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Excellence in Physics Education Award Talk: The Role of Physics Education Research in the Design and Assessment of Active Learning Curricula and Tools

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For the Activity Based Physics Group (APB), research in student learning has been a cornerstone, for the past 22 years, of the development of activity-based curricula supported by real-time data collection, analysis, and modeling. This presentation, the first of three related talks, will focus on student learning, Priscilla Laws will describe the curriculum and tools developed, and David Sokoloff will describe dissemination efforts. One of the earliest examples of seminal research, done as part of the early MBL development for middle school at TERC, showed that delaying the display of a position-time graph by 10 seconds instead of displaying it in real-time resulted in a substantial learning decrease. This result assured the use of real-time data collection in our curricula. As we developed our early kinematics and dynamics curricula for college and high school, we interviewed many students before and after instruction, to understand where they started and what they had learned. We used the results of these interviews and written student explanations of their thinking to develop robust multiple-choice evaluations that were easy to give and allowed us to understand student thinking using both "right and wrong" responses. Work such as this resulted in Questions on Linear Motion, Force and Motion Conceptual Evaluation (FMCE), Heat and Temperature Conceptual Evaluation (HTCE), Electrical Circuit Conceptual Evaluation (ECCE), Light and Optics Conceptual Evaluation (LOCE) and others which guided our curriculum development and convinced many that standard instruction in physics did not result in substantial conceptual learning. Other evaluations measured mathematical understandings.evaluations also allowed us to look at a progression of student ideas as they learned ("Conceptual Dynamics"), study the behavior of students who did and did not learn conceptually ("Uncommon Knowledge"), study the efficacy of peer groups, and finally identify some of factors that led to conceptual learning for both women and men. (e.g. increases in spatial ability).