



Developing Students' Clinical Reasoning Through Digital Clinical Cases In Pediatric Education

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Abstract. This article examines the design of digital clinical cases to develop students' diagnostic reasoning in pediatric education. It aims to formulate instructional approaches that support the selection of clinical information, comparison of alternative hypotheses, and revision of decisions in response to new evidence. Comparative analysis of purposively selected empirical studies and pedagogical modeling were used. The proposed scenario structure combines progressive disclosure of information, retention of students' initial explanations, discussion of contradictory evidence, and transfer to a similar new case. Three tables organize case components, instructional responses to reasoning errors, and criteria for reviewing digital case quality. The practical contribution is a set of task designs that make students' reasoning visible alongside their final answers. The educational effectiveness of these proposals requires separate empirical evaluation.

Keywords: pediatric education, clinical reasoning, digital clinical case, differential diagnosis, diagnostic hypothesis, cognitive error, reflection.

Introduction

Students studying pediatrics must apply their knowledge of disease manifestations to specific cases, identify relevant information, and explain their chosen diagnosis. Selecting the correct answer in an educational task does not demonstrate that all these actions have been performed. A student may also identify the answer through a familiar phrase, a recently encountered example, or a superficial resemblance between response options. Therefore, a task designed to develop clinical reasoning should reveal both the final choice and the evidence that led to it.

A study using structured reflection during clinical case practice reported improvements in students' subsequent diagnostic performance on new cases [1]. This finding supports giving comparison and justification a central role in case-based learning. However, digital tasks developed for pediatrics must also incorporate the child's age, the person reporting the complaint, and the time at



which the information was obtained into the reasoning process. Simply displaying the same text on a screen does not, by itself, elicit these thinking processes.

In a study of pediatric life support skills, animation and interactivity in virtual patient materials were associated with certain measures of practical performance [2]. This finding cannot be directly applied to every aspect of diagnostic reasoning. It indicates that the educational value of a digital tool should be considered in relation to its specific design and the outcome being measured. This article aims to develop a digital clinical case structure that translates diagnostic reasoning into observable learning activities in pediatric education.

Materials and Methods

The work was conducted as a theoretical and methodological study. The material analyzed comprised ten empirical publications examining clinical case practice, reflective reasoning, and virtual patient design. Sources were purposively selected for their direct relevance to these instructional issues and their explicit descriptions of study methods and measured outcomes. The search used the terms “clinical reasoning,” “virtual patients,” “structured reflection,” and “pediatric education.” The literature analysis was not designed as a systematic review or meta-analysis; its purpose was to identify evidence and limitations relevant to instructional design.

Sources were compared by task format, required reasoning processes, opportunities for feedback, and assessed outcomes. Educational modeling was then used to adapt these features to pediatric cases. For example, the lack of demonstrated superiority for short over long virtual cases [3] provided grounds for rejecting scenario length as an independent quality criterion. Proposals were formulated around requirements for interpreting evidence and justifying decisions.

The unit of analysis was the student’s individual diagnostic decision: which information was selected, which hypothesis it was linked to, and how the explanation changed when new evidence became available. The modeling results were presented in three tables, together with guidance on their use. The tables are methodological tools proposed by the author; they do not represent observed student outcomes or a validated psychometric scale. This approach distinguishes an instructional proposal from its subsequent empirical evaluation.



Instructional Structure of a Digital Clinical Case

Causal knowledge was considered separately. In experiments with diseases constructed for educational purposes, Woods and colleagues found that linking findings to their underlying mechanisms helped maintain subsequent diagnostic performance [4]. For pediatric cases, this suggests asking students to explain the causal connection between a finding and a hypothesis. Such explanations distinguish recall of a diagnostic label from understanding its meaning.

In the proposed structure, a digital clinical case links information, student decisions, and their justifications in sequence. Each new item of information tests the preceding decision. The child's age, reason for presentation, and symptom duration are given first. Students summarize the case, identify the main problem, and record initial hypotheses. Their response is saved before further information is revealed, allowing the instructor to observe changes in reasoning rather than infer the initial reasoning from the final answer.

The response field is designed to allow students to explain their reasoning. In the study by Chamberland and colleagues, the benefit of self-explanation for subsequent diagnostic performance was observed in topics that were less familiar to students [5]. Accordingly, a more complex case may include the question, "How do you connect this finding to your chosen hypothesis?" The explanation helps the instructor determine whether the student has understood the evidence, made a tentative connection, or has a gap in an underlying concept.

Progressive disclosure of information should avoid creating artificial difficulty. Withholding information that is necessary to understand the case from the outset interferes with the assessment of student knowledge. Information revealed later should serve a specific learning purpose: distinguishing between hypotheses, interpreting a finding that contradicts the initial conclusion, or identifying the limits of a decision. Asking a question such as "How has this information changed your thinking?" at each stage makes the reason for revising a decision explicit.

Table 1. Clinical Case Information and Students' Reasoning Processes

Case component	Task for the student	Recorded learning evidence
Initial context	Combine age, complaint, and duration to define the main problem	Brief problem statement and initial hypotheses



Case component	Task for the student	Recorded learning evidence
Selected information	Explain the reason for choosing the next question or item of information	Written justification of the information needed
Discriminating finding	Compare the implications of a finding for alternative hypotheses	Evidence supporting and weakening the hypotheses
Evidence contradicting the initial view	Explain why the previous account is retained or revised	Link between the initial and revised conclusions
Remaining uncertainty	Assess whether the evidence is sufficient and identify unresolved issues	Justified conclusion and its limitations

Identifying the source of information is particularly important in pediatric cases. The scenario clearly distinguishes parental observations, the child's own complaint, and findings recorded during examination. Students are asked to notice discrepancies between sources and formulate a clarifying question. The task is not to automatically label one report as incorrect; students must explain the content, timing, and reliability of the information. Age-related characteristics also guide the selection of subsequent questions.

For example, in an educational case involving a respiratory complaint, the initial screen provides the child's age and the duration of the complaint. The student records which additional information would help distinguish between their hypotheses. The next screen reveals the selected information and new evidence that prompts consideration of an alternative explanation. The student justifies which parts of the initial conclusion remain valid and which have changed. This example illustrates how the learning task is organized; the diagnostic algorithm is developed separately in accordance with the clinical content of the topic.

Addressing Errors in Diagnostic Reasoning

To use an error as a learning resource, its cause must be identified. An incorrect answer may result from insufficient knowledge, failure to understand an important finding, or a one-sided interpretation of the available evidence. These difficulties require different forms of correction. The instructor first examines the student's explanation and then selects a content explanation, comparison



with an alternative case, or a task requiring reconsideration of the evidence. Naming an error cannot replace explaining how it arose.

The effect of a recently encountered clinical case on a subsequent diagnosis was examined experimentally among internal medicine residents. The results showed that, under certain conditions, learners may rely excessively on a diagnosis that readily comes to mind, while reflective reanalysis may help them solve similar cases [6]. The implication for pediatric education is to turn superficial resemblance to a previous example into an explicit question. Alongside “What is similar?” the student answers, “Which difference weakens this hypothesis?”

Pattern recognition and analysis of clinical findings can be organized as complementary approaches. In experiments involving psychology students learning to interpret electrocardiograms, Eva and colleagues found that instructions combining both approaches were beneficial in the presence of misleading information [7]. As an instructional application of this finding, the proposed digital case asks students to record their initial impression and then explain the findings used to test it. This evidence cannot automatically be generalized to all pediatric cases.

Table 2. Reasoning Difficulties and Targeted Learning Tasks

Difficulty	Sign in the student's explanation	Proposed task
Anchoring on the initial hypothesis	New contradictory information is not incorporated into the conclusion	Identify and explain evidence against the initial hypothesis
Seeking only confirming evidence	Questions are asked only to support the selected diagnosis	Formulate a question that tests an alternative hypothesis
Premature closure	Other explanations are not considered after one matching finding is identified	State the most important alternative and the evidence that distinguishes it
Overgeneralizing from a recent example	The conclusion is based mainly on resemblance to a previous case	Compare the decisive differences between the two cases



Difficulty	Sign in the student's explanation	Proposed task
Neglecting context	Age or the source of information is omitted from the interpretation	Identify which explanation needs reconsideration if the context changes

Reflection should not be equated with producing a long list of diagnoses on every occasion. In the study by Lambe and colleagues, neither short nor long guided reflection improved final diagnostic accuracy relative to the control group [8]. The proposed case therefore prioritizes explaining discriminating evidence over increasing the number of alternatives. If students lack the relevant clinical knowledge, additional questions may need to be accompanied by a brief explanation of the underlying concept.

The need for reflective questions also depends on case complexity. In the study by Mamede, Schmidt, and Penaforte, reflective analysis was advantageous for complex cases, whereas no such advantage was found for simple cases [9]. Accordingly, instead of using the same long sequence of questions in every case, detailed justification is proposed for stages involving uncertainty or competing interpretations. Even a brief explanation in a simple case should make the link between evidence and the decision clear.

Feedback should address the student's specific written reasoning. Rather than merely stating "The answer is incorrect," it should explain which evidence was overlooked and how that evidence changes the relative support for the alternatives. The student then revises the initial answer in a new statement. Retaining the earlier response allows the instructor to see the substance of the revision. The learning objective is to recognize the error and formulate an explanation that helps prevent its recurrence in a subsequent case.

Designing and Evaluating the Quality of Digital Cases

Case development begins by defining the learning outcome. For example, if the task centers on selecting relevant information, students are offered several information categories and asked to explain their choice. If the aim is to reconsider a hypothesis, the case needs a field that preserves the initial hypothesis and evidence that may change the student's assessment of it. The platform's technical features are selected to match this instructional purpose. Even a simple text-based scenario can support meaningful practice when its questions and explanations are carefully designed.



For each scenario branch, the instructor specifies in advance the expected justified answer, an acceptable alternative explanation, and likely misinterpretations. This preparation helps assess the content of automated feedback. Free-text responses may express the same meaning in different words, and this variation must be considered. Instructor review is therefore retained when assessing important decisions. Reviewing clinical content and checking whether the task is understandable are treated as separate activities.

Table 3. Criteria for Reviewing the Quality of a Digital Pediatric Case

Criterion	Review question	Criterion for acceptance
Clarity of the objective	Which reasoning process is being practiced?	The task and student response align with the same learning outcome
Adequacy of context	Are age, timing, and the information source clear?	The context needed for interpretation is explicitly provided
Role of the evidence	What does each new item of information test?	It helps distinguish between hypotheses or revise a hypothesis
Visibility of the decision process	Is the student's path to the conclusion retained?	The initial choice and revised explanation can be compared
Content of feedback	Does the explanation address the cause of the error?	Evidence, reasoning, and correction are connected
Transfer to a new case	Is the student recalling an answer or applying a principle?	A new case with similar underlying content and altered details is available

When assessing student performance, it is useful to record the final diagnosis, the quality of supporting evidence, and revisions to the student's reasoning separately. If a correct diagnosis is accompanied by a weak explanation, the next task should focus on justification. A student who initially proposes an incorrect hypothesis but then revises it logically in response to new information demonstrates progress through the sequence of decisions. This distinction does not mean treating an incorrect final answer as correct; it helps the instructor select the appropriate next form of support.

To assess knowledge transfer, the exact case previously completed should not be presented again. The new task retains the central principle used to



distinguish between alternatives but changes some findings, the context of presentation, or the order of information. The student explains which evidence they consider decisive in the new situation. Studies linking structured reflection to subsequent diagnostic tasks [1, 10] provide a theoretical basis for this assessment, although performance in new pediatric scenarios requires independent measurement.

Discussion

The main methodological contribution of the proposed approach is to organize the digital clinical case as a task that records the history of a diagnostic decision. The student's initial hypothesis, selected information, consideration of alternatives, and final explanation are examined together. The instructor does not have to identify the error solely from the final answer. Classroom discussion also focuses on how specific evidence was interpreted rather than on the student's overall level of participation. This principle allows the same substantive criteria to be used in classroom activities and independent study. Differences between the sources define the limits of the instructional proposal. Studies reporting beneficial effects of reflection on subsequent diagnostic tasks [1, 10] cannot be interpreted as reaching the same conclusion as a study in which certain forms of reflection did not improve the final diagnosis [8]. Similarly, the absence of demonstrated superiority for short cases [3] indicates that reducing case length alone is insufficient. The article therefore proposes aligning the learning task, prior knowledge, and the role of new evidence rather than prioritizing the amount of reflection or the number of screens.

A limitation of the study is that the proposed structure and criteria were not tested with students studying pediatrics. The participants, disciplines, and assessment methods in the publications analyzed also differed. Subsequent evaluation should provide comparison groups with equivalent content and learning time, account for prior knowledge, and include delayed assessment using new cases. Independent assessment of written justifications against predefined criteria would also reduce reliance on a single instructor's interpretation.

Conclusion

A digital case designed to develop clinical reasoning in pediatric education should make the student's selection and interpretation of information explicit. To achieve this, recording the initial hypothesis, presenting information in purposeful stages, eliciting a response to contradictory evidence, and requiring



justification of the final decision were combined within a single scenario. The child's age and the source of information were identified as essential elements of the pediatric context. The three proposed tables can provide practical guidance for developing cases, analyzing reasoning difficulties, and reviewing case quality.

When implementing the proposed instructional approach, the emphasis is on the relationships between pieces of evidence rather than the length of the list of alternative diagnoses. Revising an answer in response to new information and applying a learned principle for distinguishing alternatives to a new case are important dimensions of assessment. The effect of this structure on the development of clinical reasoning should be established in an empirical study with an appropriate comparison and independent assessment.

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