

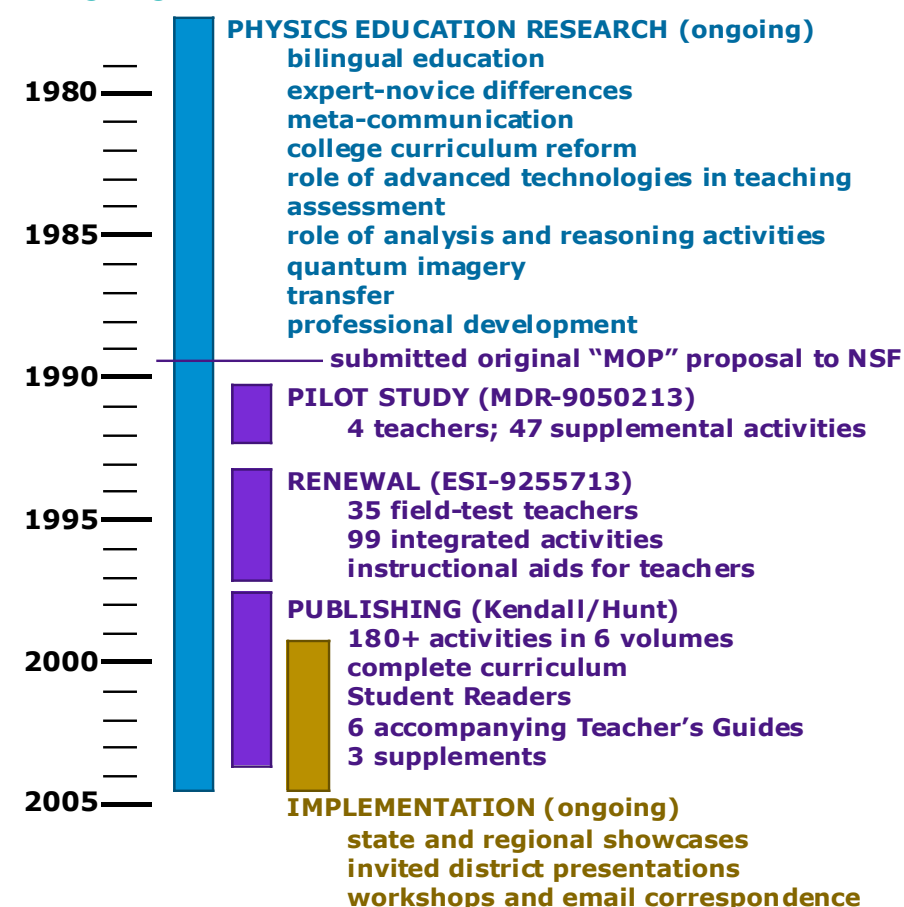
Minds-On Physics: Curriculum materials for active learning and thoughtful engagement

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History

Timeline



Summary

- ▶ 15 years from idea/proposal to publication of last book
- ▶ some volumes in 5th printing
- ▶ adopted by Grand Rapids, MI, and on short list of supported materials in Chicago, IL
- ▶ 3700+ pages of materials
- ▶ implementation/marketing ongoing
- ▶ proposal for adaptation/extension to "Physics First" model in 2004

Student Activity Books

Materials to help students become actively engaged in learning physics

The "Core" Curriculum

- ▶ 3 volumes of activities
 - Motion* (36 activities)
 - Interactions* (35 activities)
 - Conservation Laws* (25 activities) & *Concept-Based Problem Solving* (7 activities)
- ▶ each volume covers one quarter of the year
- ▶ student Reader at the end of each activities book (1–2 pages of reading per activity)

The "Supplemental" Curriculum

- ▶ 3 additional volumes of activities
 - Fundamental Forces & Fields* (29 activities)
 - Complex Systems* (31 activities)
 - Advanced Topics in Mechanics* (23 activities)
- ▶ applications of the core curriculum to a variety of special topics and phenomena
- ▶ teachers may select 20–30 of these activities to do in the 4th quarter, or something else instead (science fair projects, favorite activities, etc.)
- ▶ many activities suitable for 2nd-year/AP physics

Special Features

Activities First!

- ▶ minimal lecturing or reading before doing activities
- ▶ students struggle with ideas on their own
- ▶ short readings follow activities and summarize ideas raised in activities

Extensive teacher support materials

- ▶ detailed suggestions to help teachers prepare a lesson for each activity
- ▶ answers to every question in every activity, including "Probing for Student Understanding" questions
- ▶ Supplements and Answer Sheets, too!

Rooted in educational and cognitive research

- ▶ addresses students' prior knowledge and conceptions
- ▶ helps students make the transition from naïve beginner to proficient problem solver
- ▶ discourages formulaic approaches to solving problems
- ▶ encourages students to structure knowledge

Shifts focus of instruction

(from problems to analysis of problem situations)

- ▶ efficient and successful problem solving requires proper conceptual analysis
- ▶ students learn how to learn
- ▶ students improve conceptual understanding, reasoning and analysis skills, while improving problem solving

Assessments

- ▶ new instructional methodologies require new ways of assessing students
- ▶ hundreds of sample questions that teachers can use during activities, on tests and quizzes, etc.
- ▶ teachers get better feedback about what students do & don't understand

Metacommunication (communicating about communication, learning issues, pitfalls, etc.)

- ▶ increases student engagement, involvement, and motivation
- ▶ helps students become reflective, self-evaluative learners
- ▶ makes students more responsible for their own learning

New role for teacher

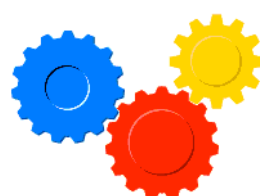
- ▶ teacher is a coach/mentor/advisor/counselor
- ▶ teacher no longer needs to be the ultimate authority
- ▶ more exciting / more fun / more interesting / more rewarding

Effective when done in small-group format

- ▶ improves communication even more
- ▶ students remember better when they talk about what they know

Carefully sequenced activities

- ▶ prior knowledge is provided in prior activities
- ▶ a progression of goals takes students from naïve beginners to proficient problem solvers as they:
 - confront their own conceptions*
 - relate concepts to each other*
 - apply concepts to problem situations*
 - organize and prioritize concepts and principles*
 - solve problems without using formulaic approaches*



Diversity

Field-testing

- ▶ urban settings of New Orleans, LA; Springfield, MA; Hartford, CT; and Chattanooga, TN
- ▶ suburban, rural, and private settings as well

Multiple contexts

- ▶ used by underprepared black university students in South Africa
 - thinking and reasoning more useful than knowing facts*
 - math and communication skills improve using MOP*
 - multiple paths provided for answering questions and solving problems*
- ▶ multiple grade levels possible
 - 8th/9th grade physical science*
 - 11th/12th grade physics*
 - supplements for introductory university physics*
 - graduate-level teacher preparation courses*

Teacher's Guides

Materials to help teachers learn physics and implement new methodologies

Instructional Aids

- ▶ an opportunity for teachers to learn the purpose of and thinking behind each activity
- ▶ a variety of useful advice in small, bite-sized chunks
 - time needed for activity*
 - preparation for students*
 - suggestions for classroom use*
 - anticipated difficulties for students*
 - probing for student understanding*
 - suggested points for classroom discussion*
 - providing support to ensure student progress*

Answers (with short explanations)

- ▶ provided for every question in the activities, including the "Probing for Student Understanding" questions found in the Instructional Aids
- ▶ with running commentary to help teachers
 - range of possible student responses*
 - ways to interpret student responses*
 - additional commentary on teaching, learning, and instruction*

Supplements (in "Motion" Teacher's Guide)

- ▶ incorporating collaborative group work
- ▶ our approach to teaching and learning, with relevant research results and useful classroom practices
- ▶ comparison of MOP with the NRC National Science Education Standards

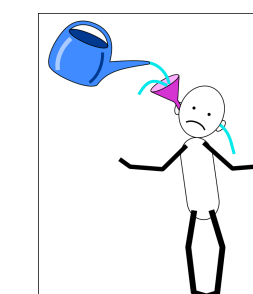
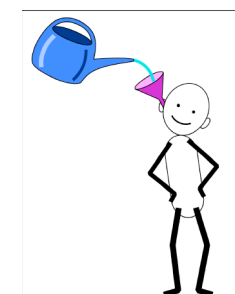
Answer Sheets

- ▶ customized to each activity
- ▶ usually 2 pages per activity
- ▶ includes grids for making graphs, space for filling in tables, drawings for making measurements, etc.
- ▶ perforated for easy removal from TG
- ▶ 3-hole punched for convenient storage
- ▶ can be photocopied and distributed to students

Three views of instructional practice

Classical view

Walk into many classrooms today and look at the way students are being taught, and you might think that the instructor is trying to pour knowledge into their students' heads. This is a 300-year old image, yet some instructors still seem to teach as though students can passively absorb what is being offered.



Modern view

Research indicates that many ideas are not processed by students, and students do not retain those ideas that manage to get in. This representation is flawed, however, because it seems to blame the student for any failures to understand.

Our view

The funnel is inverted to indicate a mismatch between the teacher's mode of delivery and the student's ability to accept or interpret the ideas being presented. The student's finger is in her ear to indicate that she is trying to retain the ideas but lacks the skills to do so. MOP addresses both of these concerns.



Testimonials

Bernie Lally, Chicopee HS, Chicopee, MA

[Oct-30-1995] *The kids seem to like what we are doing and the classes go well... I've made a few blunders but, for the most part I'm really happy with the MOP approach...*

So far the kids' response to the way we do it has all been positive... To my surprise, they do the [homework] assignments almost every day. They actually seem to like doing the homework! Pretty amazing!

[Nov-1-1995] *What amazes me is that they will work the entire 45-minute period on an activity — but, even more amazingly, they will work on two activities during a 90-minute double period lab!*

I made a mistake today, though, I slipped back for just part of two classes, and got into a kind of lecture mode where I did a lot of talking. That was a mistake and I could see it right away because I saw some eyes drooping as they tuned me out. This NEVER has happened during the past two months, not even once! Talk about proof that my old way was bad! You can bet that I'll not let that happen again. It's important that they do all of the talking with each other and that I walk around and talk with each group when they need help. They actually listen when I do that. Thanks again to all of the MOP crew.

Michael Oliphant, Millis HS, Millis, MA

As a result of using this curriculum, my students seem to be able to approach unfamiliar problem situations more effectively. They are able to work more independently with greater confidence. This new confidence goes a long way toward helping parents overcome any reluctance they might feel about using a program that is not what they are used to... Their fears are understandable. People often think that the best way to teach is the way that they were taught. But once parents see that the program is involving students in reasoning and communicating, they usually become enthusiastic supporters.



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