What kinds of scientific concepts exist?
Concept Construction and Intellectual Development in College Biology

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Abstract: Previous research has found that scientific concepts can be meaningfully classified as descriptive (i.e., concepts such as predator and organism with directly observable exemplars) or theoretical (i.e., concepts such as atom and gene without directly observable exemplars). Previous research has also found that developing understanding of descriptive and theoretical concepts is linked to students' developmental levels, presumably because the procedural knowledge structures (i.e., reasoning patterns) that define developmental levels are needed for concept construction. The present study extends prior theory and research by postulating the existence of an intermediate class of concepts called hypothetical (i.e., concepts such as subduction and evolution with exemplars that cannot in practice be observed due to limits on the normal observational time frame). The hypothesis that three kinds of scientific concepts exist was tested by constructing and administering a test on concepts introduced in a college biology course. As predicted, descriptive concept questions were significantly easier than hypothetical concept questions, than were theoretical concept questions. Further, because concept construction presumably depends in part on developmental level, students at differing developmental levels (levels 3, 4, and 5, where level 5 is conceptualized as 'post-formal' in which hypotheses involving unseen entities can be tested) were predicted to vary in the extent to which they succeeded on the concepts test. As predicted, a significant relationship ($p < 0.001$) was found between conceptual knowledge and developmental level. This result replicates previous research, and therefore provides additional support for the hypothesis that procedural knowledge skills associated with levels of intellectual development play an important role in declarative knowledge acquisition and in concept construction. The result also supports the hypothesis that intellectual development continues beyond the 'formal' stage during the college years, at least for some students. © 2000 John Wiley & Sons, Inc. J Res Sci Teach 37: 996-1018, 2000