SCI

Reflections

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Thoughtful Curricula Developing Thinking Students

200 UNION BLVD., SUITE G-18 LAKEWOOD, CO 80228 888-501-0957 **WWW.SCI-IPS.COM**

Advantages of In-Depth Approach Documented in Study

Harold Pratt

One of the major tensions science teachers face on almost a daily basis involves the choice between depth and breadth of instruction. It often boils down to how much time to spend on a given topic in order to achieve a greater level of understanding. Behind the obvious consideration of time, there is the issue of how much evidence students will either have access to or collect themselves in the process of developing an idea.

As an example, if the goal is to develop the idea of conservation of mass, you have to make a choice among three options—pronounce the law in a few words to be repeated on the next test, add a simple experiment that serves to verify and validate the law, or take sufficient time to ensure that conservation of mass is a generalization from a variety of reactions or changes. Taking this last approach requires time, the selection of several experiments, class review of the data, and may even require a repeat of an experiment if mistakes have been made. Finally, a discussion of what a law is and its limitations is needed.

The original creators of *Introductory Physical Science* faced this choice head on when they decided that concepts to be included in the text would be those that were developed with evidence, most of which the students would collect themselves. Ideas or concepts—as important as they might be—that could not be derived from evidence the students had access to would not be included.

This approach immediately set *IPS* apart from virtually every other major textbook on the market. It also runs counter to the national and state standards which include more topics than can be developed in an in-depth, inquiry-oriented manner. Some research over the years has attempted to determine the effect of inquiry-oriented instructional material on student achievement, as measured by the high stakes tests used by many states and school districts. While the results of these studies have been positive, the question of payoff at later grades or college has been questioned since these subsequent courses usually follow the "breadth" approach to content coverage. It was often argued that such broad coverage was necessary to ensure success in the college courses.

A recent editorial in *Science*[1] by the editor-in-chief, Bruce Alberts, lamented the "Failure of Skin-Deep Learning." (Alberts is a professor of biology at San Francisco State Uni-

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IN-DEPTH STUDY (from page 1)

versity and a former president of the National Academies.) In the editorial he cited research published a couple years earlier, pointing out the benefits of depth rather than breadth in high school science courses.

That research[2], which was funded by the National Science Foundation, studied 8,310 students enrolled in introductory biology, chemistry and physics courses at randomly selected four-year colleges and universities. Students were asked how much time they spent on various topics in their high school biology, chemistry and physics classes. The researchers defined exposure to a topic as "in-depth" if the students reported spending at least a month on it. In the analysis of the data, they controlled for factors such as math proficiency and socioeconomic background.

The results showed that students who had spent at least a month on one topic earned higher grades than their peers who studied more topics in the same period of time. The extent of the advantage varied somewhat among the three disciplines with physics students who had experienced deeper coverage performing in college as if they had had two-thirds of a year more preparation. For chemistry students, the gain was equivalent to a quarter of a year's worth of study, and for biology the gain was a half a year.

Although the study could not explain the benefits of in-depth study, the researchers suggested that when students are expected to develop a level of mastery, they gain confidence and experience with what it means to comprehend a concept; they become aware of the time and effort it takes to learn something new and challenging. Mastery can also help overcome the misconceptions that exist in the minds of many students and which often require considerable instructional time to unlearn.

Assuming the idea of providing an in-depth learning experience or course of study is desirable, the obvious question is "How do you select the core ideas that will be included?" The original *National Science Education Standards*[3] and the *Framework for K-12 Science Education*[4] provided criteria for the selection of the core ideas included in the respective documents. The *Framework* (page 31) specified that a core idea should:

1. *Have broad importance across multiple sciences or engineering disciplines or be a key organizing principle of a single discipline.*
2. *Provide a key tool for understanding or investigating more complex ideas and solving problems.*
3. *Relate to the interests and life experiences of students or be connected to social or personal concerns that require scientific or technological knowledge.*
4. *Be teachable and learnable over multiple grades at increasing levels of depth and sophistication. That is, the idea can be made accessible to younger students but is broad enough to sustain continued investigation over years.*

Considering these criteria and the research summarized above, does the *IPS* selection and treatment of physical science content measure up? We think so.

References

1. B. Alberts, (2012). Failure of skin-deep learning. Science, 338, 1263.

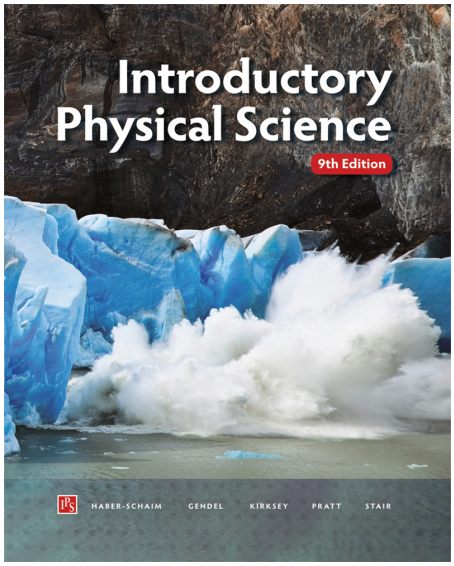
2. S. Schwartz, P.M. Sadler, G. Sonnert, R. H. Tai, Sci. (2009). Depth versus breadth: How content coverage in high school science courses relates to later success in college coursework. Science Education, 93, 798-826.

3. National Research Council (NRC). (1996). National science education standards. Washington, DC: National Academy Press.

4. National Research Council (NRC). (2011). A Framework for K-12 science education: Practices, crosscutting concepts, and core ideas. Washington, DC: National Academy Press

Harold Pratt was a staff member and writer for the National Science Education Standards. *He currently consults with NSTA during the review and feedback phase of the development of the* Next Generation Science Standards.

2013 Price Changes



IPS eBook Price Extended Through February

Since last August, the Ninth Edition of *Introductory Physical Science* has been available to schools and students through the iTunes Bookstore at a special introductory price of $14.99 (in the U.S.). As of March 1, 2013, that introductory price will expire, and the ebook cost will rise. So if you or your students would like to receive the introductory price, be sure to visit **https://itunes.apple.com/us/book/introductory-physical-science/id549155537?mt=11** by February 28th!

For more on the *IPS* ebook, visit **http://www.sci-ips.com/e_ebookinfo.htm** .

KaleidaGraph Price Increases

Those of you who use *KaleidaGraph* with your students know that we have kept our prices for the various *KaleidaGraph* packages the same for more than a decade. And you know what a great deal purchasing *KaleidaGraph* through Science Curriculum Inc. has been, since the manufacturer normally sells a single-user license for $139.95! Although we need to increase prices slightly, we remain committed to providing this valuable tool to teachers and students at significant savings. Our 2013 *KaleidaGraph* pricing is as follows:

KaleidaGraph Classroom License (SCI-032-1111)	$ 109.00
KaleidaGraph Student 5-Pack (SCI-032-5555)	$ 110.00
KaleidaGraph Building License (SCI-032-9999)	$ 315.00

Mac and Windows versions are available; please specify on your order. A complimentary "Companion Files for *IPS* and *FM&E*" CD is included with each *KaleidaGraph* purchase.

2013 *IPS* National Workshops

In July of 2013, Science Curriculum Inc. will offer three different *IPS* workshops on the Colorado School of Mines campus in Golden, CO. The workshops will cover Chapters 1-6, 7-11, and 12-16, respectively, of the 9th Edition of *IPS*. The dates for the workshops are as follows:

***Introductory Physical Science* – Part 1** (Chapters 1–6: Properties of Matter)	July 14–19, 2013
***Introductory Physical Science* – Part 2** (Chapters 7–11: Atoms and Molecules)	July 21–26, 2013
***Introductory Physical Science* – Part 3** (Chapters 12–16: Energy and Forces)	July 21–26, 2013

A workshop registration form can found later in this newsletter, or it can be downloaded at **http://www.sci-ips.com/e_workshops.htm**. For questions or additional information, please contact us toll-free (888-501-0957) or by email (**workshops@sci-ips.com**).

Registration for the Science Curriculum Inc.

Introductory Physical Science (*IPS*) National Workshops

Colorado School of Mines

July, 2013

Course selection - please check the appropriate workshop(s):

___ ***IPS* Part 1 – Properties of Matter** **July 14–19, 2013**

___ ***IPS* Part 2 – Atoms and Molecules** **July 21–26, 2013**

___ ***IPS* Part 3 – Energy and Forces** **July 21–26, 2013**

Tuition cost: The tuition cost is $300 for each one-week workshop.

For maximum benefit, it is highly recommended that the* IPS Part 1 *workshop be taken prior to the* Part 2 *and/or* Part 3 *workshop.

NOTE: Since* IPS Parts 2 *and* 3 *meet concurrently, it is not possible to enroll in both.

NAME_____

GENDER *(for lodging purposes only-please circle one)* M F E-MAIL _____

HOME ADDRESS _____

HOME PHONE _____

SCHOOL NAME _____ PHONE _____

SCHOOL ADDRESS _____

SCHOOL DISTRICT NAME _____

In what area of science teaching do you teach the most classes? (please check one)

Physical Science ____ General Science ____ Earth Science ____ Other (please specify) _____

What was your major in college? _____ Graduate concentration, if applicable _____

Have you attended a previous *IPS* or *Force, Motion, & Energy* (*FM&E*) workshop or summer program? Yes No

Have you previously taught *IPS* or *FM&E*? Yes No

If yes, which program and for how many years? _____ At what grade level(s)? _____

Credit: Credit is awarded by Colorado School of Mines as graduate-level semester hours in continuing education. Each one-week workshop can be taken for 2 semester hours credit.

I do ___ do not __ plan to take the workshop for credit.

NOTE: The tuition amount is the same with or without credit, and all registrants are expected to complete and submit all assignments.

LODGING AND MEALS *(Please complete this section <u>even if you will not be staying on campus</u>.)*

Lodging preference: ***(All accommodations are single bedroom in 2-4 bedroom suites.)***

___ I will be staying off-campus and will not need on-campus accommodations.

___ One week: $245.10 (6 nights: check-in Sunday; check out Saturday)

___ Two weeks: $531.05 (13 nights (includes weekend between workshops): check-in Sunday; check out Saturday)

Meals: ***(It is recommended that participants have lunch together to facilitate the informal exchange of ideas.)***
<u>Commuters – please complete the lunch line even if arranging for your own lunch.</u>

Breakfast (Monday-Friday)	___One week ($40.32)	___Two weeks ($80.64)	_____ I will arrange for my own breakfast.
Lunch (Monday-Friday)	___One week ($49.99)	___Two weeks ($99.98)	_____ I will arrange for my own lunch.*
Dinner (Monday-**Thursday**)	___One week ($42.36)	___Two weeks ($84.72)	_____ I will arrange for my own dinner.

* Please be aware that workshop participants who bring their own lunch are not admitted to the dining hall.

PARKING (These are 2012 prices; prices may be increased by Colorado School of Mines in the Spring.)

Like many universities, Colorado School of Mines now charges for parking anywhere on campus, including streets. Whether you will be commuting or staying on campus, if you bring a vehicle with you, you will need a parking permit. Please select one of the following:

___ I will <u>not</u> have a vehicle on campus and will not need a parking permit.

___ I'll be commuting or staying on campus and will need a parking permit for <u>one</u> Monday–Friday workshop. ($20)

___ I'll be commuting and will need a parking permit for <u>two</u> Monday–Friday workshops. ($40)

___ I will be staying on campus for two weeks. I need a parking permit for two weeks, including the intervening weekend. ($48)

DEPOSIT AND FINAL PAYMENT

A non-refundable deposit of $100 (payable to Science Curriculum Inc.) must accompany this application.

Please mail both the application and the check to:

Coordinator of School Services
Science Curriculum Inc.
200 Union Blvd, Suite G-18
Lakewood, CO 80228

A confirmation of your registration and deposit will be sent to you in the Spring, along with an invoice for the remaining balance.

Due to planning and commitment deadlines at Colorado School of Mines, *all outstanding balances will be due and must be paid in full* ***by June 5, 2013***.

Signature _____ **Date** _____

If you have any questions, please contact us at 303-988-5041 (toll-free 888-501-0957) or email workshops@sci-ips.com .