Developing, implementing, and disseminating an adaptive clinical reasoning curriculum for healthcare students and educators

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D5.1 Set of evaluation and analysis tools

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Introduction

Goal

The aim of this deliverable is to present a set of tools for the evaluation of learning activities in WP3 and WP4. The selection of tools will be based on a review of existing evaluation tools that aim to measure learner and educator satisfaction with courses in clinical reasoning, as well as the perceived impact on clinical reasoning outcomes. It will also include an analysis, selection of tools and metrics to provide information about learner interactions with the online learning materials in the form of a learning analytics dashboard. Additionally, evaluation of the usability for an online environment will be planned to ensure intuitive access to learning content.

Previous work

This deliverable expands on the work completed by the WP5 team, in collaboration with WP1, on implementing the 'needs analysis survey'. The data collected via a web questionnaire in March/April 2020 using the tool *LimeSurvey* (reported in D1.1a) and semi-structured interviews (D1.1b), aided us in developing a list of eleven learning goals for the student curriculum (and three for the train-the-trainer course), and encompassed a number of more specific objectives (reported in D2.1). With all of this information combined, a framework for the curriculum and train-the-trainer course was proposed (reported in D2.2) that presented the selected learning methods and tools (including resources in learning management and virtual patients systems). In addition an analysis reported in D7.2 concluded that the learning management system to host DID-ACT curriculum's learning resources would be Moodle.

Quality criteria

The DID-ACT consortium decided to guide the selection of tools based on the following quality criteria:

- Recommendations will be made for two separate course evaluation target groups: students and educators
- We will select evaluation tools that measure outcomes at the reaction level (level 1) in the Kirkpatrick model
- In addition, we will select evaluation tools that include self-assessment items to cover DID-ACT learning goals set in D2.1
- The selection of evaluation items and tools will be informed by a literature review to promote re-use of validated items and tools
- Data covered by the learning analytics models will be mapped against the learning goals set in D2.1 and learning methods from D2.2
- The selected learning analytics tools should not require additional payment
- Selected usability evaluation tool should meet standards in web ergonomics evaluation

Inventory of evaluation tools for DID-ACT courses

We have performed a literature search in the MEDLINE/PubMed database using the keywords “clinical reasoning” AND (“evaluation” OR “assessment”). The query was executed on June 1st, 2020. We manually checked references in the included studies and added studies we knew from previous projects. Included were studies which presented details of their evaluation tools measuring satisfaction or self-assessment of competencies after a clinical reasoning course or learning activity.

Evaluation tools for the DID-ACT students’ curriculum

Identified studies

Our search strategy located nine studies measuring student satisfaction after clinical reasoning learning activities (Appendix, table A1) and 11 studies with self-assessment evaluation tools (Appendix, table 2) .

Methods of analysis of the identified items

- Based on the data obtained in the literature search we have extracted the relevant items from the identified tools into a shared spreadsheet document.
- Next, we performed a thematic analysis of the satisfaction items to identify the common aspects asked the students while evaluating learning clinical reasoning (analysis 1)
- In a second analysis, we mapped the identified self-assessment items with the learning goals and objectives from D2.1. This was done to form a repository of potentially useful questions to select from and identify gaps in the availability of items.

Analysis 1: Thematic analysis of satisfaction items

We have identified 78 items measuring learner satisfaction in clinical reasoning learning sessions. We grouped them into seven themes presented in Table 1. The detailed inventory of identified evaluation items is presented in appendix in Table A3.

Table 1. Themes identified in clinical reasoning learning satisfaction questionnaires

Theme	Definition	# of items
1. Course organisation	Includes items which measure quality of organizing the learning session (e.g. time aspect, adequate teaching and assessment methods).	9
2. Feedback	Rates the quality of feedback provided to the learner	3
3. Clear expectations	Evaluates the clarity in presentation of the course goals, topics to be covered or problems to be solved.	11

4. Relevance	Rates the perceived usefulness of the content presented in the course.	15
5. Quality of group work	Includes items that characterise collaborative learning and positive climate in the classes.	8
6. Teacher competencies	Measures the involvement of instructors in teaching activities.	14
7. Self-directed learning	Evaluates to what degree did the learning activities motivated to continue learning without further assistance.	15
8. Other	Items we could not assign to other categories (e.g. level of anxiety before the class).	1

Analysis 2: Mapping of identified self-assessment items to DID-ACT learning objectives

From the 11 identified clinical reasoning self-assessment questionnaires, we have extracted 199 self-assessment items and mapped them to the DID-ACT project learning goals and objectives identified in D2.1. A summary of this process is presented in Table 2. The detailed inventory of evaluation items is presented in appendix in Table A4.

Table 2. Overview of self-assessment items mapped to DID-ACT learning goals and objectives:

DID-ACT learning goal	**Learning objective**	**# of items**
1. Gather/interpret/synthesize	a. collect key findings	20
	b. analyse and interpret key findings	25
2. Plan treatment/management	a. apply procedures < diagnosis/ holistic/ context/ evidence-based	19
	b. set goals < context/evidence/patient preferences-based	5
3. Patient participation	a. engage/collaborate patient/families in analysis of patient problem	6
	b. shared-decision-making	0
4. Collaborate	a. use team competencies	5
5. Self-reflection/improvement strategies	a. use critical thinking to improve performance	6
	b. evaluate outcomes with patients/colleagues	5

6. Generate DDX	a. defining/discriminating features	12
	b. clinical decision support systems/artificial intelligence	0
7. Errors	a. open climate to share	3
	b. deal with uncertainty	4
	c. influence of emotions	0
	d. strategies to overcome errors	1
8. Ethical	a. legal/moral/diversity/gender-related aspects	2
9. Interprofessional	a. communicate across professions	12
	b. inter and intra-professional value(s)	12
	c. similarities/differences across professions	2
10. CR theories	a. relate theory to practice	9
14. Decision making	a. diagnostic decisions based on hypotheses regarding the patient's problem	19
	b. making management decisions taking the patient’s goals and perceived situation into account.	9
	c. re-evaluating their decisions based on new understandings.	9
x. other	address goals out of the scope of the DID-ACT curriculum	8

In conclusion, we have found self-assessment question items for all of the major goals within the DID-ACT curriculum. However, it might be required we extend the list in the future with items for three specific learning objectives: shared-decision-making with patients, competencies in using clinical decision support systems/artificial intelligence in clinical reasoning, and the influence of emotions on errors.

Evaluation tools for the DID-ACT Train-the-Trainer course

Our literature review has not found specific evaluation instruments for measuring faculty development outcomes in clinical reasoning teaching skills. As a result of this, we have generalized the question and sought evaluation tools for general use in medical faculty teaching skills development programs [Steinert06][Fabry10][Salajegheh19].

Similarly as is the case in evaluation of undergraduate medical education, the evaluation tools covered by literature reviews were often grouped in the four levels of Kirkpatrick's evaluation model: (1) reaction, (2) learning: (2a - attitudes; 2b knowledge/skills), (3)

behaviours and (4) results (4a - organizational practice, 4b - participants' student outcomes) [Steinert06]. Examples for evaluation methods at the reaction level are teacher satisfaction questionnaires; retrospective pre-/post self-assessment of teaching competencies or theoretical knowledge tests of presented topics. A particular type of teaching skills evaluation in a simulated setting are OSTEs (Objective Structured Teaching Examinations) in which standardized students (actors playing the role of studies experiencing learning difficulties) help in evaluation of development of teaching skills by educators. Behavioral outcomes in real settings may be evaluated by participants' student satisfaction surveys or observation by external evaluators in the classrooms. At the highest level of hierarchy is examination of the influence of faculty development on better outcomes in standardized, high-stake exams of their students (e.g. USMLE) or even clinical outcomes in teaching hospitals. However, the literature has also emphasized that the higher evaluation levels are more difficult to organize and carry out, and in addition, might be easily biased by other contextual factors difficult to control [Fabry10]. Well-designed satisfaction questionnaires may deliver valuable insight for control and quality improvement. Following our goals, we will focus on measures used at the reaction and learning (self-assessment) levels of Kirkpatrick's model.

Despite the merits of using standardized evaluation instruments, it is reported that many faculty development programs apply their own locally-specific developed evaluation questionnaires. However, this is not the case with the Stanford Faculty Development Program Model which has a long history of development [Skeff88], sound theoretical background, been validated in several studies [Litzelman98][Mintz15] and adaptable to different contexts (e.g. [Mookherjee14]) and languages (e.g. German [Iblher11]).

SFDP-26: Stanford Faculty Development Program Model evaluation tool

The Stanford Faculty Development Program (SFDP) model consists of seven dimensions (categories) showing different aspects of excellence in teaching [Skeff88]:

1. **Positive Learning Climate** - investigates whether the teacher is able to create a stimulating learning environment that triggers students' enthusiasm
2. **Control of the Teaching Session** - answers the question whether the teacher is able to address the relevant teaching topic effectively
3. **Communication of Goals** - a dimension that shows whether the teacher is able to present their expectations regarding intended learning outcome of students effectively
4. **Enhancing Understanding and Retention** - shows a good alignment of selected teaching methods with intended goals
5. **Evaluation** - investigates the selection and quality of implementation of assessment techniques (formative, summative) in use by the teacher
6. **Feedback** - evaluates the ability of the teacher to provide the students with adequate information for the purpose of improving their performance
7. **Self-directed learning** - answers the question whether the teacher is able to model self-directed learning for the students and motivate them to continue learning in the given field to satisfy their needs without additional assistance.

The SFDP model has been operationalized into a 26-item 5-point Likert questionnaire called, 'SFDP-26' [Litzelman98]. We plan to use the SFDP model to structure our train-the-trainer evaluation activities in the WP5. This could involve a) the evaluation of our teaching in the clinical reasoning train-the-trainer sessions, as well as, b) the evaluation of train-the-trainer course participants' clinical outcomes in their actual clinical reasoning teaching activities. The potential selection of a reduced number or adaptation of concrete items and/or addition of context-specific items will be discussed in the later stages of the WP5 activities, knowing the detailed evaluation plan aligned with WP3 outcomes.

CBAM: Concerns-Based Adoption model

A potential extension to the direct evaluation of the DID-ACT curriculum teaching units and train-the-trainer course using the above presented inventories of question items is a holistic evaluation. Such evaluation is possible using the Concerns-Based Adoption Model (CBAM) [CBAM].

CBAM is a model that describes the process of adopting a curricular change seen from the perspective of the teacher. It has an extensive research base that covers around 40 years of development work initiated at the University of Texas by Gene Hall. The CBAM model consists of three major components: Stages of Concern (SoC), Levels of Use (LoU) and Innovation Configuration (IC). In brief:

- Stages of Concern (SoC) - The first component of CBAM is an affective scale dealing with the feelings of the teachers while introducing the innovation. It is operationalized by a 35 item questionnaire that classifies the responders into 7 non-exclusive stages of concern. The classification is expressed as relative intensity of a particular concern and is visualized by the Stage of Concern profile curves [CBAM]. The stages are developmental, meaning that it is expected that the more experienced a responder is in the adoption of the curricular innovation, the higher the stage of concern will dominate the profile. The seven consecutive SoC stages are presented in Table 3. This shows the transition of a teacher confronted in face of a curricular innovation from an unconcerned stage through self-concern, task concern and concern about the impact of the innovation on their learners.
- Levels of Use (LoU) - This is a performance scale and deals with concrete behavior of the teachers and is established based on a branched interview which divided the responders into 3 categories of non-use or 5 use of the intervention.
- Innovation Configuration (IC) - Finally, the Innovation Configuration is a descriptive tool to present the different possible variants of implementation of the intervention ordered from perfect adoption to no change.

Table 3. Typical expression of concerns about curricular innovation in the CBAM model [George13] :

Stage of concern		**Typical expression of concern**
Impact	6	I have some ideas about something that would work even better

	5	I would like to coordinate my effort with others, to maximize the innovation's effect
	4	How is my use affecting my students?
Task	3	I seem to be spending all my time getting materials ready
Self	2	How will using it affect me?
	1	I would like to know more about it
Unconcerned	0	I am not concerned about it

The CBAM model's main advantage when compared to other innovation dissemination/adoption models (e.g. Rogers' IDT [Rogers10]) is its explicit focus on curricular changes and the fact that it was developed with teachers across different school levels (from kindergarten to higher education).

We plan to use the CBAM Stages of Concern (SoC) questionnaire in the DID-ACT project as an additional evaluation instrument for measuring curricular change. The SoC questionnaire is free to use for academic purposes and will potentially be administered as part of the train-the-train course and follow-up meetings. The results presented in the stages of concern profile curves may demonstrate differences in stages of implementation of the clinical reasoning curriculum across partner institutions.

Recommendations for data collection instruments

Depending on the evaluation setting, we will administer the selected evaluation tools either as paper-based questionnaires or using a web-based survey tool. For the online questionnaire we suggest to continue using the DID-ACT project's installation of the LimeSurvey web application [LimeSurvey] which turned out to be successful in implementation of our needs analysis (report D1.1a).

In case of smaller groups or as part of pilot-studies we will consider using the same items in semi-structured interviews as in the DID-ACT local needs analysis (report D1.1b).

Other evaluation scenarios are possible for larger groups in lecture halls (e.g. in invited lectures) or hands-on workshops when administration of paper- or personal computer-based survey tools might turn out to be inconvenient. In such cases we will consider using audience response systems (ARS) on participants' mobile devices like smartphones or tablets. We had good experiences with this form of data collection using Internet pooling services like AhaSlides [ahaslides.com].

DID-ACT learning analytics dashboard

Data sources for the DID-ACT learning analytics model

We have analyzed the learning and assessment tools selected by the DID-ACT consortium for the curriculum framework (D2.2) to identify opportunities for collecting data for learning analytics purposes.

The two main key technical tools that are planned to be used to implement the curriculum are:

- A Learning Management System: the decision was made to use Moodle (LMS) [Moodle]
- A Virtual Patient System: considering the experience of project partners so far, a natural choice seems to be CASUS (VP) including a clinical reasoning concept mapping tool (CRM) [Hege17]

Each of the systems above is in fact a collection of different (a-)synchronous tools for setting up on-line learning activities including e.g. discussion boards, file upload assignments, link sharing options or tests/quizzes. Students, while using each of those tools, leave digital footprints in the system logs that we may use for analytic purposes. The students will be informed about what data is collected while using our learning systems and may decline to participate or remove data collected so far following European GDPR regulations.

We mapped the tools and related learning activities against the DID-ACT curriculum learning goals and objectives from D2.1 obtaining a learning analytics matrix presented in Table 4. The goal is to show how we could measure with the tools indicators of progress towards achieving the intended DID-ACT learning goals and objectives.

Table 4. The DID-ACT Learning Analytics Matrix (v 1.0)

DID-ACT Goals > Learning Objectives	**Tool**	**Ideas how to trace progress in achieving the goals/objectives**
1. Gather/interpret/synthesize > a. collect key findings	VP(CRM)	Match “relevant finding” nodes in the concept maps of learners and experts
1. Gather/interpret/synthesize > b. analyse and interpret key findings	VP(CRM)	Match links between “relevant findings” nodes and others types of nodes in concept maps of learners and experts
	VP (Slider question)	Trace estimation of predictive value of diagnostic tests by learners using slider questions (Bayesian

		reasoning)
2. Plan treatment/management > a. apply procedures < diagnosis/holistic/context/ evidence-based	VP(CRM)	Match “treatment” nodes in concept maps of learners and experts
2. Plan treatment/management > b. set goals < context/evidence/patient preferences-based	LMS & VP	Keyword analysis in summary statements of patient cases
3. Patient participation > a. engage/collaborate patient/families in analysis of patient problem	LMS (forum)	Qualitative analysis of discussion board entries
3. Patient participation > b. shared-decision-making	LMS (forum)	Qualitative analysis of discussion board entries
4. Collaborate > a. use team competencies	LMS (forum)	Qualitative analysis of discussion board entries
5. Self-reflection/improvement strategies > a. use critical thinking to improve performance	LMS (blog)	Qualitative analysis of blog entries
	VP	Improvement of summative scores on timeline in a VP series
5. Self-reflection/improvement strategies > b. evaluate outcomes with patients/colleagues	LMS (blog)	Qualitative analysis of blog entries
6. Generate DDX > a. defining/discriminating features	VP(CRM)	Match CRM relevant finding and ddx nodes of learner and expert
6. Generate DDX > b. clinical decision support systems/artificial intelligence	LMS & VP	Trace the use of links to EBM/EBP resources (e.g. UpToDate)
7. Errors	LMS (forum)	Number of discussion board entries

> a. open climate to share		
7. Errors > b. deal with uncertainty	VP(CRM)	Match between student and expert final diagnosis confidence estimation
7. Errors > c. influence of emotions	LMS (blog/ forum)	Qualitative analysis of blogs/discussion board entries
7. Errors > d. strategies to overcome errors	VP	Improvement of summative scores on timeline in a VP series
8. Ethical > a. legal/moral/diversity/ gender-related aspects	LMS (blog/ forum)	Qualitative analysis of blogs/discussion board entries
9. Interprofessional > a. communicate across professions	LMS (forum)	Qualitative analysis of discussion board entries in a interprofessional learning activity
9. Interprofessional > b. personal/(inter-)professional values	LMS (blog/ forum)	Qualitative analysis of blogs/discussion board entries
9. Interprofessional > c. similarities/differences across professions	LMS (blog/ forum)	Qualitative analysis of blogs/discussion board entries
10. CR theories > a. relate theory to practice	LMS & VP	Success rate on theory related questions
14. Decision making > a. diagnostic decisions based on hypotheses regarding the patient's problem	VP(CRM)	Analysis of links in concepts between “relevant findings” nodes and the other types of nodes
14. Decision making > b. making management decisions taking the patient’s goals and perceived situation into account.	VP	Analysis of decisions made by the student in turning points of the patient scenario
14. Decision making > c. re-evaluating their decisions	VP(CRM)	History of consecutive clinical reasoning concept maps

based on new understandings.		

Legend: LMS: Learning Management System (Moodle); VP: Virtual Patient System (CASUS); CRM: Clinical Reasoning Concept Mapping Tool ([Hege17)].

Available learning analytics tools

Recorded raw data from online learning activities described above requires to be processed and summarized to make conclusions. This is the task of learning analytic tools. Below we have analyzed the available learning analytics functionalities of Moodle and CASUS.

Learning analytics in Moodle

LA in Moodle is focused on students at risk (not achieving course competencies, not meeting course conditions, dropping out, failing).

Reports and logs
In reports and logs almost all activities of users can be viewed and put into reports which are then accessible by a group of users that are yet to be defined.

Analytics models

- Moodle provides some built-in models mainly targeted at predicting students' risk of dropping out or not starting at all (probably less relevant for student curriculum, but maybe for the Train-the-Trainer course to identify teachers who need some "extra encouragement")
- As well, our own models can be created or imported.

Parameters for models:

- Online/face-to-face/blended
- Analyzed timeframe
- General Indicators, such as course accessed, profile completed,....
- Activity Indicators (https://docs.moodle.org/39/en/Learning_analytics_indicators) include basically all activities implemented in moodle on different levels:
    - Viewed the activity
    - Submitted content to the activity
    - Viewed feedback (manually or automated feedback)
    - Provided feedback within the activity
    - Revised and/or resubmitted content.

  Each activity can support one or more of these levels with different depths.

Visualization:

- Includes only basic visualization using tables.

Learning analytics plug-ins for Moodle

In addition, we searched for tools/plugins available in Moodle which help to

- Create reports dynamically
- Define different access rights
- Show results using graphs.

Two plugins had been seen and chosen as alternatives, and were examined more thoroughly.

Moodle 3.8 is the current installed version of DID-ACT, so the plugins should be compatible with this version.

Plugin moodle_blocks-dashboard

Source: https://moodle.org/plugins/block_dashboard

The plugin was written and maintained by Very Fremaux and has several interesting aspects. For one, it is possible to freely define any sql statement using existing tables in the Moodle database. According to the documentation, it should be possible to use queries on a Postgres database and one may choose between different outputs for results; either as a table, in a hierarchical structure etc. Data results can also be shown in diagrams.

After several trials the installation of the plugin was completed successfully and is thus far not showing any faults. However, trying to create a configuration always resulted in an error “file_save_draft_area_files missing”.

A more sophisticated research showed that the plugin had not been modified to fit the requirements of Moodle 3.8. It seems that the last version was built for Moodle 3.3. Most users - comments starting in 2018 - were talking about similar problems during installation.

The newest version of the plugin in the Moodle plugin page is 2015032400 which is approved for Moodle 3.0.

Source: https://moodle.org/plugins/pluginversions.php?plugin=block_dashboard

Last activities on github were two years ago. The name of the plugin indicates that it runs under Moodle 3.6.

Source: https://github.com/vfremaux/moodle-block_dashboard

Ultimately, these unsuccessful attempts led to us ending further examination of the plugin.

Plugin moodle_blocks-configurable-reports

Source:
https://moodle.org/plugins/block_configurable_reports?nonjscomment=1&comment_itemid=

82&comment_context=50&comment_component=local_plugins&comment_area=plugin_general&comment_page=3

The plugin helps to create customized reports and has been created explicitly for administrators and teachers. It enables to create reports easily without any knowledge of SQL.

Standardized reports are reports about

- Courses
- Categories
- Users and their activities.

It is possible to create reports by writing unlimited SQLqueries. According to the documentation, developers can write new reports, so additional aspects can be integrated for non-SQLies.

A second database - not the Moodle one - can be used for queries.

The output of the queries can be formatted in the form of a table or a graphical element (pie chart etc.).

The owner of the report can give access to other users.

Source: https://moodle.org/plugins/pluginversions.php?plugin=block_configurable_reports

The plugin is approved for use in the most recent version of Moodle (3.10). The number of downloads of the plugin has increased continuously from May 2012 until the moment of writing the report (November 2020). This is an indication the plugin is robust enough to consider its use in the DID-ACT project. Sources can be found in github, too.

Source: https://github.com/jleyva/moodle-block_configurablereports

The installation had been done by downloading the plugin, moving the directory structure below the blocks directory, and opening the Moodle website as an ‘administrator’. This takes care of PHP extensions gd and freetype, which is essential as these enable us to use the plugin's graphical features. If they are not installed diagrams cannot be created and shown.

Installation had been done successfully without any problems. Next a standardized report had been created and configured, as expected, and successfully included the desired diagrams.

As a further test, it was tried to create a report by using an external database. As a result there is a possibility to use a different database, but it has to be in the same MariaDB or MySQL database as moodle. As well, the moodle user has to be given additional access to this database on top of the moodle database.

You address the external database by the name of the database followed by a dot. E.g.:
“select city, count(*) user from ext_data. Person
where 1=1
group by city
order by user desc”
Query and the creation of the report had been successful.

Source: https://moodle.org/mod/forum/discuss.php?d=333840#p1424026

The plugin has a comprehensive documentation.

Source:
https://docs.moodle.org/310/en/Configurable_reports#Reports_can_run_on_a_different_DB_then_the_current_.28production.29_DB

Learning analytics in CASUS

In the following section we have summarized the learning analytics capabilities of the CASUS virtual patients platform. This can be divided into two broad categories:

- Related to the progress of the student through virtual patient cases
- Related to the design of clinical reasoning concept maps.

Progress through virtual patient cases

A learning analytics panel summarizes progress with solving individual virtual patient cases. This includes in particular:

- time spent on the activity
- number of visited screen cards in the cases
- individual answers and success rate of questions included in the virtual patient cases.

The collected data can be analyzed grouped by

- individual virtual patient case
- in a detailed view for individual screen card within the virtual patient case
- for a give time-frame (e.g. weekly)
- for individual students.

The data is displayed in colored, interactive tables directly in the web browser, or can be downloaded in Microsoft Excel format for offline analysis in external software.

Design of clinical reasoning concept maps

Concepts maps illustrating the clinical reasoning process are an optional component of virtual patient cases in CASUS. Yet, when activated as a plug-in, the environment enables a range of additional analytic functionalities. These include:

- the display of stages in development for concept maps (added concept nodes and links) corresponding to the status of the concept map for a given screen card.
- the scoring of the concept nodes added by the learner in four categories of concept maps: findings, differential diagnosis, examinations and treatments.

The scoring algorithm of the individual dimensions of the map is based on matching the concepts in the expert and student map. Partial points are given if more general and specific concepts are selected by the student. Details of the scoring algorithm can be found in the study by Hege et al [Hege17]. In addition the software is able to detect some signs of common cognitive errors and biases while working on the virtual patient cases [Hege17]. The summary statements connected with clinical reasoning concept maps are graded by detection of semantic qualifiers using a rubric proposed by Smith et al [Smith16], with an implementation using natural language processing described by Hege et al in a separate report [Hege20].

The analytic functionalities are available in a graphical dashboard for learners and instructors. It is also possible to download the report in Microsoft Excel format for external analysis. However, we must underscore that some of the visualizations are still in development stages. New additions are planned as part of the future activities of WP5.

Conclusions for the DID-ACT learning analytics dashboard

Our analysis of the affordances for the recording and reporting of user activity in electronic learning environments selected for implementation of the DID-ACT curriculum delivered an inventory of opportunities. These opportunities extend specifically into data collection and processing for future activities in the evaluation work package (WP5). We have structured the analytic opportunities based on the goals and learning objectives catalog from report D2.1. At the same time, we have realized the collected data are distributed across several places, are available in different formats, and reported with some limitations in functionality of usability. This might trigger further development work.

We will continue our activities initiated in this deliverable throughout the lifetime of the evaluation work package. Including selecting and adjusting the reporting functionality of the presented learning analytics toolbox to achieve concrete evaluation events aligned with progress in the implementation of the work packages WP3 and WP4 planned to start in 2021. This will contribute to the development of a coherent DID-ACT clinical reasoning analytics model, which is planned to be reported as part of learning analytic guidelines by the end of the project (D7.3).

Usability evaluation

Based on experiences from previous projects (e.g. WAVES [Kononowicz17]) and review of the literature, we propose to measure the usability of the designed resources using the System Usability Scale [Brooke96] as presented in Table 5.

Table 5: System Usability Scale [Brooke96]

Id	Item
1	I think that I would like to use this system frequently.
2	I found the system unnecessarily complex.
3	I thought the system was easy to use.
4	I think that I would need the support of a technical person to be able to use this system.
5	I found the various functions in this system were well integrated.
6	I thought there was too much inconsistency in this system.
7	I would imagine that most people would learn to use this system very quickly.
8	I found the system very cumbersome to use.
9	I felt very confident using the system.
10	I needed to learn a lot of things before I could get going with this system

This metric consists of a set of 10 five-point Likert-scale statements regarding different aspects of usability. Half of the statements have a positive stance, the other half negative, and when added up and multiplied by 2.5, the scale returns a rating in the range 0-100. Ratings < 50 are inacceptable, >70 show good usability. We have selected this metric because of its popularity, which enables easy interpretation of results, and brevity which facilitates rapid application of the tools.

The advantages of the SUS are its global acceptance, clear score, and easy interpretation. We propose to implement it as a web questionnaire in LimeSurvey.

Conclusions

In this deliverable we have analyzed the literature in search of existing evaluation tools that were applied when measuring satisfaction and self-assessment of clinical reasoning learning outcomes. We summarized the results in face of the DID-ACT project's learning goals and objectives laid out in D2.1. The established set of items will be used as a repository of items in evaluation questionnaires in WP3 and WP4. The selected approach gives us freedom to make adjustments depending on how the DID-ACT curriculum develops.

Furthermore, we have summarized the learning analytics capabilities of the software tools (Moodle and CASUS) selected to implement the curriculum from a technical perspective. We

have analyzed the selected learning objectives from D2.1 and e-learning teaching methods from D2.2 to map them with the known analytical functions of our selected software. We have also identified a tool for evaluating the general usability of the learning environment.

The above presented results form our evaluation toolbox will serve as a basis for the concrete evaluation activities planned to be reported in the upcoming deliverables D5.2 (Evaluation of train-the-trainer course) and D5.3 (Evaluation of pilot student curriculum).

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- [Moodle_analytics] Moodle Analytics https://docs.moodle.org/39/en/Analytics
- [Moodle_analytics_plugins] https://moodle.org/plugins/?q=learning%20analytics
- [WAVE_d23] WAVE Project, D2.3 Developed VP systems APIs and platform integration http://www.wavesnetwork.eu/res/file/d-2-3-api-platform-integration.pdf

Appendix

Studies evaluating students' satisfaction with clinical reasoning learning sessions

Table A1. Studies with tools that evaluated students' satisfaction while learning clinical reasoning

Id	Study	Tool	Comments
1	Koivisto JM et al, 2016	Form: student questionnaire Level: reaction (self-assessment, satisfaction) Items: 21 items in Likert-Scale Profession: Nursing Available to use: YES	A questionnaire developed by the authors of the reported study. It is based on the clinical reasoning process described by Lewett-Jones et al. (2010) and a study by the authors on using nursing students' experiential learning processes when using a simulation game (Koivisto et al., 2015). The instrument was pilot-tested by five nursing students and refined. The questionnaire included data on demographic items, learning of the clinical reasoning process by playing, application of nursing knowledge and exploration during gaming.
2	Kelly T et al, 2019	Form: student questionnaire Level: reaction (self-assessment, satisfaction) Items: 8 items in Likert-Scale Profession: Radiation therapy Available to use: YES	An instrument developed by the authors to rate the usefulness of the module. The questionnaire includes in total eight questions in Likert-Scale scale and place for open-ended comments.
3	Pinnock R. et al, 2012	Form: student questionnaire Level: reaction (satisfaction) Items: 6 items in Likert-Scale Profession: Medicine Available to use: YES	An anonymous questionnaire to evaluate student feedback from a virtual patient experience with 6-items in Likert scale.
4	Linsen A. et al, 2018	Form: student questionnaire x 4, paper-based cases Level: a-c,e: reaction (satisfaction), d: skill Profession: Medicine (1st year and, d: medical teachers) Measured features: interest (individual, situational), engagement (situational, cognitive), problem solving of	Clinical reasoning intervention evaluated using five tools: a) Individual interest measure (7 items) - (Rotgans, 2015) b) Situational interest measure (6 items) - aroused in response to specific educational intervention (Rotgans et al 2014) c) Situational cognitive engagement measure (6 items) - engagement in learning task during group sessions (Rotgans et al 2011) d) Twelve written clinical cases

		cases, program evaluation Available to use: YES (a,e), PARTIALLY (b,c) NO (d)	e) Program Evaluation Rating Scale (38 items, Likert-scale, open questions) (Schmidt et al 1995)
5	Forsberg E. et al, 2016	Form: student questionnaire Items: 4 descriptive items Level:satisfaction, self-assessment Profession: Pediatric nursing students (postgraduate course) Available to use: YES	Four free-text questions measuring satisfaction of the clinical reasoning course and self-perceived confidence in clinical reasoning skills
6	Vidyarthi A. et al, 2016	Form: student questionnaire Items: 8 items in Likert scale Level: Satisfaction, self-assessment Profession: Medical students(final years) Available to use: YES	A survey that consists of 8 Likert scale questions measuring: perceived value of clinical reasoning of the student, exposure to different approaches to clinical reasoning during the course, satisfaction with quality of classroom practice and self-perceived quality of clinical practice.
7	Bailey D, et al, 2002	Form: Videotaped interview analysis + students' course evaluation Level: Profession: Occupational therapy students Available to use: NO	Evaluation by analysis of video recordings during debriefing and a satisfaction questionnaire. The study does not describe how students' course evaluation looks like.
8	Iyer et al, 2019	Form: Student questionnaires Items: 1. 20 multiple choice questions 2. 5 items in 5-point Likert scale Level: 1. Knowledge 2. Satisfaction Profession: medical students Available to use: YES	In this study two evaluation instruments were used: 1. Residents' self-assessed ability to recognize and apply clinical reasoning concepts that consisted of 15-items in four-point Likert scale 2. Residents' clinical reasoning knowledge - using patient scenarios.
9	Zijdenbos et al, 2010	Form: 1, 2: Student questionnaires; 3. Student interview Items: 1. 4 Items in 5-point Likert scale, one rated 1-10; 2. 10 items; 7 multiple choice, 3 in 5 point Likert scale	The course was evaluated using three methods: 1. student questionnaire directly before/after the intervention 2. student questionnaire after five months 3. student interviews

		Level: Satisfaction Profession: Medical students Available to use: YES(1,2), NO(3)	

Studies with clinical reasoning self-assessment tools

Table A2. Studies that include tools for self-assessment of learning outcomes in clinical reasoning skills

Id	Study	Tool	Description
1	Harendza S et al, 2017	Form: student questionnaire; case presentation Items: 8 items in 6-point Likert scale Level: Self-assessment Profession: Medical Students Available to use: YES	A self-assessment questionnaire rating eight clinical reasoning skills in 6-point Likert scale applied before the first and last meeting of the seminar.
2	Hardy Y et al, 2017	Form: formal case presentations, knowledge evaluating exams, survey in Likert scale Level: reaction (self-assessment, satisfaction) Profession: Pharmacy students Measured features: Available to use: NO(exams, drug information response, case presentation, exams), YES(survey)	Clinical reasoning course was evaluated using 6 tools: 1) 3 SOAP notes; 2) Formal drug information response; 3) grand rounds case presentations; 4) Midterm exam; 5) Final exam and 6) Self-perceived confidence survey in Likert scale.
3	Alfayoumi I, 2019	Form: student questionnaire, observation of students by Clinical Instructors Items: 26 Items in 5-point Likert scale(2), 3 items with 4 alternatives (3) Level: Reaction (self-assessment)(2), Skills(3,4) Profession: Nursing students	A questionnaire containing the following four sections was administered to the students at both the beginning and end of the semester. 1. Participant Demographic Sheet: age, sex, academic level, GPA, own perception of academic success (3 items) 2. General CR Behavior Scale: 26-item 5-point Likert type scale, measures students' contextual General CR Behavior, including antecedents, processes, reasoning patterns and consequences of CR

		Measured features: Available to use: YES(2), NO (1,3,4)	3. Independence in Clinical Judgement - exploring "the level of independence in patient care judgments when the student assessed patients to identify significant cues; interpreted data to identify patient problems; and to decide whether or not to intervene, respond, or take an action" - 3 itens with 4 alternatives ranging from "constantly relying on preceptor" to "making all CJs and the preceptor supporting them" - measured both by students' perceptions and CI observation 4. Independence in Clinical Reasoning: similar to (3), 4 alternative questions, options range from "independent at all times" to "dependent on the preceptor at all times" - measured both by students' perceptions and CI observation
4	Liou SR et al, 2015	Form: Student questionnaire Items: 15 items in 5-point Likert scale Level: Reaction - self-assessment Profession: Nursing students, nurses Available to use: YES	For evaluation of the course outcome a Nurses Clinical Reasoning Scale was applied. This scale included 15 items in 5-point Likert scale with 1-4 items corresponding to each of 8 steps of clinical reasoning: look, collect, process, decide, plan, act, evaluate and reflect.
5	Sobral D 2005	Form: Student questionnaire Items: 14 items in 7-point Likert scale Level: reaction (self-assessment) Profession: Medical students Available to use: YES	Scale of Reflection-in-Learning (RLS) which is a self-assessment questionnaire for appraising the reflective learning process. This instrument includes 14 items in 7-point Likert Scale. Higher RLS score correlated with higher DTI score.
6	Seif G et al 2014	Form: Student questionnaires Items: 1. 18 items in 6-point Likert scale 2. 19 items in 5-point Likert scale 3. 26 items in 5-point Likert scale Level: reaction (self-assessment) Profession: medical students, occupational therapy students, physical therapy students, pharmacy students, physician assistant students	1. Interdisciplinary Education Perception Scale (IEPS) an 18 items tool in 6-point Likert scale to measure "the effect of interprofessional education experiences on undergraduate students." This tool includes four subscales: competency and autonomy, perceived need for cooperation and perception of actual cooperation and understanding others' roles." (https://nexusipe.org/informing/resource-center/ieps-interdisciplinary-education-perception-scale) 2. Readiness for Interprofessional Learning Scale (RIPLS) - consisting of 19 items in 5-point Likert scale to examine the attitude of health and social care

		Available to use: YES (all)	students and professionals towards interprofessional learning 3. Self-Assessment of Clinical Reflection and Reasoning (SACRR) 26 items in 5-point Likert scale. A tool developed to evaluate clinical reasoning skills of occupational therapy and physical therapy students and practitioners, but "can be used with students in the health professions and has been tested on other student populations".
7	Nolt V et al 2018	Form: 1. Thematic analysis of student reflections 2. written and video assignments Level: Reaction(self-assessment) Profession: Pharmacy students Available to use: 1. YES 2. NO	1. Two reflective assignments asking about thinking strategies about subjective perception of improvement in solving clinical problems and a survey 2. Graded video responses evaluated by the instructors.
8	Sobocan M et al 2016	Form:Student questionnaire Items: 41 items in 6-point Likert scale Level: Reaction(self-assessment) Profession: Medical students Available to use: YES	This study has used an established instrument by Bordage et al (1990) called Diagnostic Thinking Inventory (DTI). The instrument consists of 41 items in 6-point Likert scale and was designed to measure two aspects of diagnostic thinking: the degree of flexibility in thinking and the degree of knowledge structure in memory.

9	Lee et al, 2016	Form: Student questionnaires Items: 1. 70 questions with 5-point Likert scale 2. 45 questions with 5-point Likert scale 3. 28 questions in 6-point Likert scale Level: Reaction(self-assessment) Profession: Nursing students Available to use: NO(Korean or could not find)	1. Nursing core competencies tool with five subcategories such as "critical thinking and evaluation (14 questions), general clinical practice capability (13 questions), special clinical practice capability (nine questions), human understanding and communication (21 questions), and professional attitude (13 questions); all of which add up to a total of 70 questions" in 5 point Likert scale. 2. Problem solving skills tool with "five subcategories of problem clarification (5 questions), causal analysis (10 questions), alternative development (10 questions), planning/implementation (10 questions), and performance assessment (10 questions), which add up to a total of 45 questions" in 5 point Likert scale. 3. Academic self-efficacy tool with "three subcategories of task difficulty (10 questions), self-regulated efficacy (10 questions), and confidence (8 questions), adding up to a total of 28 questions" in 6 point Likert scale
10	Huhn et al., 2017	Form: Student questionnaires Items: 1. 75 items in 6-point Likert scale 2. 20 items in 6-point Likert scale Level: Reaction(self-assessment) Profession: Doctor of Physical Therapy students Available to use: 1. YES(paywall), 2. YES	1. California Critical Thinking Disposition Inventory (CCTDI) - a 75-item tool in which respondents agree or disagree in a 6 point scale from seven constructs describing attributes of critical thinkers. CCTDI provides an overall score and scores for each of the dimensions. 2. Self Reflection and Insight Scale (SRIS) - a tool which is based on theories of metacognition and self-regulation to measure the readiness of individuals for purposeful behavior change. The scale consists of 20 items rated with a six-point Likert scale.
11	Elvén et al., 2018	Form: Student questionnaires and written case scenarios Items: 49 self-assessment items from 5 domains Level: Self-assessment + Outcomes (Case scenarios) Profession: Physiotherapy Available to use: Partially (only selected items because the whole questionnaire has not yet	Reasoning 4 Change (R4C) instrument consisting of 81 items distributed across four domains: Physiotherapist domain (D1), Input from client domain (D2), Functional behavioural analysis domain (D3), and Strategies for behaviour change domain (D4). The D1 domain is divided in five subscales: Knowledge (D1.1), Cognition (D1.2), Metacognition (D.1.3), Psychological factors (D1.4), and Contextual factors (D1.5) and is based on self-assessments and include 49 items in total either 6-point or 11-point Likert scale.

		been published in English version after validation)	D2, D3, and D4 consist of written case scenarios, eight in total, which are gradually extended with new information. D2 includes 12 items, D3 eight items, and D4 12 items.

Inventory of identified evaluation items to measure student satisfaction

Table A3. Inventory of satisfaction items grouped by the identified themes

Theme	Identified items
1. Course organisation	Please rate the organisation of the labs (e.g were they well organised and paced). [Kelly T et al, 2019]
	The course was well organized [Linsen A. et al, 2018]
	The problems were clearly stated [Linsen A. et al, 2018]
	I had enough time to complete the assignments [Linsen A. et al, 2018]
	The lectures provided structure to the course's subject matter [Linsen A. et al, 2018]
	The training in professional skills linked up well with the course's theme [Linsen A. et al, 2018]
	The training in professional skills was offered in an instructionally sound fashion [Linsen A. et al, 2018]
	The training in professional skills fitted within the time frame of the course [Linsen A. et al, 2018]
	The learning goals produced by the tutorial group were restricted to topics we thought would be part of the end-of-unit test [Linsen A. et al, 2018]
2. Feedback given	Do you believe receiving feedback from your peers was a helpful way to identify your strengths and weaknesses? [Kelly T et al, 2019]
	Do you believe receiving feedback from the simulated patient was a helpful way for you to identify your strengths and weaknesses? [Kelly T et al, 2019]
	Do you believe receiving feedback from the facilitator (lecturer) was a helpful way for you to identify your strengths

	and weaknesses? [Kelly T et al, 2019]
3. Clear expectations	Did you find the preparation leading up to the clinical reasoning tutorial to be helpful (including readings, case scenarios, and in-call role play)? [Kelly T et al, 2019]
	The explanations I received helped to enhance my diagnostic reasoning [Pinnock et al, 2012]
	The course's objectives were clear to me [Linsen A. et al, 2018]
	The course's subject matter was difficult to understand [Linsen A. et al, 2018]
	The problems were suitable for using a systematic approach [Linsen A. et al, 2018]
	The problems gave sufficient opportunities for formulating learning goals [Linsen A. et al, 2018]
	The problems helped me in integrating the basic with the clinical sciences [Linsen A. et al, 2018]
	The following problems were poor: (fill in numbers) [Linsen A. et al, 2018]
	The following problems were high quality: (fill in numbers) [Linsen A. et al, 2018]
	The topics treated were difficult to understand [Linsen A. et al, 2018]
	Generally, the topics were presented in a clear fashion [Linsen A. et al, 2018]
	Did you feel confident or uncertain in your clinical reasoning while working with the VP cases? [Forsberg E. et al, 2016]
4. Relevance	Do you believe today's tutorial helped you to better understand your role as a [role_name] with regards to patient care/clinical reasoning? [Kelly T et al, 2019]
	Overall, how would you rate your experience today? [Kelly T et al, 2019]
	This course adds value to my clinical training. [Vidyarthi A. et al, 2015]

	I was exposed to different systematic approaches to reasoning through clinical cases in class. [Vidyarthi A. et al, 2015]
	The questions I was asked helped to enhance my diagnostic reasoning [Pinnock et al, 2012]
	Taken together, I've worked in an agreeable way [Linsen A. et al, 2018]
	The course's subject matter was adapted to my prior knowledge [Linsen A. et al, 2018]
	The topics of this course were useful [Linsen A. et al, 2018]
	I have learned a lot during this course [Linsen A. et al, 2018]
	My expectations with regard to the contents of the course have been confirmed [Linsen A. et al, 2018]
	A sufficient variety of problems was available [Linsen A. et al, 2018]
	The lectures linked up with the topics I studied [Linsen A. et al, 2018]
	The lectures have been an indispensable part of this course [Linsen A. et al, 2018]
	I think that the training in professional skills is relevant for this curriculum [Linsen A. et al, 2018]
	If you had to mark this course's program on a scale from 1 to 10 (6 is sufficient), what mark would you assign to this course? [Linsen A. et al, 2018]
	What was your learning experience of the completed VP cases? Describe what you perceived as especially difficult, important or interesting? [Forsberg E. et al, 2016]
5. Quality of group work	The problems sufficiently stimulated group discussion [Linsen A. et al, 2018]
	The tutorial group agreed explicitly on subject matter to be studied [Linsen A. et al, 2018]
	Generally, everybody complied with the agreements [Linsen A. et al, 2018]

	The meetings have been productive [Linsen A. et al, 2018]
	Everybody actively contributed to the discussion [Linsen A. et al, 2018]
	The group discussion hardly influenced my choice of topics to be studied [Linsen A. et al, 2018]
	I found the atmosphere in my group agreeable [Linsen A. et al, 2018]
	When the test date approached, I started spending more time in preparing for the test and less time on issues agreed on in the tutorial group [Linsen A. et al, 2018]
6. Teacher competencies	The tutor displayed a fair understanding of this course's objectives [Linsen A. et al, 2018]
	The tutor displayed knowledge of the principles underlying problem-based learning [Linsen A. et al, 2018]
	One had the impression that the tutor liked his or her role [Linsen A. et al, 2018]
	The tutor encouraged us to work hard [Linsen A. et al, 2018]
	The tutor's questions stimulated the discussion [Linsen A. et al, 2018]
	At regular intervals, the tutor evaluated with us the group's functioning [Linsen A. et al, 2018]
	The tutor appeared to be sufficiently knowledgeable with respect to course's topics [Linsen A. et al, 2018]
	He intervened in ways that disturbed the progress of the group

	discussion [Linsen A. et al, 2018]
	The subject-matter contributions of this tutor were relevant [Linsen A. et al, 2018]
	Taken together, the tutor played his role well [Linsen A. et al, 2018]
	My ward attending explicitly discussed common clinical reasoning terminology [Iyer et al, 2019]
	My ward attending explicitly outlined her/his clinical reasoning on most cases. [Iyer et al, 2019]
	My teaching attending explicitly discussed common clinical reasoning terminology. [Iyer et al, 2019]
	My teaching attending explicitly outlined her/his clinical reasoning on most cases. [Iyer et al, 2019]
7. Self-directed learning	I consider the subject of this course interesting [Linsen A. et al, 2018]
	The problems sufficiently stimulated self-directed learning [Linsen A. et al, 2018]
	I have studied independent of the course's schedule to a large extent [Linsen A. et al, 2018]
	The meetings stimulated self-directed learning activities [Linsen A. et al, 2018]
	I borrowed books and journals from the library regularly [Linsen A. et al, 2018]
	The learning resources that I wished to consult were available sufficiently [Linsen A. et al, 2018]
	I have only consulted the articles suggested by the staff [Linsen A. et al, 2018]
	Because of the articles suggested by the staff, I was not encouraged to look for reading myself [Linsen A. et al, 2018]
	The articles suggested by the staff were relevant for the various problems [Linsen A. et al, 2018]
	In view of the end-of-unit test, I confined myself to studying the literature suggested by the staff [Linsen A. et al, 2018]

	To get an impression of the topics and the difficulty of the end-of-unit test, I have studied tests from previous years [Linsen A. et al, 2018]
	How much time on the average did you spend each week on independent study? (Fill in the answer in whole hours) [Linsen A. et al, 2018]
	How does this new knowledge or experience conform to prior knowledge and experiences? [Forsberg E. et al, 2016]
	How does this new knowledge or experience enhance your previous knowledge and experience and how can you use this in future situations? [Forsberg E. et al, 2016]
	I used at least one of the strategies for improving my clinical reasoning outlined in the workshop (If applicable). [Iyer et al, 2019]
8. Other	Please rate your level of anxiety leading up to this tutorial [Kelly T et al, 2019]

Inventory of evaluation items for self-assessment of clinical reasoning skills

Table A4. Mapping of self-assessment items to DID-ACT goals and objectives

Goal > Learning Objective	**Item**
1. Gather/interpret/synthesize > a. collect key findings	I learned to collect information by interviewing patient [Koivisto JM et al, 2016]
	I learned to collect information by observing patient [Koivisto JM et al, 2016]
	I learned to collect information from measurable patient data [Koivisto JM et al, 2016]
	I gathered information to characterise the patient's problem [Pinnock et al, 2012]
	[I am capable of] Identifying normal and abnormal laboratory findings. [Hardy Y. et al., 2017]
	Conducting a patient interview to gather pertinent

	patient information for developing a treatment plan. [Hardy Y. et al., 2017]
	Documenting patient findings in written form [Hardy Y. et al., 2017]
	I know how to collect an admitted patient's health information quickly. [Liou SR et al., 2015]
	I can apply proper assessment skills to collect a patient's current health information. [Liou SR et al., 2015]
	I can accurately evaluate and identify whether a patient's condition is improved. [Liou SR et al., 2015]
	When the patient presents symptoms, a) I think of the symptoms in the precise words used by the patient/b) I think of the symptoms in more abstract terms than the expressions actually used (e.g. '4-day duration' becomes 'acute'; 'two-hands' becomes bilateral) [Sobocan M. et al., 2016]
	Throughout the interview, a) If I follow the patient's line of thought, I tend to lose my own thread/b) I can still keep my own ideas clear even if I follow the patient's line of thought [Sobocan M. et al., 2016]
	As the patient tells his story and the case unfolds, a) I often find it difficult to remember what has been said/ b) I can usually keep track in my mind of what has been said [Sobocan M. et al., 2016]
	During the course of the interview, I find that, a)Some key pieces of information seem to leap out at me/b) It is often difficult to know which items of information to latch on to [Sobocan M. et al., 2016]
	When I cannot make sense of the patient's symptoms, a) I move on and gather new information to trigger new ideas/b)I ask the patient to define those symptoms more clearly [Sobocan M. et al., 2016]
	When patients use imprecise or ambiguous expressions,a)I let them go on to maintain the flow of the interview /b) I make them clarify precisely what they mean before going on [Sobocan M. et al., 2016]

	After an interview with a patient,a)I rarely think of other things that I should have asked in relation to the patient's disorder /b) I often think of other things that I should have asked in relation to the patient's disorder [Sobocan M. et al., 2016]
	Throughout the interview,a)I manage to test my ideas even if I let the patient control the interview /b) am only successful if I can control the direction of the interview [Sobocan M. et al., 2016]
	In terms of the way I conduct an interview,a)I usually cover the ground that I need to during the interview /b) Quite often I do not ask all the questions that I should at the time [Sobocan M. et al., 2016]
	When I don't understand what influences the client's target behaviour, I reconsider and collect new information [Elven et al., 2018]
1. Gather/interpret/synthesize > b. analyse and interpret key findings	I learned to process information [Koivisto JM et al, 2016]
	I learned to analyse data to reach an understanding of signs or symptoms [Koivisto JM et al, 2016]
	I am capable to summarize a complex patient case in 2-3 sentences. [Harendza S. et al., 2017]
	Evaluating therapeutic, sub-therapeutic, and toxic responses to drug therapy. [Hardy Y. et al., 2017]
	Documenting patient findings in oral form. [Hardy Y. et al., 2017]
	All of my clinical judgments are accurate [Alfayoumi I., 2019]
	I can identify abnormalities from the collected patient information. [Liou SR et al., 2015]
	I can accurately prioritize and manage any identifiable patient problems [Liou SR et al., 2015]
	I can correctly explain the mechanism behind a patient's problems. [Liou SR et al., 2015]
	Shared learning will help to clarify the nature of patient

	problems [Seif G. et al., 2014]
	In thinking of diagnostic possibilities, a) I think of diagnostic possibilities early on in the case/b) First I collect the clinical information and then I think about it [Sobocan M. et al., 2016]
	Once the patient has clearly presented his symptoms and signs, a)I think about them in my mind in the patient's own words/b) I translate them in my mind into medical terms (e.g. 'numbness' becomes 'paraesthesia' or 'paralysis') [Sobocan M. et al., 2016]
	In relation to the routine history, a) I often feel that I did not sufficiently cover the routine history/b) I usually cover the routine history to my satisfaction [Sobocan M. et al., 2016]
	While I am collecting information about a patient,a) The various items of information usually seem to group themselves together in my mind/b)I often have difficulty seeing how the pieces of information relate to each other [Sobocan M. et al., 2016]
	During the clinical interview, a) I cannot bring myself to dismiss some information as irrelevant/b)I am quite happy to dismiss some information as irrelevant [Sobocan M. et al., 2016]
	When I cannot make sense of the patient's symptoms and signs a)I move on to get new information and a new perspective/b)I look at them from a different perspective before moving on [Sobocan M. et al., 2016]
	When a possible diagnosis comes to my mind,a)I usually find myself anticipating possible abnormal signs and symptoms that go with that diagnosis/b)Quite often, it does not help me to decide what to ask the patient next [Sobocan M. et al., 2016]
	In considering the patient's signs and symptoms, a)I think about each in absolute terms as stated by the patient / b)I think of them in terms of possible opposites (e.g. progressive vs. sudden; unilateral vs. bilateral; spastic vs. flaccid) [Sobocan M. et al., 2016]

	When I am taking a history, I find that, a)I can get new ideas just by going over the existing information in my mind/b) I need to have new information to make me have a new idea about the case [Sobocan M. et al., 2016]
	When a piece of information comes along and makes me think of a possible diagnosis,a)It often makes me go back to previous information to see if things fit together or not/b) It rarely makes me review the information that I have gathered previously [Sobocan M. et al., 2016]
	As the case unfolds, a)I do not find it useful to summarise as I go along/b)I periodically take stock of the data and my ideas [Sobocan M. et al., 2016]
	When I reach my diagnostic decisions,a)There is often left-over information I have just forgotten about/b) I usually will have considered all the information [Sobocan M. et al., 2016]
	If I do not know what to make of a clinical interview,a)I can readily see the information in new ways/b)I find it difficult to see the information in new ways [Sobocan M. et al., 2016]
	I have a good ability to analyse the client's complaints based on a selected target behaviour [Elven et al., 2018]
	I have a good ability to formulate hypotheses (make assumptions) explaining how physical, psychological and environmental factors and consequences of the behaviour are interrelated, cause and control the client's difficulties in performing the target behaviour [Elven et al., 2018]
2. Plan treatment/management > a. apply procedures < diagnosis/holistic/ context/evidence-based	I learned to plan [nursing] interventions [Koivisto JM et al, 2016]
	I learned to take action [Koivisto JM et al, 2016]
	I learned to implement [nursing] interventions according to symptoms [Koivisto JM et al, 2016]
	I value using the current medical literature to answer clinical questions for exemplary patient care [Vidyarthi

	A. et al, 2015]
	I am capable to ask for relevant tests based on hypotheses. [Harendza S. et al., 2017]
	Analyzing the appropriateness of evidence based medicine in the management of a patient. [Hardy Y. et al., 2017]
	Critically evaluating clinical trials for their application into patient care. [Hardy Y. et al., 2017]
	I need prompting, help from the preceptor to initiate a therapeutic relationship with patients [Alfayoumi I., 2019]
	I constantly know the next step in patient care [Alfayoumi I., 2019]
	I can provide appropriate nursing intervention for the identified patient problems. [Liou SR et al., 2015]
	I am knowledgeable of each nursing intervention provided. [Liou SR et al., 2015]
	I can anticipate the prescription ordered by the doctor according to the patient information provided. [Liou SR et al., 2015]
	I know the follow-up steps to take if the patient's condition does not improve. [Liou SR et al., 2015]
	When I order laboratory tests,a)I do it as part of the routine clinical investigation /b) do it expecting specific information or supporting evidence [Sobocan M. et al., 2016]
	I don't make judgments until I have sufficient data. [Seif G. et al., 2014]
	I look to frames of reference for planning my intervention strategy. [Seif G. et al., 2014]
	I use clinical protocols for most of my treatment. [Seif G. et al., 2014]
	I make decisions about practice based on my experience. [Seif G. et al., 2014]

	There are good opportunities and support at my clinical training placement/workplace for focusing on clients' target behaviour and behavioural change in my clinical reasoning. [Elven et al., 2018]
	At my clinical training placement/workplace, there is not the time needed to focus on clients' target behaviour and behavioural change in my clinical reasoning. [Elven et al., 2018]
2. Plan treatment/management > b. set goals < context/evidence/patient preferences-based	I learned to identify problems/issues [Koivisto JM et al, 2016]
	I learned to establish goals [Koivisto JM et al, 2016]
	I learned to set goals [Koivisto JM et al, 2016]
	I can set nursing goals properly for the identified patient problems [Liou SR et al., 2015]
	Investigating environmental factors (physical and social) that are important for the client's target behaviour [Elven et al., 2018]
3. Patient participation > a. engage/collaborate patient/families in analysis of patient problem	I learned to prioritise patient's need for care [Koivisto JM et al, 2016]
	I am capable to recognize uncertainty in medical decisions and to communicate it to a patient. [Harendza S. et al., 2017]
	My relationship with patients is below average [Alfayoumi I., 2019]
	Patients are accepting me as a care provider [Alfayoumi I., 2019]
	I ask for the viewpoints of clients' family members. [Seif G. et al., 2014]
	I have a good ability to analyse what the client thinks, feels, says and does based on the client's own monitoring of how the target behaviour is performed in its natural context [Elven et al., 2018]
	Guiding the client to independently monitor their target behaviour in its natural context, e.g. through a diary [Elven et al., 2018]

4. Collaborate > a. use team competencies	I learned to make decisions on patient care in cooperation with other students [Koivisto JM et al, 2016]
	I constantly feel that I am part of the nursing team [Alfayoumi I., 2019]
	The team constantly relies on me [Alfayoumi I., 2019]
	Patients would ultimately benefit if health-care students worked together to solve patient problems [Seif G. et al., 2014]
	Shared learning with other health-care students will help me to communicate better with patients and other professionals [Seif G. et al., 2014]
5. Self-reflection/ improvement strategies > a. use critical thinking to improve performance	My mode of thought is analytic and logical [Alfayoumi I., 2019]
	I am continuously examining & thinking about my patient care actions/judgments after [they've] been implemented [Alfayoumi I., 2019]
	I question how, what and why I do things in practice. [Seif G. et al., 2014]
	I must validate clinical hypotheses through my own experience. [Seif G. et al., 2014]
	Regarding a proposed intervention strategy, I think, “What makes it work?” [Seif G. et al., 2014]
	Regarding a particular intervention, I ask, “In what context would it work?” [Seif G. et al., 2014]
5. Self-reflection/improvement strategies > b. evaluate outcomes with patients/colleagues	I learned to evaluate outcomes [Koivisto JM et al, 2016]
	I learned to evaluate effectiveness of interventions [Koivisto JM et al, 2016]
	I used the current medical literature to answer clinical questions that arose for my patients. [Vidyarthi A. et al, 2015]
	Evaluating disease progression and/or patient risk for disease development or complications. [Hardy Y. et al., 2017]

	I ask for colleagues' ideas and viewpoints. [Seif G. et al., 2014]
6. Generate DDX > a. defining/discriminating features	I learned to distinguish relevant from irrelevant information [Koivisto JM et al, 2016]
	I learned to make [nursing] diagnosis [Koivisto JM et al, 2016]
	I am capable to list several differential diagnoses for a specific case. [Harendza S. et al., 2017]
	I am capable to assess and justify these differential diagnoses from the context of a specific case. [Harendza S. et al., 2017]
	In considering each diagnosis, a) I try to evaluate their relative importance/b) I try to give them equal importance or weighting [Sobocan M. et al., 2016]
	In considering diagnostic possibilities, a)I often come up with unlikely diagnoses/b) I am usually in the right area [Sobocan M. et al., 2016]
	When I consider a number of possible diagnoses,a)The diagnoses tend to be related to one another/b)The diagnoses tend to be scattered [Sobocan M. et al., 2016]
	When I know very little about a particular type of disease,a)I can still usually come up with a diagnosis/b) I have great difficulty in reaching a diagnosis [Sobocan M. et al., 2016]
	When I know a lot about a particular type of disease and have to make a diagnosis, a)I find it relatively easy to pin down a diagnosis/ b)I often seem to be all over the place and have difficulty pinning down a diagnosis [Sobocan M. et al., 2016]
	When I consider my diagnostic ideas, I do so on the basis of,a)The case as a whole so far /b) A few outstanding symptoms or signs [Sobocan M. et al., 2016]
	In considering diagnostic possibilities,a)I compare and contrast the possible diagnoses/b) I consider each diagnosis separately on its own merits [Sobocan M. et

	al., 2016]
	Prior to acting, I seek various solutions. [Seif G. et al., 2014]
7. Errors > a. open climate to share	Defending patient care plan rationales in oral form. [Hardy Y. et al., 2017]
	Defending patient care plan rationales in oral form. [Hardy Y. et al., 2017]
	I ask myself and others questions as a way of learning. [Seif G. et al., 2014]
7. Errors > b. deal with uncertainty	I lack confidence when making clinical judgments [Alfayoumi I., 2019]
	In relation to the diagnosis I eventually make,a)I usually have very few doubts/b)I often feel too uncertain for my own comfort [Sobocan M. et al., 2016]
	Regarding the outcome of proposed interventions, I try to keep an open mind. [Seif G. et al., 2014]
	I can function with uncertainty. [Seif G. et al., 2014]
7. Errors > d. strategies to overcome errors	I am capable to recognize typical reasoning errors and to identify situations when they can occur. [Harendza S. et al., 2017]
8. Ethical > a. legal/moral/diversity/ gender-related aspects	I can easily deal with patients of opposite sex to mine [Alfayoumi I., 2019]
	I can easily deal with patients' family members of opposite sex to mine [Alfayoumi I., 2019]
9. Interprofessional > a. communicate across professions	Providing a written recommendation to another health care provider. [Hardy Y. et al., 2017]
	Providing a verbal recommendation to another health care provider. [Hardy Y. et al., 2017]
	I can question vague doctors' orders [Alfayoumi I., 2019]
	I recommend to the NM[nursing management] corrective actions for unit problems [Alfayoumi I., 2019]
	I question unwanted behavior of unit staff [Alfayoumi I.,

	2019]
	I can answer the phone calls to the unit [Alfayoumi I., 2019]
	I can respond to doctors' queries during rounds [Alfayoumi I., 2019]
	I can identify and communicate vital information clearly to the doctors based on the patient's current condition. [Liou SR et al., 2015]
	Shared learning will help me to think positively about other professionals [Seif G. et al., 2014]
	Team-working skills are essential for all health care students to learn [Seif G. et al., 2014]
	I don't want to waste my time learning with other health care students [Seif G. et al., 2014]
	I would welcome the opportunity to work on small-group projects with other health-care students [Seif G. et al., 2014]
	I value systematic approach to reasoning for exemplary patient care. [Vidyarthi A. et al, 2015]
9. Interprofessional > b. personal/(inter-) professional values	Learning is my responsibility [Alfayoumi I., 2019]
	I have a professional communication style [Alfayoumi I., 2019]
	Learning with other students will help me become a more effective member of a health care team [Seif G. et al., 2014]
	Shared learning with other health-care students will increase my ability to understand clinical problems [Seif G. et al., 2014]
	Communication skills should be learned with other healthcare students [Seif G. et al., 2014]
	It is not necessary for undergraduate health-care students to learn together [Seif G. et al., 2014]
	Clinical problem-solving skills can only be learned with students from my own department [Seif G. et al., 2014]

	Shared learning before qualification will help me become a better team worker [Seif G. et al., 2014]
	I'm not sure what my professional role will be [Seif G. et al., 2014]
	When I have got an idea about what might be wrong be the patient,a)I feel most comfortable if I can follow it up without being diverted /b) I feel happy to go off on another tack and come back to my original ideas later [Sobocan M. et al., 2016]
	I cope well with change. [Seif G. et al., 2014]
9. Interprofessional > c. similarities/differences across professions	The function of nurses and therapists is mainly to provide support for doctors [Seif G. et al., 2014]
	I have to acquire much more knowledge and skills than other health-care students [Seif G. et al., 2014]
10. CR theories > a. relate theory to practice	Throughout the case I drew on my knowledge of the basic sciences [Pinnock et al, 2012]
	I practised using the current medical literature to answer clinical questions that arose during the class. [Vidyarthi A. et al, 2015]
	I can explain the mechanism and development associated with the early signs or symptoms when a patient's health deteriorates. [Liou SR et al., 2015]
	I look to theory for understanding a client's problems and proposed solutions to them. [Seif G. et al., 2014]
	I use theory to understand treatment techniques. [Seif G. et al., 2014]
	I use theory to understand intervention strategies. [Seif G. et al., 2014]
	I have very good knowledge of theories and models about how behaviours are learned (e.g. operant and respondent learning) [Elven et al., 2018]
	I have very good theoretical knowledge of how diseases and injuries can affect bodily and mental functions [Elven et al., 2018]
	I have very good theoretical knowledge of how I can

	work with the client to identify and prioritise a target behaviour as the basis for goal-setting [Elven et al., 2018]
14. Decision making > a. diagnostic decisions based on hypotheses regarding the patient's problem	I learned to make decisions on patient care independently [Koivisto JM et al, 2016]
	I learned to make decisions on patient care promptly [Koivisto JM et al, 2016]
	I thought about which findings supported／refuted my diagnosis [Pinnock et al, 2012]
	I am capable to assess test results with respect to their relevance for a specific case. [Harendza S. et al., 2017]
	I am capable to immediately assign a diagnosis to typical patterns of a specific case. [Harendza S. et al., 2017]
	Discussing treatment option considerations for unique patient populations [Hardy Y. et al., 2017]
	I am anticipating patient's situation before there is sufficient data about his/her condition [Alfayoumi I., 2019]
	I can identify a patient’s health problems from the abnormal information collected. [Liou SR et al., 2015]
	When it comes to making up my mind about a diagnosis, a) I do not mind postponing my diagnostic decisions about a case/b) I feel obliged to go for one diagnosis or another even if I am not very certain [Sobocan M. et al., 2016]
	In making a diagnostic decision, a)I decide by considering each possible diagnosis separately on its own merits/b)I decide by comparing and contrasting the various possible diagnoses [Sobocan M. et al., 2016]
	When I know a lot about a particular type of disease and have to make a diagnosis,a)I check up on most possibilities before reaching a decision /b) I often have lots of ideas that I don’t explore further [Sobocan M. et al., 2016]

	When I come up with a broad idea as to what might be wrong with the patient,a)I can usually proceed to a specific diagnosis/b)I find it difficult to put it into specific terms [Sobocan M. et al., 2016]
	In relation to choosing from among the diagnostic ideas that I have,a)I am usually not capable of wholly ruling out any of the ideas I have had/b)I am capable of ruling out most of my ideas completely [Sobocan M. et al., 2016]
	When there is conflicting information about a clinical problem, I identify assumptions underlying the differing views. [Seif G. et al., 2014]
	When planning intervention strategies, I ask “What if” for a variety of options. [Seif G. et al., 2014]
	I regularly hypothesize about the reasons for my clients’ problems. [Seif G. et al., 2014]
	I clearly identify the clinical problems prior to planning intervention. [Seif G. et al., 2014]
	I anticipate the sequence of events likely to result from planned intervention. [Seif G. et al., 2014]
	Based on your hypotheses (assumptions), plan and use treatment strategies that support the client’s behavioural change [Elven et al., 2018]
14. Decision making -> b. making management decisions taking the patient’s goals and perceived situation into account.	I practised using systematic approaches to reasoning through cases in class. [Vidyarthi A. et al, 2015]
	I used a systematic approach to reason through my patients' case. [Vidyarthi A. et al, 2015]
	Determining appropriate follow-up care. [Hardy Y. et al., 2017]
	Creating a patient specific care plan for the appropriate management of disease manifestations [Hardy Y. et al., 2017]
	I think in terms of comparing and contrasting information about a client’s problems and proposed solutions to them. [Seif G. et al., 2014]

	I try to understand clinical problems by using a variety of frames of reference. [Seif G. et al., 2014]
	When implementing treatment, I often ask myself if I have considered all possible treatment strategies to help the client achieve their target behaviour [Elven et al., 2018]
	In discussion, guiding the client to identify and prioritise a target behaviour as basis for goal-setting [Elven et al., 2018]
	At my clinical training placement/workplace, I am often encouraged to focus on clients' target behaviour and behavioural change in my clinical reasoning [Elven et al., 2018]
14. Decision making > c. re-evaluating their decisions based on new understandings.	I revised my initial diagnosis as new information became available [Pinnock et al, 2012]
	Assessing changes in a patient's status related to drug therapy [Hardy Y. et al., 2017]
	I am able to verify my clinical judgments at all times [Alfayoumi I., 2019]
	I can recognize possible early signs or symptoms when a patient's health deteriorates [Liou SR et al., 2015]
	When I am interviewing a patient, a) I often seem to get one idea stuck in my mind about what might be wrong/b) I usually find it easy to explore various possible diagnosis [Sobocan M. et al., 2016]
	As the history progresses and I already have some ideas about the possible diagnosis(es),a)New information often makes me have more ideas/b)New information does not often make me have more ideas [Sobocan M. et al., 2016]
	Once I have made up my mind about a patient,a)I am prepared to change my mind /b)I really do not like to change my mind [Sobocan M. et al., 2016]
	Regarding a particular intervention with a particular client, I determine whether it worked. [Seif G. et al., 2014]

	When I receive new information about the client during consultations with the client, I always think about the significance of this information for the client's complaints and situation [Elven et al., 2018]
x. other/unclassified	I have full control over my daily activities [Alfayoumi I., 2019]
	I am asking the right questions [Alfayoumi I., 2019]
	I am asking the right people [Alfayoumi I., 2019]
	I am a habitual reader [Alfayoumi I., 2019]
	My actions are timely [Alfayoumi I., 2019]
	Learning with health-care students before qualification would improve relationships after qualification [Seif G. et al., 2014]
	For small group learning to work, students need to trust and respect each other [Seif G. et al., 2014]
	Shared learning will help me to understand my own limitations [Seif G. et al., 2014]