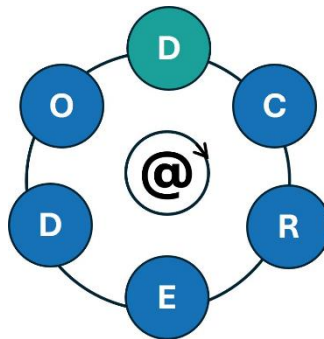


# D-CREDO

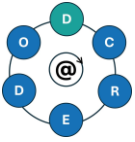
## Digital Health Technologies-Augmented Clinical Reasoning Education



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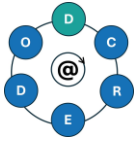
## D2.2 Learning objectives report

Deliverable number	D.2.2
Delivery date	28 February 2025
Status	Final
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## Document Revision Table

Version	Date	Author(s)	Organization	Comments
0.1	10.02.25 - 12.02.25	Jonas Verdonschot	EMC	First draft prepared, adding introduction and objectives
0.2	17.02.25	Jonas Verdonschot	EMC	Add method section (2), adjusting introduction and objectives (1), add Appendix 1 (7)
0.3	24.02.25	Andrzej Kononowicz	JU	Update and edit draft.
0.4	27.02.25	Jonas Verdonschot	EMC	Add Results (3) and Appendix 2 (7)
0.5	28.02.25	Jonas Verdonschot	EMC	Add Discussion (4) and Conclusion (5)
1.0	13.03.25	Jonas Verdonschot	EMC	Finalized



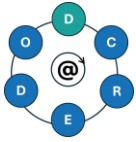
## Summary

**Objectives:** The document presents a report on the D-CREDO activity to define and refine a set of learning objectives through a structured consensus process. This process will ensure alignment of learning objectives to form the bases for the planned D-CREDO Learning Units. The outcomes will contribute to the development of a conceptual framework for the educational model and, in the longer term, shape the project's learning units and guidelines.

**Approach:** A modified Delphi method was used to gather and establish a consensus on learning objectives (LOs) for integrating digital health tools into clinical reasoning education for students and educators. The process involved four key steps: (1) collecting LOs from multiple sources, including the WP2.1 rapid review, national and institutional guidelines, educational frameworks, and the needs assessment interviews (D4.1). (2) consolidating and refining LOs through collaborative discussions within a dedicated working group, (3) conducting a stakeholder survey using Qualtrics to rate and prioritize the LOs, and (4) holding a final consensus meeting to finalize the selection. The working group, composed of representatives from each D-CREDO partner institution, ensured a diverse and balanced contribution. LOs were categorized based on relevant criteria, including Bloom's taxonomy level, target audience, the health profession involved, the applicable D-CREDO tool category, and alignment with DID-ACT clinical reasoning themes. The process was managed through structured discussions, iterative feedback, and consensus-building to ensure transparency, alignment with project goals, and relevance for clinical reasoning education.

**Results:** The working group collected 118 initial learning objectives. After the consensus process, a set of 26 final LO's were formulated. Each LO is categorized by Bloom's taxonomy level, relevance to different health professions and alignment with five key D-CREDO tool categories. The survey outcomes and subsequent working group discussions confirmed the clarity, applicability, and educational value of these objectives, ensuring their feasibility within clinical reasoning curricula.

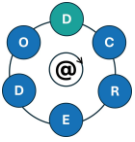
**Conclusion:** This deliverable successfully established a consensus-driven set of 26 learning objectives that integrate digital health tools into clinical reasoning education for both students and educators. By combining evidence from the literature, national guideline requirements, and expert feedback, the project has created an outcomes-based framework that is adaptable, robust, and aligned with existing curricula such as DID-ACT. These learning objectives will guide the development of future learning units and faculty development strategies, positioning D-CREDO to advance clinical reasoning education in an evolving digital health landscape.



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# 1. Introduction and objectives

## 1.1 Motivation

The primary goal of Work Package 2 (WP2) is to develop a solid conceptual and theoretical basis for the student and train-the-trainer learning units planned within the D-CREDO project Work Package 3. As our plan is to build an outcome-based curriculum, we emphasize not only the importance of incorporating findings from recent literature into the educational model but also the foundational role of learning objectives (LOs) derived from a consensus of experts in the field, ensuring that the curriculum is grounded in evidence-based and sound educational principles.

Following the rapid review conducted in D2.1, which identified key publications and foundational insights into the integration of digital health tools in clinical reasoning education, D2.2 builds upon this work by focusing on the development of consensus-based LOs. The joint formulation of LOs by the D-CREDO consortium partners contributes to the harmonization of competencies across institutions.

Defining LOs that guide digital health technology education for clinical reasoning is crucial for shaping the content, structure, evaluation, and quality assurance of the learning units (LUs). These objectives will align with both national standards and recognized learning objective catalogues whenever feasible. Moreover, the agreed-upon LOs, coupled with evidence-based learning strategies, will serve as a valuable complement to existing health professions curricula, faculty development programs, and open-access learning resources aimed at improving clinical reasoning skills augmented by digital health tools.

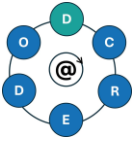
Through a collaborative and iterative process, involving expert discussions and online meetings, we aim to systematically draft, refine and confirm a well-structured set of LOs that support the D-CREDO learning units (LUs).

## 1.2 Objective

The objective of the deliverable D2.2 is to establish a consensus-based set of LOs that will guide the development of educational materials for teaching the integration of digital health tools in clinical reasoning. These LOs will provide a structured foundation for the subsequent creation of learning units, ensuring clarity in the expected competencies for students and trainers.

By synthesizing insights from existing literature, national learning objective catalogues, and expert discussions, the project aims to create a standardized framework that can be adapted across institutions. The agreed-upon LOs will contribute to the quality, coherence, and relevance of digital health education, ensuring that students acquire the necessary competencies to effectively integrate digital tools into clinical reasoning practice.

This deliverable report outlines the process and outcome of the consensus-building activity aimed at defining a robust and transferable set of LOs for digital health-enhanced clinical reasoning education. The joint review of literature, selection of LOs, and establishment of policies and guidelines will collectively contribute to an



educational framework that ensures consistency, relevance, and quality in digital health education across partner institutions.

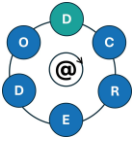
### 1.3 Quality Criteria

In alignment with the key performance indicators defined at the stage of writing the D-CREDO proposal, we set the following specific performance indicators to be addressed in the activity:

- $\geq 1$  Learning objective related to each D-CREDO type of tool;
- $\geq 1$  Learning objective in each DID-ACT theme;
- $\geq 30\%$  Learning objectives relevant for non-medicine health professions;
- Learning objectives available at the project website;
- Learning objectives developed through a consensus process;
- Learning objectives fit within the DID-ACT curriculum framework;
- Learning objectives with references to literature review results;
- Number of Learning objectives balances coverage of topics with feasibility of implementation given time and resource constraints.

## 2. Methods

We designed our consensus-building process inspired by the Delphi method to first select and then establish a consensus on the most relevant LOs for integrating digital health tools to enhance clinical reasoning for both students and teachers in clinical reasoning education. This iterative process involved multiple stages, including data collection, consolidation, stakeholder engagement, and consensus-building. The process was highly collaborative, fostering engaging discussions and knowledge-sharing among consortium members. To keep the process on track, we planned and communicated each phase effectively, ensuring transparency and alignment (see Image 1). These aspects were discussed in detail when establishing a working group for the D2.2 activity, which consisted of one or two partners from each institution, ensuring a balanced representation of perspectives.



## General Timeline

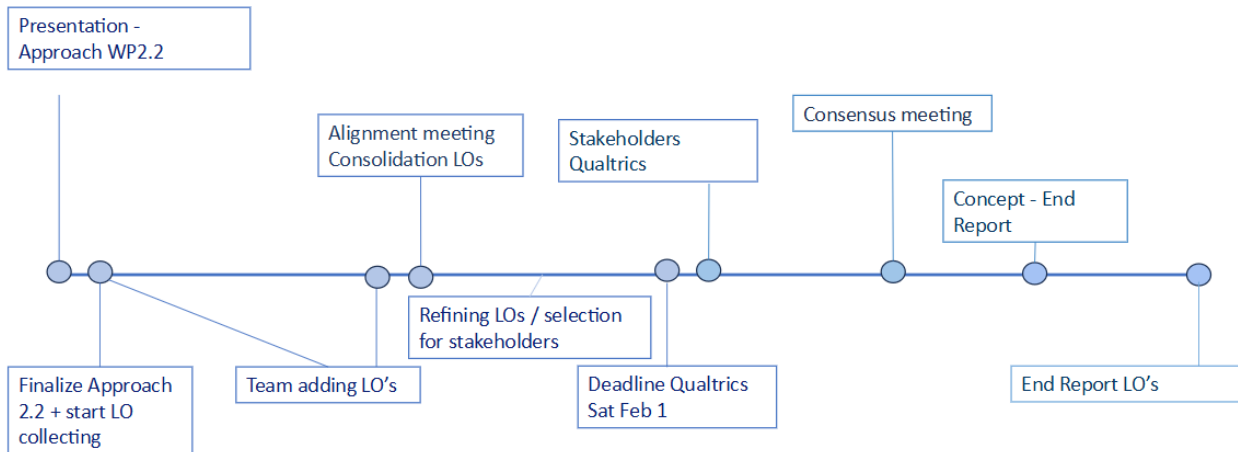


Image 1: the timeline presented at the first meeting with the working group

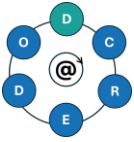
### 2.1 Gathering Learning Objectives

A dedicated and highly engaged working group was formed, consisting of representatives from each D-CREDO partner institution. The commitment and enthusiasm of the group greatly contributed to the quality of the collected data. Each member gathered LOs from multiple sources, including:

- Articles identified in the rapid review (D2.1).
- National and institutional guidelines (NKLM catalogue for Germany, National Dutch Catalogue, “Raamplan 2020”; Polish Ministry of Education Regulations (2023); Catalogue for the Revision of the Curriculum in Austria; Framework of Digital Competence of a Healthcare Professional in Ukraine).
- Other relevant educational frameworks (e.g. DECODE).

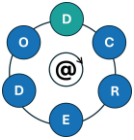
In order to meet the objectives and the quality criteria, we kept track of the LOs and categorized them. All collected LOs were structured within an extensive Excel database (see Image 2), carefully categorized to facilitate later analysis. To ensure systematic tracking and organization, each LO was labeled with:

- **The source of the LO:** This included identifying whether the LO originated from a research article, guideline, or institutional policy.
- **The corresponding Bloom’s taxonomy level** (Krathwohl, 2001): This categorization ensured that later learning units would align with the appropriate cognitive complexity required for students.
- **The target group:** Some LOs were specifically targeted toward students, while others were designed for educators, and some applied generally to both groups.



- **The target health profession (medical, nursing, or both):** Some LOs were specifically targeted toward medical students, while others were designed for nursing students, and some applied generally to both professions.
- **The relevant D-CREDO tool:** LOs were categorized according to their alignment with one of the five D-CREDO tools:
  - AI in Image Analysis
  - Large Language Models (LLMs) & Big Data
  - mHealth Apps & wearables
  - Electronic Health Records (EHR) & Clinical Decision Support Systems (CDSS)
  - Telehealth
  - A general category for LOs that spanned multiple tools.
- **The most applicable DID-ACT theme:** Each LO was mapped to a relevant theme within clinical reasoning education, including:
  - Theories of clinical reasoning
  - Gathering, interpreting, and synthesizing patient information
  - Generating differential diagnoses including defining and discriminating features
  - Developing a treatment/management plan
  - Aspects of patient participation in clinical reasoning
  - Collaborative aspects of clinical reasoning
  - Interprofessional aspects of clinical reasoning
  - (Interprofessional) Collaboration and exchange (TTT)
  - Ethical aspects
  - Self-reflection on clinical reasoning performance and strategies for future improvement
  - Errors in the clinical reasoning process and strategies to avoid them
  - Attitudes towards clinical reasoning teaching (TTT)
  - Teaching, assessing, and evaluating clinical reasoning (TTT)
  - Decision Making
- **The contributor who added the LO:** This allowed for future follow-up discussions and clarifications on specific LOs if needed.
- **Additional notes for context:** This included details such as whether the LO had been translated from another language (e.g., German or Ukrainian) or required further interpretation.





Establishing Learning Objectives			
Set of learning objectives published on the project website as D2.2		<i>Learning Objective - Guideline</i>	
* A consensus on the learning objectives (LOs) for the LUs. Whenever feasible, these objectives will align with both national standards and recognised learning objective catalogues.		<i>Audience (A)</i> Does the objective clearly state who will be learning? <i>Example: "Faculty," "Staff."</i>	
Number	Learning Objectives	Source	Bloom's Taxonomy
1	[Students are able to] develop the abilities to distinguish correct information from rhetoric.	Grunhut et al. (from Rapid Rev 4.	Analyze
2	[Students are able to] understand how to create and disseminate thoroughly validated, trustworthy	Grunhut et al. from Rapid Rev 2.	Understand
3	Students are able to apply solutions of telemedicine in a patient-oriented way and can explain conditions.	10.7.1.5 - NKLM 1.0 (National 3.	Apply
4	Students are able to explain specific requirements, challenges, chances, and, limitations of the physician-patient relationship through new digital technologies and	11.4.3.5 - NKLM 1.0 (National 3.	Apply
5	Students are able to use information technology for obtaining and transferring information and documenting treatments.	10.7.1 - NKLM 1.0 (National c 3.	Apply
6	Structured information of patients: Students consider and improve individual health competence and participation - if applicable by using digital information and ass	E.08 - III c - NKLM 2.0	
7	Students are familiar with the digitalization in medicine, latest developments in artificial intelligence, personalized medicine, and digital image processing.	VII.2-13.1 - NKLM 2.0	2. Understand
8	Students are able to advise patients about benefits and harms of digital media	VIII.2-06.3.5 - NKLM 2.0	5. Evaluate
9	Students are able to explain characteristics of a physician-patient communication via digital channels.	VIII.2-06.3.11 - NKLM 2.0	2. Understand
10	Students are able to explain different types of knowledge-based systems and medical applications of clinical decision support systems to optimize patient care and	VII.2-13.1.4 - NKLM 2.0	2. Understand
11	Students are able to summarize the medical history, physical exam, and findings and document these in the electronic health record.	A.01 - III c - NKLM 2.0	6. Create
12	Students are able to order patient-specific diagnostics in the electronic health record.	A.03 - III c - NKLM 2.0	3. Apply
13	Students are able to document a treatment plan in an electronic health record.	A.07 - III c - NKLM 2.0	3. Apply
14	Students are able to use an electronic patient record (initiated/shared by the patient) together with the patient.	VIII.2-06.3.6 - NKLM 2.0	3. Apply
15	Students are able to enter data and practice clinical documentation in an electronic health record.	Everett-Thomas et al. (from R 5.	Apply
16	Teachers are able to assess students' documentation and critical thinking skills using virtual simulation and electronic health records.	Everett-Thomas et al. (from R 5.	Evaluate
17	Students are able to describe the technical requirements, proposed benefits and challenges of providing health care to patients through telemedicine.	Michelle Anawati (from Rapid 4.	Analyze
18	Students are able to explain the differences between the various categories of telemedicine (teleconsultation, tele-expertise, medical telemonitoring, tele-medical a	Michelle Anawati (from Rapid 2.	Understand
19	Students are able to describe the technical requirements that must be in place to provide patient care safely through a telemedicine platform.	Michelle Anawati (from Rapid 2.	Understand
20	Students are able to describe the patient groups that would benefit from participation in a telemedicine program.	Michelle Anawati (from Rapid 2.	Understand
21	Students are able to describe the components of a telemedicine patient consultation.	Michelle Anawati (from Rapid 3.	Understand
22	Students are able to demonstrate effective communication skills with individual patients or family members during a telemedicine consultation.	Michelle Anawati (from Rapid 3.	Apply

Image 2: The Excel sheet with the LOs numbered, followed by categories.

## 2.2 Consolidation of Learning Objectives

The working group held a series of productive meetings to review and refine the collected LOs. These meetings were characterized by vibrant discussions and a shared commitment to ensuring that the final set of LOs was both comprehensive and practical. The consolidation process involved:

- Cleaning the dataset to remove redundancies
- Rephrasing and standardizing LOs for clarity and consistency
- Identifying gaps in the LOs and addressing missing elements
- Checking the categorization of the LOs based on their alignment with the D2.2 objectives

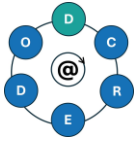
To ensure that the final LOs were well-defined and actionable, the working group formalized them using the SMART method—making them Specific, Measurable, Achievable, Relevant, and Time-bound (Chatterjee & Corral, 2017). This approach helped ensure that the LOs were clear, assessable, and aligned with the educational goals of the D-CREDO project.

Throughout these discussions, diverse perspectives were actively considered, and group members collaborated effectively to refine the LOs. Tasks were distributed among working group members to finalize the selection of LOs for further evaluation.

## 2.3 Survey

Once the consolidated LOs were agreed upon, the next step was to gather stakeholder input. A structured survey was developed using Qualtrics to assess and prioritize the selected LOs. The development of the survey was a collaborative effort, incorporating valuable feedback from multiple consortium members to refine its design.

The preparation phase included discussions within the consortium to determine the best survey approach, as well as multiple rounds of feedback from consortium members to improve clarity and usability of the questionnaire. The final survey was designed to allow stakeholders to rate the relevance of each LO and provide an opportunity for respondents to suggest additional LOs. The survey started with a detailed



introduction into the objectives of the consensus building process, criteria for evaluation of the LOs, and contact details in case of any questions. The survey collected basic demographic data about the respondent and continued with 6 pages of LOs grouped by the categories of D-CREDO digital health tools. Each learning objective was rated on a 5-point Likert-scale of relevance. The estimated time of response was 15 minutes. The survey enabled the participants to stop the response process and resume it later. The survey was distributed to a broad group across D-CREDO, including consortium members and associated partners. To assure a high response rate, reminder letters were sent out. Stakeholders were given a one-week period to complete the survey, and their feedback proved instrumental in refining the final selection of LOs.

To ensure a structured evaluation, respondents were asked to assess the relevance of each LO based on its clarity, precision, and applicability to clinical reasoning education. The LOs needed to define measurable outcomes that could be effectively assessed while maintaining a strong focus on enhancing students' clinical reasoning skills through digital health tools. Additionally, they had to align with the needs of undergraduate medical and nursing students, ensuring that they were appropriate for their educational level. The input from respondents was essential in validating the relevance and value of these LOs for clinical reasoning education. For the complete survey, see Appendix 1.

## 2.4 Consensus Meeting and Final Selection

Following the survey, the results were carefully analyzed to refine and prioritize the LOs. This included:

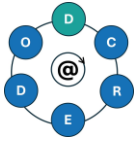
- Identifying the most highly rated LOs
- Incorporating qualitative feedback from survey respondents
- Refining LOs based on stakeholder input

A final consensus meeting was held with the working group to review the survey findings and make necessary adjustments. These discussions were thorough and collaborative, ensuring that all perspectives were taken into account. The finalized LOs were then presented in a dedicated D-CREDO group meeting, where they were met with broad support. This final stage helped ensure that the selected LOs were well-aligned with project objectives and stakeholder expectations, solidifying their role in shaping future learning units.

## 3. Results

### 3.1 Initial learning objectives

A total of 118 LOs were identified. These objectives were categorized to ensure alignment with the educational frameworks, cognitive levels, and digital health tools relevant to clinical reasoning. This represents the initial comprehensive set of LOs gathered from various sources. The working group reviewed and refined this list, selecting the most relevant objectives to present to stakeholders for further validation and alignment with the project goals.



92 LOs targeted students, emphasizing digital literacy and clinical reasoning in medical education, 18 focused on educators, aiming to enhance teaching strategies and interprofessional collaboration, and another 18 addressed healthcare professionals.

3 LOs emphasized Bloom's levels of knowledge recall (Remember), 28 focused on comprehension (Understand), and 46 emphasized application (Apply) to integrate digital tools into practice. Additionally, 17 LOs involved analysis (Analyze) to foster critical thinking, another 17 supported evaluation (Evaluate) to assess digital tool use, and 7 focused on creation (Create) for innovative solutions.

The LOs spanned a range of digital health tools. EHR & CDSS were most represented (33), followed by Telehealth applications (26) covering remote consultations and digital patient interactions. LLMs & Big Data (14) highlighted emerging AI applications in healthcare, while mHealth apps & wearables (7) supported patient engagement and real-time monitoring. 2 focused on AI in medical image analysis, and 36 addressed broader digital health and clinical reasoning topics.

The LOs were mapped to key themes from the DID-ACT framework, ensuring a structured approach to clinical reasoning education. 12 LOs emphasized gathering, interpreting, and synthesizing patient information, highlighting the need for accurate data interpretation in digital health. 7 LOs focused on developing treatment and management plans, supporting students in making evidence-based decisions using digital tools.

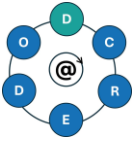
8 LOs covered decision-making, ensuring students critically assess digital health technologies and their impact on patient care. 8 LOs addressed ethical aspects, emphasizing the importance of responsible digital health implementation. Aspects of patient participation were covered by 6 LOs, focusing on shared decision-making and patient-provider communication.

Additionally, 4 LOs targeted errors and their prevention in the clinical reasoning process, helping students recognize potential risks and biases in digital tools. 4 LOs focused on self-reflection on clinical reasoning, encouraging learners to evaluate their own thought processes. Educator-focused objectives included teaching, assessing, and evaluating clinical reasoning (6) to support faculty in integrating digital tools effectively. Other key areas included collaborative aspects of clinical reasoning (3) and interprofessional aspects of clinical reasoning (2), ensuring teamwork and interdisciplinary collaboration are central to digital health education.

### 3.2 Results of the survey

The survey aimed to refine and validate a set of LOs related to clinical reasoning education and the integration of digital health tools. Through an iterative process, the initial pool of LOs was evaluated, leading to a final set of 31 LOs based on expert feedback.

A total of 30 respondents participated in the survey, with 28 completing all sections. The participants represented 10 different countries, contributing diverse perspectives on the relevance and clarity of the proposed LOs. The respondents had varying levels of experience, with an average of 14 years in their respective fields (range: 0 to 40 years).



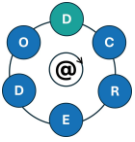
A total of 28 respondents provided 39 feedback entries, offering insights into the selection and refinement of learning objectives (LOs). They explained their choices, suggested refinements, identified potential missing topics, and shared their perspectives on the difficulty of specific objectives.

To quantify the feedback, each learning objective was analyzed individually. The mean, minimum, and maximum scores, along with the total number of responses per LO, were calculated to assess the overall agreement and variation in ratings. These findings helped identify areas where further clarification or adjustments were needed. An example of this can be seen in Table 1, and the full dataset is provided in Appendix 2.

Learning Objective	Average	Min	Max	Count
Students are able to critically evaluate the use of digital technologies in clinical reasoning, identifying their strengths, limitations, and potential for error while proposing strategies to optimize their impact on patient care.	4.57	2	5	30
Students are able to describe the functionalities and applications of digital technologies in enhancing clinical workflows, including their role in supporting diagnosis, monitoring, and patient management.	3.87	2	5	30
Students are able to explain the requirements, challenges, opportunities, and limitations of the physician-patient relationship in the context of digital technologies and reflect on how to integrate these considerations into their practice.	3.73	2	5	30
Students are able to critically evaluate the validity, reliability, and applicability of digital tools and information in the context of clinical reasoning.	4.43	2	5	30
Students are able to clearly explain medical information derived from information technologies to patients in an understandable and empathetic manner.	4.07	1	5	30

*Table 1 - Qualtrics results of the General LOs*

The results provide a foundation for finalizing the LOs, ensuring they align with the needs of educators and learners in clinical reasoning education with digital health tools.



### 3.3 Final list of learning objectives

The working group conducted a productive session to refine the LOs based on survey evaluations. By carefully integrating feedback, we enhanced the clarity, relevance, and educational value of each LO. This collaborative effort resulted in a well-balanced final set of 27 LOs, ensuring their effectiveness in clinical reasoning education with digital technologies.

In alignment with the key performance indicators, we formulated at least one (but actually reached at least three) LOs for each D-CREDO type of tool. Table 2 provides a structured overview of the LOs and their alignment with the DID-ACT themes, specifying the DID-ACT theme each learning objective corresponds to and whether the LO is intended for medical students, nursing students, or both.

By systematically mapping these elements, we ensure that the LOs not only meet the predefined key performance indicators but also contribute meaningfully to the broader goal of enhancing clinical reasoning education through digital health tools.

Below Table 2, which presents the final set of LOs:

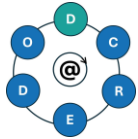
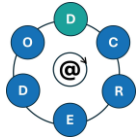
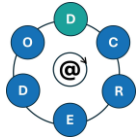


Table 2: The final list of LOs

Category	Target Group	Learning Objective <i>Student are able to ..</i> <i>Educators are able to...</i>	Applicable to Medical/Nursing or Both	DID-ACT Theme
General	Students	Explain the potential benefits of digital technologies in clinical reasoning and list their strengths and limitations.	Both	1. Theories of clinical reasoning
General	Students	Discuss the ethical and legal aspects of using digital technologies in the clinical reasoning process.	Both	9. Ethical aspects
General	Students	Evaluate the validity and reliability of the output of digital technologies in the clinical reasoning process.	Both	11. Errors in the clinical reasoning process and strategies to avoid them
General	Students	Evaluate the use of digital technologies in various clinical settings considering factors such as timing, workload, workflow, and integration in the healthcare team.	Both	6. Collaborative aspects of clinical reasoning
General	Students	Make and justify clinical decisions based on data from digital technologies.	Both	14. Decision Making
General	Students	Explain the meaning and value of the output of digital technologies in an understandable manner appropriate to the target group.	Both	5. Aspects of patient participation in clinical reasoning
General	Educators	Teach the potential benefits of digital technologies in clinical reasoning and list their strengths and limitations.	Both	12. Attitudes towards clinical reasoning teaching (TTT) 13. Teaching, assessing, and evaluating clinical reasoning (TTT)
General	Educators	Teach the ethical and legal aspects of using digital technologies in the clinical reasoning process.	Both	12. Attitudes towards clinical reasoning teaching (TTT) 13. Teaching, assessing, and evaluating clinical reasoning (TTT)

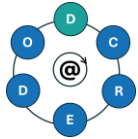


AI in Image Analysis	Students	Use the output of the AI-generated image analysis to reflect on their own diagnostic process, such as making the differential diagnoses.	Medical	3. Generating differential diagnoses including defining and discriminating features 10. Self-reflection on clinical reasoning performance and strategies for future improvement
AI in Image Analysis	Students	Evaluate the impact of AI-generated imaging on clinical decision-making compared to conventional diagnostic methods.	Medical	1. Theories of clinical reasoning 11. Errors in the clinical reasoning process and strategies to avoid them
AI in Image Analysis	Educators	Teach and adapt learning activities that challenge students to critically analyze and compare AI-generated results with those from conventional methods.	Medical	8. (Interprofessional) Collaboration and exchange (TTT) 13. Teaching, assessing, and evaluating clinical reasoning (TTT)
LLMs and Big Data	Students	Evaluate potential influences on their own clinical reasoning process when using LLMs.	Both	10. Self-reflection on clinical reasoning performance and strategies for future improvement
LLMs and Big Data	Students	Apply basic principles of prompt engineering to effectively use LLMs for their clinical reasoning process.	Both	1. Theories of clinical reasoning
LLMs and Big Data	Educators	Teach basic principles of LLMs, supporting students to effectively and responsibly use LLMs in their clinical reasoning process.	Both	13. Teaching, assessing, and evaluating clinical reasoning (TTT)
mHealth apps and wearables	Students	Integrate mHealth technologies into shared decision-making, taking into account patient preferences and context.	Both	5. Aspects of patient participation in clinical reasoning 14. Decision Making
mHealth apps and wearables	Students	Describe how mHealth apps and wearables can be used in routine patient care, for instance continuous patient monitoring and timely intervention.	Both	4. Developing a treatment/management plan 14. Decision Making

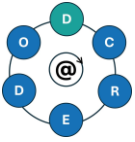


mHealth apps and wearables	Educators	Teach and adapt learning activities that enable students to integrate mHealth technologies to support their clinical reasoning process.	Both	13. Teaching, assessing, and evaluating clinical reasoning (TTT)
EHR and CDSS	Students	Analyze and document patient data within the EHR and create management plans.	Both	13. Teaching, assessing, and evaluating clinical reasoning (TTT)
EHR and CDSS	Students	Create management plans collaboratively with the healthcare team within the EHR.	Both	6. Collaborative aspects of clinical reasoning 7. Interprofessional aspects of clinical reasoning
EHR and CDSS	Students	Use the CDSS effectively and responsibly in the clinical reasoning process.	Both	1. Theories of clinical reasoning  10. Self-reflection on clinical reasoning performance and strategies for future improvement
EHR and CDSS	Students	Monitor patient outcomes over time and adjust their strategies accordingly within the EHR.	Both	4. Developing a treatment/management plan
EHR and CDSS	Educators	Teach students to effectively and responsibly use EHRs within the clinical reasoning process.	Both	13. Teaching, assessing, and evaluating clinical reasoning (TTT)
EHR and CDSS	Educators	Teach students to effectively and responsibly use CDSS within the clinical reasoning process.	Both	13. Teaching, assessing, and evaluating clinical reasoning (TTT)
Telehealth	Students	Explain when to use telehealth methods for consultation and remote diagnosis considering different contexts.	Both	2. Theories of clinical reasoning 3. Gathering, interpreting, and synthesizing patient information





Telehealth	Students	Reflect on how the clinical reasoning process differs in a telehealth setting compared to in-person clinical settings, identifying the unique challenges and opportunities posed by virtual consultations.	Both	1. Theories of clinical reasoning  Generating differential diagnoses including defining and discriminating features
Telehealth	Students	Conduct a simulated telehealth visit considering the boundaries of remote consultation.	Both	1. Theories of clinical reasoning 2. Gathering, interpreting, and synthesizing patient information 3. Generating differential diagnoses including defining and discriminating features  Developing a treatment/management plan
Telehealth	Educators	Teach and adapt learning activities that prepare students to effectively apply clinical reasoning in a simulated telehealth setting.	Both	8. (Interprofessional) Collaboration and exchange (TTT) 13. Teaching, assessing, and evaluating clinical reasoning (TTT)



## 4. Discussion

Deliverable D2.1 provided a foundational literature review, highlighting the evolving role of digital health tools and their impact on clinical reasoning education. It revealed both the promise of novel technologies (e.g., EHR and LLMs) and the relative underrepresentation of more established digital tools (e.g., mobile apps, mHealth). Building on these findings, D2.2 addressed the need for a clear, standardized set of LOs that integrates diverse digital health tools into clinical reasoning education for students and educators.

From the outset, the consortium recognized that a literature-based approach alone would not suffice for creating practical, consensus-driven LOs. Hence, a Delphi-inspired methodology was employed, incorporating expert feedback, national curricular standards, and the DID-ACT framework. This approach ensured that the project not only reflected the latest evidence (as collected in D2.1) but also accounted for real-world educational contexts and interprofessional considerations. The consensus-building process spanned multiple rounds of review and refinement, culminating in a survey that quantitatively and qualitatively assessed the clarity, relevance, and feasibility of each proposed LO.

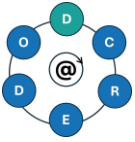
Survey results and subsequent discussions confirmed the importance of covering all five D-CREDO categories of digital tools: AI in image analysis, LLMs & Big Data, mHealth apps and wearables, EHRs & CDSS, and telehealth. Although certain tools initially drew heightened interest, the iterative feedback process helped to balance the final LOs set by incorporating underrepresented tools such as mobile apps. In addition, aligning LOs with the DID-ACT themes ensured that the final selection accounted for critical areas such as ethical considerations, patient participation, self-reflection, and interprofessional collaboration.

This comprehensive approach enabled the working group to surpass several of the original performance indicators by producing a cohesive, well-structured set of 27 LOs. Each LO underwent rigorous scrutiny regarding its alignment with Bloom's taxonomy levels, its application to both medical and nursing contexts, and its capacity to guide meaningful assessment in clinical reasoning education.

## 5. Summary and conclusions

D2.2 successfully transformed the insights gained from D2.1's rapid review into a consensus-based, outcomes-oriented framework of LOs. These 27 LOs address a broad spectrum of digital health tools and map to recognized clinical reasoning and educational theory standards. Through a systematic review, stakeholder engagement, and iterative consensus-building, the consortium has established a robust educational foundation for subsequent development in WP3.

Looking ahead, these finalized LOs will guide the creation of learning units (LUs) and training materials in WP3 that prepare students and educators to leverage digital tools effectively and responsibly in clinical reasoning. By integrating evidence-based best practices with expert consensus, D-CREDO ensures a scalable, adaptable, and future-facing curriculum that addresses the evolving landscape of digital health.



## 6. References

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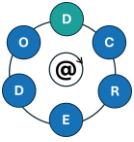
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## 7. Appendices

### Appendix 1 – Qualtrics format

#### Introduction

##### **Welcome to the D-CREDO Learning Objectives Survey**

Thank you for taking the time to participate in this survey. The D-CREDO project aims to enhance clinical reasoning education through the integration of innovative digital tools, such as AI in image analysis, Large Language Models, telehealth, mHealth and wearables, and Electronic Health Records. These tools are designed to empower medical and nursing students by supporting their clinical reasoning skills in realistic and impactful ways.

As a valued stakeholder, your expertise and insights play a crucial role in shaping the project's success. Over the past months, we have gathered a broad range of learning objectives (LOs) from various reliable sources, including literature, interviews, and best practices in clinical reasoning education. These LOs have been refined to reflect the project's goals and its focus on digital health tools within clinical reasoning education.

Now, we need your help to ensure the LOs are the best fit for the D-CREDO project. This survey presents the LOs for your review and asks you to assess their relevance. Your assessment will help prioritize the most relevant and impactful learning objectives, ensuring the project aligns with both stakeholder needs and educational excellence.

The final list of LOs will help shape Learning Units (LUs), ensure quality control, and support assessment. As a key outcome of D-CREDO, the list will be shared widely and may influence updates to educational standards. Additionally, the insights gained will help shape policy recommendations and contribute to the development of the D-CREDO Educational Framework.

**This survey will take approximately 10-15 minutes to complete.**

*„Co-funded by the European Union (D-CREDO project, 2024-1-PL01-KA220-HED-000247790). Views and opinions expressed are, however, those of the author or authors only and do not necessarily reflect those of the European Union or the Foundation for the Development of the Education System. Neither the European Union nor the granting authority can be held responsible for them.,,*

#### **Demographics**

Please specify your profession: \_\_\_\_\_

Please indicate how many years of experience you have in health professions education: \_\_\_\_\_

Please specify the country in which you work: \_\_\_\_\_

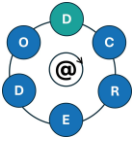
#### **Goal of the Survey**

This survey aims to identify the most relevant learning objectives for clinical reasoning education with integrated digital health tools and gather suggestions for any missing learning objectives that should be considered.

#### **Categories**

You will assess LOs across different categories, including:

- General: Applicable to all LOs, including for example ethical considerations.
- AI in Image Analysis
- Large Language Models
- Telehealth



- mHealth & wearables
- Electronic Health Records (EHRs)

**Criteria**

In the following section, you will see a list of Learning Objectives (LOs). Please assess their relevance, keeping the following criteria in mind. These LOs are designed for undergraduate medical and/or nursing students, as well as some for the educators who teach them.

1. **Specificity** – The LO should be clear, precise, and directly applicable to the context of clinical reasoning education.
2. **Measurability** – The LO should define outcomes that can be assessed effectively.
3. **Focus on Clinical Reasoning** – The LO should enhance students’ clinical reasoning skills, using digital health tools as a means to support and develop these skills.
4. **Educational Level** – The LO should align with the needs of undergraduate medical and nursing students.

**Procedure**

Rate the Learning Objectives (LOs) within each category on a Likert scale from 1 to 5, where:

- 1 = Not relevant
- 2 = Slightly relevant
- 3 = Moderately relevant
- 4 = Very relevant
- 5 = Highly relevant

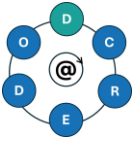
If you believe a learning objective is missing or that its wording needs to be changed, please add it in the comment box provided at the end of each section.

Your thoughtful input will help ensure the learning objectives are practical, impactful, and well-aligned with the goals of the D-CREDO project.

**Rating the LOs**

Please rate these general learning objectives on a scale from 1 to 5, with 1 being *not relevant* and 5 being *relevant*.

	1	2	3	4	5
Students are able to critically evaluate the use of digital technologies in clinical reasoning, identifying their strengths, limitations, and potential for error while proposing strategies to optimize their impact on patient care.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to describe the functionalities and applications of digital technologies in enhancing clinical workflows, including their role in supporting diagnosis, monitoring, and patient management.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to explain the requirements, challenges, opportunities, and limitations of the physician-patient relationship in the context of digital technologies and reflect on how to integrate these considerations into their practice.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to critically evaluate the validity, reliability, and applicability of digital tools and information in the context of clinical reasoning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to clearly explain medical information derived from information technologies to patients in an understandable and empathetic manner.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to develop a comprehensive understanding of the ethical considerations, biases, and implications of using digital health technologies for clinical reasoning, fostering critical thinking and responsible application in patient care.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to work collaboratively with peers and instructors to analyze and propose strategies for optimizing the use of information technology in medical care scenarios.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to make and justify clinical decisions based on data from digital health technologies, demonstrating effective collaboration as part of a healthcare team.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Educators are able to prepare students to navigate the opportunities and challenges posed by digital health innovations, emphasizing their responsible and effective use in clinical practice.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



*If you have any additional feedback, suggestions, or comments about the learning objectives, their relevance, or if you would like to suggest any missing learning objectives, please share them below.*

Please rate these learning objectives of AI in image analysis on a scale from 1 to 5, with 1 being not relevant and 5 being relevant.

	1	2	3	4	5
Students are able to demonstrate the ability to integrate AI-generated image insights into clinical decision-making, comparing AI outputs with traditional diagnostic methods to form evidence-based conclusions in simulated settings.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to use the output of the AI-generated image analysis to reflect on their own diagnostic process, such as making the differential diagnoses.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Educators are able to develop case-based learning activities where students analyze cases where AI outputs conflict with traditional methods, encouraging problem-solving and exploration of why discrepancies occur.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*If you have any additional feedback, suggestions, or comments about the learning objectives, their relevance, or if you would like to suggest any missing learning objectives, please share them below.*

Please rate these learning objectives of LLMs and Big Data on a scale from 1 to 5, with 1 being not relevant and 5 being relevant.

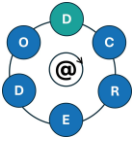
	1	2	3	4	5
Students are able to explain the principles behind large language models (LLMs) (such as ChatGPT) in order to best employ it in clinical reasoning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to critically question a model's output and reflect on their own clinical reasoning process such as the differential diagnoses or other clinical decisions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to comprehend and apply the principles of prompt engineering to make best use of large language models in clinical reasoning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Educators are able to apply AI models to create effective and engaging learning experiences in clinical reasoning for students.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Educators are able to understand and effectively explain the principles of prompt engineering, enabling optimal use of large language models to support clinical reasoning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*If you have any additional feedback, suggestions, or comments about the learning objectives, their relevance, or if you would like to suggest any missing learning objectives, please share them below.*

Please rate these learning objectives of mHealth apps and wearables on a scale from 1 to 5, with 1 being not relevant and 5 being relevant.

	1	2	3	4	5
Students are able to integrate mHealth technologies into shared decision-making with patients, taking into account their preferences and context.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to integrate mHealth apps and wearables into routine nursing care for continuous patient monitoring and timely intervention.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to effectively manage and organize large amounts of information (e.g. mHealth apps) by identifying, prioritizing relevant data, and disregarding non-relevant information.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Educators are able to create case-based learning activities that simulate real-world scenarios involving mHealth apps and wearables, enabling students to develop skills in interpreting data, addressing patient concerns, and integrating these technologies into personalized care plans.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*If you have any additional feedback, suggestions, or comments about the learning objectives, their relevance, or if you would like to suggest any missing learning objectives, please share them below.*



Please rate these learning objectives of EHR and CDSS on a scale from 1 to 5, with 1 being not relevant and 5 being relevant.

	1	2	3	4	5
Students can explain how Electronic Health Records (EHR) integrate with clinical decision support systems (CDSS) to enhance clinical decision-making.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to discuss challenges of prioritizing multiple forms of data including clinical decision supports to make informed decisions about patient care.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to analyze patient data within the EHR and collaboratively create therapeutic plans based on structured clinical discussions and feedback from supervising clinicians.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to monitor patient outcomes over time, compare their care plans with attending clinician decisions, and adjust their strategies accordingly.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students can assess how using Electronic Health Records (EHR) affects their own clinical reasoning skills and performance, including potential biases and benefits for decision-making and patient care.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Educators are able to assess students' documentation and critical thinking skills using virtual simulation and electronic health records.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*If you have any additional feedback, suggestions, or comments about the learning objectives, their relevance, or if you would like to suggest any missing learning objectives, please share them below.*

Please rate these learning objectives of telehealth on a scale from 1 to 5, with 1 being not relevant and 5 being relevant.

	1	2	3	4	5
Students are able to develop a diagnostic and management plan (including additional investigations, treatment options, consultations) for patients assessed through a telemedicine platform in a virtual patient-simulated clinical scenario of an ambulatory care setting case.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to explain when to use telemedicine methods and tools for consultation (doctor-patient, doctor-doctor) and remote diagnosis.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are able to reflect on how clinical reasoning differs in a telehealth setting compared to a traditional, in-person clinical setting, identifying the unique challenges and opportunities posed by virtual consultations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Educators are able to design and deliver instructional strategies and simulations that prepare students to effectively utilize telehealth technologies, emphasizing the development of clinical reasoning and communication skills in virtual settings.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*If you have any additional feedback, suggestions, or comments about the learning objectives, their relevance, or if you would like to suggest any missing learning objectives, please share them below.*

### **Thank You for Your Valuable Feedback**

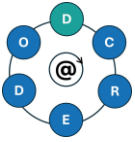
*Your input is critical to the success of the D-CREDO project. By sharing your expertise, you are helping us prioritize and refine learning objectives that will shape the future of clinical reasoning education.*

*If you have any further questions or additional feedback, please feel free to reach out to our team at [j.verdonschot@erasmusmc.nl](mailto:j.verdonschot@erasmusmc.nl) or visit our website: <https://d-credo.eu>.*

*Thank you once again for your time and contribution!*

**Warm regards,**

*The D-CREDO Project Team*



## Appendix 2 – Qualtrics Results

**Number of responses:** *General N=30, D-credo Tools: N=28*

**Countries:** *N=10*

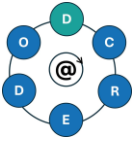
**Years of experience:** *Mean=14, min=0, Max=40*

**Feedback** *N=39*

### General

Learning Objective	Average	Min	Max	Count
Students are able to critically evaluate the use of digital technologies in clinical reasoning, identifying their strengths, limitations, and potential for error while proposing strategies to optimize their impact on patient care.	4.57	2	5	30
Students are able to describe the functionalities and applications of digital technologies in enhancing clinical workflows, including their role in supporting diagnosis, monitoring, and patient management.	3.87	2	5	30
Students are able to explain the requirements, challenges, opportunities, and limitations of the physician-patient relationship in the context of digital technologies and reflect on how to integrate these considerations into their practice.	3.73	2	5	30
Students are able to critically evaluate the validity, reliability, and applicability of digital tools and information in the context of clinical reasoning.	4.43	2	5	30
Students are able to clearly explain medical information derived from information technologies to patients in an understandable and empathetic manner.	4.07	1	5	30
Students are able to develop a comprehensive understanding of the ethical considerations, biases, and implications of using digital health technologies for clinical reasoning, fostering critical thinking and responsible application in patient care.	4.10	2	5	30





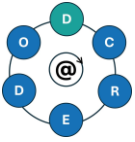
Students are able to work collaboratively with peers and instructors to analyze and propose strategies for optimizing the use of information technology in medical care scenarios.	3.43	1	5	30
Students are able to make and justify clinical decisions based on data from digital health technologies, demonstrating effective collaboration as part of a healthcare team.	4.13	1	5	30
Educators are able to prepare students to navigate the opportunities and challenges posed by digital health innovations, emphasizing their responsible and effective use in clinical practice.	4.13	1	5	30

#### AI in Image Analysis

Learning Objective	Average	Min	Max	Count
Students are able to demonstrate the ability to integrate AI-generated image insights into clinical decision-making, comparing AI outputs with traditional diagnostic methods to form evidence-based conclusions in simulated settings.	3.96	1	5	28
Students are able to use the output of the AI-generated image analysis to reflect on their own diagnostic process, such as making the differential diagnoses.	4.11	2	5	28
Educators are able to develop case-based learning activities where students analyze cases where AI outputs conflict with traditional methods, encouraging problem-solving and exploration of why discrepancies occur.	4.25	1	5	28

#### LLMs and Big Data

Learning Objective	Average	Min	Max	Count
Students are able to integrate mHealth technologies into shared decision-making with patients, taking into account their preferences and context.	4.50	1	5	28
Students are able to integrate mHealth apps and wearables into routine nursing care for continuous patient monitoring and timely intervention.	4.25	1	5	28



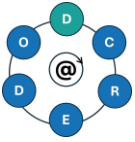
Students are able to effectively manage and organize large amounts of information (e.g. mHealth apps) by identifying, prioritizing relevant data, and disregarding non-relevant information.	3.82	1	5	28
Educators are able to create case-based learning activities that simulate real-world scenarios involving mHealth apps and wearables, enabling students to develop skills in interpreting data, addressing patient concerns, and integrating these technologies into personalized care plans.	4.32	2	5	28

#### mHealth apps and wearables

Learning Objective	Average	Min	Max	Count
Students are able to integrate mHealth technologies into shared decision-making with patients, taking into account their preferences and context.	4.50	1	5	28
Students are able to integrate mHealth apps and wearables into routine nursing care for continuous patient monitoring and timely intervention.	4.25	1	5	28
Students are able to effectively manage and organize large amounts of information (e.g. mHealth apps) by identifying, prioritizing relevant data, and disregarding non-relevant information.	3.82	1	5	28
Educators are able to create case-based learning activities that simulate real-world scenarios involving mHealth apps and wearables, enabling students to develop skills in interpreting data, addressing patient concerns, and integrating these technologies into personalized care plans.	4.32	2	5	28

#### EHR and CDSS

Learning Objective	Average	Min	Max	Count
Students are able to explain different types of knowledge-based systems and medical applications of clinical decision support systems to optimize their clinical decision making and name chances and limitations.	3.46	1	5	28



Students are able to analyze patient data within the EHR and collaboratively create therapeutic plans based on structured clinical discussions and feedback from supervising clinicians.	3.54	1	5	28
Students are able to analyze patient data within the EHR and collaboratively create therapeutic plans based on structured clinical discussions and feedback from supervising clinicians.	4.11	1	5	28
Students are able to monitor patient outcomes over time, compare their care plans with attending clinician decisions, and adjust their strategies accordingly.	4.07	1	5	28
Students are able to evaluate the cognitive effects of EHR use on clinical reasoning, including the risks of automation bias and the benefits of note customization.	3.86	1	5	28
Educators are able to assess students' documentation and critical thinking skills using virtual simulation and electronic health records.	4.18	2	5	28

#### Telehealth

Learning Objective	Average	Min	Max	Count
Students are able to develop a diagnostic and management plan (including additional investigations, treatment options, consultations) for patients assessed through a telemedicine platform in a virtual patient-simulated clinical scenario of an ambulatory care setting case.	4.07	1	5	28
Students are able to explain when to use telemedicine methods and tools for consultation (doctor-patient, doctor-doctor) and remote diagnosis.	4.14	1	5	28
Students are able to reflect on how clinical reasoning differs in a telehealth setting compared to a traditional, in-person clinical setting, identifying the unique challenges and opportunities posed by virtual consultations.	4.14	1	5	28
Educators are able to design and deliver instructional strategies and simulations that prepare students to effectively utilize telehealth technologies, emphasizing the development of clinical reasoning and communication skills in virtual settings.	4.25	2	5	28