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## Conceptual development and critical attitude in physics education: a pathway in the search for coherence

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In the seventies and eighties, the aim of numerous studies about students' ideas in science was to document the reasons for the perception, in many countries, of physics teaching as deeply ineffective. More importantly, these studies sought to inform change in what appeared as "inappropriate" students' knowledge. Intrinsicly linked to this concern was the question of the nature of this knowledge, which was seen as more or less "in pieces" or "theory-like". For epistemological as well as methodological reasons, our team at Université Paris Diderot (Paris 7) sought to identify what might reflect a coherence in students', teachers' or lay people's comments relating to physics - hence our interest in lines of reasoning observed *a propos* of various physical contents, such as linear causal reasoning. Two questions then arose. First, would the promotion of more fruitful lines of reasoning in our students represent a meaningful objective for physics teaching? And second, how might research inform the design of appropriate teaching environments? These questions have gained critical importance in recent years with the claimed predominance of teaching objectives centered on competences. Among these objectives, critical thinking is unanimously presented as of central importance. Revisiting the question above, a more focused formulation might then be: Can critical thinking be fostered in students without conceptual structuring and (still more importantly) without stressing the pivotal role of a search for coherence in science? With this



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in mind, I will briefly synthesize some recent investigations bearing on the co-development of conceptual understanding and critical stance in university students. In characterizing students' responses when confronted to various explanations of a physical phenomenon, these studies bring to bear conceptual markers as well as meta-cognitive, affective and critical indicators. Some profiles of co-development will be characterized, including "delayed critique" and "expert anesthesia of judgment". The results strongly suggest that to disregard the objective of conceptual structuring is counterproductive for the development of students' critical attitude. Through these exploratory studies, it appears that the conditions in which students can begin to search for coherence —whether in pursuit of conceptual understanding or to activate their critical potential— constitute a crucial objective for further research.