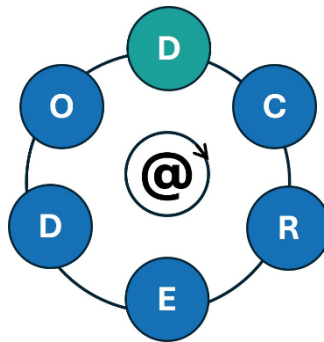


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# D-CREDO

## Digital Health Technologies-Augmented Clinical Reasoning Education



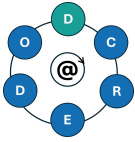
2024-1-PL01-KA220-HED-000247790

## D3.2 Development of learning units for students

Deliverable number	D.3.2
Delivery date	31 March, 2026
Status	(final)
Authors	JU, Instruct

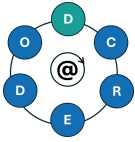
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## Document Revision Table

Version	Date	Author(s)	Organization	Comments
0.1	12/11/25	Instruct	Instruct	Initiated document
0.2	6/01/26	Instruct	Instruct	General description of the development process
0.3	7/03/26	Andrzej Kononowicz	JU	Draft of tables with outcome of key performance indicators and the methodology of integration of virtual patients and digital tools
0.4	1/04/26	Andrzej Kononowicz	JU	Draft of the full-text of the deliverable
0.5	8/04/26	All	All	Comments by the consortium
1.0	29/04/26	Andrzej Kononowicz	JU	Final version of the deliverable addressing the comments by the consortium
1.1	3/06/26	Andrzej Kononowicz	JU	Updated version to reflect changes in learning units



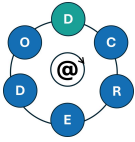
## Summary

**Objectives:** The objective of this activity was to develop a set of student learning units (LUs), including virtual patients (VPs), focused on the use of digital health tools in clinical reasoning. The developments were to be aligned with the blueprint defined in the D3.1 document and the educational approach outlined in the D-CREDO white paper (D2.3).

**Approach:** Working in parallel in small groups, the consortium involving all partners developed student LUs in 6-8 week batches. This included outlining student activities, designing multimedia materials, integrating digital tools into VPs, and developing model answers, teacher guides, and assessment tasks. Selected LUs were adapted for the needs of nursing students. A multiprofessional team of reviewers, independent of the development process, conducted iterative reviews, including an initial didactical review of the LU outline, followed by didactical and content reviews of educational materials prior to development and upload of the materials to the learning management and virtual patient systems.

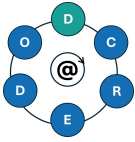
**Results:** We developed 8 new or adapted LUs covering key aspects of digital health in clinical reasoning including foundations of use of digital tools in clinical reasoning, telehealth, responsible use of AI, Large Language Models, Clinical Decision Support Systems, Electronic Health Records, AI in image analysis, and wearables. These LUs incorporate 20 VPs adapted from the iCoViP repository across four case types: regular, domain-adapted, key feature and role-playing. The total estimated learning time of activities in LUs is over 37 hours. Two LUs and three VPs were adapted for nursing education. A total of 13 digital tools were integrated into VP activities covering all five D-CREDO tool categories. VP integration followed a project-specific taxonomy, including direct, generic, clinical exposure, mock-up, population-to-patient, and video-based integration.

**Conclusion:** The developments followed the list of student LUs outlined in the D3.1 blueprint, with only minor adjustments. The LUs were designed to be student-centred and active, emphasising experiential learning through the use of integrated digital tools within VP contexts, while carefully managing cognitive load. The quality of the materials was ensured through a system of iterative internal reviews. The next steps in the project include developing train-the-trainer learning units for educators to support delivery of the student LUs, conducting a pilot evaluation of the developed units, and subsequently refining the LUs based on user feedback.



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## 1 Introduction

The goal of the D3.2 deliverable is to report on the development process of the D-CREDO student learning units (LUs). The division into modules should follow the blueprint set by the consortium in D3.1. The deliverable will feature a list of all the implemented LUs and virtual patients (VPs), as well as any necessary modifications to the blueprint. Additionally, the report will detail the digital tools integrated into the LUs and VPs, including the methodology used for integration. The LUs will be made available as open access on the project Moodle system and cover learning activities to foster clinical reasoning around selected digital tools.

## 2 Methods

### Preparation

To prepare the deliverable, we asked all partners to sign up for the learning units from the blueprint they wanted to develop. At the same time we also formed a multiprofessional team of reviewers, who were not involved in the development process. We ensured that in each LU-team all partners were involved either as developer or as reviewer and that each team had a multiprofessional perspective on the topic.

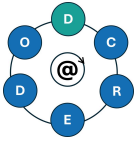
Another preparatory step was providing the development infrastructure. For each LU-team we created a development folder in GoogleDrive which included

- Prepared LU outline template
- Links to the preparatory work (blueprint and reviewer comments from D3.1)
- Documents for didactical and content review as designed in WP4.

### Implementation

Two teams worked in parallel developing one LU each (see Table 1). Each LU was developed, reviewed, and implemented in Moodle and CASUS in about 6-8 weeks. The draft versions of the educational material was developed in GoogleDrive and only after the review rounds, the content was transferred and implemented in Moodle or CASUS. This transfer was coordinated by Instruct in close cooperation with LU team leads.

After the first round of development the team coordinators compiled a "lessons learned" document supporting the coordinators of the following development rounds. During a team meeting these aspects were elaborated by the team coordinators and discussed in the consortium. Important aspects were for example the need of regular weekly meetings to coordinate the activities; setting adequate time frame to ensure that students (and educators) can complete the activities; the use of templates for videos, slidesets and infographics; compliance with the CC BY-NC-SA 4.0 licence for external multimedia material; and use of images of diverse patients (age, gender, skin color, etc).



We have set up a dashboard to monitor the progress of developing the LUs (Figure 1). The dashboard visualises the four batches of work into which we have divided the development activities, spanning from 1<sup>st</sup> October 2025 to the end of March 2026. To ease communication around the developed materials, we have assigned codes to each of the student learning units (101-109). However, these codes do not indicate a sequence of progression through the LUs in the D-CREDO curriculum and will not be visible to users. The components of the LUs that we monitored include the learning unit outline (LD), instructions & presentations (ID), virtual patients (VP), digital tool integrations (DT), assessments (AS), and transfers to Moodle and CASUS (TF). Each of the components had a colour-coded indicator of status.

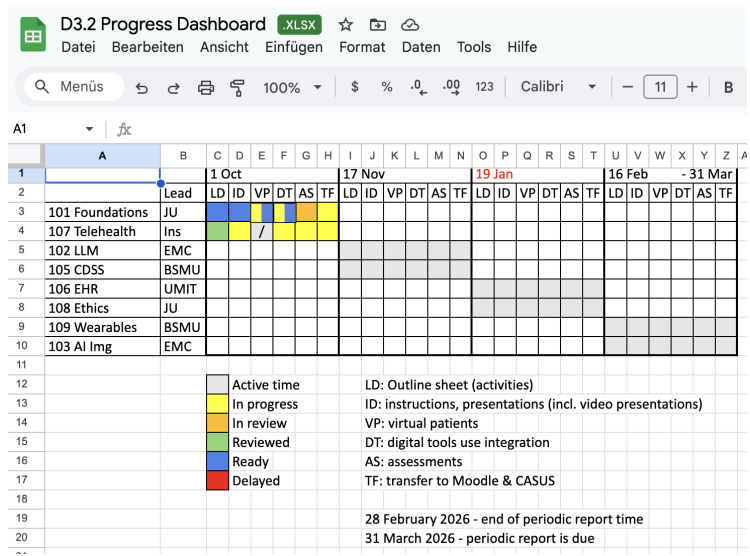
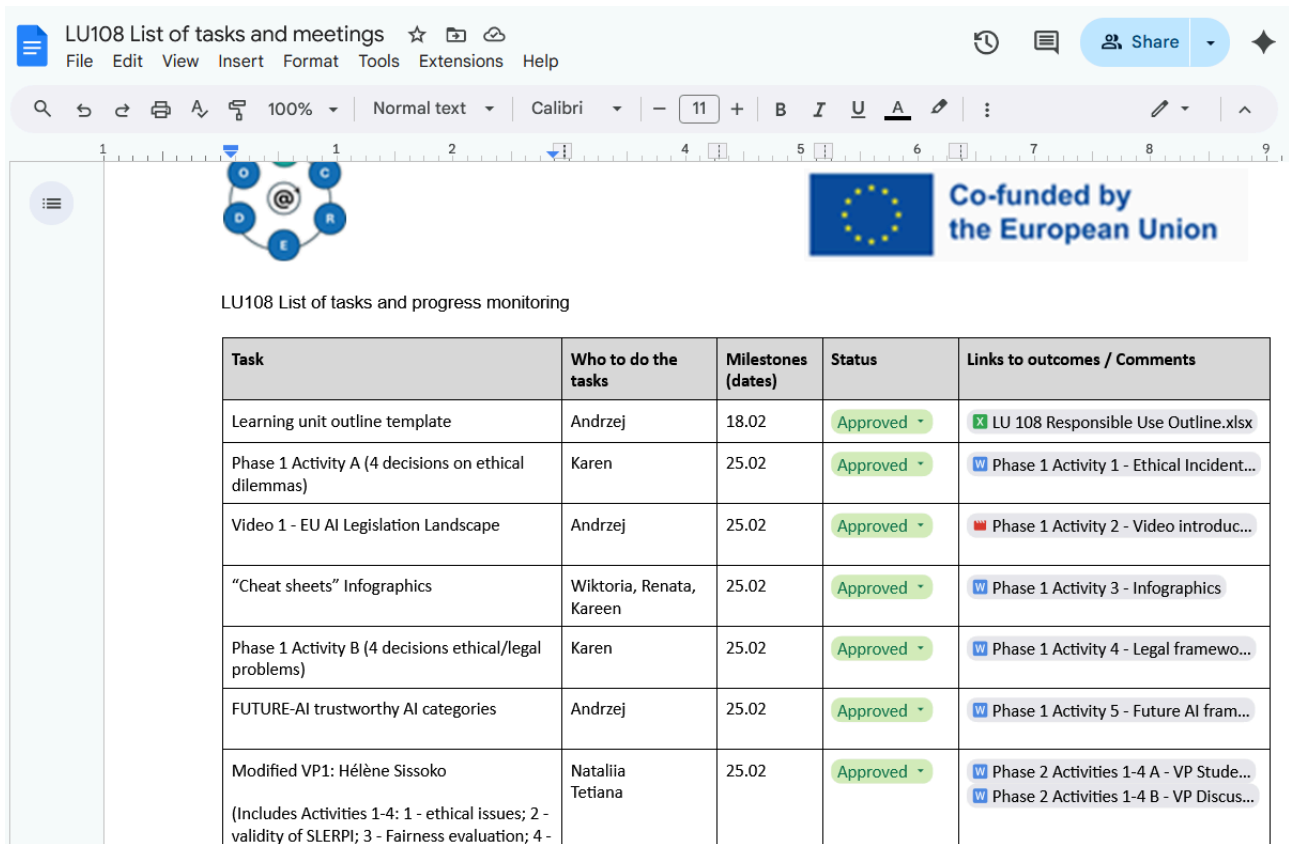
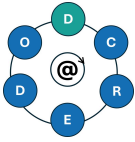


Figure 1: Visual dashboard to monitor the progress of all developed student LUs

Each of the learning unit development groups had set up its own detailed task monitoring system based either on Trello boards or Google documents (Figure 2).



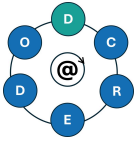
Task	Who to do the tasks	Milestones (dates)	Status	Links to outcomes / Comments
Learning unit outline template	Andrzej	18.02	Approved	<a href="#">LU 108 Responsible Use Outline.xlsx</a>
Phase 1 Activity A (4 decisions on ethical dilemmas)	Karen	25.02	Approved	<a href="#">Phase 1 Activity 1 - Ethical Incident...</a>
Video 1 - EU AI Legislation Landscape	Andrzej	25.02	Approved	<a href="#">Phase 1 Activity 2 - Video introduc...</a>
"Cheat sheets" Infographics	Wiktoria, Renata, Kareen	25.02	Approved	<a href="#">Phase 1 Activity 3 - Infographics</a>
Phase 1 Activity B (4 decisions ethical/legal problems)	Karen	25.02	Approved	<a href="#">Phase 1 Activity 4 - Legal framewo...</a>
FUTURE-AI trustworthy AI categories	Andrzej	25.02	Approved	<a href="#">Phase 1 Activity 5 - Future AI fram...</a>
Modified VP1: H�el�ene Sissoko (Includes Activities 1-4: 1 - ethical issues; 2 - validity of SLERPI; 3 - Fairness evaluation; 4 -	Natalia Tetiana	25.02	Approved	<a href="#">Phase 2 Activities 1-4 A - VP Stude...</a> <a href="#">Phase 2 Activities 1-4 B - VP Discus...</a>

Figure 2: Example of an internal task list, their status, and outcomes for the development of a student LU

## Review

We divided the review process into several steps, which were implemented in parallel with the development process:

- (1) Didactical review of the outline of the LU by at least two reviewers including a meeting with the team if necessary.
- (2) Didactical review of the educational material, such as video scripts, drafts of virtual patients, case vignettes, or role-play scripts prior to the development.
- (3) Content review of the educational material by content matter experts prior to the development.
- (4) Final review of the LU and the educators material in Moodle by the review group, the consortium, and associate partners.



### 3 Results

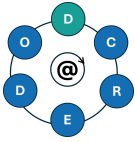
#### Learning unit outlines

The learning units for students are available in the project Moodle (see Table 1 with links). We also uploaded the material for educators that helps them to implement the learning units (see link in Table 1).

Learning unit	Team lead	Student course in Moodle	Material for educators	Total time
(101) Foundations of Digital Health Technologies in Clinical Reasoning	JU	<a href="#">Student course</a>	<a href="#">Resources for the D-CREDO student courses</a>	4h 30min
(107) Clinical Reasoning at a Distance	Ins	<a href="#">Student course</a>		5h 30min
(102) Using Large Language Models for Clinical Reasoning	EMC	<a href="#">Student course</a>		4h
(105) Clinical Reasoning with Clinical Decision Support Systems	BSMU	<a href="#">Student course</a>		5h 30min
(106) From Data to Care: Understanding Electronic Health Records	UMIT	<a href="#">Student course</a>		6h
(108) Responsible Use of Digital Tools	JU	<a href="#">Student course</a>		4h
(109) Digital Tools in Integrated Patient-Centered Care	BSMU	<a href="#">Student course</a>		4h
(103) Using digital tools for image analysis in clinical reasoning	EMC	<a href="#">Student course</a>		3h 30min

Table 1: Overview of the D-CREDO learning units for students.

The backbone of each D-CREDO learning unit is the description spreadsheet. Based on the template developed in the blueprint deliverable (D3.1, Activity 3), it specifies a detailed list of activities planned for each phase of the learning unit. Each learning unit consists of 2-3 (a-)synchronous phases and a separate assessment phase. The cover page presents the key metadata from the blueprint, such as the title, clinical reasoning (CR) theme, specific learning objectives (LOs), prerequisites, D-CREDO tool categories, and time estimation (Figure 3).



LU107 Telehealth Outline .XLSX

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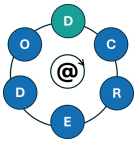
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	A	B	C	D	E	F
1	<b>Title of Learning unit</b>	Clinical Reasoning at Distance				
2	<b>Learner level</b>	Novice				
3	<b>Theme(s)</b>	Developing a treatment plan, Gathering information, Generating differential diagnoses				
4	<b>Overarching and specific learning objectives</b>	LO1. Explain when to use telehealth methods for consultation and remote diagnosis considering different contexts. LO2. 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. LO3. Conduct a simulated telehealth visit considering the boundaries of remote consultation.  Specific LOs: After the LU students will be able to - Explain at least three clinical scenarios where telehealth is suitable or less suitable - Compare the use of telehealth in urban, rural, and resource-limited settings, recognizing context-based benefits and constraints for CR. - Explain key elements of clinical reasoning that can be affected by remote consultations. - Discuss at least two unique challenges and two opportunities. - Apply specific steps of the clinical reasoning process in a telehealth setting.				
5	<b>Prerequisites</b>	Foundations of Clinical Reasoning (D-CREDO) Generating differential diagnoses (DID-ACT) Developing treatment plan (DID-ACT) Collect & prioritize findings (DID-ACT) Person-centered care (DID-ACT) Basic patient communication and feedback skills				
6	<b>Covered D-CREDO tool(s)</b>	Telehealth Tools				
7	<b>Target group(s)</b>	Medical and nursing students				
8	<b>Description</b>	This learning unit introduces novice medical and nursing students to clinical reasoning in telehealth settings. Students learn to gather information, generate differential diagnoses, and develop treatment plans during remote consultations, while reflecting on the unique opportunities and limitations of virtual care.				
9	<b>Phases:</b>	Asynchronous (online) Preparation	Synchronous (online or F2F)	Synchronous (online or F2F)	Assessment	
10	<b>Group size</b>	Unlimited	20-25	20-25	Unlimited	
11	<b>Approx. workload (ECTS)</b>	60 min	ca. 150 min	ca. 90 min	30 min	
12	<b>Adaptations</b>		Online recommended, but can be held F2F as well (rooms and equipment needed)	Optional phase, e.g. if students record their roleplays they could meet again and analyze the videos in depth regarding CR aspects		

LU Outline Phase 1 Phase 2 Assessment

Figure 3: The cover page of a sample description spreadsheet for the LU “Clinical Reasoning at Distance”.

In the following tabs of the LU description, each phase is specified in detail through a characterization of the constituent activities, classified according to specific LOs, ICAP activity category, used educational methods or strategies, group settings, approximate duration, required materials, and alternative scenarios (Figure 4 presents a sample phase tab from the LU107 description). In the last column of Table 1, we present the total duration of activities (including assessment activities) designed and described in the spreadsheets for each learning unit. The total duration of activities across all learning units amounts to 37 hours.



LU107 Telehealth Outline .XLSX

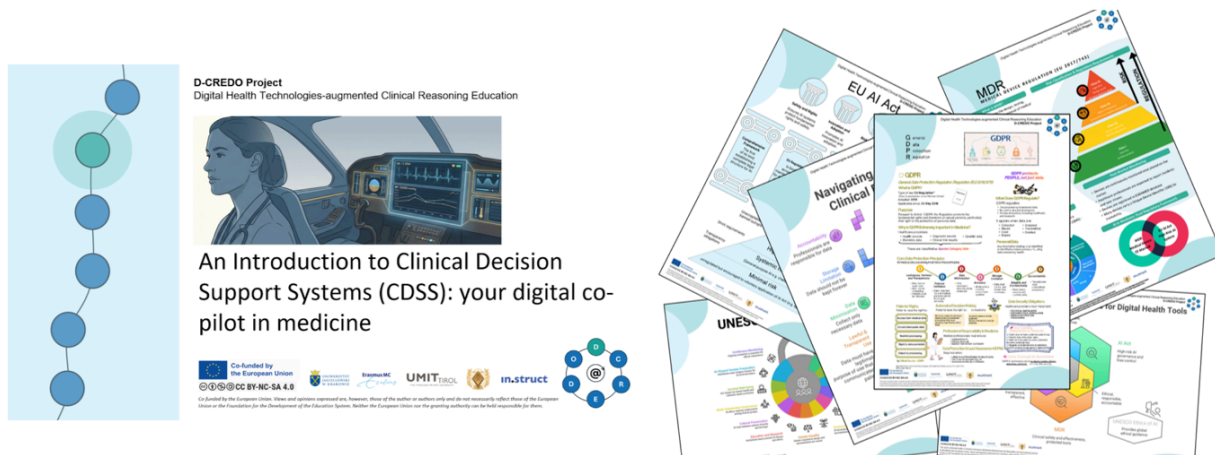
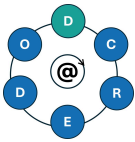
Phase of Instruction	Intention / spec. LOs	ICAP	Description	Methods/strategy	All / Small groups / Pairs / Individual	Approx duration (min)
Phase 2: synchronous	Online or F2F (F2F if space and technical equipment is available)					
LO&agenda	Familiarize students with structure and LOs of this phase and clarify any open questions from phase 1	Passive		Input	All	5
Evaluation/Assessme	Explain at least three clinical scenarios where telehealth is suitable or less suitable. Identify key elements of clinical reasoning that are affected by remote consultations.	Interactive	The students' responses on the exercise in phase 1 are shared and discussed	Discussion	either in plenary or use a specific discussion format	10
Information/Presentat		Active	Students are informed about the roleplay and what they are expected to do. Students are divided into small groups (either mono- or interprofessional) and they receive the information about the roles (important that each student only receives the information for their first role). Students familiarize themselves with the information.	Groupwork	All	10
Application/Exercise	- Explain at least three clinical	Interactive	Simulated Telehealth Scenarios:	Activities	Roleplay	Small groups (3-5) depending on group size and task duration

LU Outline Phase 1 Phase 2 Assessment

Figure 4: Details of activities in a synchronous phase 2 for the LU “Clinical Reasoning at Distance”.

### Instructional materials

The goal of the D-CREDO curriculum is to support active student learning. As specified in the white paper (D2.3), we aim to promote hands-on, collaborative learning rather than rely on approaches that lead to passive learning, such as long lectures and reading assignments. Correspondingly, we place greater emphasis in the learning units on virtual patients, student interactions (e.g. group discussions, quizzes and assignments), and the integration of digital tools. However, there were moments within the learning units where some transfer of knowledge was necessary. We developed a collection of e-learning resources that include voice-over video recordings of mini-lectures, external videos and reading materials, infographics, descriptions of activities, quizzes, assignments, group works, and model answers for facilitators of the learning units. The development process for all learning resources (including virtual patients, assessments, etc) involved reviewing the concept of the resource to be developed, creating a draft version (for example, in the case of videos, this included a detailed screenplay), developing the multimedia materials, and final production. In developing multimedia materials, we used AI-based tools such as text-to-image tools (OpenAI DALL-E, Napkin AI, Google NotebookLM), text-to-voice tools (ElevenLabs AI Voice Generator), and text-to-video tools (HeyGen). When using these tools, a key assumption was that they would assist, rather than replace, human involvement in the development process. Human contributors provided detailed instructions for each component and carefully reviewed and approved all generated outputs. Figure 5 presents an overview of exemplary instructional materials developed as part of this activity.



### Red Flags indicating need for an in-person care

#### 1. Acute or Emergency Presentations

This includes conditions such as sudden onset of severe chest or abdominal pain ("Acute Abdomen"), syncope, active bleeding. In such cases it might be indicated to organize an immediate transport to the nearest hospital / emergency room.

#### 2. Hemodynamic or Clinical Instability

This includes conditions, such as tachypnea, tachycardia, arrhythmia, suspected sepsis shock. In such cases it might be indicated to organize an immediate transport to the nearest hospital / emergency room.

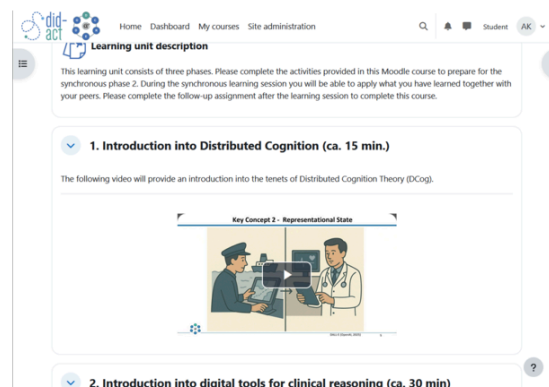


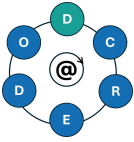
Figure 5: Overview of exemplary instructional materials developed for the student LUs.

## D-CREDO virtual patients

The D-CREDO learning units are case-based. The primary vehicle for this is virtual patients that showcase how digital health tools impact clinical reasoning. Rather than developing cases from scratch, we stated in the project proposal that we would reuse, where possible, the existing collection of virtual patients from the European project iCoViP [5] and adapt them to the needs of the learning units. Already at the stage of blueprinting (D3.1) we made a preselection of candidate virtual patients from the repository of over 200 cases. While developing the learning units the list was further refined based on the collected experiences. The final list comprises 20 adapted cases available as a Google spreadsheet [7]. The list contains both male and female patients (male=12; female=8), from all age groups (age range: 15-76) and with variation in ethnicity. The total number of VPs available in the learning units exceeds the declared key performance indicator of 15 VPs cases.

The resulting adapted VPs differ in their structure and in the way they are used within a learning unit, in order to fit the planned learning experience. The taxonomy below describes these variations.

- **Regular** - An interactive patient scenario that retains the typical structure of the iCoViP project, usually consisting of 5-8 screen cards with questions or activities aligned with one or more digital health tools.

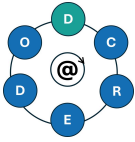


- **Domain-adapted** - A regular VP whose content has been adapted to another health profession, for example nursing, while retaining the original case structure.
- **Key feature** - The initially full-length VP was reduced to a short patient scenario consisting of 1-3 screen cards that focus on one or two critical clinical decisions related to a digital health tool. In this way, students do not have to spend time on elements of the case that are not relevant to the targeted clinical reasoning aspect and can instead focus on the most relevant part of the scenario (e.g. the decision between in-person care and remote consultation; example in Figure 6).
- **Role playing** - The virtual patient served as the basis for a student role-play involving a digital tool. A script for the role-play scenario was developed based on this case.

Figure 6: A D-CREDO key-feature virtual patient depicting Markus Doman, a post-COVID-19 patient, in a telehealth setting (LU107).

Additionally and not counted in this list, some of the learning units contain “Worked examples” - an original VP from the iCoViP collection is accompanied by a model answer to a digital health tool-related activity. Students select a VP from the iCoViP database, often as part of formative or summative assessment. To illustrate the expected response, the designers of the D-CREDO learning unit prepared model answers for a specific worked-example VP (e.g. Khadija Okeke, a 5-year old girl from the iCoViP collection in LU105). Students can compare their own responses with worked examples, even if they selected a different VP.

The VP cases were developed to be patient-centred, incorporating rich background information to illustrate the patient perspective and foster an empathic approach. Many of the cases include patient images generated using AI-based tools such as Adobe Firefly or DALL-E, to simulate authenticity but preserve real patient privacy (e.g. Figure 7, left). However, we are aware of the limitations of this approach (as reported in [2]) and therefore use it only where it is appropriate to maintain clinical fidelity. Key student decisions are captured using various question formats (e.g. MCQs, open-ended questions), accompanied by feedback. To accommodate the uncertainty inherent in clinical reasoning, appropriate assessment methods are used, such as slider questions with ranges of acceptable answers (e.g. Figure 6, right).

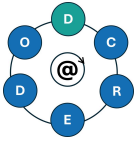


Some VP cases proved particularly suitable for scenarios involving digital health tools and therefore appear more than once in the list. One example is the case of Franz Huber, a 65-year-old car mechanic diagnosed with type 2 diabetes mellitus. The case is presented at different stages of the clinical pathway, from the initial diagnosis to decisions about follow-up care, from both medical and nursing perspectives. We consider this a strength of the VP integration into the curriculum, as it demonstrates coherence across different LUs of the D-CREDO curriculum.

## Integration of digital health tools

The starting point for integrating digital health tools into VPs was the list of tools identified during the blueprinting of the learning units in D3.1 and the rapid literature review in D2.1. Ultimately, we selected 13 tools that, in our view, represent a good match between tool capabilities, accessibility, and the needs of specific VP cases (Table 2). The list included examples of each category of D-CREDO tools (mobile/wearables n=4; electronic health records (EHR)/clinical decision support systems (CDSS) n=5; Large Language Models (LLM)/Big data n=2, Telehealth tools n=1 and AI in Image Analysis n=1).

#	LU	Tool category	Digital tool	Type of integration
1	LU101	Mobile/wearables	Mobile ECG (Kardia Mobile ECG 6L)	Video-based integration
2	LU101	EHR+CDSS	Medical calculator: CHA <sub>2</sub> DS <sub>2</sub> -VASc score calculator	Direct tool integration
3	LU101	Mobile/wearables	Mobile application: MySugr (Diabetes Management)	Direct tool integration
4	LU102	LLM and Big data	General LLM (e.g. ChatGPT)	Generic tool integration
5	LU103	AI in Image Analysis	Sklip + simulated AI image analysis output	Video-based integration + Mockup
6	LU105	EHR+CDSS	Physician-Facing CDSS: Isabel DDX Companion	Direct tool integration
7	LU105	EHR+CDSS	Patient-Facing CDSS: Ada or Symptomate	Direct tool integration
8	LU106	EHR+CDSS	EHR dummy	Clinical exposure; Mockup integration
9	LU107	Telehealth tools	General videoconferencing tool (e.g. Zoom)	Generic tool integration
10	LU108	EHR+CDSS	Machine Learning Model on-line: SLERPI	Direct tool integration
11	LU108	LLM and Big data	Orange Data Mining	Population-to-patient integration



12	LU109	Mobile/wearables	WatchPAT ONE	Video-based integration
13	LU109	Mobile/wearables	Migraine Buddy	Direct tool integration

Table 2: Overview of the D-CREDO digital health tools in use in the learning units


Following our experience from previous project where a different type of models (the Virtual Physiological Human initiative [3]) was introduced into VPs, we introduced our own taxonomy of digital tool integrations into VPs consisting of 6 types:

1. **Direct tool integration** - students extract relevant clinical information from the virtual patient case and enter it into a real web-based or mobile application suggested by the facilitator that is available to them (for example as a free or demo version). The output produced by the tool is then interpreted in the context of the virtual patient's diagnostic or management problem.

Examples of this integration involve medical calculators (e.g. CHA<sub>2</sub>DS<sub>2</sub>-VASc score), validated machine-learning models (e.g. SLERPI, Figure 7), clinical decision support systems and mobile apps (e.g. Isabel DDX Companion, Symptomate), disease management apps (MySugr for diabetes management or Migrane Buddy for acute headache). A list of references is available in chapter 6 of this report.

**Discussion guide** (VP activities 1, 2, 4)  
Discussion focuses on the intersection of clinical presentation, patient's background, and the potential for cognitive or systemic biases.

**VP exercise (Activity 2)**  
Card 6  
SLERPI  
- Q1: Has SLERPI confirmed Mrs Sissoko's diagnosis of SLE?  
**Model answer:**  
Mrs Sissoko meets one clinical (alopecia) and four laboratory criteria (proteinuria, positive ANA, low C3 and C4 levels, and immunological disorder with anti-dsDNA). SLERPI calculates a 99.99% probability of SLE, with "definite" diagnostic certainty, confirming the diagnosis of SLE.



**SLERPI**  
Systemic Lupus Erythematosus Risk Probability Index  
Does this patient have SLE?

**What is SLERPI?**

- ✓ A diagnostic support tool that estimates the probability of systemic lupus erythematosus.
- ✓ A machine learning model based on LASSO-logistic regression that provides:
  - Continuous probability of SLE
  - Binary classification with a ≥50% threshold
  - A simplified, point-based scoring version


**How SLERPI works?**

- ✓ Integrates 14 variably weighted clinical and serological features using LASSO logistic regression to calculate an individual probability of SLE.
- ✓ Generates a continuous SLE risk (0–100%), reflecting the likelihood of lupus versus other rheumatic diseases.
- ✓ Supports clinical decision-making by classifying patients into diagnostic certainty levels

**Model development**

- ✓ Machine learning approach
- ✓ LASSO logistic regression
- ✓ Internal validation: 10-fold cross-validation
- ✓ 802 adults (401 SLE, 401 rheumatologic disease controls)
- ✓ Two tertiary rheumatology centers (Greece)

**Model Performance**



- ✓ Sensitivity: 95.1%
- ✓ Specificity: 93.7%
- ✓ Accuracy: 94.8%

Threshold: ≥50% predicted probability (Youden index)

**Results interpretation**

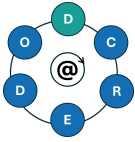
- 0 – 14 % : Unlikely SLE
- 15 – 43 % : Possible SLE
- 44 – 86 % : Likely SLE
- 87 – 100 % : Definite SLE

SLERPI supports *not* replace clinical judgment

<https://pancretan-ha.gr/SLERPI/>

Adamthou, C., Geritouris, L., Nikoipoulou, D., Nikoipoulou, M., Raps, A., Botoulaki, A., Fournoulis, A., Sidiropoulos, P., Bourmpas, D. T., & Bertassi, G. K. (2023). Lupus or not? SLE Risk Probability Index (SLERPI): a simple, clinician-friendly machine learning-based model to assist the diagnosis of systemic lupus erythematosus. *Annals of the Rheumatic Diseases*, 82(5), 758–766. <https://doi.org/10.1136/annrheumdis-2022-225069>

Figure 7: Hands-on exercise with the on-line machine learning model SLERPI [1] to confirm the diagnosis of systemic lupus erythematosus in the VP Hélène Sissoko (LU108)



2. **Generic tool integration** - students use in the context of the virtual patient a category of widely available digital tools as part of the exercise. They or their facilitators select a concrete instance of such a tool depending on availability and apply it in the context of the virtual patient .

This type of integration is particularly useful for widely used tools such as videoconferencing platforms or LLMs. Most medical schools now provide such tools to their students and teachers, but it is not standardised which specific tools are adopted (e.g. Zoom vs MS Teams; ChatGPT vs Copilot vs Claude vs Gemini, etc.), and these choices also evolve over time. However, from the perspective of tool integration, this variability is not critical, as the core functionalities are comparable and no proprietary tool-specific features are required. "An example of a generic tool integration for large language models is presented in Figure 8. The student is navigated through consecutive stages of the patient story (Hedwig Paul with primary biliary cholangitis) with several prompts suggested along the way to support and reflect upon their clinical reasoning. The selection of the LLM tool depends on the preferences of the students and the technical infrastructure of their university.

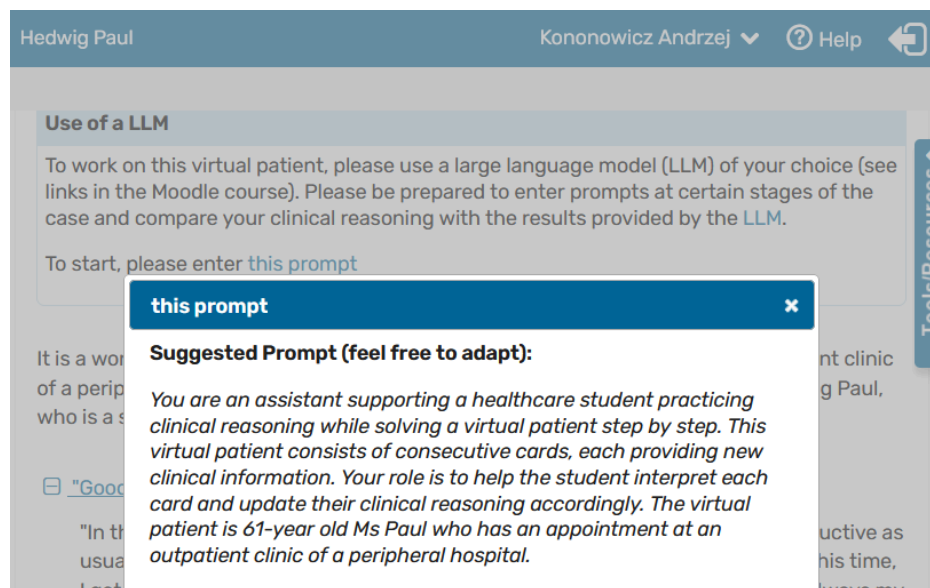
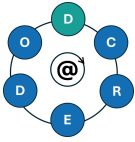


Figure 8 A prompt engineering task embedded in the "Hedwig Paul" VP within the Large Language Models learning unit (LU102).

3. **Clinical exposure integration** - students observe or explore the use of a given type of digital health tool as part of their clinical attachment or other clinical workplace experiences and then return to the classroom to reflect on their observations and discuss them in relation to the virtual patient and the learning objectives of the unit.
4. **Mockup integration** - The students are provided with a simplified simulation of the actual system within the learning environment. The mock-up reproduces the key features of the real-world application that are relevant for the exercise, allowing students to interact with the tool without the need of accessing the real system.

The two types of integration described above are particularly useful for complex clinical systems such as Electronic Health Records (EHR) or Radiology Information Systems/Picture Archiving and Communication



Systems (RIS/PACS). While free, open-source alternatives to such systems exist (e.g. OpenEMR), their setup and maintenance generate costs that are not sustainable for open access, especially considering that these systems are already available in the clinical environments of teaching hospitals. For this reason, we have embedded assignments in our LUs that require students to explore selected features and perform specific tasks using those tools during their clinical attachments (clinical exposure integration). To ensure fluency in working with virtual patients, we have also simplified system integration within the VPs by presenting selected screenshots and mock-ups (e.g. interactive forms in the EHR module, LU106). These approaches provide students with key information and system perspectives necessary to support clinical reasoning in a digital tool context.

This solution was also adopted in LU103 on AI image analysis, where access to proprietary software is institution-specific and often prohibitively expensive. In addition, our aim of presenting both the benefits and limitations of the technology could potentially conflict with the educational use policies of some of these tools. For this reason, in some cases within the LU, we realistically simulated the output of a generic AI image analysis system using multimodal generative AI (e.g. Google Gemini). This allowed us to illustrate not only the typical benefits of such technologies but also the challenges and limitations associated with their outputs.

5. **Population-to-patient integration** - Students analyse a dataset representing a sample of patients from a broader population using a digital analytical tool (for example data mining or machine learning software). They examine the performance, limitations, and potential biases of the resulting model and discuss whether its predictions can be responsibly applied to the individual virtual patient in the scenario.

As aptly noticed by Wasserman and Loftus “Even though a health professional usually is dealing at any given time only with one patient, it is often forgotten just how much the demographics of patient populations shape clinical reasoning” [6]. Following this principle, some tools integrated into VPs, although used in a specific patient case, require analysis of a larger patient population, for example when assessing decision aid fairness for a patient subgroup using machine learning tools (e.g. Orange Data Mining in LU108).

6. **Video-based integration** - A video (or series of screenshots) demonstration shows the proper use of the digital tool within the context of the virtual patient and prompts discussion on how the obtained results should be interpreted in the diagnostic or management reasoning process.

The final type of integration deals with cases where digital health tools have in fact a physical component as is the case in wearable and mobile devices. Such tools have a growing role in clinical reasoning, yet we cannot expect the students to possess such devices. If the university where the learning unit including VPs is not providing the students with access to such devices it is better the students are able to experience them in the context of the virtual patient by a video and related practical tasks that require answering questions based on the videos. Such types of integration were applied for instance to embed in the VP a hand-held ECG device (Figure 9) in LU 101 or home sleep apnoea testing device in LU109.

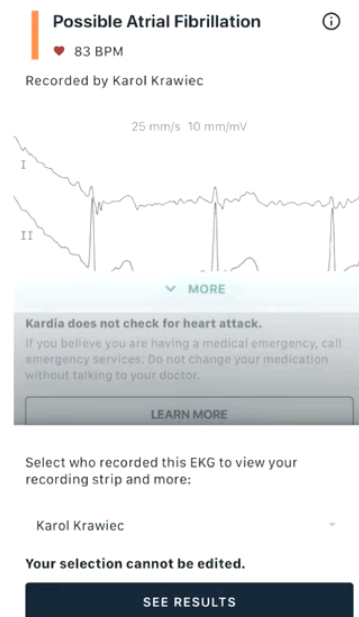
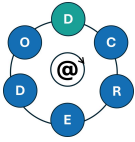
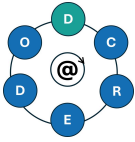


Figure 9: Integration of a mobile handheld ECG device into screening for atrial fibrillation in an elderly patient “Karol Krawiec” in a remote rural setting (LU101).

The list presented in Table 2 includes only those digital health tools used in the VPs that involve explicit practical exercises in LUs. In addition, the virtual patients and other assignments within the LUs incorporate further tools that influence clinical reasoning and serve as a backdrop to patient cases, but were not developed as separate activities, such as smartwatch-based lifestyle monitoring, patient portals for data acquisition, and AI-generated educational materials for patients.

## Health profession adaptations

As stated in the project proposal, at least one student LUs should be adaptable to more than one health profession group. The composition of the consortium, largely shaped by the perspective of medical students and the involvement of physicians who authored the cases (BSMU, EMC, JU), is balanced by our Austrian partners from UMIT, who educate nursing rather than medical students. According to the nursing partner's assessment of the blueprint in D3.1, all LUs, except LU103 on AI in medical imaging, have the potential to be adapted to the needs of nurses. However, in line with the allocated funding and declared KPI indicators, we have, under the lead of UMIT, developed nursing-specific adaptations of two LUs (LU101 on Foundations of CR and LU106 about Electronic Health Records) and three VPs (Karol Krawiec, Franz Huber, and Sibylle Jonas). These adaptations involved shifting from physician diagnoses to nursing diagnoses (e.g. "atrial fibrillation" to "excess fluid volume", or "type 2 diabetes mellitus" to "unstable blood glucose levels"), changed focus in documentation (structured admission assessment, problem lists with nursing diagnoses, measurable outcomes, planned interventions), as well as modifying the dialogue and assignments to foreground nursing assessment frameworks and terminology, patient-centred goal setting, care planning and prioritization, and documentation competencies.



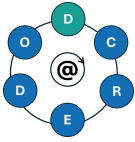
## Assessments

Each of the learning units has in the outline an assessment section which specifies both formative and summative assessment tasks. In line with the assessment methods identified in D4.2 and aligned with the selected learning objective, this stage includes not only test questions but also case vignettes and VP assignments using digital tools, reflective essays, SWOT analyses, concept map assignments. Model answers for the assignments are available to educators.

## Transfer to Moodle and CASUS

The completed learning resources were implemented, as the final step in the development workflow, in the project learning management system (Moodle) and the virtual patient system CASUS by Instruct. Each learning unit was implemented as a Moodle course, aligned with the DID-ACT general clinical reasoning curriculum and organised into levels of difficulty (novice, n = 2; intermediate, n = 4; advanced, n = 2).

Each asynchronous phase of an LU begins with stating the learning objectives and a general description. In most LUs we provide different forms of self-assessment (i.e. MCQs, “compare & classify”, gap filling, quizzes) to check comprehension and if needed, refresh their knowledge on the prerequisites for this course. The content of the LU is structured into chapters with learning activities and material. Some of these activities or resources are conditionally displayed upon fulfilment of prerequisite tasks (e.g. access to model answers requires prior submission of assignments), using Moodle’s restricted access mechanism. Another type of personalisation involves displaying different versions of learning resources depending on the user’s professional background (medical or nursing student), as specified in the user profile. The integration of virtual patients with Moodle courses is implemented via the LTI interface, with VPs available as separate activities within the courses. Each LUs concludes with references for further reading, and a link to the satisfaction survey developed as part of deliverable D4.2. Figure 10 presents an example of a partial view of the content for the student LU105.



First, please sign-up for a 30-day free trial version of the [CDSS Isabel](#). You will find information on the registration process in the following video:

You will also need to install a symptom checker, such as [Ada](#) or [SYMPTOMATE](#)

[Quiz question on CDSS](#)

**Completion** ▾

## 2. Application of CDSS in Clinical Reasoning (ca. 60 min)

Please complete the following virtual patient. If you have not yet followed the above instructions to register with Isabel, please do before opening the case.

[Virtual Patient Walter Mertens](#)

**Completion** ▾

Optionally or if instructed by your tutor, please also complete the second, more advanced, virtual patient using Isabel. This will take about 30-45 mins.

[Virtual Patient Thomas Sachs](#)

**Completion** ▾

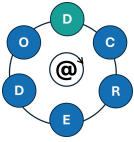
[Reflective questions about the use of Isabel in the virtual patient](#)

**Completion** ▾

## References / More information



Figure 10: Partial view of the content for the student LU105, “Clinical Reasoning with Clinical Decision Support Systems”.



Teacher resources for the synchronous phases are available in the D-CREDO educator area on Moodle (example in Figure 11).

**(Novice) Foundations of Digital Health Technologies in Clinical Reasoning**

**To be provided here:**

- Link to [student course](#)
- Learning unit & assessment description file
- Any material, such as worksheets or sample assessment(s)
- Link to facilitator evaluation form

[Outline of learning unit and assessment](#)

[Learning Unit Outline](#)  
Hidden from students

[Student Course](#)

**Resources for synchronous phase**

- [VP1 Group Activity 1](#)
- [VP1 Group Activity 1 - Sample Solution](#)
- [VP1 Group Activity 2](#)
- [VP1 Group Activity 2 - Sample Solution](#)
- [VP Karol Krawiec - Phase 2](#)

**LU101: VP1 Group Activity 1 - Sample Solution**

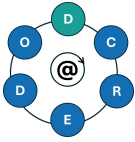
- Which digital health tools were used in patient care? To which D-CREDO tool categories do they belong? Which components of clinical reasoning does the digital health tool support?

Digital Health Tool	D-CREDO category	Components of clinical reasoning in which the tool supports the healthcare team
Handheld ECG	mHealth Apps & Wearables	<ul style="list-style-type: none"> <li>Gathering, interpreting, and synthesising patient information</li> <li>Patient participation in clinical reasoning</li> </ul>
Video conferencing	Telehealth	<ul style="list-style-type: none"> <li>Gathering, interpreting, and synthesising patient information</li> <li>Patient participation in clinical reasoning</li> </ul>
Risk calculator (CHA2D2-VASc)	Electronic Health Records & Clinical Decision Support Systems	<ul style="list-style-type: none"> <li>Gathering, interpreting, and synthesising patient information</li> <li>Developing a treatment/management plan</li> </ul>

- Who are the stakeholders in the scenario and how do they influence the reasoning

Name	Role	Impact on reasoning
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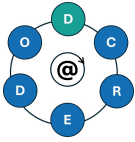
Figure 11: Teacher resources for the synchronous tasks of LU105, “Clinical Reasoning with Clinical Decision Support Systems”.



## Quality indicators

In summary, we present a comparison between the quality criteria for this deliverable and the level of achieved results (Table 3).

Quality indicator	Result
Development of $\geq 7$ new or adapted student LUs	We have developed 8 new or adapted LUs for students: Foundations of Digital Health Technologies in Clinical Reasoning; Clinical Reasoning at a Distance; Using Large Language Models for Clinical Reasoning; Clinical Reasoning with Clinical Decision Support Systems; From Data to Care: Understanding Electronic Health Records; Responsible Use of Digital Tools; Digital Tools in Integrated Patient-Centered Care; Using digital tools for image analysis in clinical reasoning.
Development of $\geq 15$ new or adapted VPs	The LUs comprise 20 new or adapted VPs from the iCoViP project repository, covering five case types: regular, domain-adapted, key feature, role-playing, and worked example.
New content and activities for at least 35h blended learning (time includes VP activities)	The estimated total duration of activities in the LUs amounts to 37 hours (Table 1). In our view, this may be an underestimation of the actual time required, and several activities were intentionally removed due to concerns about overloading students within their already demanding curricula. The actual time required to complete the LUs will be verified in pilot studies (D4.3) planned for the winter semester of 2026/2027.
$\geq 1$ LU and $\geq 3$ VPs for non-medical health profession (e.g. nursing)	Two LUs and three VPs were adapted by nursing professionals to meet the needs of students in their field.
LUs and VPs follow blueprint and white paper	We used the blueprint defined in D3.1 as a guiding framework for the development of the LUs and VPs. The list of LUs was implemented as specified in the blueprint, with only minor modifications to the wording of titles and unit descriptions. We also retained most of the VPs shortlisted in the VP blueprint, although some had to be omitted due to time constraints within the curriculum or limited alignment with the selected digital tools. Despite that the total number of implemented VPs clearly exceeds the number set in quantitative KPI. Following the guidance from the white paper, we designed student-centred, active learning LUs that provide multiple opportunities for experiential, hands-on learning, while avoiding excessive cognitive load and overly complex tasks for the intended learner level.



<p>Digital tool examples aim to allow a form of (free-of-charge) interaction with the tool, either as full access to the digital tool, demo version or through a simulated use of the tool using low-fidelity e-learning methods (e.g. interactive images, videos; question pools)</p>	<p>In total, 13 digital tools were integrated as assignments into the VPs, exceeding the minimum of 10 digital tools specified in the blueprint (KPI in D3.1). These tools represent all categories of D-CREDO tools. The integration of the VPs follows an integration taxonomy developed for the D-CREDO project, which comprises the following types: direct tool integration, generic tool integration, clinical exposure integration, mock-up integration, population-to-patient integration, and video-based integration.</p>
<p>LUs implemented in the DID-ACT Moodle; VPs implemented in the VP system CASUS;</p>	<p>Instruct has implemented all D-CREDO LUs as Moodle courses, transferred the VPs to CASUS, and integrated them with both the courses and the required digital tools.</p>
<p>All content in English</p>	<p>All LUs and VPs content is provided in English to ensure maximum global accessibility. In addition, some partners are planning adaptations into national languages. However, these activities go beyond the scope of the project and are supported by additional funding not covered by D-CREDO.</p>

Table 3: Comparison of the D3.2 results with the quality indicators for this deliverable.

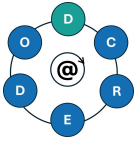
## 4 Conclusions

This deliverable reports on the outcomes of Activity A3.2, which over seven months of intensive and collaborative work, transformed the blueprint of D-CREDO LUs into a set of Moodle courses covering all declared learning objectives, virtual patients ( $n \geq 15$ ), and digital health tools ( $n \geq 10$ ). The total duration of activities exceeds the planned 35 hours. Selected learning units and virtual patients were also adapted to meet the needs of nursing students. All set KPIs were achieved.

The next steps in the project include the development of train-the-trainer learning units for educators to support the delivery of the student learning units (A3.3), a pilot evaluation of the developed learning units (A4.3), and subsequent refinement of the LUs based on user feedback (A3.4).

## 5 Literature references

1. Adamichou C, Genitsaridi I, Nikolopoulos D, Nikoloudaki M, Repa A, Bortoluzzi A, Fanouriakis A, Sidiropoulos P, Boumpas DT, Bertias GK. Lupus or not? SLE Risk Probability Index (SLERPI): a simple, clinician-friendly machine learning-based model to assist the diagnosis of systemic lupus erythematosus. *Ann Rheum Dis.* 2021 Jun;80(6):758-766.
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3. Kononowicz AA, Narracott AJ, Manini S, Bayley MJ, Lawford PV, McCormack K, Zary N. A framework for different levels of integration of computational models into web-based virtual patients. J Med Internet Res. 2014 Jan 23;16(1):e23.
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[https://docs.google.com/spreadsheets/d/1qWQSV4s3i6g5i3jISY2fYkLoZlpiJ010qse3EyfOnwl/edit?usp=drive\\_link](https://docs.google.com/spreadsheets/d/1qWQSV4s3i6g5i3jISY2fYkLoZlpiJ010qse3EyfOnwl/edit?usp=drive_link) (last update June 3, 2026).

## 6 References to digital tools examples in the learning units

#	Tool name	Reference
T01	Ada	<a href="https://ada.com">https://ada.com</a>
T02	CHA2DS2-VASc score calculator	<a href="https://www.mdcalc.com/calc/801/cha2ds2-vasc-score-atrial-fibrillation-stroke-risk">https://www.mdcalc.com/calc/801/cha2ds2-vasc-score-atrial-fibrillation-stroke-risk</a>
T03	ChatGPT	<a href="https://chatgpt.com">https://chatgpt.com</a>
T04	Isabel DDX Companion	<a href="https://www.isabelhealthcare.com/products/isabel-ddx-companion">https://www.isabelhealthcare.com/products/isabel-ddx-companion</a>
T05	Kardia Mobile ECG 6L	<a href="https://alivecor.com/products/kardiamobile6l">https://alivecor.com/products/kardiamobile6l</a>
T06	Migraine Buddy	<a href="https://migrainebuddy.com">https://migrainebuddy.com</a>
T07	MySugr	<a href="https://www.mysugr.com">https://www.mysugr.com</a>
T08	Orange Data Mining	<a href="https://orangedatamining.com">https://orangedatamining.com</a>
T09	Sklip	<a href="https://play.google.com/store/apps/details?id=com.sklip">https://play.google.com/store/apps/details?id=com.sklip</a>
T10	SLERPI	<a href="https://pancretan-ha.gr/SLERPI">https://pancretan-ha.gr/SLERPI</a>
T11	Symptomate	<a href="https://symptomate.com">https://symptomate.com</a>
T12	WatchPAT ONE	<a href="https://www.itamar-medical.com/watchpat-one">https://www.itamar-medical.com/watchpat-one</a>
T13	Zoom	<a href="https://www.zoom.com">https://www.zoom.com</a>

