbstentwickelten Forschungsfrage — beinhaltet</li> </ul> </li> <li>4. Keywörter zu Prüfungsformaten, die REAS indirekt fördern, werden nicht kodiert.</li> </ol>

**Appendix B: Excerpt of Variables Collected in the BRIDGE Study****Figure B1.** Sociodemographic Variables.**Geschlecht**

**Variable:** geschlecht  
**Text:** Ihr Geschlecht?  
**Ausprägung:**  
1 = Weiblich (w)  
2 = Männlich (m)  
3 = Anderes (div)

**Alter**

**Variable:** alter  
**Text:** Wie alt sind Sie?

**Herkunft Eltern**

**Variable:** herkunft\_eltern  
**Text:** Sind Ihre Elternteile beide in Deutschland geboren?  
**Ausprägung:**  
1 Ja.  
2 Nein, nur mein Vater wurde in Deutschland geboren.  
3 Nein, nur meine Mutter wurde in Deutschland geboren.  
4 Nein, meine beiden Elternteile wurden nicht in Deutschland geboren.

**Kommunikationssprache**

**Variable:** sprache  
**Text:** In welcher Sprache kommunizieren Sie am besten?  
**Ausprägung:**  
1 In Deutsch.  
3 In Deutsch genauso gut wie in einer anderen Sprache.  
4 In einer anderen Sprache:

**Variable:** andere\_sprache (Texteingabe bei Ausprägung 4)  
**Ausprägung:** Freitextfeld

### Bildungsabschluss Eltern

**Variable:** bildungsabschluss\_eltern

**Text:** Geben Sie bitte den höchsten Bildungsabschluss Ihrer familiären Bezugspersonen (z.B. Eltern) an:

**Ausprägung:**

- 1 Kein Schulabschluss
- 2 Hauptschulabschluss
- 3 Realschulabschluss
- 4 Fachhochschulreife
- 5 Studium (Berufsakademie, FH, Universität)
- 6 Promotion
- 7 Hochschulreife

### HZB-Note

**Variable:** HZB\_note

**Text:** Welche Note hatten Sie in Ihrer Hochschulzugangsberechtigung (z.B. Abitur)?

**Ausprägung:** 1.00 - 4.00

### Ausbildung

**Haben Sie bereits eine Berufsausbildung abgeschlossen?**

**Ausprägung:** 0 = nein, 1 = ja

**Variable:** kaufm\_ausbildung

**Text:** Ja, eine kaufmännische.

**Variable:** gewerbl\_ausbildung

**Text:** Ja, eine gewerbliche.

**Variable:** jur\_ausbildung

**Text:** Ja, eine juristische.

**Variable:** krankenschw\_pfl\_ausbildung

**Text:** Ja, zum/zur Krankenschwester/Krankenpfleger.

**Variable:** rettungssan\_ausbildung

**Text:** Ja, zum/zur Rettungssanitäter/in.

**Variable:** rechtpfl\_ausbildung

**Text:** Ja, zum/zur Rechtspfleger/in.

**Variable:** steuerfach\_ausbildung

**Text:** Ja, zum/zur Steuerfachangestellten.

**Variable:** finanzwirt\_ausbildung

**Text:** Ja, zum/zur Finanzwirt/in.

**Variable:** verwaltungswir\_ausbildung

**Text:** Ja, zum/zur Verwaltungswirt/in.

**Variable:** andere\_ausbildung / andere\_ausbildung\_text (Texteingabe bei Ausprägung 1)

**Text:** Ja, eine andere:

**Kontrollvariable:** keine\_ausbildung

**Text:** Nein, ich habe keine Berufsausbildung abgeschlossen.

## ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING

**Figure B2.** Sociodemographic Variables (Medicine).**Doktorarbeit****Variable:** m\_doktorarbeit / m\_doktorarbeit\_anderer\_bereich\_text**Text:** Haben Sie vor Ihrem PJ neben dem Studium an einer medizinischen Doktorarbeit gearbeitet?**Ausprägung:**

- 0 Nein.
- 1 Ja, im Grundlagenbereich.
- 2 Ja, im klinischen Bereich.
- 3 Ja, in einem anderen Bereich: m\_doktorarbeit\_anderer\_bereich\_text

**Staatsexamen Note****Variable:** m\_staatsexamennote**Text:** Mit welcher Note haben Sie den schriftlichen Teil des Physikums (M1, 1. Abschnitt der ärztlichen Prüfung) abgeschlossen?**Ausprägung:** 1 - 4**Variable:** m\_staatsexamennote\_2**Text:** Mit welcher Note haben Sie den mündlichen Teil des Physikums (M1, 1. Abschnitt der ärztlichen Prüfung) abgeschlossen?**Ausprägung:** 1 - 4**Hammerexamen Note****Variable:** m\_hammerexamennote**Text:** Mit welcher Note haben Sie das „Hammerexamen“ (M2, 2. Abschnitt der ärztlichen Prüfung) abgeschlossen?**Ausprägung:** 1 - 4**Famulaturen****Variable:** m\_famulatur\_1, m\_famulatur\_2, m\_famulatur\_3, m\_famulatur\_4**Text:** Beschreiben Sie kurz Ihre Famulaturen (Abteilung, Ort):**Ausprägung:** Freie Textfelder

**Figure B3.** Media Usage (Medicine).**Nutzung Medien zur Vorbereitung**

**Wie oft haben Sie in Ihrem bisherigen PJ pro Woche durchschnittlich folgende Medien (Print und/oder Online) bei der Bearbeitung von Aufgaben und der Suche nach Informationen im Kontext des PJ genutzt?**

**Ausprägung:**

- 1 Nie
- 2 Selten
- 3 Einmal pro Woche
- 4 Mehrmals pro Woche
- 5 Täglich
- 6 Mehrmals täglich

**Variable:** m\_nutz\_zeitungen

**Text:** Tageszeitungen (z.B. FAZ)

**Variable:** m\_nutz\_nachrichtenmagazine

**Text:** Nachrichtenmagazine (z.B. Stern)

**Variable:** m\_nutz\_empf\_lehrbuecher

**Text:** Empfohlene Lehrbücher

**Variable:** m\_nutz\_fachzeitschriften

**Text:** Fachzeitschriften (z.B. Journals)

**Variable:** m\_nutz\_unterlagen\_lehre

**Text:** Unterlagen aus den Lehrveranstaltungen (z.B. Vorlesungsskripte)

**Variable:** m\_nutz\_freie\_literaturdb

**Text:** Lizenzfreie Literaturdatenbanken (z.B. Google Scholar, ERIC)

**Variable:** m\_nutz\_radio\_tv

**Text:** Radio/Fernsehen

**Variable:** m\_nutz\_online\_quellen

**Text:** Online Quellen (z.B. Wikipedia)

**Variable:** m\_nutz\_videoplattformen

**Text:** Videoplattformen (z.B. YouTube)

**Variable:** m\_nutz\_socialmedia

**Text:** Social Media (z.B. Facebook, Twitter)

**Variable:** m\_nutz\_elearning

**Text:** E-Learning-Angebote (z.B. udemy.com)

**Variable:** m\_nutz\_foren

**Text:** Foren

**Variable:** m\_nutz\_lerngruppen

**Text:** Lerngruppen

**Variable:** m\_nutz\_amboss

**Text:** AMBOSS

**Variable:** m\_nutz\_pubmed

**Text:** PubMed

**Variable:** m\_nutz\_andere\_med\_db

**Text:** Andere Medizinische Datenbanken

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**Figure B4. Information Overload (Medicine).**

Wenn Sie an Ihr bisheriges PJ denken, inwieweit treffen folgende Aussagen auf Sie zu?

**Ausprägung:**

- 1 trifft gar nicht zu
- 2 trifft nicht zu
- 3 trifft eher nicht zu
- 4 trifft eher zu
- 5 trifft zu
- 6 trifft voll zu

**Variable:** m\_abgelenkt\_von\_infouelle

**Text:** Ich bin oftmals abgelenkt von der übermäßigen Fülle an Informationen in den Medien.

**Variable:** m\_ueberfordert\_von\_infomenge

**Text:** Ich fühle mich überfordert von der Menge an Informationen aus den Medien, mit denen ich täglich konfrontiert werde.

**Variable:** m\_verarbeitung\_ist\_problem

**Text:** Meistens ist mein Problem, dass ich zu viele Informationen verarbeiten muss und nicht, dass ich zu wenig Informationen habe, um mir eine Meinung zu bilden.

**Figure B5. News Processing (Critical Thinking).**

Stellen Sie sich vor, Sie hören eine neue interessante bzw. wichtige Nachricht im Radio oder sehen eine Nachricht im Fernsehen oder Internet. Wie gehen Sie im Normalfall mit dieser Nachricht und neuen Information um?

Bitte geben Sie bei jeder Aussage an, inwieweit diese im Allgemeinen auf Sie persönlich zutrifft.

**Ausprägung:**

- 1 trifft gar nicht zu
- 2 trifft nicht zu
- 3 trifft eher nicht zu
- 4 trifft eher zu
- 5 trifft zu
- 6 trifft voll zu

**Variable:** nachrichtenverarb\_abgrenzen\_inhalte

**Text:** Ich grenze die verschiedenen Inhalte der Nachricht voneinander ab.

**Variable:** nachrichtenverarb\_wahrnehmen\_versch\_absichten

**Text:** Ich nehme verschiedene Absichten der Nachricht wahr.

**Variable:** nachrichtenverarb\_kontext\_tagesgeschehen

**Text:** Ich setze die Nachricht in den Kontext des aktuellen Tagesgeschehens.

**Variable:** nachrichtenverarb\_bewerte\_vertr

**Text:** Ich bewerte die Vertrauenswürdigkeit der Nachricht.

**Variable:** nachrichtenverarb\_hintergrund\_pruefung

**Text:** Ich prüfe die Hintergründe der in der Nachricht verwendeten Argumente.

**Variable:** nachrichtenverarb\_weitere\_infos\_einholen

**Text:** Ich hole bei der Bearbeitung von Nachrichten weitere Hintergrundinformationen ein.

**Variable:** nachrichtenverarbsumme

**Variable:** nachrichtenverarbmean

Bei diesen Variablen wurde für jeden Probanden die Summe (der Mittelwert) aus den Items der Skala Nachrichtenverarbeitung gebildet.

**Figure B6.** Need for Cognition.

Bitte lesen Sie sich jede Aussage zur Beschreibung Ihrer eigenen Person aufmerksam durch. Inwieweit treffen folgende Aussagen auf Sie persönlich zu?

**Ausprägung:**

- 1 trifft gar nicht zu
- 2 trifft nicht zu
- 3 trifft eher nicht zu
- 4 trifft eher zu
- 5 trifft zu
- 6 trifft voll zu

Die mit \* markierten Items wurden bereits invertiert.

**Variable:** nfc\_1\*

**Text:** Es genügt mir, nur die Antwort zu kennen, ohne die Gründe für die Antwort eines Problems zu verstehen.

**Variable:** nfc\_2

**Text:** Ich habe es gern, wenn mein Leben voller kniffliger Aufgaben ist, die ich lösen muss.

**Variable:** nfc\_3

**Text:** Ich würde kompliziertere Probleme einfachen Problemen vorziehen.

**Variable:** nfc\_4\*

**Text:** In erster Linie denke ich, weil ich muss.

**Figure B7.** Cognitive Reflection Test (CRT).

**Variable:** iq\_ball\_schlaeger

**Text:** Ein Schläger und ein Ball kosten zusammen 1,10 Dollar. Der Schläger kostet 1 Dollar mehr als der Ball. Wie viel kostet der Ball?

**Ausprägung:** 000-999

**Variable:** iq\_ball\_korrekt

**Ausprägung:**

- 0 falsch
- 1 richtig

**Variable:** iq\_5maschinen

**Text:** Wenn fünf Maschinen fünf Minuten für fünf Produkte brauchen. Wie lange benötigen dann 100 Maschinen, um 100 Produkte zu erstellen?

**Ausprägung:** 000-999

**Variable:** iq\_5ma\_korrekt

**Ausprägung:**

- 0 falsch
- 1 richtig

**Variable:** iq\_seerosen

**Text:** In einem See wachsen Seerosen. Jeden Tag verdoppelt sich die Menge der Seerosen. Die Seerosen brauchen 48 Tage, um den gesamten See zu bedecken. Wie lange würde es dauern, bis die Seerosen die Hälfte des Sees bedeckt haben?

**Ausprägung:** 000-999

**Variable:** iq\_see\_korrekt

**Ausprägung:**

- 0 falsch
- 1 richtig

Die Bearbeitungszeit für diese Seite betrug 3 Minuten. Nach Ablauf der Zeit wurden die Probanden automatisch weitergeleitet. Es gibt daher einige wenige Missings.

**Appendix C: GEN-COR and DOM-COR Pre-Assessments****Figure C1.** GEN-COR Pre-Assessment.Fördern E-Bikes die Gesundheit?

Nehmen Sie sich bitte 20 Minuten Zeit, um diese Aufgabe zu bearbeiten.

Sie überlegen, sich ein E-Bike zur Förderung Ihrer Gesundheit anzuschaffen. Dafür recherchieren Sie online nach Informationen zur Förderung von E-Bikes zur Gesundheit.

Im Folgenden prüfen Sie die Zuverlässigkeit der Informationen Ihrer Online-Recherche. Bitte bearbeiten Sie dafür die folgenden zwei Aufgaben. Recherchieren Sie für die Beantwortung der Fragen im Internet. Geben Sie bitte immer die verwendeten Internetquellen (URLs) an:

1. Fügen Sie in der unteren Tabelle die von Ihnen verwendeten Quellen mit jeweiliger URL ein und geben sie zudem an, ob Sie die jeweilige Quelle für zuverlässig erachten. (Sie haben hierfür 10 Minuten Zeit.)

Quelle (URL)	Beurteilung der Zuverlässigkeit

2. Verfassen Sie eine kurze Stellungnahme, in der Sie auf Basis Ihrer Recherche aus Aufgabe 1 ein begründetes Urteil darüber abgeben, ob E-Bikes zur Gesundheitsförderung beitragen. Verweisen Sie auch hier auf entsprechende Informationen aus Ihrer Recherche und geben Sie bitte die Quellen (URLs) an. (Sie haben hierfür 10 Minuten Zeit.)

**Figure C2. DOM-COR Pre-Assessment.**

**Situation:** Sie sind im Rahmen Ihres PJ im Bereich der Inneren Medizin eingesetzt und nehmen einen neuen Patienten auf, bei dem sich das im folgenden geschilderte Bild ergibt:

Ein 26-jähriger Patient wird wegen einer schwer einstellbaren arteriellen Hypertonie vom Hausarzt in Ihre internistische Fachpraxis überwiesen. Der Patient klagt zudem über eine allgemeine Leistungsschwäche. Unter Therapie mit einem Kalziumantagonisten (Seit 4 Wochen Amlodipin 5 mg 1-0-0) messen Sie einen Blutdruck von 175/115 mmHg. Bereits bei der Begrüßung des Patienten fällt Ihnen auf, dass sein rundes Gesicht aufgedunsen wirkt und er adipös ist. Bei der körperlichen Untersuchung des Patienten (Größe 179 cm, Gewicht 120 kg) stellen Sie Folgendes fest: Der Patient leidet unter Akne der Gesichtshaut, die Adipositas ist stammbetont; am Abdomen sowie an den Hüften finden sich breite livide Streifen. Die mitgebrachten Laborwerte zeigen eine geringe Hyperglykämie (Nüchternblutzucker 129 mg/dl) und ein grenzwertiges Serumkalium (3,5 mmol/l).

**Aufgabenstellung:****1. Station:**

Für die in Kürze anstehende Visite der Oberärztin Prof. B. T. wollen Sie sich online informieren, *welche diagnostischen Schritte gemäß den entsprechenden Leitlinien empfohlen werden.*

- **1A:** Recherchieren Sie im freien Netz für **ca. 10 min**, um relevante Informationen zum empfohlenen diagnostischen Vorgehen zu finden.
- **1B:** Skizzieren Sie Ihren Entwurf des Diagnostikplans für den o.g. Fall basierend auf den von Ihnen benutzten Online-Quellen. Geben Sie dabei auch den Grad der Evidenz der genutzten Quellen/Informationen an und begründen Sie diesen anhand Ihrer Recherche (**ca. 10 min**).

**2. Klinische Konferenz:**

Im Rahmen Ihres PJ-Unterrichts werden Sie gebeten, den oben geschilderten Fall im Rahmen einer Klinischen Konferenz vorzustellen. Erwartet wird auch, dass Sie einen Überblick über die klinische Studienlage geben und diese in ihrer Relevanz für die evidenzbasierten Leitlinien bewerten.

Aufgrund der Zusammenschau der oben genannten Symptome vermuten Sie ein endokrinologisches Syndrom und richten Ihre nun folgende Recherche dementsprechend aus. Recherchieren Sie im freien Netz für **ca. 15 min** und versuchen Sie im obengenannten Sinne relevante Studien zu identifizieren. Benennen Sie die Ihrer Einschätzung nach die wichtigsten 2-3 Studien. Begründen Sie Ihre Auswahl und skizzieren Sie die jeweils wichtigsten Ergebnisse (**15 min**).

## ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING

**Figure C13.** Excerpt of the COR Rating Scheme.

COR facet	Description	List of criteria	COR construct	Score evaluation (highest possible score)	Grading Scale from 0 - 4:					Percentage weight
					0 Not fulfilled	1 Mostly not fulfilled	2 Partially fulfilled	3 Mostly fulfilled	4 Completely fulfilled	
1. Definite answer (in the sense of the task)	on the 2nd question: Is the answer definite and understandable? Has a clear judgement been made?									
2. Comprehension	<ul style="list-style-type: none"> <li>Was the content of the question addressed?</li> <li>Was the content of the question missed?</li> </ul>				Content reference is composed of: <ul style="list-style-type: none"> <li>Assessment of source credibility as well as</li> <li>Judgement in the sense of the assignment</li> </ul>					
3. Quality of sources used	Use of additional sources Have additional sources been consulted? Is the number of sources used appropriate? (at least 2 sources)				[EXCERPT] Unreliability of a source <ul style="list-style-type: none"> <li>The linked websites of the tasks, newspaper articles and the sponsor websites behind them</li> <li>Impressum of the linked websites</li> <li>Identification of bias</li> </ul>					
4a. (Task with link) Identify possible bias & draw conclusions	<ul style="list-style-type: none"> <li>Test person has (not) identified bias</li> <li>Test person draws the right conclusions (connection between bias and reliability of the website)</li> </ul>				Examples of possible bias: <ul style="list-style-type: none"> <li>Promotion of other products, Corruption, Political influence, Lobbyism</li> <li>Drawing relevant conclusions (in relation to the credibility of the website)</li> </ul>					

## Appendix D: Additional Material of the COR-WBT Development

Figure D1. The RADCAB Method (Christennson 2006).

### The RADCAB™ Rubric Information Evaluation Assessment



RADCAB CONCEPTS	CRITERIA & PERFORMANCE LEVELS				Points
	Down and Out in Researchville 1	Tired Researcher 2	Research Pro 3	Totally Rad Researcher 4	
<b>RELEVANCY R</b>	I have no idea how to find relevant information.	I know I can create keywords from my research questions to find relevant information but it takes too much time.	I create keywords from my research questions and use them to find relevant information.	I use quotation marks around my search terms and the minus sign "-" where needed, and I use the site operator to limit searches to credible sites.	_____
<b>APPROPRIATENESS A</b>	I have no idea how to discern appropriate information for my age or core values.	I know some information sources seem difficult to understand and some offend me but I try to read them anyway.	I leave information sources quickly that are too hard for me to understand or offend my core values.	I set personal boundaries about what I view, read and listen to, and I close out information sources that confuse me or offend my core values.	_____
<b>DETAIL D</b>	I have no idea if an information source has enough information for me.	I am frustrated with determining if an information source has the information I need.	I can make a good guess if the information source has the depth of coverage I need to complete my assignment.	I use specific details from a website such as its site map, its internal search engine and its page organization to inform me about the depth of coverage the information source offers.	_____
<b>CURRENCY C</b>	I don't care about the currency of my information source.	I know it is important to find out about the currency of an information source, but I tend to hope for the best rather than take the time to look for it.	I look for copyright information or "last updated" information in my information source.	I comb my information source for copyright information or "last updated" information because I understand that information sources that are continually updated have fresher and more trustworthy content than those that are unattended.	_____
<b>AUTHORITY A</b>	I don't care who authors the information I find on the Internet.	I understand it is important to know who is writing the information I read on the Internet but I don't want to take the time to find out.	I look for the authority behind the information on a website because I know it affects the accuracy of the information found there.	When I find the author of a website I go the extra mile to find out what institution, organization or agency he or she is affiliated with and I look for contact information.	_____
<b>BIAS B</b>	I don't care if there is bias in my information source.	I would like to know if there is biased reporting in the information I read, but I don't know how to figure that out.	When I read from an information source I try to understand if there is some hidden agenda to the information being reported. I ask myself, "Does the information exist because someone wants to inform me, persuade me, entertain me, or sell me something?"	When I read from an information source I try to detect bias in the writing by looking at important clues like: the domain name, the domain suffix, the advertising featured, the mission statement, the authorship, and the tone of voice or language used.	_____
Name:	Date:	Assignment:		<b>Total</b>	

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Figure D2. The CAAP Test (Blakeslee, 2004).

### The CRAAP Test Worksheet

Use the following list to help you evaluate sources. Answer the questions as appropriate, and then rank each of the 5 parts from 1 to 10 (1 = unreliable, 10 = excellent). Add up the scores to give you an idea of whether you should use the resource (and whether your instructor would want you to!).

**Currency:** *the timeliness of the information*.....

- When was the information published or posted? \_\_\_\_\_
- Has the information been revised or updated? \_\_\_\_\_
- Is the information current or out-of-date for your topic? \_\_\_\_\_
- Are the links functional? \_\_\_\_\_

**Relevance:** *the importance of the information for your needs*.....

- Does the information relate to your topic or answer your question? \_\_\_\_\_
- Who is the intended audience? \_\_\_\_\_
- Is the information at an appropriate level? \_\_\_\_\_
- Have you looked at a variety of sources before choosing this one? \_\_\_\_\_
- Would you be comfortable using this source for a research paper? \_\_\_\_\_

**Authority:** *the source of the information*.....

- Who is the author/publisher/source/sponsor? \_\_\_\_\_
- Are the author's credentials or organizational affiliations given? \_\_\_\_\_
- What are the author's credentials/organizational affiliations if given? \_\_\_\_\_
- What are the author's qualifications to write on the topic? \_\_\_\_\_
- Is there contact information, such as a publisher or e-mail address? \_\_\_\_\_
- Does the URL reveal anything about the author or source? \_\_\_\_\_

**Accuracy:** *the reliability, truthfulness, and correctness of the content*.....

- Where does the information come from? \_\_\_\_\_
- Is the information supported by evidence? \_\_\_\_\_
- Has the information been reviewed or refereed? \_\_\_\_\_
- Can you verify any of the information in another source? \_\_\_\_\_
- Does the language or tone seem biased and free of emotion? \_\_\_\_\_
- Are there spelling, grammar, or other typographical errors? \_\_\_\_\_

**Purpose:** *the reason the information exists*.....

- What is the purpose of the information? \_\_\_\_\_
- Do the authors/sponsors make their intentions or purpose clear? \_\_\_\_\_
- Is the information fact? opinion? propaganda? \_\_\_\_\_
- Does the point of view appear objective and impartial? \_\_\_\_\_
- Are there political, ideological, cultural, religious, institutional, or personal biases? \_\_\_\_\_

**Total:**

45 - 50 Excellent | 40 - 44 Good  
 35 - 39 Average | 30 - 34 Borderline Acceptable  
 Below 30 - Unacceptable

Adapted from Juniata College for use at South Central College

**Table D3.** Learning Content for the Structure and Functions of the Search Engine ‘Google’ (for details, see Kohmer, 2020).

Allgemeine Informationen	<p>Google ist Marktführer unter den Internet-Suchmaschinen und gilt als meistbesuchte Webseite der Welt. Zudem ist sie die umfassendste Suchmaschine im Vergleich zu anderen Anbietern und durchsucht die meisten Einträge nach Informationen. (intenSEO, 2020)</p> <ul style="list-style-type: none"> <li>- 5,6 Milliarden Suchanfragen pro Tag</li> <li>- 90,4% Marktanteil weltweiter Suchmaschinen im Internet</li> <li>- Durchschnittlich 3-4 Suchen pro Person/Tag</li> <li>- Am Arbeitsplatz laufen 90% der Suchanfragen über Google (Kroker, 2020)</li> </ul>
Hauptsuche	<ul style="list-style-type: none"> <li>- Anzeige von 10 Suchergebnissen pro Seite</li> <li>- Suchergebnisse beinhalten den Titel, eine Zusammenfassung des Inhalts und den Link zum jeweiligen Treffer</li> </ul>
	<p><i>Automatische Vervollständigung:</i> Bei der Eingabe von Suchwörtern, werden Vorschläge zur Erweiterung der Suchanfrage unter dem Eingabefeld angezeigt (z.B. Geschenke „für Männer“, „für Frauen“) (vgl. Google Inc., 2012)</p>
	<p><i>Rechtschreibprüfung:</i> Bei Eingabe falsch geschriebener Wörter, liefert Google einen Vorschlag zur korrekten Schreibweise („Meinten Sie [korrekter Begriff]“), welcher per Klick ausgewählt werden kann, um eine Suche nach dem korrigierten Suchbegriff auszuführen (vgl. FHNW, 2020)</p>
	<p><i>Knowledge Graph:</i> semantische Suchfunktion (Fokus auf Bedeutung der Suchanfrage), anhand welcher bei bestimmten Suchbegriffen, wie Orten, berühmten Sehenswürdigkeiten, Bauwerken und Personen, Tieren und Pflanzen, sowie teilweise sachlichen Begriffen, eine Detailansicht mit Basisdaten und einem Ausschnitt des zugehörigen Wikipedia-Artikels angezeigt wird (beispielsweise in Form des Standorts der Sehenswürdigkeit oder Fotos der Persönlichkeit); Die Informationen erscheinen in einer Infobox über den Suchergebnissen (vgl. Singhal, 2012)</p> <p>Google ist in vielen Browsern standardmäßig integriert, sodass bei Eingabe eines Suchbegriffs in der Adressleiste des Browsers und das Betätigen der <i>Enter</i>-Taste eine automatische Suchanfrage des Begriffs bei Google erfolgt</p>
Erweiterte Suchfunktionen	<p>Über den Suchergebnissen ist eine Leiste aufgeführt, über diese erweiterte Suchfunktionen ausgewählt werden können: <i>Shopping</i> (Produkte von Händlern), <i>News</i> (Nachrichten), <i>Bilder</i>, <i>Videos</i>, <i>Maps</i> (Landkarte), <i>Bücher</i> (retrodigitalisierte Bücher), <i>Scholar</i> (Literaturrecherche wissenschaftlicher Dokumente), <i>Flüge</i> (Reisebuchungen), <i>Finanzen</i> (aktuelle Marktberichte)</p> <p><i>Hinweis: Im Kontext wissenschaftlichen Schreibens empfiehlt es sich, Google Scholar zu verwenden, da hierbei das Internet nach wissenschaftlichen Artikeln und Publikationen durchsucht wird (vgl. FHNW, 2020)</i></p>
	<p><b>Google News:</b></p> <ul style="list-style-type: none"> <li>- Nachrichtensuchmaschine des Unternehmens Google (in 70 Ländern und auf 35 Sprachen verfügbar)</li> <li>- sammelt Nachrichten und Schlagzeilen aus über 700 Nachrichtenquellen aus dem deutschsprachigen Raum (4500 englischsprachige Quellen) (Internet Archive, 2017)</li> <li>- erfasst die größte Breite an Nachrichtenartikeln im Vergleich zu anderen Anbietern, wie <i>Thomson Reuters</i> oder <i>Wikinews</i> (van Erp &amp; Vossen, 2017, S.112)</li> <li>- Über den Suchfilter ist eine Eingrenzung nach <i>Relevanz</i> oder <i>Aktualität</i> der Nachrichten möglich</li> <li>- Informationen werden mittels eines Computer-Algorithmus ohne menschliche Intervention gesammelt, selektiert und aggregiert (Latar, 2018, S.32)</li> </ul>

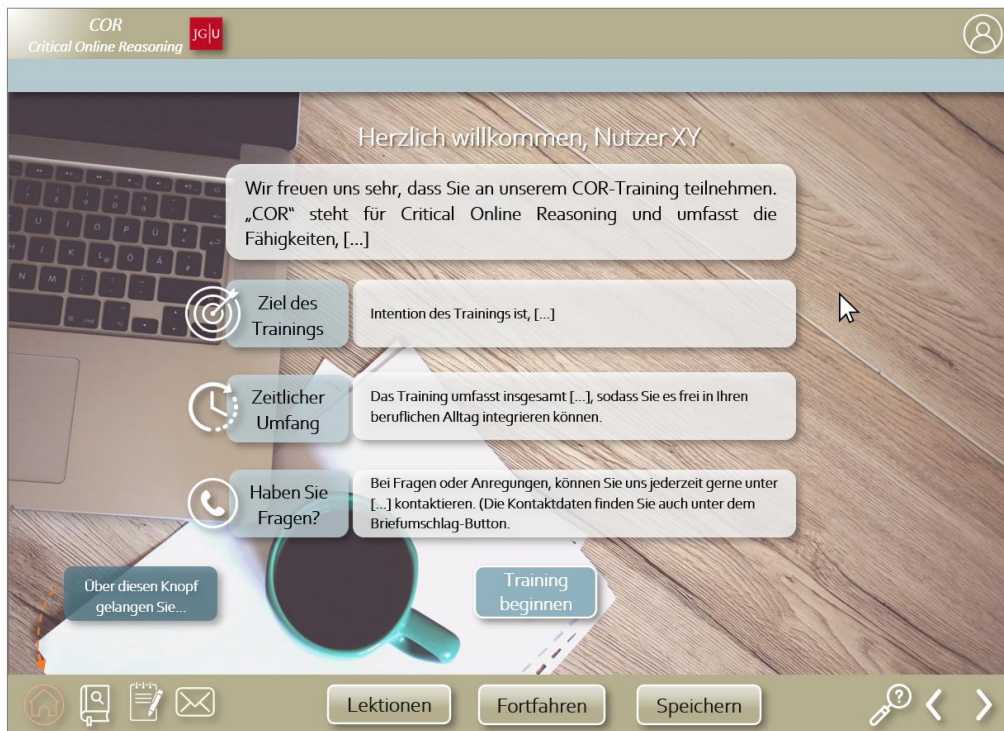
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	<p><i>Hinweis: Nachrichtenquellen stammen meist von großen Medien- und Nachrichtenagenturen, wodurch eine strukturelle und inhaltliche Vielfalt nicht gewährleistet werden kann (ebd., S.131). Google-Algorithmen arbeiten gezielt gegen die Verbreitung von Falschmeldungen, dennoch kann keine vollkommene Glaubhaftigkeit gewährleistet werden (vgl. Bünte, 2019; Gärtner, 2020).</i></p> <p><b>Google Books:</b></p> <ul style="list-style-type: none"> <li>- größte Sammlung retrodigitalisierter Bücher (Digitalisierung analoger Publikationen) im WWW</li> <li>- Inhalte aus über 40 Millionen Büchern in mehr als 400 Sprachen</li> <li>- Kooperationen mit Verlagen zur Digitalisierung der Archive</li> <li>- Anzeige von vollständigen Büchern und Ausschnitten (abhängig von der Freigabe der Autorenrechte) (vgl. Google Inc., 2019)</li> <li>- Über den Suchfilter ist eine Eingrenzung nach <i>Vorschau verfügbar, Google E-Books</i> und <i>kostenlose Google E-Books</i> und dem <i>Publikationszeitraum</i> möglich</li> <li>- Sortierung der Einträge nach <i>Relevanz</i> oder <i>Datum</i></li> </ul> <p><i>Hinweis: Es findet keine Zuordnung von Schlagwörtern zu den hinterlegten Büchern, wie z.B. in Bibliothekskatalogen statt. Dadurch können keine Bücher eines bestimmten Fachgebiets selektiert werden, die Suchergebnisse sind häufig undifferenziert. Der Großteil der Bücher ist zudem auf English (Iyer et al., 2020, S.10). Google Books stellt keine vollwertige Alternative zu Literaturdatenbanken dar, ist dennoch nützlich um sich in Thematiken einzulesen.</i></p> <p><b>Google Scholar:</b></p> <ul style="list-style-type: none"> <li>- weltweit größte akademische Suchmaschine für kostenpflichtige und kostenlose wissenschaftliche Literatur (über 389 Millionen hinterlegte Dokumente)</li> <li>- Anzeige der Inhaltsangabe (Abstract) von kostenpflichtigen Artikeln (Thieme &amp; Weiß, 2020, S.89)</li> <li>- Über den Suchfilter ist eine Eingrenzung nach <i>Relevanz</i> oder <i>Datum</i> möglich</li> <li>- Die Suchfunktion überprüft die Herkunft der Publikation (z.B. Fachzeitschrift, Hochschulrepositorium), ihren Aufbau und Erwähnung in anderen Dokumenten. Der Algorithmus bewertet die Dokumente somit nach Wissenschaftlichkeit, die genauen Kriterien sind jedoch nicht offengelegt (Lewandowski, 2012, S.5)</li> <li>- Kooperation mit Großverlagen wie <i>Elsevier, Springer</i> und <i>Taylor &amp; Francis</i> (Kagovnak, 2017, S.35)</li> </ul> <p><i>Hinweis: Auch Vorlesungsunterlagen, PowerPoint-Präsentationen und studentische Arbeiten werden als wissenschaftliche Texte eingeordnet, die fachliche Qualität der Inhalte ist daher stets zu überprüfen (Thieme &amp; Weiß, 2020, S.89). Wie auch bei Books, können keine Fachgebiete selektiert werden, weshalb der Dienst keine vollwertige Alternative zu Datenbanken darstellt (Kagovnak, 2017, S.35).</i></p>	
Boolesche Operatoren	Neben der Eingabe von einfachen Suchbegriffen, ermöglicht Google die Anwendung einer erweiterten Syntax. Diese kann über den Menüpunkt „erweiterte Suche“ aufgerufen, oder in das Suchfeld eingegeben werden. Die Syntax basiert auf logischen Operatoren, welche als <i>Boolesche Operatoren</i> bezeichnet werden. Diese dienen der logischen Verknüpfung von Begriffen und können die Suche, je nach Rechercheabsicht, präzisieren (Hardwick, 2018).	
Google Operatoren* (vgl. Hardwick 2018; FHNW, 2020)	“Suchbegriff(e)“	Um nach exakten Begriffen und Phrasen zu suchen, setzt man diese in Anführungszeichen (z.B. “Hausmittel bei Ohrenscherzen“)

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	<b>-Suchbegriff</b>	Um Wörter von der Suche auszuschließen, setzt man einen Bindestrich/Minus davor, was bei der Suche mehrdeutiger Begriffe nützlich ist (z.B. ph <b>-wert</b> )
	Suchbegriff(e) <b>OR</b> Suchbegriff(e)	Insofern innerhalb der ersten Treffer nicht alle Suchbegriffe enthalten sein müssen, können die Begriffe mit OR (Englisch: <i>oder</i> ) verbunden werden; OR ist dabei groß zu schreiben (z.B. Medizinstudenten Uni Mainz 2017 <b>OR</b> 2018).
	<b>filetype:</b> Dateiformat	Suchergebnisse bestimmter Dateiformate, u.a. pdf, docx, txt, ppt, werden angezeigt (z.B. <b>filetype:</b> pdf). <i>Hinweis: besonders nützlich für Google Scholar, um frei verfügbare Fachartikel zu erhalten</i>
	<b>site:</b> URL	Eine bestimmte Webseite nach Ergebnissen durchsuchen (z.B. <b>site:</b> uni-mainz.de Semesterferien). <i>Hinweis: besonders nützlich für Webseiten, die keine eigene Suchfunktion anbieten</i>
	<b>related:</b> URL	Eine ähnliche Webseite zu einer vorliegenden Webseite finden (z.B. <b>related:</b> uni-mainz.de)
	<b>intitle:</b> Suchbegriff(e)	Webseiten mit bestimmten Begriffen im Titel werden angezeigt (z.B. <b>intitle:</b> Apple)

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**Figure D4.** Excerpts of GUIs of the COR-WBT (for details, see Kohmer, 2020).*Starting Page of the WBT**Pre-Assessment-Survey*
 Medizin  Rechtswissenschaften  Lehramt'. Question 2 asks for a rating on a scale of 1-5 for various internet research behaviors. The table below shows the items and their corresponding rating scales."/>

Wenn ich nach Informationen im Internet recherchiere...	Trifft überhaupt nicht zu		Trifft mittelmäßig zu		Trifft vollkommen zu
...verfolge ich eine feste Strategie.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
...verwende ich meistens eine Suchmaschine.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
...nutze ich die verschiedenen Funktionen der Suchmaschine.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
...weiß ich, welche Suchbegriffe ich verwenden muss.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
...überfliege ich die Suchergebnisse und Webseiten nach passenden Begriffen.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
...achte ich auf bestimmte Kriterien um einzuschätzen, ob eine Webseite zuverlässig ist.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### Exercise on Credibility Cues (Author)

COR  
Critical Online Reasoning JGU

Modul 4: Credibility Cues Lektion 9: Credibility Cues Teil 2 – Verfasser-Cues Seite 2/5

Überlegen Sie zunächst, was Ihrer Meinung nach Eigenschaften eines (un-)zuverlässigen Verfassers sind.

Achtung: Ein Verfasser muss nicht immer eine physische Person sein. Auch Organisationen, Institutionen, Vereine, Unternehmen oder Zeitungen verfassen Webseiten, Artikel oder Videos.

Verfasser von Online-Quellen

- Texteingabe... Positive Referenzen
- Texteingabe... Guter Ruf
- Texteingabe... Lobbyismus
- Texteingabe... Unbekannt / keine Informationen auffindbar
- Feedback mit Ergänzungen

Weiter

Lektionen Fortfahren Speichern

### Exercise on Argumentative Structures

COR  
Critical Online Reasoning JGU

Modul 6: Argumentationsanalyse Lektion 12: Bestandteile einer Argumentation Seite 6/7

Debatte Elektroautos

In den vergangenen Jahren wird immer wieder über die Umweltschäden von E-Autos diskutiert. Öffnen Sie folgenden Link zur Thematik:

<https://www.ingenieur.de/technik/fachbereiche/e-mobilitaet/sind-elektroautos-umweltschaedlicher-als-benziner-studie-liefert-klare-antwort/>

- Wie lautet die aufgeführte These?  
Texteingabe... E-Autos weniger schädlich als angenommen
- Welche Begründungen werden genannt?  
Texteingabe... Neue Studie widerlegt Behauptung
- Welche Belege werden aufgeführt?  
Texteingabe... In 95% der Fälle sind E-Autos ökologischer (BBC; Uni Cambridge; Exeter)
- Handelt es sich um eine induktive oder deduktive Argumentation?  
Texteingabe... Deduktiv

Weiter

Lektionen Fortfahren Speichern

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**Appendix E: Excerpts of the DOM-COR WBT in Medicine****Figure E1.** Explanation of the PICO scheme.

PICO ist eine Hilfe für die Formulierung einer klinischen Fragestellung z.B. zur Wirkung von Interventionen.

**Beispiele:**

<b>P</b>	Patient, Population	Wer sind die Patienten? Was ist die Population? Was sind deren Symptome, Alter, Geschlecht, usw.?	<i>Patienten mit diagnostiziertem Glioblastom</i>
<b>I</b>	Intervention	Was wird für den Patienten/ die Population getan? z.B. Therapie (Medikament, chirurgisches oder diagnostisches Verfahren), Screening, Rehabilitation etc.?	<i>Temozolomid plus Tumor Treating Fields</i>
<b>C</b>	Comparison (Kontrolle)	Gibt es keine Kontrollgruppe? Placebo Keine Behandlung Standardbehandlung	<i>Temozolomid alleine</i>
<b>O</b>	Outcome (Zielgröße)	Was soll mit der Studie erreicht werden? Was soll am Ende gemessen und verglichen werden?	<i>Gesamtüberleben</i>

Kann ergänzt werden um:

<b>T</b>	Time (Zeithorizont)		<i>Zwei Monate</i>
<b>S</b>	Study Design, Setting (Rahmenbedingungen)		<i>Randomisierte kontrollierte Studie</i>

**Figure E2.** Explanation of the Medical Database PubMed.**1. Grundansicht**

The image shows the PubMed.gov homepage with a search bar and a 'Search' button. A blue arrow points to the search bar with the text 'Hier findet die Sucheingabe statt'. Below the search bar, there is a diagram with four main sections: 'Ermöglicht eine Einschränkung der Suche', 'Find', 'Download', and 'Explore'. Each section has a list of sub-options and a corresponding icon.

- Ermöglicht eine Einschränkung der Suche** (Icon: Magnifying glass): About PubMed, FAQs & User Guide, Finding Full Text.
- Find** (Icon: Magnifying glass): Advanced Search, Clinical Queries, Single Citation Match.
- Download** (Icon: Download arrow): E-utilities API, FTP, Batch Citation Matcher.
- Explore** (Icon: Globe): MeSH Database, Journals.

Additional annotations with arrows point to the diagram:

- An arrow points from 'Suche nach klinischen Studien' to the 'Find' section.
- An arrow points from 'Suche nach Mesh-Begriffen' to the 'Explore' section.
- An arrow points from 'Suche nach Zeitschriften' to the 'Explore' section.

Figure E3. Search Results in PubMed.

PubMed.gov hepatic cirrhosis Search

Advanced Create alert Create RSS

130,976 results

Sorted by: Best match Display options

Anzahl an Ergebnissen

Anzahl Ergebnisse nach Jahr (Filterung möglich)

Einschränkung auf Artikeltyp

Speichern und/oder versenden der Trefferliste

Anzeige der Trefferliste anpassen (z.B. Sortierung der Trefferliste)

Angaben zum Dokument

Abstract

RESULTS BY YEAR

TEXT AVAILABILITY

ARTICLE ATTRIBUTES

ARTICLE TYPE

1 [Hepatic cirrhosis]. complications].

2 Liver: targeted siRNA Lipid Nanoparticles Treat Hepatic Cirrhosis by Dual Antifibrotic and Anti-inflammatory Activities.

3 [Hepatic cirrhosis].

4 Bone microarchitecture and bone turnover in hepatic cirrhosis.

Figure E4. Application of the PICO Scheme in Task 1 ‘Remdesivir’.

**Senkt die Behandlung mit Remdesivir die Sterberate von Patienten, die an COVID-19 erkrankt sind?**

Ordnen Sie die Fragestellung in das PICO-SCHEMA ein:

P - Patient:

I - Intervention:

C - Comparison:

O - Outcome:

S - Setting:

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Figure E5. Introduction to Medical Guidelines.

The screenshot shows the AWMF online search interface. The browser address bar displays [www.awmf.org/leitlinien/leitlinien-suche.html](http://www.awmf.org/leitlinien/leitlinien-suche.html). The page header includes the AWMF logo and navigation links: RSS, AWMF-aktuell, Termine, GMS e-journal, Kontakt, Presse. A search bar contains the text "Suchbegriff eingeben" and a search button. Below the search bar, there are radio buttons for "Leitliniensuche" (selected) and "Seiteninhaltsuche". The main navigation menu includes: Die AWMF, Fachgesellschaften, Leitlinien (highlighted), Forschung & Lehre, Medizin. Versorgung, Service. The breadcrumb trail shows: Home -> Leitlinien -> Leitlinien-Suche. The left sidebar contains a list of navigation items: Leitlinien-Suche (highlighted), Aktuelle Leitlinien, Angemeldete Leitlinien, Patienteninformation, Leitlinienprogramme, AWMF-IMWi, Leitlinien-Kommission, LL-Glossar, AWMF-Regelwerk, LL- Partner & Links, LL- Veranstaltungen, Dokumentenarchiv, Leitlinien-Statistik, Leitlinien-News. The main content area features a large banner with the word "Leitlinien" and an image of a magnifying glass over a book. Below the banner, the search form is titled "Leitlinien-Suche" and includes a search input field, a checkbox for "Suche in MeSH (Was bedeutet MeSH?)", and a section for filtering results by category. The filter section is titled "Suche auf folgende Kategorien einschränken" and includes dropdown menus for Status, Dokumententyp, Entwicklungsstufe, Gesellschaft, and Organisation, all set to "Alle". There is also a "Sortieren nach:" dropdown set to "Relevanz" and an "Ergebnisse pro Seite:" dropdown set to "10". A search button is located at the bottom right of the filter section. On the right side, there are "Such-Tipps" (Search Tips) providing instructions on how to use the search function effectively.

www.awmf.org/leitlinien/leitlinien-suche.html

RSS | AWMF-aktuell | Termine | GMS e-journal | Kontakt | Presse

Suchbegriff eingeben --> suchen

Leitliniensuche Seiteninhaltsuche

Darstellungsoptionen: A A Sprache: DE EN

Die AWMF Fachgesellschaften **Leitlinien** Forschung & Lehre Medizin. Versorgung Service

Home -> Leitlinien -> Leitlinien-Suche

**Leitlinien-Suche**

Aktuelle Leitlinien

Angemeldete Leitlinien

Patienteninformation

Leitlinienprogramme

AWMF-IMWi

Leitlinien-Kommission

LL-Glossar

AWMF-Regelwerk

LL- Partner & Links

LL- Veranstaltungen

Dokumentenarchiv

Leitlinien-Statistik

Leitlinien-News

## Leitlinien

### Leitlinien-Suche

Suchbegriff eingeben

Suche in MeSH (Was bedeutet MeSH?)

#### Suche auf folgende Kategorien einschränken

Status: Alle

Dokumententyp: Alle

Entwicklungsstufe: Alle

Gesellschaft: Alle

Organisation: Alle

Sortieren nach: Relevanz

Ergebnisse pro Seite: 10

--> suchen

#### Such-Tipps:

- Die Suchfunktion durchsucht - wenn sie nicht durch Auswahl einzelner Kategorien eingeschränkt wird - alle aktuell publizierten und alle angemeldeten Leitlinien. Als Suchbegriff können ganze Wörter oder Wortteile benutzt werden. Mehrere Suchbegriffe werden durch logisches UND verknüpft.
- Suche nach allen Leitlinien, die einer ausgewählte Kategorie zugehören (z.B. alle S3-Leitlinien, alle LL einer Fachgesellschaft etc.): Ins Suchfeld nichts oder ein Leerzeichen eingeben, die gewünschte Kategorie auswählen und auf "Suche" klicken!

**Figure E6.** Cloze Text on Medical Guidelines.

Medizinische Leitlinien sind systematisch entwickelte Feststellungen,

bei ihren Entscheidungen über die angemessene Gesundheitsversorgung ... unterstützen sollen. Sie sind  und müssen an den Einzelfall angepasst werden. Teilweise berücksichtigen sie ökonomische Aspekte des Behandelns.

Leitlinien sind wichtige Instrumente der Qualitätsentwicklung im Gesundheitswesen (3, 4). Ihr vorrangiges Ziel ist die  der medizinischen Versorgung durch die Vermittlung von aktuellem Wissen, das vorzugsweise systematisch  und kritisch bewertet wird (5-7).

Leitlinien unterscheiden sich von anderen Quellen aufbereiteten Wissens (systematische Übersichtsarbeiten, Health Technology Assessments (HTA) mit oder ohne Metaanalysen) durch die Formulierung von klaren , in die auch eine klinische  der Ziele mit Relevanz für Patient\*innen/Bürger\*innen, Aussagekraft und Anwendbarkeit von Studienergebnissen eingeht (8-11).

Leitlinien sind als  zu verstehen, von denen in begründeten Fällen abgewichen werden kann oder sogar muss. Die Anwendbarkeit einer Leitlinie oder einzelner Leitlinienempfehlungen muss in der  Situation geprüft werden nach dem Prinzip der Indikationsstellung, Beratung, Präferenzermittlung und partizipativen Entscheidungsfindung (3, 12-16).

**Quelle 1. Abschnitt:**

Leitlinien für Diagnostik und Therapie 1. Rundbrief: Was sind Leitlinien? W.Lorenz Marburg, 9.7.1999

**Quelle 2., 3. und 4. Abschnitt:**

<https://www.awmf.org/leitlinien/awmf-regelwerk/einfuehrung.html>

## ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING

**Figure E7.** Cloze Table on Medical Guidelines.

Ziehen Sie die gegebenen Antwortmöglichkeiten in die passenden grünen Felder.

Evidenzgrad (analog zu NICE)	Vereinfachte Definition der Quellen	Empfehlungsgrad S3/NVL	Symbol NVL	Beschreibung
I		A		Starke Empfehlung
	Kontrollierte Studien ohne Randomisierung; Beobachtungsstudien		↑	Empfehlung
IV		C	↔	
-	Klinischer Konsenspunkt		-	

II oder III	Metaanalysen; hochwertige randomisierte kontrollierte Studien
Expertenmeinung	B
GCP	↑ ↑
Empfehlung offen	Good clinical practice / gute klinische Praxis

## ACQUISITION AND PROMOTION OF COR SKILLS IN MEDICINE, LAW, TEACHING

<b>Lebenslauf</b>	
seit 09/2024	Wissenschaftliche Mitarbeiterin Johannes Gutenberg-Universität Mainz Lehrstuhl für Wirtschaftspädagogik Univ.-Prof. Dr. Olga Zlatkin-Troitschanskaia
seit 05/2024	Wissenschaftliche Mitarbeiterin Johann Wolfgang Goethe-Universität Frankfurt a.M. Institut für Neurophysiologie Dr. Maruschka Weber
08/2024	Promotion (magna cum laude) zum Doktor der wirtschaftlichen Staatswissenschaften (Dr. rer. pol.), Johannes Gutenberg-Universität Mainz  Thema: “Acquisition and Promotion of Critical Online Reasoning Skills – Analyses among Students in Professional/Practical Year/Studies in Medicine, Law, and Teaching”  Betreuerin: Prof. Dr. Olga Zlatkin-Troitschanskaia
09/2023-05/2024	Wissenschaftliche Hilfskraft Johann Wolfgang Goethe-Universität Frankfurt a.M. Institut für Neurophysiologie Dr. Maruschka Weber
08/2018-05/2024	Wissenschaftliche Hilfskraft Johannes Gutenberg-Universität Mainz Lehrstuhl für Wirtschaftspädagogik Univ.-Prof. Dr. Olga Zlatkin-Troitschanskaia
04/2018-12/2020	Studium der Wirtschaftspädagogik mit Schwerpunktfach Englisch Johannes Gutenberg-Universität Mainz Abschluss: Master of Education
10/2014-04/2018	Studium Lehramt am Gymnasium mit Schwerpunktfächern Englisch und Französisch Johannes Gutenberg-Universität Mainz Abschluss: Bachelor of Education
08/2011-08/2014	Studium General Management (Business Studies) EBS Universität für Wirtschaft und Recht Abschluss: Bachelor of Science