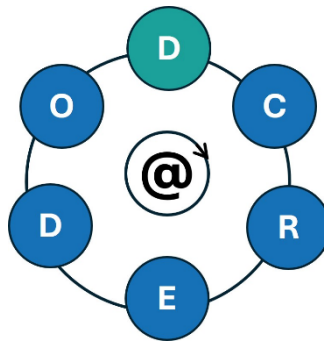


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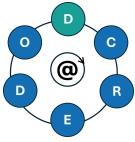
Digital Health Technologies-Augmented Clinical Reasoning Education



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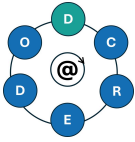
D4.1 Report on the Targeted Needs Assessment

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Document Revision Table

Version	Date	Author(s)	Organization	Comments
01	17.11.24	Tetiana Shchudrova	BSMU	First Draft
02	25.11.24	Inga Hege	Instruct gGmbH	Updated draft, added results, discussion, conclusions
03	26-29.11.24	All partners	BSMU, EMC, Instruct, JU, UMIT TIROL	Updating and editing draft, revision based on comments
1.0	30.11.24	Tetiana Shchudrova Inga Hege Andrzej Kononowicz	BSMU Instruct gGmbH JU	Finalisation



Summary

Objectives: The EU project D-CREDO (Digital Health Technologies-augmented Clinical Reasoning Education) aims to enhance the skills of health professions students and faculty in using digital health tools. We plan to develop high-quality learning units alongside virtual patients that will prepare students for the responsible use of digital tools, in particular artificial intelligence (AI) in image analysis, large language models (LLM) and big data, mHealth apps and wearables, electronic health records (EHR) with clinical decision support systems (CDSS), and telehealth in clinical reasoning. This document presents the D-CREDO project report on the targeted needs assessment for using digital health tools in clinical reasoning education. The main objective of this targeted needs assessment was to build on the general needs assessment carried out before the start of this project to gain detailed knowledge of the specific needs of stakeholders (students, faculty, managers, practitioners, nurses, etc.) in partner institutions and among associated partners with regard to clinical reasoning education augmented with digital health technologies and tools.

Approach: The targeted needs assessment involved two forms of data collection: a web survey and semi-structured interviews with students, teachers and other stakeholders. As an additional activity to improve the quality of the deliverable we conducted a needs analysis workshop with Ukrainian educators. We analyzed the survey responses quantitatively and the free-text responses and the interviews qualitatively.

Results: In total, we received 118 survey responses and conducted 30 interviews. The results confirmed the relevance of the digital health tools we selected for our project. In addition, we saw a strong need for the train-the-trainer courses, as educators do not yet feel confident in using many of the digital tools, and even less confident in teaching their students how to use them.

Conclusion: The results of the targeted needs assessment support the purpose and approach of the D-CREDO project and the planned learning units. We have gained important insights on how to structure the learning units, for example by offering courses at different levels of competence.

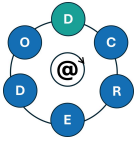
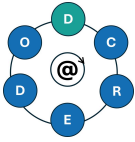


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1 Introduction

The objective of the targeted needs analysis was to gain a more comprehensive insight into the specific needs of stakeholders with regard to clinical reasoning education augmented with digital health technologies and tools. The targeted needs assessment was conducted to identify stakeholders' views on the relevance and current use of digital health technologies and tools, in particular artificial intelligence (AI) in image analysis, large language models (LLM) and big data, mHealth apps and wearables, electronic health records (EHR) with clinical decision support systems (CDSS), and telehealth in clinical reasoning, to evaluate the current state of teaching on digital tools for clinical reasoning in partner and affiliated partner institutions, and to identify any gaps in the partners' educational offerings. We also sought to ascertain which digital health technologies and tools stakeholders would like to see included in the new learning units, which clinical reasoning domains they believe should be addressed, and their views on the optimal methods for teaching and assessment. In addition, we invited input on the structure and content of a train-the-trainer course.

The targeted needs analysis was based on the findings of the general needs analysis conducted by the consortium prior to the project. The needs analysis was carried out using two forms of data collection: a web survey and semi-structured interviews. To enhance the quality of the deliverable, the consortium organised a needs analysis workshop as an additional activity.

2 Quality criteria

The D-CREDO consortium decided to guide the development and implementation of the specific needs analysis based on following quality criteria:

The quantitative indicators:

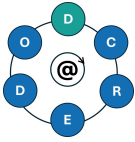
- ≥ 25 interviews
- ≥ 100 survey responses

The qualitative indicators:

- diverse range of participants representing the stakeholders of the project (students, faculty, managers, practitioners, nurses, etc.) including two health professions (Medicine, Nursing)
- survey and interview questions reviewed and agreed upon by all partners
- questions in the survey and interview inform the blueprinting of the learning units (LUs) and virtual patients (VPs) and establish a baseline to which the pilot studies can relate
- final target needs assessment report

Additional quality criteria:

- pre-testing of survey
- use of an electronic survey system (LimeSurvey)
- interview guideline for implementation and analysis provided



3 Methods

3.1 Design and implementation of the survey

The survey was developed on the basis of the findings of the general needs analysis, which was conducted prior to the commencement of the D-CREDO project in 2023-2024. We qualitatively analyzed the free text responses of the general needs analysis, and based on that, developed a first draft version of the targeted needs survey. We circulated and discussed this draft during our online meetings and a small group with partners from each institution worked on the refinement and finalization of the survey. We also discussed the need for translating the survey into partner languages and the partners from Ukraine felt that their stakeholders would feel more comfortable answering the questions in their mother language. All other partners decided that English would be ok for their stakeholders.

We focused in the survey design on two main stakeholders - educators/faculty staff and students with specific questions for each target group.

The final survey was divided in 4 sections (see Appendix 1):

- Section A: Demographics (questions 1-5)
- Section B: Learner and Learning environment (questions 6-14)
- Section C: Train-the-trainer (questions 15-17)
- Section D: final open-ended question with general comments regarding all aspects of the questionnaire (question 18)

The sections were enabled depending on the respondent group:

- Students: sections A, B, D
- Faculty and other groups of stakeholders: sections A, B, C, D

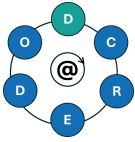
We implemented the survey using the open-source survey system LimeSurvey 4.1.4 in English and then the Ukrainian partners provided the translation, which was included into LimeSurvey. Thus, the survey is available in these two languages at:

<https://survey.instruct.eu/index.php/935446?lang=en>

<https://survey.instruct.eu/index.php/935446?lang=uk>

Before the publication of the survey we pilot-tested the questionnaire with students and faculty from our partner institutions (n=12). They provided some minor suggestions for improvements, which we implemented before the publication and distribution. The survey was distributed over local communication channels of the project partner institutions and associated partners. We started to collect data on October 28th and closed on November 22nd, 2024. The results of the survey analysis are presented in the following section.

Fig. 1 presents the landing page of the survey, and Fig. 2, 3 - the exemplary pages of the survey.



LimeSurvey Load unfinished survey Language: English - English ▾

Language: English - English Change the language

D-CREDO Project: Specific Needs Analysis Survey

The EU project D-CREDO (Digital Health Technologies-augmented Clinical Reasoning Education) plans to develop high-quality learning units alongside virtual patients that will prepare students for the responsible use of digital tools in clinical reasoning (CR). CR is a fundamental concept in education, referring to the cognitive process that healthcare professionals use to assess and manage patient problems. It involves gathering and analyzing patient information, formulating hypotheses, making diagnoses, and deciding on appropriate treatments. The process requires the integration of both theoretical knowledge (medical and nursing science) and practical experience (clinical practice) to ensure effective patient care.

In this survey, we will ask you about your opinion on the relevance and usage of digital health technologies and tools in clinical reasoning and your views on the optimal methods for teaching and assessment at your institution. Your input is highly valued and will help in designing the D-CREDO learning units and establishing evidence-based policies for the use of digital tools in clinical reasoning education.

Please answer the questions as accurately as possible. Your answers will be stored anonymously. The study has been approved by the Biomedical Research Ethics Committee of Bukovinian State Medical University. The findings from this survey may be published in congress contributions and scientific publications. With your participation, you agree to the use of your data for these purposes.

Fig. 1. D-CREDO Specific Needs Analysis Survey landing page

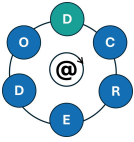
Please indicate which technologies/tools you use for clinical reasoning and, if so, how confident you are in using them.

	Not using it	Not confident at all	Somewhat confident	Fairly confident	Completely confident	No answer
Artificial Intelligence (AI) in image analysis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Large Language Models (LLM) (generative AI, ChatGPT, etc.) and Big data	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
mHealth apps and Wearables (e.g. smartwatch)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Electronic Health Records (EHR) with Clinical decision support systems (CDSS)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Telehealth (virtual visits, telemonitoring)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Please indicate which aspects of clinical reasoning are taught at your institution and, in your opinion, have the potential to be augmented with the listed digital health technologies/tools

	Is taught	Teaching could be augmented with digital health technologies/tools	No answer
Theories of clinical reasoning	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Gathering, interpreting, and synthesising patient information (patient assessment)	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Generating differential diagnoses	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Developing a treatment/management plan	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Patient participation in clinical reasoning	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Interprofessional collaboration of clinical reasoning	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Ethical aspects of clinical reasoning	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Self-reflection on clinical reasoning performance and strategies for future improvement	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Errors in the clinical reasoning process and strategies to avoid them	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Fig. 2. D-CREDO Specific Needs Analysis Survey exemplary page (section B)



Train-the-trainer

Faculty will need support and guidance for effective teaching of clinical reasoning using digital technologies/tools, including AI in image analysis, generative AI and big data, mHealth apps and wearables, EHR with clinical decision support, and telehealth

Choose one of the following answers

Please choose... ▾

Which aspects do you find challenging and would benefit from support (1=not at all challenging, 5=extremely challenging)

	1	2	3	4	5	No answer
Technical know-how on common issues with the use of digital tools	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Knowledge about the technology behind digital tools	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Learning theories that explain the use of digital tools in clinical reasoning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Integration strategies for digital tools into the teaching/curriculum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Methodology for using virtual patients with digital tools	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Integration strategies for digital tools into the development of assessment materials	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Policies for the use of digital health tools by students	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Please indicate any specific learning objectives related to the teaching about digital tools in clinical reasoning that you would like to achieve in the train-the-trainer courses

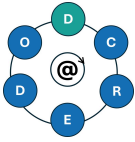
Fig. 3. D-CREDO Specific Needs Analysis Survey exemplary page (section C)

3.2 Design and implementation of the interviews

In addition to the survey, we designed interview guides to capture perspectives on the needs of stakeholders from a variety of groups. We aimed to include medical and nursing students, healthcare educators (at both preclinical and clinical levels), healthcare practitioners, IT specialists, curriculum planners/managers, course coordinators, and managers in healthcare education. The purpose of the interviews was to gain in-depth knowledge about the situation concerning clinical reasoning education with digital tools from different perspectives.

To help ensure consistency and compatibility for triangulation with the survey results, the interview questions were designed in a similar format to the surveys (see Appendix 2):

- Demographics (questions 1-5)
- Current situation regarding the use and teaching of digital health technologies and tools in clinical reasoning (questions 6-8)
- Needs of students and faculty (questions 9-11)
- Anticipated challenges and barriers to the implementation of the new learning units (questions 12-14)
- Open-ended question with general comments regarding all aspects of the interview (15)

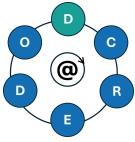


As a first step, the BSMU team prepared an interview guide and a draft of the questions. Within our project consortium and our regular meetings we discussed and finalized these documents and agreed on the final versions. The interview guide with instructions were provided on Google Drive and translated if needed by all partners. The interviewers were instructed on how to conduct the interviews and remaining questions were clarified during the team meeting. Partners then conducted the interviews either online or face-to-face in the time from 21.10.2024 - 20.11.2024 in their mother language or in English if applicable. Prior to the interview, the interviewers informed the participants about the purpose and process of the study and participants could give or deny their consent to take part. The interviewers made audio recordings or field notes. For the analysis the partners transcribed the audio and translated the transcription or field notes into English if needed. Finally, all interview notes were collected in an anonymous format on our project Google Drive.

The implementation of the survey and the interviews has been approved by the Biomedical Research Ethics Committee of Bukovinian State Medical University (Protocol No.3 dated 17.10.2024) for use in the D-CREDO project.

3.3. Workshop

As an additional activity informing the specific needs assessment, we had the opportunity to conduct two 2 hour workshops at the LMU University of Munich, Germany with 15 educators from Ukrainian healthcare institutions on October 17th 2024. The workshops were held in the context of a meeting at the Institute for Medical Education at the University of Munich with healthcare educators from Ukraine. The workshops were conducted by partners from Instruct and BSMU with the aim to gain insights into the knowledge and usage of AI tools in healthcare and healthcare education at the participants' institutions. At the beginning we briefly introduced the D-CREDO project and then discussed the needs, uses, and barriers of digital tools (with a focus on AI tools). We used a flipchart to document our discussions and reflections.



4 Results

4.1 Survey

A total of 232 users accessed the survey. Of these, 118 (51%) provided complete answers to at least half of the questions and were therefore included in the data analysis.

The following section presents a quantitative analysis of representative questions from the survey.

Demographics

Question 1 **In which country do you work/study?**

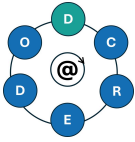
Country	Student	Faculty	Other	Total
Austria	2	10	1	13
Germany	1	3	1	5
Netherlands	4	13		17
Poland	11	11	1	23
Spain		1		1
Turkey	3	1	2	6
Ukraine	35	16	2	53
Total	57	54	7	118

Question 2 **In which institution do you work/study?**

A total of 15 institutions participated in the survey.

Question 3 **What educational programme do you relate mostly to?**

Educational programme	Total	%
Medicine	98	83%
Nursing	19	16%
Other (Dentistry)	1	1%
Total	118	100%



Question 4 How would you describe your primary role/roles at your institution?

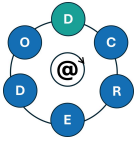
Primary role(s) at the institution	Total	%
Student	56	47%
Teacher	47	40%
Researcher	22	19%
Dean	1	1%
Curriculum Planner/Manager	10	8%
Course Director	8	7%
Resident/Intern/Medical doctor	9	8%
Nurse	6	5%
Other (Educational advisor)	2	2%

Question 5 [Faculty] How many years of experience in healthcare education (excluding years of study) do you have?

Experience in healthcare education	Total	%
Less than 2 years	7	11%
2-5 years	13	21%
6-10 years	15	24%
More than 10 years	27	44%
Total	62	100%

Question 5 [Student] Your year of study

Year of study	Total	%
1 year	1	2%
2 year	5	9%
3 year	13	23%
4 year	17	30%
5 year	11	20%
6 year	8	14%
Other	1	2%
Total	56	100%



Learner and Learning environment

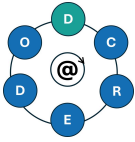
Question 6 **Please indicate which technologies/tools you use and, if so, how confident you are in using them** (0 = not using it, 1 = not confident at all, ..., 4 = completely confident)

Confidence in the use of digital health technologies and tools					
Digital health technologies and tools	Not using it	Not confident at all	Somewhat confident	Fairly confident	Completely confident
Large Language Models (LLM) (generative AI, ChatGPT, etc.) and Big Data (n=116)	24%	10%	30%	27%	9%
mHealth apps and Wearables (n=117)	34%	14%	21%	17%	15%
Telehealth (virtual visits, telemonitoring) (n=116)	52%	10%	18%	10%	9%
Electronic Health Records (EHR) with Clinical decision support systems (CDSS) (n=116)	63%	14%	12%	7%	3%
Artificial Intelligence (AI) in image analysis (n=116)	59%	10%	23%	6%	2%

n - number of responses

Question 7 **Please indicate the relevance of the following technologies for clinical reasoning practice and the relevance of teaching in their use** (1 = not at all relevant, ..., 5 = extremely relevant)

Relevance of digital health technologies and tools for clinical reasoning practice						
Digital health technologies and tools	Not at all relevant	Slightly relevant	Moderately relevant	Very relevant	Extremely relevant	IDK
Electronic Health Records (EHR) with Clinical decision support systems (CDSS) (n=104)	5%	3%	14%	20%	37%	21%
Artificial Intelligence (AI) in image analysis (n=102)	6%	6%	17%	37%	20%	15%



mHealth apps and Wearables (n=104)	6%	6%	15%	28%	27%	18%
Telehealth (virtual visits, telemonitoring) (n=106)	10%	6%	13%	21%	33%	17%
Large Language Models (LLM) and Big Data (n=105)	6%	8%	27%	30%	21%	10%

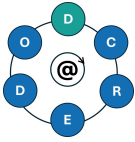
n - number of responses, IDK - I don't know

Relevance of teaching to use digital health technologies and tools						
Digital health technologies and tools	Not at all relevant	Slightly relevant	Moderately relevant	Very relevant	Extremely relevant	IDK
Large Language Models (LLM) and Big Data (n=103)	4%	5%	15%	28%	38%	11%
Artificial Intelligence (AI) in image analysis (n=99)	5%	7%	17%	27%	33%	10%
Electronic Health Records (EHR) with Clinical decision support systems (CDSS) (n=101)	3%	5%	16%	23%	33%	21%
mHealth apps and Wearables (n=102)	6%	9%	17%	24%	28%	17%
Telehealth (virtual visits, telemonitoring) (n=102)	8%	7%	20%	17%	33%	16%

n - number of responses, IDK - I don't know

Question 8 Please indicate which technologies/tools you use for clinical reasoning and, if so, how confident you are in using them (0 = not using it, 1 = not confident at all, ..., 4 = completely confident)

Confidence in the use of digital health technologies and tools for clinical reasoning					
Digital health technologies and tools	Not using it	Not confident at all	Somewhat confident	Fairly confident	Completely confident
Large Language Models (LLM) and Big Data (n=113)	35%	9%	29%	20%	6%

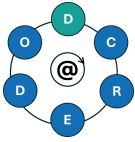


mHealth apps and Wearables (n=109)	52%	9%	18%	11%	9%
Telehealth (virtual visits, telemonitoring) (n=111)	61%	4%	19%	8%	8%
Electronic Health Records (EHR) with Clinical decision support systems (CDSS) (n=110)	65%	7%	15%	7%	5%
Artificial Intelligence (AI) in image analysis (n=113)	65%	7%	19%	5%	4%

n - number of responses

Question 9 Please indicate which aspects of clinical reasoning are taught at your institution and, in your opinion, have the potential to be augmented with the listed digital health technologies/tools

Aspects of clinical reasoning	Is taught		Teaching could be augmented with digital health technologies/tools	
	Total	%	Total	%
Theories of clinical reasoning	65	55%	74	63%
Gathering, interpreting, and synthesising patient information (patient assessment)	70	59%	79	67%
Generating differential diagnoses	65	55%	84	71%
Developing a treatment/management plan	65	55%	78	66%
Patient participation in clinical reasoning	49	42%	62	53%
Interprofessional collaboration in clinical reasoning	52	44%	66	56%
Ethical aspects of clinical reasoning	60	51%	53	45%
Self-reflection on clinical reasoning performance	49	42%	69	58%
Errors in the clinical reasoning process and strategies to avoid them	46	39%	77	65%



Question 10 **Which of the following technologies/tools are used in your institution for teaching clinical reasoning?**

Digital health technologies and tools used for teaching	Total	%
Telehealth (virtual visits, telemonitoring)	15	24%
Large Language Models (LLM) (generative AI, ChatGPT, etc.) and Big Data	11	18%
Electronic Health Records (EHR) with Clinical decision support systems (CDSS)	10	16%
mHealth apps and Wearables	9	15%
Artificial Intelligence (AI) in image analysis	3	5%
IDK	28	45%

n=62, IDK - I don't know

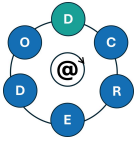
Question 11 **Please indicate which technologies/ tools you use in teaching clinical reasoning and, if so, how confident you are in using them (0 = not using it, 1 = not confident at all, ..., 4 = completely confident)**

Confidence in the use of digital health technologies and tools in teaching clinical reasoning					
Digital health technologies and tools	Not using it	Not confident at all	Somewhat confident	Fairly confident	Completely confident
mHealth apps and Wearables (n=56)	61%	7%	18%	9%	5%
Large Language Models (LLM) and Big Data (n=57)	63%	7%	19%	9%	2%
Telehealth (virtual visits, telemonitoring) (n=59)	66%	5%	17%	7%	5%
Electronic Health Records (EHR) with Clinical decision support systems (CDSS) (n=58)	69%	14%	7%	9%	2%
Artificial Intelligence (AI) in image analysis (n=56)	79%	11%	9%	2%	0%

Question 12* **Are there any specific tools within the following categories that facilitate the clinical reasoning process and that you believe would be beneficial to include in the curriculum?**

Question 13* **Please indicate any specific learning objectives related to the utilization of digital tools in clinical reasoning that you would like to achieve**

*A summary of the responses to the open-ended questions will be presented in conjunction with the findings of the qualitative analysis of the semi-structured interviews.



Question 14 Please indicate your preferences regarding the assessment of your skills in using digital tools for clinical reasoning

Assessment method	Total	%
Virtual patients	37	66%
Simulation with standardized patients	34	61%
Simulation role play	30	54%
Case-based discussion	29	52%
Multiple choice questions	25	45%
Team-based projects	25	45%
Essay questions	13	23%
Other	-	-

n=56

Train-the-trainer

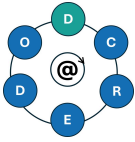
Question 15 Faculty will need support and guidance for effective teaching of clinical reasoning using digital technologies and tools, including AI in image analysis, generative AI and big data, mHealth apps and wearables, EHR with clinical decision support, and telehealth

Need for support and guidance	Total	%
Strongly Disagree	1	2%
Disagree	0	0%
Undecided	2	4%
Agree	21	45%
Strongly Agree	23	49%

n=47

Question 16 Which aspects do you find challenging and would benefit from support (1 = not at all challenging, ..., 5 = extremely challenging)

Challenging aspects of teaching clinical reasoning using digital technologies and tools					
Aspects	not at all challenging	slightly challenging	moderately challenging	very challenging	extremely challenging
Integration strategies for digital tools into the teaching/curriculum	0%	12%	17%	53%	17%

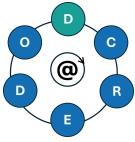


Knowledge about the technology behind digital tools	3%	9%	26%	43%	19%
Integration strategies for digital tools into the development of assessment materials	3%	10%	26%	36%	24%
Policies for the use of digital health tools by students	2%	12%	26%	40%	21%
Technical know-how on common issues with the use of digital tools	2%	12%	31%	40%	16%
Learning theories that explain the use of digital tools in clinical reasoning	3%	12%	26%	43%	16%
Methodology for using virtual patients with digital tools	5%	10%	28%	41%	16%

n=58

Question 17* Please indicate any specific learning objectives related to the teaching about digital tools in clinical reasoning that you would like to achieve in the train-the-trainer courses

*A summary of the responses to the open-ended questions will be presented in conjunction with the findings of the qualitative analysis of the semi-structured interviews.



4.2 Interviews

We conducted a total of 30 interviews with faculty and students. Among the stakeholders interviewed were two professionals (a medical doctor and an educational advisor on use of technology) who are not currently part of the teaching staff. The following table shows the number of interviews per stakeholder group and country. The majority of the interviews were conducted with members from partner and associate partner institutions. However, we also included stakeholders from the former DID-ACT project (<https://did-act.eu/>) as they can provide a specific perspective on our project, which we felt would be a valuable addition to our partners and associated partners views.

Demographics

Country of work/study

Country	Faculty	Student	Other	Total
Austria	3	2		5
Germany	2	1		3
Netherlands	3	1	1	5
Poland	4	3	1	8
Sweden	2			2
Switzerland	1			1
Ukraine	6			6
Total	21	7	2	30

Educational programme

Medicine	Nursing	Both	Other
21	7	2	2

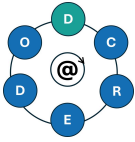
Total=30

Primary role(s) at the institution

Student	Teacher	Researcher	Course Director	Dean	Curriculum Planner/Manager	Educational advisor
7	18	8	3	2	7	1

Experience in healthcare education

1-5 years	6-10 years	11-20 years	More than 20 years	Other (Student)
5	7	6	5	7



The following sections present a summary of the results of the interviews and open questions from the survey. A comprehensive analysis of the responses identified common themes related to the respective questions, which are described in the following sections. To illustrate the findings, example comments from the interviews or survey are presented. If not otherwise indicated the quotes are from health professionals (physicians and nurses).

Current situation regarding the use and teaching of digital health technologies and tools

I. Current use of the digital health technologies and tools

Do you use any of the following technologies and tools? Please, give examples of how you use them

Digital health technologies and tools	%
Large Language Models (LLM) (generative AI, ChatGPT, etc.) and Big Data	60%
mHealth apps and Wearables	40%
Telehealth (virtual visits, telemonitoring)	30%
Electronic Health Records (EHR) with Clinical decision support systems (CDSS)	27%
Artificial Intelligence (AI) in image analysis	20%

n=30

The results for this question show that respondents primarily use free versions of generative AI tools (mostly ChatGPT) for content creation and writing assistance, such as creating and editing emails, presentations, articles, educational materials, exam questions, as well as proofreading, grammar checking and translation.

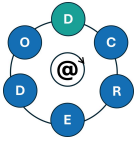
- *"I use Chat GPT - idea generation, language correction, and in teaching with students"*
- *"ChatGPT to generate responses or emails, supplement information for classes or presentations, to create images"*
- *"ChatGPT, etc to create summaries, shorten texts, make corrections, check translations, as a learning aid"*
[Nursing student]

LLM and big data are also used to access information and research, such as searching for medical data and algorithms on web portals or apps, literature searches using tools such as Research Rabbit, and summarising findings.

- *"Research Rabbit to support in literature research"*
- *"ChatGPT searching for medical data on web portals"*
- *"ChatGPT, etc. when researching literature and editing texts for the study programme"* [Nursing student]

Faculty are exploring the use of generative AI to complement traditional teaching methods, but time constraints limit deeper experimentation or customisation.

- *"Experimenting, use for supporting in writing exam questions, In the preparation of case examples"*
- *"Use AI tools to generate images as illustrative materials for presentations I use during lectures and classes"*
- *"Generative AI to create the outline for students' assessments"*
- *"I use free versions trials for summarizing in writing, not enough time to go into details"*



Wearables (smartwatch) and mHealth apps are mostly used privately to measure daily physical activity, sleep analysis, etc. Professionally, an app recognizing lung and heart sounds is used.

- *“Mostly private, not professional use”*
- *“Smartwatch to measure my daily physical activity”*
- *“I personally like sleep analysis from smartwatches and sometimes discuss it with my patients”*
- *“Some apps on my phone to search for the medications or some algorithms”*
- *“Only for myself, I do not trust them for medical decisions and analyses”* [Medical student]

Respondents have experience of using telehealth technology only in the form of virtual visits

- *“Use in clinical practice very often”*
- *“Use telehealth systems like helsi.pro for online consultations”*
- *“I provide technical support during medical teleconferences”*

Respondents use the EHR as a data source for analysis, patient management via e-health platforms, patient medication monitoring and clinical decision making with CDSS tools such as online risk calculators (e.g. stroke, heart attack, FRAX, Polscore2) and tools such as Isabel DDX Companion for differential diagnosis. In teaching, EHRs and CDSSs are integrated into educational sessions to familiarise students with their functionality and practical applications in clinical practice. Some respondents reported using EHR and CDSS tools, including specialised apps such as BiliApp and online calculators, in educational settings to enable students to learn their functionality and practical applications in clinical scenarios.

- *“Online calculators for assessing the risk of stroke and heart attack, FRAX osteoporosis risk calculator, etc.”*
- *“Trying out EHR as an app (nursing)”*
- *“Use for teaching - students learn how the EHR works, with educational sessions provided”*
- *“BiliApp - I use it and show it to my students”*
- *“I use ‘Isabel’ for differential diagnosis in clinical practice”*

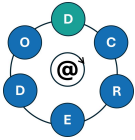
Artificial intelligence (AI) is rarely used by respondents for image analysis, with the only practical use reported being Google image analysis for rashes.

II. Current opinion on the relevance and usefulness of the digital health technologies and tools for clinical reasoning practice

Which of the given categories of digital health tools do you think are helpful in clinical reasoning practice?

Digital health technologies and tools	%
Electronic Health Records (EHR) with Clinical decision support systems (CDSS)	67%
Artificial Intelligence (AI) in image analysis	53%
Large Language Models (LLM) (generative AI, ChatGPT, etc.) and Big Data	50%
mHealth apps and Wearables	47%
Telehealth (virtual visits, telemonitoring)	33%

The results for this question show that respondents find Electronic Health Records (EHR) with/and Clinical Decision Support Systems (CDSS) most useful and relevant for clinical reasoning practice. EHRs are useful for



organising and storing health data, for communication between health professionals and as a feedback system.

- *"Very useful tools with which you can organize health data. Chatbots help with gatekeeping"*
- *"Much easier to communicate with other doctors and also to control the patient"*
- *"EHR can be useful as a feedback system on your own performance or peer performance"*

CDSS are helpful for differentials diagnostics and decreasing medical errors

- *"CDSS are especially useful for widening the differentials diagnosis, help not to forget about something important"* [Medical student]
- *"EHR with CDSS are helpful in clinical reasoning practice. They can offer diagnostic suggestions"*
- *"CDSS which are linked to EHRs in hospitals, this would help verify and complete patient information"* [Medical student]

At the same time, respondents suggest that AI should be used as a support system and not over-relied on.

- *"AI at this stage cannot replace but only support decision-making in diagnosis and counteract cognitive errors"*
- *"CDSS are valuable, but still important to know whether everything is covered; use as a support, not the final answer"*

Respondents also consider the use of AI tools for image analysis (especially ECGs, X-rays, rashes) to be very helpful in clinical reasoning practice to generate diagnostic suggestions and find the right diagnosis.

- *"Analysis tools such as Queen of hearts for analyzing ECGs are certainly very useful"*
- *"In imaging AI might be better than human, looking at hundreds images gets boring and difficult, biased"*

LLM and Big Data technologies are considered useful for generating differential diagnoses and providing medical information in the clinical reasoning process, but should not replace the physician.

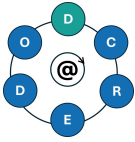
- *"Useful for synthesising and retrieving the care plan and patient, collection of statistical data on disease entities"* [Medical student]
- *"Helpful as a differential diagnosis generator and to check if your dd is broad enough"*
- *"Can be useful for quick search of medical information and as an assistant in diagnostic reasoning"*
- *"It should not replace the physician/clinicians, but it can be supportive to the clinical reasoning process"* [Medical student]

Respondents believe mHealth apps and wearables are useful for patient monitoring and emergency alerts, but only if they are reliable.

- *"Especially helpful for the diabetic patients and their parents"*
- *"MDCalc is helpful and used often. AI emergency alerts (for example medication, dosage, etc.)"* [Medical student]
- *"It has potential in recognizing diseases, for patient monitoring to provide worthwhile data to the physician"* [Medical student]
- *"I think that these smartwatches and wearables could be useful if we certified them and made them more trustable"* [Medical student]

Telehealth technologies are most useful for health and therapy monitoring, allowing the integration of physical parameters into the clinical decision-making process, improving the effectiveness of care and saving time.

- *"Virtual visits can teach students the pitfalls for teleconsultation vs real life consultation and how you can come to a decision with less available information (such a physical exam) and how to deal with this."*



III. Current state of teaching about the use of digital technologies and tools in clinical reasoning

Do you teach about the use of these technologies and tools in clinical reasoning at your institution?

Digital health technologies and tools	%
Telehealth (virtual visits, telemonitoring)	23%
Electronic Health Records (EHR) with Clinical decision support systems (CDSS)	17%
mHealth apps and Wearables	17%
Large Language Models (LLM) (generative AI, ChatGPT, etc.) and Big Data	7%
Artificial Intelligence (AI) in image analysis	7%

Currently, the use of digital health technologies and tools in clinical reasoning is taught in a few institutions (by some of the teachers).

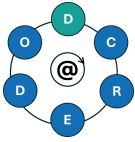
- *"I teach how to use telehealth and what are their limitations"*
- *"Students observe how I use these technologies during my clinical practice, and this is how I teach about them"*
- *"Telehealth is taught using a simulated virtual visit"*
- *"We already do teach about telehealth in communication classes"*
- *"I show apps to the students"*
- *"Various apps introduced and taught in courses within medical education: Pedihelp (app for pediatric emergencies); Ariba (app for general medicine) - this app was taught and its use was assessed in OSCE; MDCalc (app to calculate risk factors and prognosis), AI in image analysis was taught in a lecture on endoscopy" [Medical student]*

Needs of students and faculty

I. Aspects of clinical reasoning that could be enhanced with the digital health technologies

Which aspects of clinical reasoning do you think could be enhanced the most with the digital health technologies and tools we've discussed? Please explain why

Aspects of clinical reasoning	%
Generating differential diagnoses	90%
Errors in the clinical reasoning process and strategies to avoid them	90%
Clinical decision-making	83%
Gathering, interpreting, and synthesising patient information (patient assessment)	77%
Developing a treatment/management plan	63%
Interprofessional collaboration in clinical reasoning	63%
Self-reflection on clinical reasoning performance	50%
Patient participation in clinical reasoning	43%
Ethical aspects of clinical reasoning	33%



The results for this question show that respondents believe that digital health technologies and tools have the potential to facilitate clinical reasoning, in particular AI tools and CDSS systems can support differential diagnosis by expanding diagnostic possibilities, reducing errors and biases through systematic analysis of patient data. These tools prioritise relevant information, generate potential diagnoses and provide new perspectives that clinicians might not consider on their own, highlighting the need for their continuous improvement.

- *"CDSS foster and systematise the differential diagnosis, thereby reducing diagnostic errors that can occur"* [Medical student]
- *"LLMs and AI-driven diagnostic support tools can provide differential diagnoses, reducing bias and helping clinicians consider a broader range of possibilities"*
- *"There is a risk of tunnel vision, where clinicians focus too narrowly. AI could perform a broad check to ensure that other possibilities are considered, helping to prevent such biases"*
- *"These tools can be used to discuss possible mistakes and develop strategies to avoid them in real-life practice"*

Respondents believe that digital health tools improve clinical decision making by combining patient data with the latest medical knowledge and providing data-driven insights and outcome predictions. While these tools improve efficiency, support complex case management and facilitate shared decision-making (SDM), final decisions should remain clinician-led to address ethical considerations.

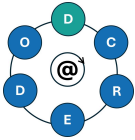
- *"Synthesising a patient's medical data together with knowledge of the latest treatments can improve the efficiency of clinical, therapeutic and diagnostic decision-making"* [Medical student]
- *"AI algorithms can support decision-making by predicting patient outcomes based on historical data, which is particularly valuable in complex cases"* [Nursing student]
- *"AI can support clinical decision-making by providing data-driven insights and recommendations, helping clinicians make more informed choices"*
- *"Digital tools can help, but should not make the final decision (also because of ethical reasons).The final decision should still be made by doctors "* [Medical student]

Digital health tools enhance patient assessment and developing a treatment/management plan by centralizing and synthesizing vast datasets from various sources, including EHRs integrated with CDSS, to provide a comprehensive and accurate view of the patient. AI and LLMs facilitate faster data collection, systematic interpretation, and preliminary analysis, though expertise remains essential for nuanced decision-making, interpretation and development of individual treatment plans.

- *"LLMs are well-suited for synthesising information, which is essential given the vast amount of it available today"*
- *"Digital health tools enable more accurate, continuous, and comprehensive data collection"* [Nursing student]
- *"Because of the vast amounts of data from different areas, they could be helpful in collecting and combining the data (interpretation I'm not sure - this is something where expertise is important)"*
- *"AI can make this process more systematic and faster"*

According to respondents, digital health technologies such as telemedicine and EHRs could facilitate interprofessional collaboration in clinical reasoning, while reducing the risk of errors.

- *"Telehealth creates an environment for the exchange of information engaging participants from different professions in the clinical reasoning process"*
- *"Because different professional groups are supported by the system the information can be summarised more easily"*



- *“Help with structured and comprehensive patient handovers, which can reduce misdiagnosis or misedication”*
[Medical student]

Half of respondents agree that digital health technologies could encourage self-reflection on clinical reasoning skills, and around a third believe that they could potentially be helpful in identifying and managing ethical issues.

- *“LLM, guideline/framework in the tools could prompt questions and enhance reflection”*
- *“Learning from your own performance by reviewing EHR and/or assessments with the use of AI”*
- *“EHRs with CDSS will be useful for considering the ethical aspects of clinical reasoning and clinical decision-making”*
- *“AI does not have a ethical compass, but could be feeded with such information”*

On the other hand, some respondents are not in favour of the use of digital technologies for self-reflection, recognising errors or ethical reasoning.

- *“Digital tools should stay out of the realm of self-reflection, this area should remain personal. We should not let AI start thinking for us”* [Medical student]
- *“Sometimes I wonder if it is ethical that I check something in front of my patient?”*
- *“It is unclear how AI would help in this process and recognize errors, because CR processes are so individualized. Better to work as a team and discuss each individual process and reflect on that”* [Medical student]

II. Examples of digital health tools that facilitate clinical reasoning

According to respondents, the following are useful digital health tools that facilitate clinical reasoning and therefore are recommended to be included in the curriculum:

Large Language Models (LLM) and big data category:

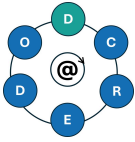
- *ChatGPT, LLMs with higher reasoning capabilities (such as OpenAI's o1-preview model)*
- *Consensus (AI-powered Academic Search Engine)*
- *Microsoft Copilot (for literature search and review)*

Artificial Intelligence (AI) in image analysis category:

- *RadiAnt DICOM Viewer*
- *3D Slicer image computing platform*
- *ITK-SNAP*
- *Queen of Hearts (PMcardio OMI AI ECG model)*
- *Programs for automatic 3D reconstruction*

Clinical decision support systems (CDSS) category:

- *Isabel (DDx Companion, Clinical Educator)*
- *DXPlain*
- *MDCalc*
- *PediHelp (assistant-app for pediatric emergencies and anesthesia)*
- *arribaEdu (app for general medicine)*
- *Bili App Newborn Jaundice Tool*
- *The Clinical Challenge app (Erasmus MC)*

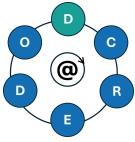


III. Specific learning objectives

Learning objectives related to using digital health technologies/tools in clinical reasoning suggested by respondents:

Students will be able to

- Understand the functionalities, strengths, weaknesses, and limitations of digital health tools (e.g., EHR, CDSS, telehealth, AI, mHealth apps, wearables)
 - *“Describe the types and functionalities of digital health technologies/tools relevant to clinical reasoning”*
 - *“Know the pros and cons of devices, know how to use them”*
 - *“Use new tools and technologies with high awareness of their possibilities and threats”* [Medical student]
 - *“Describe the opportunities and risks of digital health technologies/tools”*
 - *“Use the digital tools in such a way that patients benefit from them”* [Nursing student]
 - *“Use and navigate health apps, so that you can actually use and apply them in case of emergency”* [Medical student]
- Use digital tools for diagnosis, decision-making, patient monitoring, etc
 - *“Identify key digital health tools (e.g., CDSS, EHR, telemedicine platforms) and their role in supporting clinical reasoning practice”*
 - *“Select suitable digital health technologies/tools for specific situations; use digital health technologies/tools for clinical decision-making”*
 - *“Apply digital tools (e.g., EHR, CDSS, AI-powered assistants) to support clinical reasoning and decision-making”*
 - *“Develop confidence in navigating and applying digital health technologies/tools in clinical reasoning practice”*
- Confidently access, interpret, and synthesize data from multiple digital sources to create a complete clinical picture
 - *“Correctly interpret data from various digital tools and use it for clinical decision-making, particularly large amounts of data from electronic patient records or wearables”*
 - *“Demonstrate the ability to access, interpret, and synthesize data from multiple digital sources to support an accurate and complete clinical picture of the patient”* [Nursing student]
- Identify relevant outputs from tools and apply them appropriately in clinical reasoning
 - *“Analyse and interpret data from digital health technologies/tools”*
 - *“Synthesise information from digital tools for the clinical reasoning and knowledge extraction process”*
 - *“Distinguish which tool output is relevant for me and which is now relevant”* [Medical student]
- Critically evaluate the validity, reliability, and applicability of digital tools and information
 - *“Assess the validity, reliability, and applicability of digital health tools to ensure evidence-based practice”*
 - *“Interpret and critically analyse data provided by digital health tools to make informed clinical decisions”*
- Apply a systematic and interdisciplinary approach to analyze and improve diagnostic decisions
 - *“Make and justify decisions based on data from digital health technologies/tools with the involvement of the multi-professional, interprofessional team”*



- Recognize ethical considerations, including data security, patient privacy, and legal frameworks
 - *“Understand the ethical considerations (e.g., patient privacy, data security) and best practices for use of digital health technologies/tools relevant in clinical reasoning”*
- Develop awareness of tool biases, risks, and potential for diagnostic errors
 - *“Knows the ethical aspects and risks connected with using the digital technologies”* [Medical student]
 - *“Students should learn that tools are not the 'holy grail'; developing the 'pluis, niet pluis' (the 'sense' or 'feeling' of whether something is right or not) is equally important. While digital tools can assist, students must understand how to use them effectively and recognize their limitations”*

Teachers

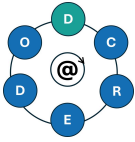
- Build foundational knowledge and practical skills to use digital tools effectively in clinical practice
 - *“Teach basic foundation of the tools, basic foundation/theory of CR, limitations of digital tools, basic problems of such digital tools and how systems could be enhanced + understanding how students will use such system in practice”*
 - *“Education should align more closely with practical applications. As more technologies and tools become part of clinical practice, it is essential to follow this trend and integrate these advancements into our teaching.”*
- Equip students to adapt to emerging digital technologies and integrate them responsibly into healthcare
 - *“Foster critical thinking approach in decision-making using digital tools, taking into account the need to consult and verify information”*
 - *“Teach the student to critically think about the use of these tools and how to improve diagnostic decisions with the use of tools”*
- Foster confidence and independent critical thinking in nursing and interprofessional clinical decision-making
 - *“Make nursing students confident in their nursing clinical decision making; to see the whole patient and make their own judgment independent from physicians”*

IV. The needs and support of the faculty

How do you think the faculty should be supported in teaching about the use of digital health tools in clinical reasoning?

All respondents agree that teachers need pedagogical support in the form of extensive training (workshops, training sessions, train-the-trainer courses, peer-to-peer groups) on the functionalities, benefits and limitations of digital health tools.

- *“It would be optimal to first introduce ttt courses for teachers on the use of digital medical technologies/tools in clinical reasoning. This could be a blended learning format, where part of the learning material is available online, followed by a training session to practice skills and teaching methodology”*
- *“Lecturers themselves do not know the tools - they should be taught these tools”*
- *“It should be part of the didactic of medicine training. It is important to train the trainer and encourage the use of digital tools in their own practice”* [Medical student]



They also emphasise the need for guidelines and high quality educational materials, resources and best practices - case studies, scenarios, clinical case sets incorporating digital tools to demonstrate their use, guidelines for student use of digital health tools and training in ethical issues, and assessment and feedback tools to facilitate integration into clinical reasoning education. Teaching about digital health tools should also be included in the curriculum.

- *“Many lecturers will be afraid of the transition to the digital age. Input in the form of well-prepared examples, specific cases, scenarios is needed”*
- *“Clear guidelines and conditions should be established, with explanations on how the tools work. Adequate time and support should be provided for developers to ensure effective integration of these tools into the curriculum”*
- *“Furthermore, educational courses need to be prepared not only with the target population [students] in mind, but also with the educators. Create guidelines on how to teach with these technologies in order to create educational standards”*

It is also essential that faculty have access to technical resources, including digital tools, devices, platforms for educators and infrastructure such as simulation centres. These resources would ideally be funded by the university, with the additional provision of ongoing technical support.

- *“Access to the latest digital health tools, software and devices for educational purposes, IT support”*
- *“Facilitate/enable access to digital health tools”*
- *“Financial support from universities to provide them with the necessary equipment using digital technologies”*

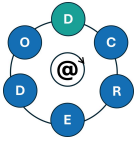
To ensure the successful implementation of the new learning units, institutions must adopt a complex systemic approach and provide comprehensive support to boost faculty motivation and guarantee that they feel confident, competent and equipped to effectively integrate these technologies into clinical reasoning education.

- *“It starts with the vision. Tools should be of good quality, easily accessible, and available. However, they often require significant effort to use effectively. Resources such as money and time are needed, and collaboration between different educational programs should be encouraged”*
- *“I think it is important to support the faculty, especially those who are starting their careers. They are not yet susceptible to established patterns and clichés and are often open to the use of digital medicine tools. They need to be ‘instilled’ with the need for change and the need to use these technologies in education to optimize their courses” [Medical student]*
- *“Does not see a lot of structural support, from time to time there are courses about use of chatGPT in research for writing publications. An overview would be good: what exists, how can I use it. Gap between university and the practice world should be addressed in teaching. Structured approach to address most important topics”*

Anticipated challenges and barriers to the implementation of the new learning units

In your opinion, what aspects of implementation do you anticipate will be more challenging and therefore benefit from support?

Challenging aspects	%
Knowledge about the technology behind digital tools	67%
Technical know-how on common issues with the use of digital tools	63%
Integration strategies for digital tools into the development of assessment materials	60%



Integration strategies for digital tools into the teaching/curriculum	57%
Policies for the use of digital health tools by students	50%
Methodology for using virtual patients with digital tools	50%
Learning theories that explain the use of digital tools in clinical reasoning	50%

Both survey respondents and interviewees agreed that more challenging factors in implementing new learning units on digital health tools in clinical reasoning that would benefit from support are: knowledge of the technology behind digital tools, strategies for integrating digital tools into the teaching/curriculum, and development of assessment materials. Interviewees also found technical aspects of using digital tools to be quite challenging, while survey respondents identified policies for student use of digital health tools as one of the most challenging factors.

Knowledge about the technology behind digital tools:

- *"Low level of knowledge about the technology behind digital tools, basics needed to use the tools safely"*
- *"It is important to understand how tools work, and what information it is based on"*

Integration strategies for digital tools into the teaching/curriculum and development of assessment materials:

- *"Curriculum is already overloaded"*
- *"Need support and structured strategies"*
- *"The biggest challenge I think is that everything is changing so quickly. The problem is the transfer of information downwards, from those who know to those who need to know. It's all about integration strategies for these tools"*

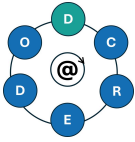
Policies for the use of digital health tools by students:

- *"Policies are limited, hard to implement because specific rules and regulations regarding digital tools have not been established"*
- *"Yes: at this point LLMs are not allowed for students!"*
- *"Hot topic!! Again black/white thinking about AI"*

What other critical aspects/barriers/challenges do you see in implementing the D-CREDO learning units at your institution? How could these challenges be overcome at your institution?

The primary obstacles to the implementation of the new learning units, as identified by the stakeholders, can be summarised as follows:

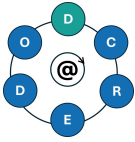
- Cultural and psychological barriers, including resistance to change, scepticism about digital tools and reluctance to update pedagogical approaches
 - *"The main barriers are a certain prejudice or reluctance on the part of teachers to use new technologies/digital tools and resistance to change in general and to implementing new methodologies in teaching practice"*
 - *"The biggest barrier is the mental shift so that decision-makers are convinced of the effectiveness of using digital tools in clinical reasoning. That is, the barrier of apprehension/scepticism in the use of digital tools"*
 - *"Integrating new aspects into established courses is usually not welcomed and it takes a long time to find teachers who are willing to use and teach about new innovative practices" [Medical student]*
 - *"Disbelief in usefulness and lack of awareness of the existence of tools - these are very important barriers"*



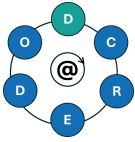
- *"Resistance to change - we repeat what we have learned instead of inspire ourselves to be better teachers"*
- The issue of curriculum overload has been identified as a significant challenge, particularly in the context of limited space in already full programmes and the prioritisation of traditional content. Additionally, there is a perceived gap between theory and practice
- *"Digital tools in clinical reasoning should be implemented at early stages - but our overloaded programme will cause resistance"*
- *"The most important issue is the full curriculum, and teachers are not motivated for changes, also time factor"*
- *"Gap between theory and practice: there's a lack of understanding how things could be relevant in practice"*
- Another critical barrier has been identified as insufficient time for faculty training, preparation and teaching due to competing responsibilities
- *"Time - crucial. We do not have dedicated time for learning about them as teachers"*
- *"Time is absolutely crucial and difficult - you have to be good at everything"*
- *"The barrier is time. What can be done about this rapid progress? I hope this will slow down"*
- Limited resources, such as a lack of funding for tools, inadequate access to software and technology, and a lack of technical and organisational support, were also identified as obstacles by interviewees
- *"If we conduct such classes, do we need a computer lab? How to organise this?"*
- *"The barrier is lack of software"*
- *"Lack of financial incentive"*
- *"The major critical aspect for Ukrainian universities is lack of resources"*
- A lack of expertise, limited qualified educators, insufficient training opportunities, and a gap in awareness of digital tools' benefits and limitations are also considered to be barriers to implementation
- *"Lack of qualified educators is very important!"*
- *"There's very limited experience, problem of existing material is often, things have to be adapted to own teaching"*
- *"Which resources are available, legal issues with LLMs, patient info and data protection questions, interoperability with wearables (app, OS, hardware). There aren't a lot of teachers using any of the above technologies at this point for themselves or in clinical routine"*
- A further challenge is uncertainty about how to evaluate students' use of digital tools in clinical reasoning.
- *"Lack of ability to objectively assess [students] as an intrinsic part of outcome verification is a barrier"*
- *"Assessment - a big unanswered question of how to use these tools during skills assessment"*

The proposed solutions to overcome the challenges are identified as follows:

- Faculty training and support should be provided in the form of workshops, expert-led sessions, and ongoing training, with the objective of familiarising faculty members with digital tools. This should be supported by interdisciplinary teams including medical informatics specialists.
- *"This can be overcome by providing support and regular training in the use of these digital technologies and by gradually moving from simpler to more complex concepts"*
- *"I think that teachers should be well prepared and informed about these technologies. And they should have time dedicated only to practice with it, not sharing this time with other responsibilities" [Nursing student]*



- *"Experts needed for explanation and training on tool usage, including medical informatics specialists. Educational specialists are also essential. A multidisciplinary team is necessary, covering content, IT, and educational expertise. Policymakers typically follow the developments and decisions made by the experts and teams involved"*
- It is essential to ensure that the necessary resources are allocated to facilitate the integration of digital tools, software, and infrastructure within the institution. Furthermore, it is crucial to provide access to tools on a paid basis. Faculty contributions should be recognised and rewarded; clear strategies and leadership must be provided to encourage adoption.
- *"It must be easy accessible for all students and teachers; in the exploding market it is difficult to select appropriate tools and teachers need advice on that; risks and limitations must be clear in advance before starting to use it in teaching"*
- *"Personnel, organisational, local and time resources would have to be created, feasibility and practicability checked, cost-benefit analysis carried out"*
- *"Motivation - we need to have guaranteed access to paid tools"*
- *"Recognise and reward the efforts of faculty members in this area through promotions, grants, or teaching awards"*
- Curricular integration: gradually introduce digital health tools into courses via electives or smaller modules, linking them to existing learning objectives, develop structured assessment frameworks to assess students' competence in using digital tools for clinical reasoning.
- *"Limited time for digital tools in curricula. Their profile needs to be raised"*
- *"Perhaps it will be possible to add courses on digital technology through electives rather than through the standardized curriculum" [Medical student]*
- *"Short LU would be ok, should be a palette of different tools, VPs, more diverse LUs would be beneficial! And instructions on how to use them, more workshops!"*
- Raise awareness: promote the importance of digital health tools through communication and leadership, emphasising their relevance to modern healthcare education.
- *"Will be important to address the importance and how relevant the new technologies will be seen. Also individual persons within faculty will be important, charismatic leaders"*
- *"Raising awareness of the importance of these technologies and benefits of such tools to the learning objectives already existing in educational programs"*
- *"First, it should be common sense that the upcoming technologies are important, so they have to be addressed, on the other hand also the modern technologies have to be seen critically, pros and cons have to be assessed and elaborated"*



4.3 Workshop

Digital tools that we discussed during the workshop:

Tools	Use Cases (personally)	Would like to learn more
LLM (mostly ChatGPT)	<ul style="list-style-type: none"> ● Creation of educational material ● Text creation, editing,... ● Answering general questions 	<i>Advanced use of ChatGPT</i>
Research Rabbit, Consensus, etc.	<ul style="list-style-type: none"> ● Literature search ● Research ● Literature summary 	
Wearables	<ul style="list-style-type: none"> ● Private usage 	
EHR	<ul style="list-style-type: none"> ● Use in clinical practice 	Use in education
DALL-E, Adobe Firefly	<ul style="list-style-type: none"> ● Image & video creation 	
-	<ul style="list-style-type: none"> ● Image analysis (e.g. dermatology, radiology) 	Learn more about tools and use cases in clinical practice and education
-	<ul style="list-style-type: none"> ● Telehealth 	Learn more about use cases in clinical practice and education

Challenges/Barriers:

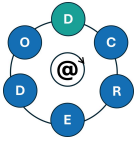
We discussed several challenges in the use of the above mentioned tools and use cases:

- Costs of tools
- Teachers need more skills to teach it and do not feel comfortable teaching something they are not familiar with.
- Legal and ethical aspects (regulations, data protection, responsibilities, plagiarism)
- Quality, Reliability issues
- Infrastructure with many tools that are not connected
- Power outages
- Generation gap in use of digital / AI tools

We especially focused then on discussing aspects to consider when teaching about/with digital tools:

Students already use LLMs such as ChatGPT to create texts or answers. So, instead of prohibiting the use of LLMs we developed ideas on how to integrate the tools into teaching by e.g.

- use such LLM-created answers/texts to discuss about it and thereby elaborating on pros/cons/pitfalls of LLMs
- use it to create own clinical presentations and discuss them in groups.



- Use cases created by LLM that contain errors and discuss that with students and this way also show limitations.

Overall, we saw a need to change and adapt the educational process as there will be less need for memorizing facts, but a need to be familiar with the concepts of digital tools and their fast development.

5 Discussion

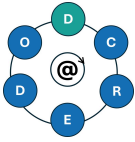
With the survey, interview, and workshop participants from eight different countries we were able to collect and consider a great variety of perspectives that inform the next steps of the D-CREDO project. In the following discussion and conclusions, we will specifically focus on how these results can inform the blueprint of the LUs and VPs in WP3 (quality indicator of this deliverable). Thus, we will establish a baseline to which the pilot studies can then relate and build on.

In the survey we noticed that only about 50% completed the questionnaire answering all questions. We can only speculate about the reasons. One reason might be that such specific aspects of digital tools in education are still not general knowledge and participants felt overwhelmed at a certain stage of the questionnaire.

In the interviews and workshops, students and faculty were often not very competent in using digital tools. Some of the tools and terms were new to them. Some are using them in their clinical practice and education, but do not have a deeper knowledge about the full potential, advantages, or disadvantages of these tools. The use of digital tools including ethical and legal considerations or usage scenarios is limited and mostly not included systematically into the curriculum nor into faculty development programs. However, educators do not feel confident in teaching on or with digital tools, they are not using themselves, so one conclusion is to provide more train-the-trainer courses, which might address this challenge to some extent.

Also, in the survey more than 50% did not yet use AI tools, neither in general nor in clinical reasoning, for image analysis, telehealth applications, or EHR and the level of confidence in using such tools was mostly "somewhat confident". Participants mostly use LLMs and wearables, however the interview responses revealed that this is mostly for private matters and not in a professional context. Thus, we may assume that most participants are on the level of unconscious or conscious incompetence concerning most of the tools [1]. Also, such tools are rarely used for teaching.

By far, the most common tools were LLMs with ChatGPT being the most prominent (workshop and interviews). Other digital tools, e.g. used in image analysis or EHR, participants may have heard about, but not yet worked with or taught about. Such tools are often only introduced in clinical practice in specific content domains and not on an undergraduate education level. The reason for this might be the broad availability and dissemination of LLMs and especially ChatGPT. It can be used without any costs for a wide range of use cases not only in the professional setting, but also for private purposes. Similarly, wearables, such as smartwatches are used, but mostly for private purposes. All other tools have more specific use cases and are usually not easily accessible if not provided by an institution and are restricted to a professional use.



The most commonly envisioned aspect of clinical reasoning to be supported with D-CREDO tools was differential diagnosis generation and error prevention with 90% of respondents who agreed with that. This is not surprising considering the popularity and evidence of usefulness of symptom checker tools like Isabel or Ada for DDX [Ceney21][Gilbert20][Wallace22] and Drug-Drug-Interaction (DDI) clinical decision support [Van de Sijpe22].

In general, students expressed some anxiety in the interviews about not being taught about digital tools, but being expected to apply and use them in their daily practice after medical / nursing school. This stresses again the relevance of our planned learning units with a focus on such tools that students are most likely to encounter early on, e.g. during their clinical rotations or internships.

The least popular aspect of clinical reasoning which was considered to be enhanced by D-CREDO tools were ethical aspects with only one third supporters. This is understandable and can be interpreted as a positive finding that our respondents recognize the priority of human judgement in moral dilemmas. At the same time it is not necessary to be interpreted as lacking the relevance of the topic of digital tools to ethical aspects of clinical reasoning as for instance whether to use a digital tool like artificial intelligence in health related decision-making is often a matter of an ethical decision [Benzinger22].

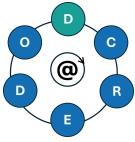
For the creation of learning units within the D-CREDO project this means that we cannot assume that despite the AI- and digital hype, students and educators are familiar with basic underlying concepts. Thus, such basic aspects need to be included into the learning units to be able to reach the learning objectives.

In the survey 97% of faculty supported the idea that there is a need for supporting and educating faculty about using these tools in education. This strongly supports our initiative to provide train-the-trainer courses along with the learning units for students.

The topics to be covered in these courses need to be a wide range as most of the survey respondents find them relevant for clinical reasoning but to some degree challenging. Therefore, when planning our train-the-trainer courses we need to carefully design and distribute the learning objectives, to not overwhelm participants and provide learning units that can be completed in a reasonable time.

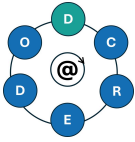
As easily accessible tools with a wide range of usage scenarios in private or professional life (ChatGPT, mHealth apps/wearables) are more used by participants, we will consider starting the series of learning units with these more familiar topics to not overload students and educators and let them explore the digital tools from this common ground.

Concerning the relevance of the tools for clinical reasoning practice and education, most of the tools were regarded as very or extremely relevant and such tools could inform and support all aspects of clinical reasoning. This strongly supports the conclusions from the general needs assessment and our focus on the selected tools. Also, virtual patients were the most preferred assessment methods of clinical reasoning, which supports the project's intention of including VPs into the learning units to provide training, but also assessment with digital tools in a simulated environment.



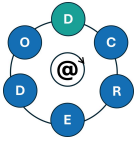
6 Conclusions

The survey, interviews, and workshop showed a clear need for providing educational material and learning units for educators and students on the use of digital tools for clinical reasoning. The level of competence in using and teaching with such digital tools was surprisingly low among faculty and also students, so the learning units need to start on a basic level but need to be within a reasonable timeframe as the time for clinicians is limited. One option could be to divide the learning units for teachers into novice and intermediate levels to be able to provide an optimally tailored level of difficulty.



7 References

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8 Appendices

Appendix 1 - Survey

D-CREDO Project: Specific Needs Analysis Survey

Text for teachers/faculty

The EU project D-CREDO (Digital Health Technologies-augmented Clinical Reasoning Education) plans to develop high-quality learning units alongside virtual patients that will prepare students for the responsible use of digital tools in clinical reasoning (CR).

"Clinical reasoning" is a fundamental concept in education, referring to the cognitive process that healthcare professionals use to assess and manage patient problems. It involves gathering and analyzing patient information, formulating hypotheses, making diagnoses, and deciding on appropriate treatments. The process requires the integration of both theoretical knowledge (medical and nursing science) and practical experience (clinical practice) to ensure effective patient care.

In this survey, we will ask you about your opinion on the relevance and current usage of digital health technologies and tools in clinical reasoning, your views on the optimal methods for teaching and assessment at your institution, and your input on the ideal structure and content of a train-the-trainer course. Your input is highly valued and will help design the D-CREDO learning units and establish evidence-based policies for using digital tools in clinical reasoning education.

Please answer the questions as accurately as possible. Your answers will be stored anonymously. The study has been approved by the Biomedical Research Ethics Committee of Bukovinian State Medical University for use in the D-CREDO project.

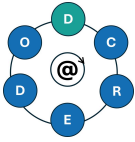
The findings from this survey may be published in conference contributions and scientific publications. By participating, you agree to the use of your data for these purposes.

Text for students

The EU project D-CREDO (Digital Health Technologies-augmented Clinical Reasoning Education) plans to develop high-quality learning units alongside virtual patients that will prepare students for the responsible use of digital tools in clinical reasoning (CR).

"Clinical reasoning" is a fundamental concept in education, referring to the cognitive process that healthcare professionals use to assess and manage patient problems. It involves gathering and analyzing patient information, formulating hypotheses, making diagnoses, and deciding on appropriate treatments. The process requires the integration of both theoretical knowledge (medical and nursing science) and practical experience (clinical practice) to ensure effective patient care.

In this survey, we will ask you about your opinion on the relevance and usage of digital health technologies and tools in clinical reasoning and your views on the optimal methods for teaching and assessment at your institution. Your input is highly valued and will help in designing the D-CREDO learning units and establishing evidence-based policies for the use of digital tools in clinical reasoning education.



Please answer the questions as accurately as possible. Your answers will be stored anonymously. The study has been approved by the Biomedical Research Ethics Committee of Bukovinian State Medical University for use in the D-CREDO project

The findings from this survey may be published in congress contributions and scientific publications. With your participation, you agree to the use of your data for these purposes.

PART A Demographics

In which country do you work/study?

Country

In which institution do you work/study?

Institution/University

What educational programme do you relate mostly to?

- Medicine
- Nursing
- Other (please specify)

How would you describe your primary role/roles at your institution? (multiple answers possible)

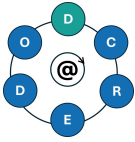
- Student
- Teacher
- Researcher
- Dean
- Curriculum Planner/Manager
- Course Director
- Resident/intern doctor
- Other (please specify) ...

How many years of experience in healthcare education (excluding years of study) do you have? (faculty only)

- less than 2 years
- 2-5 years
- 6-10 years
- more than 10 years

Your year of study (students only)

1 - 2 - 3 - 4 - 5 - 6 - internship



PART B Learner and Learning environment (for students and other participants as lifelong learners)

In the EU project D-CREDO it is planned to develop a set of high-quality student learning units alongside virtual patients that educate on the use of digital health tools in clinical reasoning and are validated regarding their impact on clinical reasoning skills.

In the following, we will ask you learner-related questions.

Please indicate which technologies/tools you use and, if so, how confident you are in using them

- Artificial Intelligence (AI) in image analysis
- Large Language Models (LLM) (generative AI, ChatGPT, etc.) and Big data
- mHealth apps and Wearables (e.g. smartwatch)
- Electronic Health Records (EHR) with Clinical decision support systems (CDSS)
- Telehealth (virtual visits, telemonitoring)

* Not confident at all / somewhat confident / fairly confident / completely confident / not using it

Please indicate the relevance of the following technologies for clinical reasoning practice and the relevance of teaching in their use

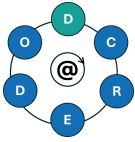
Technology/tool	CR practice	CR teaching
Artificial Intelligence (AI) in image analysis		
Large Language Models (LLM): generative AI, ChatGPT, etc. and Big data		
mHealth apps and Wearables		
Electronic Health Records (EHR) with Clinical decision support systems (CDSS)		
Telehealth (virtual visits, telemonitoring)		

* Not at all relevant/ slightly relevant/ moderately relevant/ very relevant/ extremely relevant / don't know

Please indicate which technologies/tools you use for clinical reasoning and, if so, how confident you are in using them

- Artificial Intelligence (AI) in image analysis
- Large Language Models (LLM) (generative AI, ChatGPT, etc.) and Big data
- mHealth apps and Wearables (e.g. smartwatch)
- Electronic Health Records (EHR) with Clinical decision support systems (CDSS)
- Telehealth (virtual visits, telemonitoring)

* Not confident at all / somewhat confident / fairly confident / completely confident / not using it



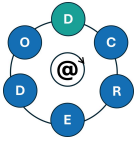
Please indicate which aspects of clinical reasoning are taught at your institution and, in your opinion, have the potential to be augmented with the listed digital health technologies/tools

Aspect of clinical reasoning	Is taught	Teaching could be augmented with digital health technologies/tools
Theories of clinical reasoning	<input type="checkbox"/>	<input type="checkbox"/>
Gathering, interpreting, and synthesising patient information (patient assessment)	<input type="checkbox"/>	<input type="checkbox"/>
Generating differential diagnoses	<input type="checkbox"/>	<input type="checkbox"/>
Developing a treatment/management plan	<input type="checkbox"/>	<input type="checkbox"/>
Patient participation in clinical reasoning	<input type="checkbox"/>	<input type="checkbox"/>
Interprofessional collaboration of clinical reasoning	<input type="checkbox"/>	<input type="checkbox"/>
Ethical aspects of clinical reasoning	<input type="checkbox"/>	<input type="checkbox"/>
Self-reflection on clinical reasoning performance and strategies for future improvement	<input type="checkbox"/>	<input type="checkbox"/>
Errors in the clinical reasoning process and strategies to avoid them	<input type="checkbox"/>	<input type="checkbox"/>
Other (please specify) ...	<input type="checkbox"/>	<input type="checkbox"/>

Which of the following technologies/tools are used in your institution for teaching clinical reasoning? (faculty only)

(multiple choice)

- Artificial Intelligence (AI) in image analysis
- Large Language Models (LLM) (generative AI, ChatGPT, etc.) and Big data
- mHealth apps and Wearables
- Electronic Health Records (EHR) with Clinical decision support systems (CDSS)
- Telehealth (virtual visits, telemonitoring)
- Don't know



Please indicate which technologies/ tools you use in teaching clinical reasoning and, if so, how confident you are in using them (faculty only)

- Artificial Intelligence (AI) in image analysis
- Large Language Models (LLM) (generative AI, ChatGPT, etc.) and Big data
- mHealth apps and Wearables
- Electronic Health Records (EHR) with Clinical decision support systems (CDSS)
- Telehealth (virtual visits, telemonitoring)

* Not confident at all / somewhat confident / fairly confident / completely confident / not using it

Are there any specific tools within the selected categories that facilitate the clinical reasoning process and that you believe would be beneficial to include in the curriculum?

- Artificial Intelligence (AI) in image analysis
- Large Language Models (LLM) (generative AI, ChatGPT, etc.) and Big data
- mHealth apps and Wearables
- Electronic Health Records (EHR) with Clinical decision support systems (CDSS)
- Telehealth (virtual visits, telemonitoring)

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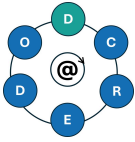
Please indicate any specific learning objectives related to the utilization of digital tools in clinical reasoning that you would like to achieve.

Free text field

Please indicate your preferences regarding the formative assessment of your skills in using digital tools for clinical reasoning

(multiple choice)

- Multiple choice questions
- Essay questions
- Team-based projects
- Virtual patients
- Simulation with standardized patients
- Simulation role play
- Case-based discussion
- other



PART C Train-the-trainer (TTT) (faculty only)

Faculty will need support and guidance for effective teaching of clinical reasoning using digital technologies/tools, including AI in image analysis, generative AI and big data, mHealth apps and wearables, EHR with clinical decision support, and telehealth

* Strongly Disagree /Disagree /Undecided /Agree /Strongly Agree

Which aspects do you find more challenging and would benefit from support

- Technical know-how on common issues with the use of digital tools
- Knowledge about the technology behind digital tools
- Learning theories that explain the use of digital tools in clinical reasoning
- Integration strategies for digital tools into the teaching/curriculum
- Methodology for using virtual patients with digital tools
- Integration strategies for digital tools into the development of assessment materials
- Policies for the use of digital health tools by students

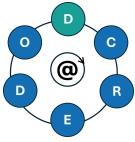
Likert 1-5 from not at all challenging to extremely challenging

Please indicate any specific learning objectives related to the teaching about digital tools in clinical reasoning that you would like to achieve in the train-the-trainer courses

Free text

Do you have further comments or suggestions?

Free text field



Appendix 2 - Interview

D-CREDO Project: Specific Needs Analysis Interview

Clinical reasoning encompasses health professionals' thinking and acting in assessment, diagnostic and management processes in clinical situations.

The latest digital health technologies and tools are being rapidly integrated into healthcare, particularly in clinical reasoning practice, raising hopes for improving healthcare quality and concerns within academia regarding their use. These include the potential for excessive reliance on them in decision-making processes, the negative impact on human clinical reasoning skills, and the risk of unethical use in an educational context.

The EU project D-CREDO (Digital Health Technologies-augmented Clinical Reasoning Education) plans to develop high-quality learning units alongside virtual patients to prepare students for the responsible use of digital tools in clinical reasoning practice.

In this interview, we will ask you about your opinion on the relevance and current usage of digital health technologies and tools in clinical reasoning, your views on the optimal methods for teaching and assessment at your institution, and your input on the structure and content of a train-the-trainer course. Your input is highly valued and will help design the D-CREDO learning units and establish evidence-based policies for using digital tools in clinical reasoning education.

Please answer the questions as accurately as possible. Your answers will be stored anonymously. The study has been approved by the Biomedical Research Ethics Committee of Bukovinian State Medical University for use in the D-CREDO project.

The findings from this interview may be published in conference contributions and scientific publications. By participating, you agree to the use of your data for these purposes.

1. In which country do you work/study?

2. In which institution do you work/study?

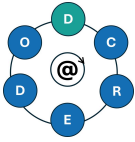
3. What educational programme do you relate mostly to?

- a. Medicine
- b. Nursing

Other (please specify)

4. What is your primary role at your institution?

- a. Student
- b. Teacher
- c. Researcher
- d. Dean
- e. Curriculum Planner/Manager
- f. Course Director



Other (please specify) ...

5. How many years of experience in healthcare education do you have?

6. Do you use any of the following technologies and tools? Please, give examples of how you use them

- a. Artificial Intelligence (AI) in image analysis
- b. Large Language Models (LLM) (generative AI, ChatGPT, etc.) and Big data
- c. mHealth apps and Wearables (e.g. smartwatch)
- d. Electronic Health Records (EHR) with Clinical decision support systems (CDSS)
- e. Telehealth (virtual visits, telemonitoring)

7. Which of the given categories of digital health tools do you think are helpful in CR practice?

- a. Artificial Intelligence (AI) in image analysis
- b. Large Language Models (LLM) (generative AI, ChatGPT, etc.) and Big data
- c. mHealth apps and Wearables (e.g. smartwatch)
- d. Electronic Health Records (EHR) with Clinical decision support systems (CDSS)
- e. Telehealth (virtual visits, telemonitoring)

8. Do you teach about the use of these technologies/tools in clinical reasoning at your institution?

- a. Artificial Intelligence (AI) in image analysis
- b. Large Language Models (LLM) and Big data
- c. mHealth apps and Wearables
- d. Electronic Health Records (EHR) with CDSS
- e. Telehealth

9. Which aspects of clinical reasoning do you think could be enhanced the most with the digital health technologies and tools we've discussed?

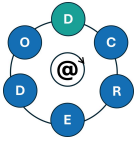
Please explain why

- a. Gathering, interpreting, and synthesising patient information (patient assessment)
- b. Generating differential diagnoses
- c. Clinical decision-making
- d. Developing a treatment/management plan
- e. Patient participation in clinical reasoning
- f. Interprofessional collaboration in clinical reasoning
- g. Ethical aspects of clinical reasoning
- h. Self-reflection on clinical reasoning performance
- i. Errors in the clinical reasoning process and strategies to avoid them

Other (please specify)

10. Are there any particular tools within the selected categories that facilitate clinical reasoning and that you believe would be beneficial to include in the curriculum?

- a. Artificial Intelligence (AI) in image analysis
- b. Large Language Models (LLM) and Big data
- c. mHealth apps and Wearables



- d. Electronic Health Records (EHR) with CDSS
- e. Telehealth

11. Please indicate any specific learning objectives related to the utilization of digital health technologies/tools in clinical reasoning that you would like to achieve.

12. How do you think the faculty should be supported in teaching about the use of digital health tools in clinical reasoning?

13. In your opinion, what aspects of implementation do you anticipate will be more challenging and therefore benefit from support?

- a. Technical know-how on common issues with the use of digital tools
- b. Knowledge about the technology behind digital tools
- c. Methodology for using virtual patients with digital tools
- d. Learning theories that explain the use of digital tools in clinical reasoning
- e. Policies for the use of digital health tools by students
- f. Integration strategies for digital tools into the teaching/curriculum
- g. Integration strategies for digital tools into the development of assessment materials

14. What other critical aspects/barriers/challenges do you see in implementing the D-CREDO learning units at your institution? How could these challenges be overcome at your institution?

15. Do you have any further comments?