THE FORCE CONCEPT INVENTORY (FCI) is an online inventory of core concepts and assessment items used by teachers of introductory physics to help measure student learning of physics concepts. Teachers share assessment results with colleagues nationwide and learn how to teach these concepts more effectively.

HOW IS IT NOTABLE?
Since its inception 20 years ago, FCI has allowed its developers and users to both understand the challenges of teaching and learning physics, and to successfully devise and improve solutions and supports to meet those challenges. This inventory has contributed to the development of a wide array of associated instructional supports, accompanying lessons, activities, and professional development materials, including the prominent Modeling Instruction method.

Knowing more about FCI is valuable for high school and undergraduate physics teachers, but also for:

- Other STEM teachers who could benefit from distinct discipline-specific “content inventories” spawned by the creation of FCI.
- Those who train and support STEM teachers.
WHAT ARE THE KEY ELEMENTS?

One initial challenge, identified by physics education research, is that personal experience often leads to strongly held beliefs about how the physical world works. These beliefs, while grounded in common sense, often are incompatible with actual Newtonian concepts of force and motion. For example, one common misconception is the idea that sustaining motion requires a continued force.

This realization resulted in the development of FCI’s two components:

- An inventory of the six core concepts of mechanics and correlated misconceptions. The inventory provides a detailed guide for physics teachers to understand specific misunderstandings and how they relate to core physics concepts.
- A well-researched set of assessment items designed to measure the level of student understanding of these core concepts.

Used as a tool to evaluate instruction, the inventory exposes the inadequacies of traditional physics instruction. FCI assessment results also illuminate the real challenges involved in addressing beliefs based primarily on personal experience. This has helped drive the development of the Modeling Instruction approach, a student-centered instructional practice that uses conceptual models and guided inquiry to help students develop real understanding of the most important physics concepts regarding force and motion. Other instructional supports, informed by FCI data and aligned with its measures, continue to be developed and to support improved physics teaching and learning.

Physics teachers armed with FCI data create and lead online communities, enabling them to share and improve their instructional practices — and address their own persistent misconceptions. These communities spur great teacher accountability for student learning because they encourage teachers to use and share student performance results, and the student performance results are based on robust understandings of the discipline being assessed.
WHY THIS PRACTICE?

Deeply rooted misconceptions about force and motion get in the way of effective physics teaching and learning. For two decades FCI has enabled introductory physics teachers to improve student performance by addressing two vexing challenges: persistent student misconceptions and knowing where instruction has or has not been effective.

FCI gives teachers the ability to:

- Identify student misconceptions. The multiple choice assessment items’ powerful distractors make them very discriminating; the tool’s extensive usage in classrooms and research settings provides a high degree of validity to assessment results.
- Address persistent student misunderstandings. FCI is very useful in measuring the effectiveness of instructional interventions.
- Set and track goals relative to other classes and instructors. Data shared through the user community allows teachers to understand how well their students are doing, compared to other entry-level physics students.
- Participate in a community that seeks to improve physics teaching and learning through data and knowledge sharing. The Modeling Instruction community is a powerful example of a decentralized, teacher-led, online community driven by strong accountability.

EVIDENCE OF SUCCESS

There is compelling evidence for FCI’s usefulness in identifying misconceptions and measuring effectiveness of instructional practices. Students of teachers who use FCI with proven instructional practices have exceptional performance on widely accepted assessment measures.

Student performance

Students of expert modeling teachers achieve post-test FCI scores of close to 80%, placing them among top-performing entry-level physics students. See this site for details on performance.

Reach among high school physics teachers

10% of U.S. high school physics teachers use FCI with Modeling Instruction, a remarkable scale up given the complexities of the content and the grassroots nature of the user communities.

Reach to other science topics

Additional concept inventories and Modeling Workshops covering topics in biology, chemistry, physical sciences, and energy and matter have been developed and piloted, and Modeling Instruction has been extended to include high school chemistry, biology, and physical science.
HOW TO USE IT

In the classroom and across the teacher community:

• FCI is available for free from this site, including scoring guides and suggestions for use. The materials offer concrete support to improve teacher practice.
• Teachers share student performance data and effective instructional practices in online professional learning communities. Sharing exceptional performance motivates teachers to join this grassroots support network.

To learn more:

• The original 1992 article about Force Concept Inventory, lays out the design of the tool.
• The American Modeling Teachers Association provides resources and workshops to support Modeling Instruction.
• The Field-tested Learning Assessment Guide offers discipline-specific tools and classroom assessment techniques.
• CI Hub is a concept inventory community for developers, researchers, faculty, and students.

PARTNER DETAILS

The American Modeling Teachers Association is a teacher-created and teacher-led membership organization that provides intensive professional development workshops, concept inventories with teacher resources, and a professional learning community to support the implementation of Modeling Instruction. Its PD workshops are open to high school and post-secondary science teachers worldwide.

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About

100Kin10 is a growing alliance of over 100 leading public, private, and non-profit partner organizations that have committed to strategically addressing the nation’s shortage of STEM teachers and improving STEM learning for all students by training 100,000 excellent science, technology, engineering, and math teachers over the coming 10 years.