



# How to ACTFAST But Think Deliberately: An Intervention to Teach Critical Thinking in the Pediatric Clerkship

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Critical thinking skills are essential for medical students to develop during their training.<sup>1-4</sup> Students should be able to create concise, clear conceptualizations of active clinical issues, which requires proficiency in evaluating, appraising, and synthesizing patient data. Previous work has identified various ways in which students develop these critical thinking skills including the development of illness scripts, and use of both intuitive (system 1, fast, pattern recognition) and analytic (system 2, deliberate, learned) thinking.<sup>5,6</sup>

Although more experienced clinicians may have a library of mental heuristics from which to make accurate diagnoses, novice clinicians may lack the content knowledge to effectively analyze findings from patients' histories or objective data.<sup>7-10</sup> Critical thinking is especially challenging for learners within the pediatric clerkship. First, students report limited preclerkship exposure to pediatrics, which deprives them of the content knowledge to apply to the high-order skill of analysis.<sup>11,12</sup> Second, pediatric decision making requires additional considerations for which traditional clinical reasoning approaches may not readily apply, such as modulation of differential diagnoses for age or developmental stage. In addition, critical thinking, often taught as diagnostic reasoning grounded in clinical data, is not confined to the diagnostic process; students must also think about management issues and prognosis.<sup>13,14</sup> In our experience, students enter the clerkship familiar with the concept of differential diagnosis, but may struggle to form an assessment when the diagnosis is known but management decisions are needed.

In cognitive psychology, the concept of analogical problem solving describes how learners apply skills from one domain to another, for example transferring a lesson derived from battling a military opponent to battling a medical issue.<sup>15</sup> Analogical problem solving is enhanced when an educator gives guidance or cues to facilitate understanding of the analogy, creating an opportunity that may help students apply concepts despite their pediatric knowledge gap.<sup>16</sup> Therefore, the purpose of our work was to teach critical thinking to pediatric clerkship students using nonclinical scenarios as analogies to bridge the gap between pre-clinical and advanced medical knowledge, applying a framework we developed called ACTFAST. Our hypothesis was that students exposed to ACTFAST would incorporate its elements into clinical assessments and would report higher levels of self-efficacy in developing clinical assessments compared with a control group.

## Methods

We conducted a prospective, nonrandomized, controlled study at a tertiary care pediatric academic medical center. The subjects were medical students rotating on a 6-week pediatric clerkship, with clinical experiences on inpatient wards, primary care, emergency department, and newborn nursery. We assigned the intervention to students on alternating rotation blocks throughout the academic year; students not assigned to the intervention served as the control group.

## Curricular Development

In an iterative, collaborative fashion, the authors (representing active clinicians, pediatric educators, and clerkship directors) developed a framework of critical thinking using the following guiding principles: (1) simple to learn, (2) enforcing steps of analytic reasoning, (3) introduced within nonclinical contexts (ie, commonplace knowledge with which students would already be familiar), and (4) applicable to any case, whether diagnostic or not. We created a mnemonic to assist medical students in remembering its components. External medical education experts reviewed the framework for pedagogical soundness and clarity. The components of the framework, collectively called ACTFAST, are depicted in the **Figure** (available at [www.jpeds.com](http://www.jpeds.com)).

We developed scenarios for each of the categories of clinical questions, namely, diagnosis, trajectory, management, and severity. The scenarios were explicitly "nonmedical," meaning that they were not related to clinical scenarios. For example, students were given the following vignette for a management dilemma scenario:

*You are working with Habitat for Humanity, building new houses. Your job is to frame the new home, then have it inspected for quality before moving on. You have a stack of 2 × 4s, bolts, a drill, nails, and hammers and an architect's blueprint. The blueprint instructs you to hammer each connection by hand, but using the drill and bolts could make the job much faster.*

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To develop the scenarios, we first generated a list of common clinical questions, and grouped them into 4 categories: diagnosis (“What is the likely unifying diagnosis?” or “Is this asthma or pneumonia?”), trajectory (“Is the patient improving with antibiotics?”), management (“Should we consult rheumatology?” or “When can the patient be discharged?”), and severity (“Is this patient at risk of developing liver failure?”). We discussed these categories with medical educators from multiple disciplines, to ensure that relevant clinical questions would fit into the categorical frameworks. From these lists, we transformed questions into analogous ones focused on a nonclinical setting, that is, the Habitat for Humanity management scenario was generated from the clinical question, “What treatment should I choose?”

### Implementation

For the intervention group, we delivered a one hour teaching session on the first clinical day of the rotation. During the session, a faculty facilitator presented the nonmedical scenarios, and students worked in small groups of 2-3 to apply the ACTFAST framework in a stepwise fashion. Students reviewed their application with the facilitator, then the facilitator presented an answer key and reviewed an analogous clinical scenario. In the Habitat for Humanity example, students worked through the question “which building strategy should we choose?” and provided arguments to support their choice. Then, the facilitator reviewed a case of a child presenting with fever and a swollen knee, with a synovial fluid sample with 40 000 white blood cells/ $\mu$ L, and Lyme titer pending. Students were guided to think through the question, “Which treatment should we choose?” and the facilitator highlighted evidence that contributed for and against that decision.

Students assigned to the control group received the standard clerkship curriculum, which did not include any didactic content dedicated to clinical reasoning or critical thinking.

### Assessment

A previously devised, mandatory but nonevaluative part of the midclerkship feedback meeting was the “formative clinical exercise.” In this exercise, all students presented an initial patient case to a clerkship director. We developed a rubric to assess the students’ application of critical thinking principles by mapping each element of the ACTFAST framework to a rubric domain. For each domain, we wrote descriptors corresponding to 0, 1, and 2 point scores. We had pilot tested the rubric with 3 students who had completed their clerkship before the study period. Their formative clinical exercises were audio recorded, and all 4 raters used the rubric to score each presentation. Interrater reliability of the rubric scores showed a Cronbach alpha of 0.70 and intraclass correlation of 0.76. During the study period, raters individually used the rubric to score the assessment and plan presented in the formative clinical exercise for participants in both the intervention and control groups. To avoid contamination, group assignments were made based on rotation block. Therefore, raters were not blinded to group assignments.

### Survey Development

We developed preintervention and postintervention surveys to assess students’ comfort with their critical thinking and clinical assessment skills. We conducted cognitive pretesting of the survey with students who completed their clerkship before the study period, asking them to verbalize their interpretations of the questions as they completed them, with subsequent refinements.<sup>17</sup> We administered the preintervention survey during the pediatric clerkship orientation and the postintervention survey at the midclerkship point, immediately before the formative clinical exercise.

### Statistical Analyses

We tabulated subject characteristics by group, using the  $\chi^2$  and Fisher exact tests to assess equivalence. We used an intention-to-treat analysis; 2 intervention group students absent during the ACTFAST session were considered intervention subjects. We checked for normality of data and used *t* tests for paired analysis of repeated measures for survey results, both preintervention vs postintervention and intervention vs control. We similarly compared rubric scores (intervention vs control). Last, we performed simple content analysis of open-ended responses to the question, “Do you have any comments about the ACTFAST curriculum?”, identifying recurring themes expressed by the students about their perceptions of the educational experience. We used JMP 14.0.0. (SAS Institute, Cary, North Carolina) for quantitative analyses.

The medical school office of educational scholarship approved the study and the hospital institutional review board determined the protocol to be exempt.

### Results

A total of 101 students participated, 53 in the intervention group and 48 in the control group. Participants were not significantly different in terms of previous completion of the medicine clerkship (53% intervention and 56% control;  $P = .84$ ) or half of year (43% intervention and 53% control in the first half of their year;  $P = .57$ ).

Students in the intervention group reported that because of the ACTFAST curriculum, they were more likely (compared with no change or less likely) to include in their clinical assessments: a statement about the patient’s clinical status (80%), their thought process (78%), a history that did not fit with their likely diagnosis (72%), laboratory results or imaging that did not fit with their most likely diagnosis (70%), the diagnosis they felt was most likely (68%), discussion of management dilemmas (66%), and alternative diagnoses or plans (66%). Of the intervention group, 74% reported that ACTFAST was extremely or very helpful in developing assessments.

Free-text comments from students about the curriculum centered on 4 themes: the usefulness of having a framework for critical thinking, assessments beyond diagnosis, use of nonclinical scenarios, and early introduction of the framework (Table; available at [www.jpeds.com](http://www.jpeds.com)).

Students in the intervention group had slightly higher total and component rubric scores during the formative clinical exercise, although these differences were not statistically significant. Within both groups, there were statistically significant increases in survey scores paired from preintervention to postintervention. The intervention group had greater gains in self-reported domains of confidence, knowledge, framework use, and clarity of assessment statements compared with the control group, although this did not achieve statistical significance (Table).

## Discussion

We developed a framework, ACTFAST, to teach pediatric clerkship students the process of critical thinking in a nonclinical context analogous to clinical decision making. Students reported satisfaction with the teaching approach, with positive changes in survey scores over time in both the intervention and control groups; however, differences between groups in rubric scores measuring critical thinking performance during an oral case presentation did not reach statistical significance.

Our finding that rubric scores did not differ between groups may have been because the formative clinical exercise was an imperfect milieu to assess the impact of ACTFAST. Students were expected to give a presentation on which they had already received feedback, revised, and practiced; thus, they were not presenting a case de novo. Another possible explanation is that both groups gained practical experience in thinking through problems as they proceeded through the clerkship, which overshadowed the incremental benefit of ACTFAST. Additionally, although our framework was designed to be generalizable to a wide range of clinical problems, the formative clinical exercise tended to focus on differential diagnosis, limiting our ability to assess the broader applicability of ACTFAST.

We also noted the lack of differentiation between groups in our survey scores. As expected, preintervention and postintervention reports of confidence and knowledge about clinical assessment increased in both control and intervention groups. We found higher self-efficacy scores in the intervention group, particularly among those with less prior clinical experience, suggesting that students felt more prepared to demonstrate their clinical reasoning and more confident in their critical thinking skills after participating in the ACTFAST workshop. Unfortunately, these results also did not reach statistical significance.

Our work has some similarities with other stepwise frameworks to teach clinical reasoning, such as SNAPPS, the problem representation approach, and SITUPS because they are learner led and encourage students to verbalize their thinking.<sup>18-20</sup> Our work is also in line with the development of a transitional curriculum focused on critical thinking skills as described by van Gessel et al, and Case Based Clinical Reasoning curriculum as described by ten Cate et al.<sup>21,22</sup> However, our work differs in that these methods require clinical content knowledge before embarking on the process of

critical thinking and assessment and tend to focus on differential diagnoses. The ACTFAST framework, taught with nonclinical scenarios, allowed us to begin discussing the critical thinking process at the very beginning of the pediatrics clerkship and discuss management and trajectory questions earlier in the educational process.

Limitations to our work include that our participant population was taken from a single institution. As mentioned, our testing structure may not have been sufficiently discriminatory to detect change between the intervention and control groups to a statistically significant threshold. Our participant assignments were not truly randomized, and our raters were therefore not blinded to group assignment. Our rubric was administered after the intervention only; thus, it did not measure change in clinical assessment skills over time. Finally, to ensure that all students, regardless of study participation, had an equivalent educational and feedback experience, we did not add an end of clerkship assessment to the intervention students.

We found the framework easy to implement, and we noted a shift in our own ability to guide students through critical evaluation of patient scenarios, both in practice and on rounds. Use of the ACTFAST mnemonic provided a shared vocabulary for educator and learner, and helped educators to specify their questions and ask for supporting evidence. For example, rather than asking, "What is your assessment?", we were able to focus on "How effective has our antibiotic plan been to date?" As medical schools condense their preclerkship curricula with less exposure to pediatrics before the clinical years, having a quick, memorable, and impactful framework can be helpful to both the pediatric learner and educator.

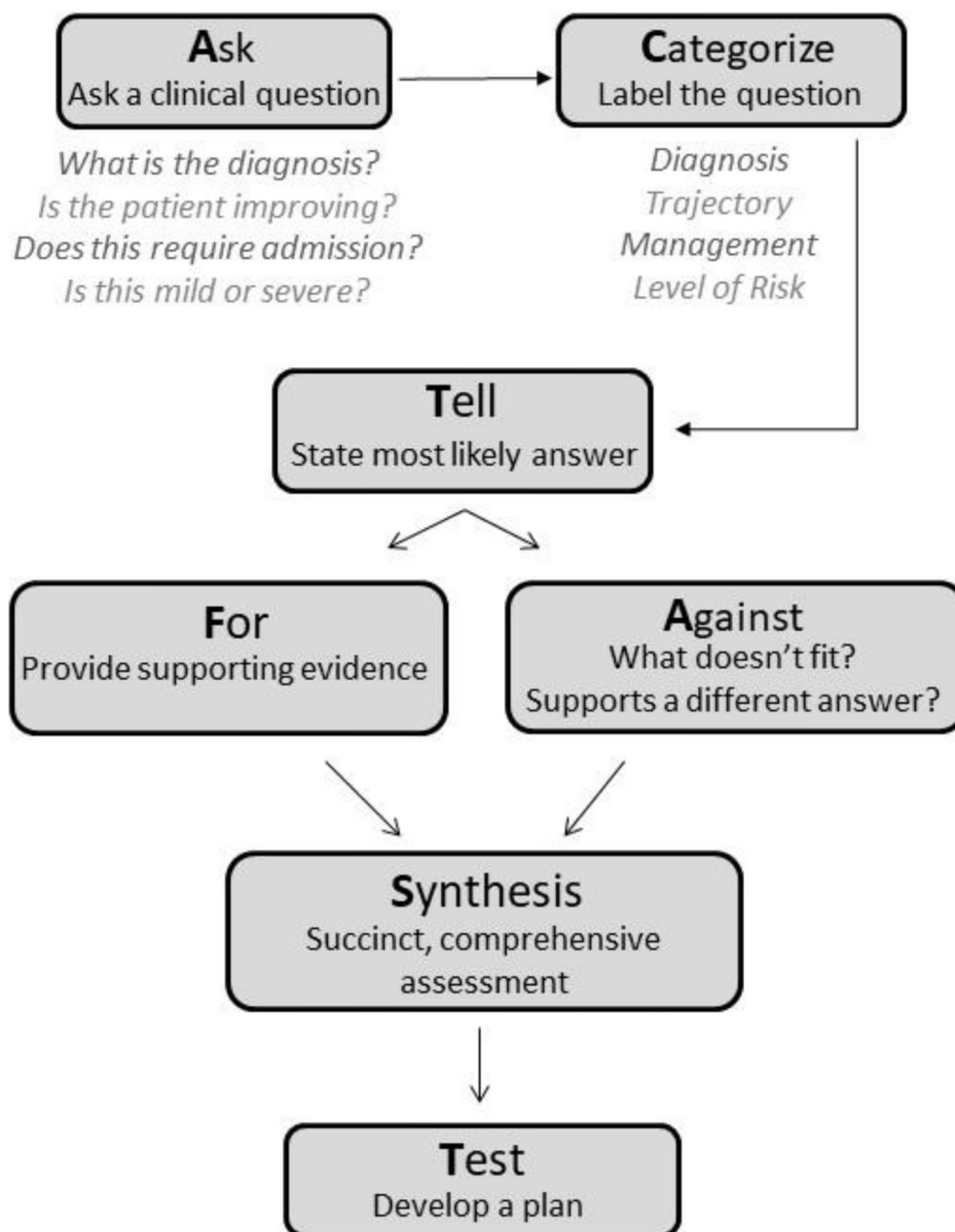
Given initial results about our implementation of ACTFAST and students' receptivity to the curriculum, we plan to introduce the curriculum before the beginning of the clerkship year, to provide opportunities for reinforcement throughout the year and expansion to different levels of learners. We also hope to conduct direct rounds observations to assess the framework's impact in practice. ACTFAST can be considered an additional tool for pediatric educators to develop a structure for working with learners as they grapple with incorporating new content knowledge. ■

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**Figure.** ACTFAST framework for critical thinking.

**Table.** Thematic analysis of students' perceptions about ACTFAST

Theme	Elaboration	Representative quotes
Availability of a framework	Ready access to a framework allowed them to approach the reasoning process systematically	"The framework helps demystify the assessment and plan." "This was ... the first time I was taught a systematic method for assessment, and it has been very helpful!"
Clinical assessment transcends diagnosis	Framework encouraged to approach problems beyond the process of arriving at differential diagnoses	"I really appreciated how we learned about presentation of management dilemmas as well as presentations of most likely or most dangerous diagnoses." "It is helpful to have a set structure to follow for our assessments for every presentation."
Applicability to nonclinical cases	Framework perceived to have generalizable value beyond clinical cases	"The nonmedical situations were a great way of getting us to think in the assessment and plan format." "I enjoyed ... the inclusion of nonmedical and medical examples for building an assessment and plan." "The examples of non-clinical cases really helped me understand how to apply it to a broad range of scenarios."
Curriculum placement	Exposure to the framework desired earlier in their medical school experience	"Very helpful—wish we had it during first year!" "Very helpful. Please continue the curriculum; would have been even more helpful earlier." "I wish it were a longitudinal curriculum! It would help solidify my assessment/planning skills."

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