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Curriculum and Faculty Development Newsletter

Dec. 2001

TYC Physics Workshop Project

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Implementation of Some Ideas from IPC4

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[*Editior's note:* Martin Mason is now at Palomar College in San Marcos, CA 92069. His new email is mmason@palomar.edu]

I came back from IPC4 brimming with ideas about how to change the way I teach my calculus physics courses and a nifty blue canvas tote-bag. My calculus-based physics course meets for 4 fifty-minute lectures and one three-hour lab. I had 34 students sign up, and 32 showed up the first day. I used Serway PS&E as the text.

I decided to try to implement some of the things I had seen at the conference. I really like some of the ideas that Gregor Novak and Evelyn Patterson presented about Just in Time Teaching or JiTT so I decided to start there.

One of the major components of JiTT is the online submission of homework on a daily basis prior to class. Since my TYC is not technology enabled, I tried a more low tech version the first semester.

Students received a short worksheet reminiscent of those used in JiTT at the end of each class period. The same worksheet was also available on-line. The worksheet was due prior to the next class period. How I received the homework was up to the students, but what happened in practice is that I got a big batch of them on paper right before class each day. I was then able to evaluate them and plan the class accordingly. I stamped each paper and turned it back to the students ungraded at the beginning of class. Students had the opportunity to add to their papers during class as we discussed the ideas they had difficulty with. Papers were collected at the end of each class, and graded and returned by the end of the week.

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The baby with the bath water (and the rubber ducky, the tub, the towel, the powder, ...)

David Weaver
Chandler-Gilbert Community College
Chandler, Arizona

They did it to me again! Hieggelke and O'Kuma managed to disrupt my teaching life one more time. After every previous encounter (MBL I, MBL II, CE/OCS, and PEP-TYC), I came back to Chandler-Gilbert Community College (CGCC) and made significant changes to my teaching practices. What was I thinking by attending the Physics In Context (PIC) workshop in Dayton, Ohio? You'd think I would learn...

Rather than making merely significant changes in my courses, this time I threw out everything and started from scratch. Gone is the topic-driven approach (i.e. "It's week 4, we must be talking Projectile Motion..."). Gone is the unit testing/homework assessment model. Gone is the textbook, the treasured labs, the outstanding (at least I thought so) test and homework items. Gone is everything that I've done before. It's a new millennium, right?

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I hired a senior physics major to work as a tutor to lead homework sessions each of the hours prior to class. I spent some time training him not to work the problems but guide the students in their own solutions. About 50% of the class attended these sessions. I noticed a couple of amazing things right away. Homework turn-in shot up to 90%, and class attendance was around 95%. Students had a much greater investment in what was happening in class each day.

Another great part of the JiTT strategy is that it forced students to read and think about the material prior to class. This meant students arrived with good questions, and an interest in the answer. The external homework sessions freed up a great deal of class time that would usually be spent on problem solving.

As the class went along, I noticed another thing. By the sixth week census, I still had 31 students. Average test scores did not change from previous years, but more students were sticking with the class.

The students formed several study groups, and there was a sense of peer support that had not existed previously. Students were spending more time on campus studying and working together.

The outcome of the first semester was suprising, the class average of the remaining students was lower than past years after drops, but the retention was incredible. Of 32 students starting the first day, 27 completed the class with a C or better.

The second semester I decided to take advantage of the "extra" class time freed up by the external homework sessions. I made every Tuesday a "Workshop" day and used workshop type activities to reinforce topics.

I didn't collect homework on Tuesdays, instead requiring students to turn in a worksheet of questions completed during the workshop. At first, students thought this would be a great idea, but then they realized that the workshops required much more work from them.

I started the class with 26 of the 27 students from the previous semester and picked up 5 more. After 17 weeks of workshops and JiTT, 28 students passed with a C or better.

For me, adapting ideas from JiTT and IPC4 meant an incredible improvement in student success.

Don't Wait!

David Weaver
Chandler-Gilbert Community College
Chandler, AZ

At the recent PIC workshop in Dayton, OH, we followed the time-honored tradition of lunch time "sharing." I was struck by several comments about waiting for "physics' turn" to get computers. This reminded me of what I did after attending my first Curt n' Tom "boot camp" about seven years ago in Colorado Springs ...

I was really fired up to begin implementing MBL stuff after seeing the potential. However, even though my dean said that the school would support my efforts, computer allocations were/are done through a mostly faculty committee which wasn't bound by dean commitments. Furthermore, I did the workshop during the summer and I didn't want to wait more than a year (at best) to navigate the proposal process.

I happened to be walking through our shipping and receiving area late that summer and I saw some Mac Classics on a shelf. I found out that our English department could no longer stomach using such wimpy machines for their word processing. They needed the latest, coolest color Macs.

When I inquired whether I could move the Mac Classics to the physics lab, I discovered that I had absolutely no competition in the bottom-feeder department. Several years later, when the time came to move beyond the Classics, I had a much easier time justifying replacing computers that were over a decade old than I would have trying to get a "new" set of physics computers.

I currently sit on the Instructional Computing Committee at our college. There is a constant influx of new computers into our college, often making older machines available. However, the idea of "Trickle Down" computing is still foreign to many people. They seem to think that if they're going to get into this computer thing, they might as well start with the most current technology.

But, I would contend that starting sooner with older machines beats the heck out of starting later with the latest technology.

Don't wait!

Introductory College Physics: 21st Century (ICP/21) Ready to Start Phase II

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Introductory College Physics: 21st Century (ICP/21) is ready to enter its second phase of development. ICP/21 can be used predominantly in the two-year or four-year college, where the classes are smaller and laboratory and lecture can be integrated easily. It can be used in both technical physics and transferable college physics courses. Since it is modular and flexible, it can also be used in part or as a whole in high school physics classes.

The modules were written with the technical student in mind. The technologies include specialties in both engineering and medicine. The types of physics courses taken by these students vary nearly as much as their individual technological specialties. Some take the regular algebra-trigonometry based college physics. At many schools, these students are mixed in with the biology and other majors. Other programs and schools have developed special courses to fit their students and programs. In each case, mathematics requirements vary as well as the backgrounds of the students.

The strength of the ICP/21 modules is their flexibility. The instructor can edit them according to what they want to do in the classroom. ICP/21 modules are written so that they can accommodate the needs of a wide range of courses. Taken in its entirety, the overall mathematical level of the modules is at the algebra-trigonometry college physics level.

ICP/21 places importance on students understanding basic concepts and having confidence in applying them, rather than exposing them to many ideas, which are neither understood nor remembered. Several features are found throughout each module.

Students are actively engaged. The need for lectures has been greatly reduced. Most classroom time is devoted to laboratories, work sheet activities, and discussion among students.

Cooperative learning is encouraged. Students work together not only in the laboratory, but in the classroom exchanging their ideas in how to solve the problems.

The curriculum has multiple tracks for many laboratories. One incorporates the advantages of using high technology equipment in the laboratory and classroom (MBL, CBL, multimedia, and computer analysis of data) while other tracks allow the instructor to teach the same concepts using traditional equipment. If the instructor has a favorite laboratory for a particular concept, this can be easily substituted.

Quantitative problem solving is equally important as student understanding of the concepts. Procedures and problem solving strategies are emphasized and not just getting the "right answers." Students use multiple representations for most problems and are able to tie together the knowledge gained by analyzing a problem from a pictorial, physical, graphical, and mathematical perspective.

Through the use of learning cycles students will actively test their own conceptual understandings of our natural world. If their conceptual models do not work they can be led to the construction of a more accepted scientific module that does.

Currently the toolkit and seven modules are completed and ready for field-testing. These include: Motion, Forces, Torque, Work/Energy, Waves/Sound, Circuits, and Magnetism. This Spring two additional modules on Heat and Geometrical Optics will be ready. Three new modules are also now being written on Fluids, Physical Optics, and Electrostatics. Last year a "mini field test" was conducted using four of the modules at a couple of two-year schools. We are happy with the results. Next year, we want to do a more thorough field test. We are looking for instructors who are interested in participating.

If you are interested e-mail me at dickisoa@scc-fl.com.

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Background

I spent '99-'00 on sabbatical, getting Novell CAN and Cisco CCNA certifications. I'm not sure exactly why, other than it sounded interesting and different. When I returned to teaching last Fall, I picked up with using ActivPhysics 1 and 2 and RealTime Physics and CASTLE activities. I enjoyed what we were doing in class, but I felt like something was missing.

My homework sets and tests were as creative as ever, but were getting longer and longer. I was spending more and more time grading, leaving me less time to focus on moving the class forward. I was sitting in a computer lab in October (right after I gave one of my biggie-sized tests) when a colleague asked me how I liked being back from sabbatical. I answered that I was enjoying the teaching/learning, but detesting the testing. He said, "Why don't you get rid of the tests?" I said, "I can't do that!" to which he replied, "Why not?" Why not, indeed.

I attended the PIC workshop in early November and then, in early December, sat through several dozen fabulous student research project presentations. I was inspired by building digital control circuits in Dayton and by the whole idea of teaching physics in context. I was again reminded of how much my students learned when they had to complete out of class research projects. Yet again last semester, I had numerous students tell me in their class evaluations that the best part of the class had been the projects.

I decided that I needed to not only change what we did, but how I assessed our progress and the time to change was now!

What I did

I decided that we would do at least one major construction project for each of the two trig based courses. Since this decision came at the end of the Fall semester, I had no time to go through the regular channels to get what we would need. The day after Christmas found me using the web from a library near my in-laws to order all the parts and supplies required by the projects. Then, I sold the construction kits to the students at the beginning of the semester. Since I chose not to use a text, most students found the $15 (PHY 111) or $25 (PHY 112) fee very reasonable.

The mostly Mechanics course students (PHY 111) built two or more mousetrap powered cars (MPCs) (see http://www.docfizzix.com/ for kits and directions). They competed in speed, distance, tractor pull, and creative categories.

The students in the mostly E&M course (PHY 112) began by building the control circuit from the PIC workshop (http://www.sinclair.edu/departments/phy/Fred/PIC/). They connected sensors to a LabPro and used the control circuit to turn things on/off based on sensor input. The E&M students then embarked upon a robot-building project that is near completion. For more information, check out the calculator robots and the CBL-based robots at http://www.smallrobot.com/. I plan to stage CGCC's first non-destructive version of Robot Wars soon.

I am letting the projects dictate the physics we explore. For example, the mechanics students have built multi-representational models of their MPCs. They've used LabPros to collect motion data and force data. They've generated data tables, motion diagrams, r vs. t, v vs. t, and a vs. t graphs as well as kinematics equations for their cars. We will begin energy analysis of them next week. The E&M students are exploring series and parallel circuits, batteries, electromagnetic relays, LEDs, etc. as they relate to their control circuits.

I am thinking of using an air conditioner (think Phoenix!) as the context for fluids and thermodynamics in PHY 111 and a photocopier for the optics portion of PHY 112. As always, I will run out of semester way before I run out of fun things to do and learn (like sound and waves in PHY 111 and atomic, nuclear, relativity and quantum in PHY 112). Maybe I could write a summer project that would allow me to develop contexts that address all of the required topics in these courses.

Neuvo Assessment

In place of regular homework, I am using JiTT methodologies on BlackBoard. I ask Warm-Up (preview) questions and Puzzle (review/extension) questions that are due an hour before class begins. I can speed read the responses in a very few minutes and fine-tune the class activities to a degree unknown to me prior to JiTT. I've recently started using Physlets in my Warm-Ups and Puzzles and they are too cool for words! I award full credit if the students make an honest effort and we address this homework in class on the day it is due (if need be), so my grading efforts are significantly reduced and the students get near instantaneous response.

In place of testing, I meet with each student individually for 15 minutes, three times dur-

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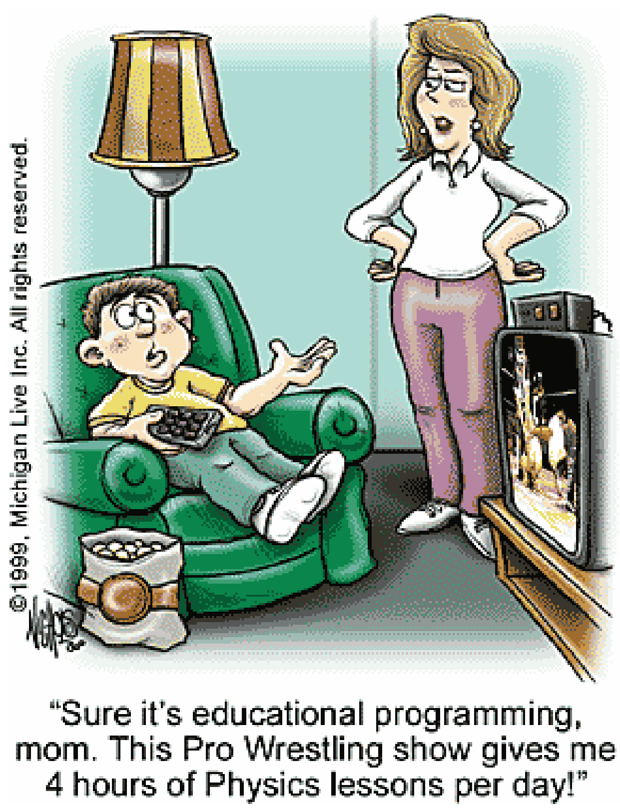
ing the semester. They solve a problem at my whiteboard while I review their notebook. Then, we chat about their solution and/or their notebook. They receive a grade for this "Interview" (during which my grading criteria includes punctuality, proper attire, preparation and presentation), for their notebook, for their performance in the competition, and a partner grade from their partners. Again, my grading workload is reduced while the student is given, I think, a much more authentic assessment. This regimen is much closer to the performance evaluations they will receive on the job than my old test methodologies.

I have a number of years of pre/post-test data to compare to, so I can see if throwing my physics baby out with the bathwater has harmed my students learning (they couldn't do any worse on the CSEM...) or not. If, per chance, they do a wee bit better than before, I won't have a clue whether it was the projects, using JiTT, or my alternative assessment strategies that is responsible. Is that why we preach the importance of a single variable in experimental design? To be continued (?)...

The Physics of Cartoons

Alex Neubert
Canton College of Technology
Canton NY

One of the things that I am always sure to look at in our local newspaper is the cartoon page because of the physics applications and discussion starters that some of the cartoons present. Frequently, at the beginning of class, I would show a cartoon on an overhead projector and ask students to comment on the physics as a way of getting them to think about applications, or at the end of class as a summary of the days lesson. Sometimes I would use one as an assignment for our next class.



Cartoon used by permission of Kevin Nichols. For more see the Wooden Nichols site at http://www.mlive.com/nichols/

However, my most common use of cartoons is with BlackBoard and the philosophy of Just in Time Teaching (JiTT). Even though my frequently announced expectation is that students will have read the text material ahead of time, my experience is that most of them don't. In an effort to get them to think about material before class, about twice a week I require them to log onto our campus course management system (BlackBoard), look at a cartoon or photograph, and then send me a short answer of a few sentences to a question related to the cartoon or photograph. For the most part, I don't care what their answer is. They get a homework point for responding and showing that they have at least thought about the question. Although the philosophy of JiTT says that I should look at their responses before class, sometimes I get sidetracked and don't get to their responses until later. No credit is given for responses submitted after the daily class time.

The cartoon strip that I use most often is John McPherson's *Close to Home*. McPherson has a B.S. in mechanical engineering and worked as a design engineer for 7 years. This background certainly shows in his work. I e-mailed him a few years ago and he was very gracious in giving me permission to use his cartoons in my classes via BlackBoard.

Everyone likes cartoons and my students respond well to them. I encourage you to check your local newspaper and see what physics lessons are waiting to be discovered on the cartoon page.

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Magnetism TIPERs Pilot Testing Opportunity

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Teachers who are interested in exploring new approaches using alternative question formats in magnetism are invited to consider participating in the opportunity to pilot test part of a collection of magnetism TIPERs (Tasks Inspired by Physics Education Research). These TIPERs have been developed with the support of the CCLI program of the National Science Program and also included efforts by Co-PIs Tom O'Kuma (Lee College, TX) and David Maloney (Indiana-Purdue University at Fort Wayne, IN).

This project is developing an interrelated collection of new materials for the topics and concepts in magnetism. These materials are designed to be easy-to-incorporate, in part (or in whole), into courses as classroom materials, web assignments, or homework.

These materials employ various TIPER formats. These formats include: Ranking Tasks (RT); Working Backwards Tasks (WBT); What, if anything, is Wrong Tasks (WWT); Qualitative Reasoning Tasks (QRT); Bar Chart Tasks (BCT); Conflicting Contentions Tasks (CCT); Linked Multiple Choice Tasks (LMCT); Desktop Experiments Tasks (DET); Changing Representations Tasks (CRT); Concept Oriented Demonstrations Tasks (CODT); Meaningful, Meaningless Calculations Tasks (MMCT); Predict and Explain Tasks (PET); Estimation Tasks (ET); Knowledge Organization Tasks (KOT); Knowledge Bridging Tasks (KBT); and Concept Oriented Simulations Tasks (COST). Such materials support new active learning approaches and can usually be easily incorporated in small pieces without making major changes.

The goal of pilot testing TIPERs and associated assessment tools is to improve their usability and usefulness in teaching and learning magnetism.

We are planning to have 16 sets of magnetism TIPERs ready in January with distribution to Spring 2002 pilot testers as soon as possible. The complete set will only be made available to pilot testers. At the http://tycphysics.org/ website there will be three example sets of magnetism TIPERs from this project for people interested in looking at some of them before deciding to participate.

Our expectations of field testers is that they will:

- use 10 -15 or more tasks from any of the available sets (including at least 3 different formats) with as many students as deemed reasonable; report briefly on each task via the web (or paper); and send us the student originals to help us improve the tasks; and/or
- use the pre/post TIPER magnetism assessment tool, report briefly on the assessment tool via the web (or paper), and provide us with the originals in order to analyze possible changes; and finally
- participate in a brief summative usefulness survey on these TIPER sets, assessment tool, and formats.

The individual task reports (via web or paper) will include:

A. Identification of each task
B. Number of students
C. Physics course type
D. School type
E. When and how each task was used
F. Usefulness of each task
G. Comments about the task

The summative usefulness survey will include questions on:

- How useful do you think it was to have multiple formats (sets of TIPERs) available addressing a specific topic in magnetism?
- How useful do you think each specific format is for learning for your students?

We hope some of you will help make these better and find out that they do improve student learning in the area of magnetism. If you have any questions or are interested in participating, please contact me.

'Sweetening' Technical Physics with Hershey Kisses

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During the spring 2001 semester, I taught PHY 133: The Physics of Sound & Light for students in Forsyth Tech's Electronics Engineering Technology program. This curriculum prepares individuals to become technicians who design, build, install, test, troubleshoot, repair, and modify developmental and production electronic components, equipment, and systems such as industrial/computer controls, manufacturing systems, communication systems, and power electronic systems. PHY 133 is an algebra/trig-based course that emphasizes graphical analysis, wave motion, sound, light, and modern physics. To supplement the graphical analysis needs of this course, I utilized an Authentic Learning Task that I discovered while attending the Two-Year College Physics Workshop on Physics in Context held at Sinclair Community College in Dayton, Ohio during November 2nd-4th, 2000.

In 1993, Sinclair Community College and the University of Dayton formed a partnership and established the Advanced Integrated Manufacturing (AIM) Center. Two objectives of AIM are to improve the competitiveness of the manufacturing sector through mission-critical projects, education, and training research, as well as upgrading the skills of the manufacturing workforce. To meet these needs, the AIM program has developed a sequence of Instructional Modules. Each module contains a set of interdisciplinary curriculum materials called Authentic Learning Tasks (ALTs), a series of discrete learning events that build experience and competencies related to specific instructional goals. ALTs often replicate a real-world application, but they are more limited in scope. Their primary focus is to build specific skills or competencies. More information on the AIM Center can be found at http://www.aimcenter.org.

During the Physics in Context workshop, Bob Chaney (Department of Mathematics, Sinclair Community College, rchaney@sinclair.edu) outlined the Instructional Module called Basic Statistical Variation. This module contains four ALTs entitled "Measures of Central Tendency", "Measures of Variability", "The Coin Toss", and "Is a Kiss Just a Kiss?", all designed to give the student an awareness of both the usefulness of statistics to manufacturing and ways in which computers can be used to simplify data analysis. With only five hours of class time allocated to the graphical analysis portion of my PHY 133 course, I decided to address some fundamentals of statistics, a primer on process control, and the ALT "Is a Kiss Just a Kiss?". The ALT complemented my instruction and was well received by the students as a valid learning experience. But what impressed me most was how the students brought on-the-job work experience to the ALT and subsequently, applied some of the ALT's learning objectives to their current work.

To begin our graphical analysis studies, I introduced students to the fundamental statistical concepts of a population, a sample, measures of central tendency (mean, median, and mode), and measures that reflect the amount of variability (range, variance, and standard deviation) among the members of a sample. Various applications to manufacturing and process control were discussed, followed by the ALT "Is a Kiss Just a Kiss?". The purpose of this Authentic Learning Task is to help students better understand the normal distribution and its applications. Student teams weighed the candies in one full bag of Hershey Kisses and constructed a histogram showing the number of candies as a function of mass. Statistical measures were calculated, reports were written, and each team gave a presentation of its findings to the class. Our results indicate that the mass distribution of Hershey Kisses tends to be normal and that this is a reasonable distribution for many processes. The attached figure shows typical results. Notice the bimodal character of the distribution.

The goal of this activity was to have students measure variations in a manufacturing process; in particular, that of producing Hershey Kisses. After completing the ALT, students demonstrated that they were able to collect, process, and display data so usable information is represented. They were also able to prepare basic charts and graphs, make inferences based on data analysis, and apply measures of central tendency and variability to their results.

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During the team presentations, student comments showed extensions of this activity into their program of study and their line of work.

Students were surprised to find that some bags of Hershey Kisses had a wide range in the mass distribution. One team commented that manufacturers must consider profits and/or losses that would result from such a wide range in produced candy masses, and the impact this would have on the product's price and competition in the marketplace.

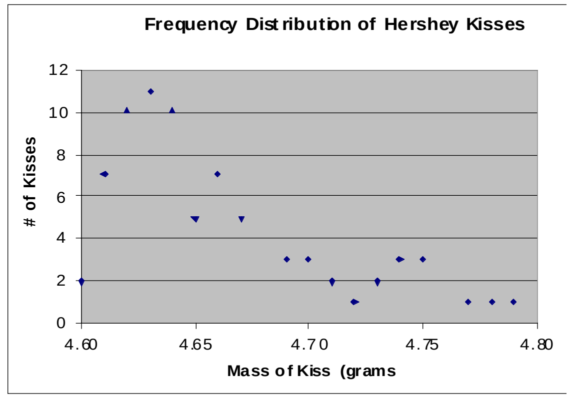
One team proposed the variation in the weight of the Kisses was due to the "dribble factor." The candies are manufactured in a batch control process, in which a sequence of one or more steps is performed in a defined order. Batch control systems are generally configured to control four different types of applications. They are used for the control of solids, which normally use input parameters from weighing equipment; for the control of liquids, with input parameters from flow-metering equipment; for the control of the environment, such as temperature, dew point, and other variables; and for the control of "universal" systems, which accept inputs from many different types of sensors.

When weighing solids during a batch control process (as in the case of the Kisses), two parameters of the system need to be considered. The first, called "dribble", occurs when the loading chute discharge rate changes from a high-speed to a low-speed discharge, so the weighing scale can have enough reaction time to measure the solid accurately and not overshoot the intended product weight. The other parameter, called "preactuate", considers the amount of solid still in the loading chute, but not yet fallen to the weighing scale after the discharge has been cut off. These two parameters will vary with each system, but must be accounted for if accurate weighing is desired.

Students also speculated that temperature might influence how fast the liquid chocolate flowed out of the loading chute during the manufacturing process; however, this was considered to be secondary to the "dribble factor." One student thought the silver wrappers around each Kiss might have variations in thickness, and measured wrapper thicknesses in an effort to isolate a control variable. This thought proved to be insignificant.

During our final discussions, students demonstrated an appreciation for why statistics are important to manufacturing, and why it is important to have a measure for variation.

One student commented that "you need to have reproducibility so you can make your parts as close to the same as possible," which led to an interesting discussion on the role of quality control in the pharmaceutical industry. From their on-the-job work experience, students discussed how fast and slow production rates influenced a manufacturing process and the quality of final products. Students identified several process control variables that influence product quality, and



took a field trip to a local milk dairy facility where one of the students worked.

One student claimed he had heard of "that sigma factor" (the standard deviation), but was not quite sure what it meant. Another student mentioned "three sigma quality control." Students reasoned that it is important to have a measure for variation, particularly in the field of manufacturing, because nothing is perfect. No matter how perfect a manufacturing process happens to be, you cannot make each product exactly the same. Additionally, just because a product is not perfect does not mean it will not fulfill its required function. Students commented that statistics are important in manufacturing because they enable you to make a product close to design specifications, thus preventing a company from losing money or shorting customers.

Even though the students were simply measuring the masses of chocolate candies, I was very impressed with the seriousness of their measurements and analyses, and the professionalism of their final presentations. Through this activity, students became proficient with spreadsheets, graphical analysis, and data organization.

Since completing this activity, three students have mentioned to me that they have seen the usefulness of this activity in their actual field of work.

I encourage other instructors to look into these Authentic Learning Tasks as instructional resources and to implement them into their technical physics courses.

TYC Physics Workshops for the 21st Century: 1999 - 2001 Workshop Participant's Colleges

(listed by state)

Central Alabama Community College	Alexander City	AL
Jefferson State Community College	Birmingham	AL
Alabama Southern Community College	Monroe	AL
Shelton State Community College	Tuscaloosa	AL
Pima County Community College	Tucson	AZ
Estrella Mountain Community College	Avondale	AZ
Chandler-Gilbert Community College	Mesa	AZ
Cuyamaga College	El Cajon	CA
College of the Desert	Palm Desert	CA
Hartnell College	Salinas	CA
San Jose City College	San Jose	CA
Palomar College	San Marcos	CA
Santa Rosa Junior College	Santa Rosa	CA
Rio Hondo College	Whittier	CA
Los Angeles Harbor College	Wilmington	CA
Los Angeles Pierce College	Woodland Hills	CA
Lake City Community College	Lake City	FL
Miami-Dade Community College	Miami	FL
Central Florida Community College	Ocala	FL
Seminole Community College	Sanford	FL
Middle Georgia College	Cochran	GA
Abraham Baldwin Agricultural College	Tifton	GA
Waycross College	Waycross	GA
Spoon River College	Canton	IL
Kaskaskia College	Centralia	IL
R. J. Daley College	Chicago	IL
Prairie State College	Chicago Heights	IL
Highland Community College	Freeport	IL
Joliet Junior College	Joliet	IL
Ivy Tech State College	Kokomo	IN
Vincennes University	Vincennes	IN
Butler County Community College	El Dorado	KA
Maysville Community College	Maysville	KY
Louisiana State University at Alexandria	Alexandria	LA
Delgado Community College	New Orleans	LA
Alpena Community College	Alpena	MI
Washtenaw Community College	Ann Arbor	MI
Bay de Noc Community College	Escanaba	MI
St. Clair County Community College	Port Huron	MI
Anoka-Ramsey Community College	Coon Rapids	MN
Dunwoody Institute	Minneapolis	MN
DeVry Institute of Technology	Kansas City	MO
Moberly Area Community College	Moberly	MO
St. Louis Community College at Forest Park	St. Louis	MO
Surry Community College	Dobson	NC
Wayne Community College	Goldsboro	NC
Lenoir Community College	Kinston	NC
Carteret Community College	Morehead City	NC
Forsyth Technical Community College	Winston-Salem	NC

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Just-in-Time Teaching with the Conceptual Physics Student

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I attended the Two-Year College Physics Workshop on Internet and Web-Connected Physics (WCP) at Joliet Junior College in Joliet, Illinois during June 21st-24th, 2000. During this workshop, participants learned about Just-in-Time Teaching (JiTT), an active-learning methodology that requires students to complete pre-class web assignments before formal classroom instruction. After familiarizing myself a bit more with the JiTT teaching strategy, I decided to implement the approach in my Conceptual Physics course during the spring 2001 semester. My objective was to expose students to another activity-based physics tool and to assess the success of this method as an instructional resource.

Forsyth Tech offers Conceptual Physics as a one-semester survey course that meets five hours a week. Three hours are delegated to lecture, and two hours to lab. Since my classes are very activity-based, I freely integrate lecture and lab components in a seamless manner. The course does not have a mathematical pre-requisite, and most of the 40 students enrolled are college transfer majors that take the class just to meet graduation requirements. We use the 8th edition of Paul Hewitt's *Conceptual Physics* as our main text. JiTT activities were chosen to supplement our studies of work, energy, and power as presented in Chapter 6 of Hewitt.

Just-in-Time Teaching (JiTT)
The JiTT approach is described in the 1999 Prentice Hall textbook *Just-in-Time Teaching: Blending Active Learning with Web Technology*, by Gregor Novak, Evelyn Patterson, Andrew Gavrin, and Wolfgang Christian (ISBN 0-13-085034-9). Briefly stated, JiTT is an exciting new teaching and learning methodology designed to engage students by using feedback from pre-class web assignments. An instructor uses this feedback to adjust classroom lessons so students receive rapid response to the specific questions and problems they are having. The goal is to replace a generic lecture (that may or may not address what students actually need help with) with a lecture that specifically addresses students' needs and misconceptions. Instructors that have successfully used JiTT report that this process also encourages students to take more control of the learning process and become active, and interested learners.

Broadly defined, JiTT is an effort to involve students by using feedback between out-of-class and in-class activities. The core element of JiTT is the interactive lecture. Interactivity is established by using World Wide Web-based preparatory assignments that are due shortly before class. Instructors adjust and organize their classroom lessons based on their student responses "Just-in-Time." Thus, feedback between the classroom and Web is established.

The students are forced to take more responsibility for actually learning the material themselves. The main idea is to engage students with course material early, before they hear a lecture on it. After completing these web-based essay activities, students come to class better prepared to share ideas and opinions. Since the students have already thought about the questions, the discussions are of greater value to them.

JiTT employs two main types of web-based assignments: Warm-Up Exercises and Puzzles. Warm-Up Exercises and Puzzles serve loosely as bookends for a given topic, beginning with the Warm-Up and ending with the Puzzle. The Warm-Ups provide an introduction to a given topic, while the Puzzles provide a conclusion. These assignments pose questions that are motivated by a clear set of learning objectives. The questions introduce students to technical terms and challenge them to confront previously held notions. As an added benefit, the questions tend to be extendible and readily lend themselves to other real-world applications, lecture topics, or laboratory demonstrations.

The Warm-Up Exercises are the heart of the Just-in-Time instruction system. Before each class, an instructor will read the student responses and adjust the lesson in response to the students' demonstrated knowledge. Conceptual questions have been found to be particularly valuable.

Students' answers (presented in anonymous, edited form) can be used as talking points for the instructor, while the issue is still fresh in the students' minds. By using this method, the instructor can customize the lecture to the students and their misunderstandings. In this manner, students sitting in the classroom recognize their own

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wording, both correct and incorrect, and thus become engaged as part of this interactive feedback loop.

The Puzzle is typically a single question that may be somewhat vague and usually involves several concepts. As the name implies, the Puzzle is a physics scenario with an extra twist that requires the student to see beyond the end-of-the-chapter formulas. This is often accompanied by further challenging commonly held misconceptions. To a physicist, the Puzzles may appear trivial — many can be answered without calculations. But they usually present a significant challenge to the introductory physics student.

JiTT and the Conceptual Physics Student

After five weeks of instruction, I had a pretty good feel for what my Conceptual Physics students were comfortable with and capable of doing. As we approached the topic of Energy, I decided to use three sets of JiTT Warm-Up Exercises to ease them into the material. Each set of Warm-Ups was obtained from Nick Nicholson's (nniccacc@core1.wwisp.net) physics website at Central Alabama Community College in Alexander City, Alabama. The Warm-Ups I selected were:

Work
http://207.157.12.149/phy-webpages/warmups/110-lp7-work.html

Kinetic Energy and Power
http://207.157.12.149/phy-webpages/warmups/110-wu12-ke-pwr.html

Work, Energy, and Power
http://207.157.12.149/phy-webpages/warmups/110-wu13-work-energy-pwr.html

Each Warm-Up set of exercises consisted of three questions based up the reading material in Chapter 6: Energy of Paul Hewitt's text *Conceptual Physics*, 8th edition. Students also had the ability to include general comments about the nature of the assignment, the reading material, and the level-of-difficulty of each question.

Since many of my students do not have access to the Internet, I assigned the Warm-Up Exercises as a group project during one of our two-hour lab sessions. Our physics lab has 20 computers with Internet access, so I divided the class into 20 teams with two students per team. Students were given the reading assignment the day before the lab. During the actual lab session, students were free to use their textbook, other physics resources within the room, and were permitted to share ideas with their partner and other teams. Although we had used the computers earlier in the semester for Internet research, MBL activities, and graphical analysis, there was a unique novelty of using these same computers to solve physics problems on a webpage. Although the computer did not bestow upon the students magical powers to solve problems, it did generate an excitement and a level of interest that kept most of the students actively engaged in wrestling with physics during the whole laboratory session. And that alone is enough justification for me to use JiTT activities in other courses.

As with almost any assignment, some students got it, and some just simply got stuck. Most of the students that had done the assigned reading were able to develop problem-solving strategies that headed in the right direction, even if their final answer turned out to be wrong. A selection of student comments are listed below:

We liked the assignment, it was cool!

I enjoyed doing this assignment over the computer.

We liked the idea of working online to do homework and assignments.

The other problems were kind of easy to answer; we just needed to think a little.

The first problem was a challenge.

The first question was very difficult to answer, but challenging.

We had no idea how to figure out the first question.

Question #2 seemed to lack all the necessary information.

The last problem was complicated.

The last question was confusing so we answered the question the best way we knew how.

You should make easier problems!

The assignment helped me understand things better. I enjoyed working with Jackson.

We should spend more time on word problems and how to relate the formulas to them.

Some of the problems were given to us in a way that was a bit different than those

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in the book and because of this, the problems were a bit difficult to answer.

We had a slight misunderstanding on some questions but we did a great job figuring them out.

These questions were HARD! We could not figure out how to change Watts to a measure of distance.

After the lab session, I reviewed all of the answers the student teams submitted. During our next class meeting, I solved all of the Warm-Up Exercises, paying particular attention to the misconceptions that I noticed in the students' answers and problem-solving approaches. While doing this, I noticed that the JiTT format helped me to find out early what the students knew, and which concepts or topics they were having trouble with. With one lab session and one lecture devoted to JiTT activities, I found it easy to fill in the gaps that remained in our study of Energy in two more lecture sessions.

JiTT allows one to run lectures in a highly interactive mode. It also encourages students to participate on their own initiative and ask questions during lectures. My objective in trying the JiTT strategy was to expose students to another activity-based physics tool and to assess the success of this method as an instructional resource. I was very pleased with the impact that it had on my Conceptual Physics students and will look for opportunities to introduce other JiTT activities in my other physics courses.

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TYC Physics Workshops for the 21st Century: 1999 - 2001 Workshop Participant's Colleges

(by state)

Mesa Technical College	Tucumcari	NM
Erie Community College-City Campus	Buffalo	NY
SUNY College of Technology at Canton	Canton	NY
DeVry Institute of Technology	Long Island City	NY
LaGuardia Community College	Long Island City	NY
Clinton Community College	Plattsburgh	NY
Northwest State Community College	Archbold	OH
University of Cincinnati Clermont College	Batavia	OH
Columbus State Community College	Columbus	OH
Sinclair Community College	Dayton	OH
Firelands College-Bowling Green State University	Huron	OH
Kent State University	Kent	OH
Marion Technical College	Marion	OH
Jefferson Community College	Steubenville	OH
Cuyahoga Community College	Cleveland	OH
North Oklahoma College	Tonkawa	OK
Florence-Darlington Technical College	Florence	SC
Northeast State Technical Community College	Blountville	TN
Chattanooga State Technical Community College	Chattanooga	TN
Volunteer State Community College	Gallatin	TN
Nashville State Technical Institute	Nashville	TN
Austin Community College	Austin	TX
North Lake College	Irving	TX
Kilgore College	Kilgore	TX
Lamar State University	Port Arthur	TX
College of the Mainland	Texas City	TX
North Seattle Community College	Seattle	WA
Clark College	Vancouver	WA
Fox Valley Technical College	Appleton	WI
West Virginia Northern Community College	Wheeling	WV
Casper College	Casper	WY

The Influence of TYC Workshops

Darwin Church
University of Cincinnati
Clermont College
Batavia, Ohio

Introduction
The TYC Physics Workshops have had a tremendous influence on how I teach physics. About six years ago, after teaching my first physics course, I realized that what I was doing in the classroom needed to change to help improve student learning. I was not aware of the literature available in the area of physics education research. The workshops have helped to quickly ground me in the techniques and methods that have proven to be successful. I learned that my experiences and problems were common to other people and that some solutions were available. In this article I would like to share my background and some of the changes I have made as a result of attending the TYC Workshops. For people familiar with physics education research, this is all old news.

Background
In the fall of 1995 Clermont College began to offer an algebra/trigonometry based College Physics sequence. Although for the previous ten years the majority of courses I taught were in electrical engineering technology (EET), the college did not have a full-time physics teacher and needed someone to teach the courses; so I volunteered. The EET students were mostly sophomore level, and I taught the courses in a fairly traditional style of lecture, homework, and tests. With small classes for the lectures and labs, there was the opportunity to have frequent student-teacher interaction and to give individual attention. The EET students learned the material to my satisfaction.

When I began teaching the physics sequence, the students did not have the math experience and problem solving skills that the sophomore EET students did. Using my traditional teaching methods did not have the same successful results: the students did not learn the material to my satisfaction. I emphasized problem solving, but soon found that students made mistakes because they lacked an understanding of the basic concepts. Even if they produced a correct numerical answer to a physics problem, they could not always give a clear explanation of what the answer meant or how they had arrived at it.

I had been taught physics through using equations, but by using this method, the students were just not learning as well as I thought they should be. I began to look for ways to change how I was teaching.

Agents of Change
Sometime during 1996 a copy of the Winter 96 *CaFD Newsletter* appeared in my mailbox at school. It was the first one I had ever seen, and the first article by Dennis Albers really got my attention. He expressed similar frustrations to those I had experienced and detailed how he had changed his physics teaching. He stated, "Lectures of any kind, whether by charismatic lecturers, by lecturers who do frequent demonstrations, by lecturers who meticulously develop theory, and with or without traditional labs attached to the lecture, have no significant impact on test scores." I thought that this was an over statement, but from my personal experience, I knew there was some truth in the statement that was worth further investigation. I guess our pride makes it difficult to admit our "great" lectures are not worth as much as we would like to think.

The CaFD Newsletter was a great resource. I learned about the TYC Physics Workshops and contacted Curt Hieggelke to get a book of ranking tasks, which I immediately found to be helpful. I bought a copy of a book by Arnold Arons called *Teaching Introductory Physics* and the CD *Interactive Journey through Physics* by Cindy Schwarz. My teaching style was beginning to change.

In April 1998 I attended my first TYC workshop on Physics Simulations. I subsequently have attended three other TYC Physics Workshops: CE/ALPS Workshop, November 1998; Internet and Web-Connected Workshop, June 2000; and the recent HTML and Physlets Workshop, August 2001. I left each of these workshops with many new ideas and materials to try.

Changes in the Classroom
My teaching of physics has evolved as a result of the above workshops. Instead of just teaching the chapters in a textbook to cover the material, I began to reflect more on what I was trying to accomplish.

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I asked myself three basic questions:

1. What do I want the students to know or do?
2. How am I going to teach it? (or how will the students learn it best?)
3. How am I going to assess the student's learning?

The answer to the first question was I wanted the students to have a conceptual understanding of the fundamental physics concepts and be able to solve problems with understanding.

Secondly, in order to accomplish this, I stopped using the traditional techniques consisting of a lecture accompanied by examples that I worked on the board. Instead, I now use mini-lectures that are preceded or followed by simulations from a CD-ROM, demonstrations, ranking tasks, conceptual exercises, or numerical problems, all designed to have the students actively involved. I realized that having them actively involved in learning is more effective than having them passively watch me work through an example.

After reading Eric Mazur's book *Peer Instruction*, I began doing some of these activities in groups of 3 or 4 students. Part of the challenge has been learning how to use these tools. The greatest challenge has been in deciding which activities to use. It can be very time consuming reviewing the variety of tools available.

Finally, the above activities are a way to assess the student's learning, but I also expect them to write explanations and draw diagrams and graphs to further assess their learning. I have also used the Force Concept Inventory (FCI) and the Conceptual Survey of Electricity and Magnetism (CSEM).

Results

I have made these changes over several years. Each year the student's learning has improved. This past year the results on the FCI and the CSEM were higher than previous years, and the students answered questions that they could not answer well in previous years. Two other indications of the success of this method were that the drop-out rate has been reduced and my student teaching evaluations have gone up.

My teaching has evolved to be more student-centered rather than teacher-centered. The variety of activities, methods and techniques to present the material has had the further benefit of reaching students with different learning styles who had previously struggled with the traditional presentation.□

Future Activities

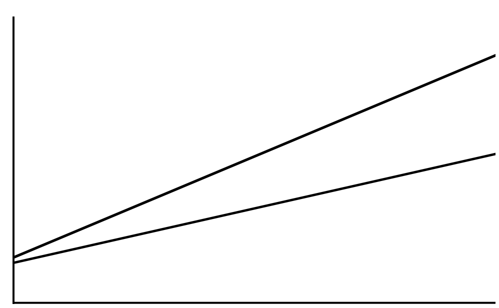
Although I will continue to strive for better physics learning outcomes by continuing to improve what goes on within the four walls of the classroom, I am also interested in directing student's efforts outside of class. The last two workshops I attended on web-connected physics and physlets were helpful in this area. This past year I began using "Blackboard" and ideas from the book *Just-In-Time Teaching* (JiTT). "Blackboard" is a web-based, course management software package.

One idea of JiTT is to have students do assignments and submit them to you prior to coming to class. You can review the assignments to see where the students are having problems, and then use this information to direct the classroom activities. Using the web is one of the easiest and most effective ways to do this. Including the use of interactive Physlets (small Java applets for physics animations) will greatly expand the range of questions that can be assigned.

I am greatly indebted to Curt Hieggelke and Tom O'Kuma for organizing the workshops and to the presenters at the workshops. Conversations with other workshop participants have also been valuable. Without attending the workshops, the changes that I have made would have occurred much more slowly. Thanks from my past and future students and me.

WWT TIPER

A student is shown the velocity-time graph below and is asked to decide which motion is faster and why.



The student responds:
"A is faster because it has a larger slope."

What, if anything, is wrong with the above solution for this situation? If something is wrong, explain the error and how to correct it. If the solution is legitimate as it stands, explain why it is valid.

Physics Workshops for the 21st Century: 2001-2004

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We have been awarded a new grant (#0101589) from the Division of Undergraduate Education (DUE) of the Advanced Technological Education (ATE) Program of the National Science Foundation (NSF). This award provides a series of faculty professional development workshops (four per year for three years) for high school and two-year college teachers who teach the core physics courses for technology and other programs. These workshops cover the major developments in teaching and learning strategies that have emerged in the last few years.

The goal of this project is to help high school and two-year college students develop a stronger understanding of science, with an emphasis on physics and its applications in industry. This goal is important because of the large number of students, particularly women and minorities, who are enrolled in technology or transfer programs at two-year colleges.

The vital task of updating and improving physics programs at high schools and two-year colleges is difficult due to the rapidly occurring changes in technology, the distribution of physics teachers, the heavy and complex workload of the faculty, and their lack of knowledge about the needs and applications of physics in the workplace.

This program addresses these issues by providing a series of faculty development workshops for teams of high school and two-year college teachers who teach core physics courses for technology programs and other programs. These workshops are designed to acquaint the participants with the integration and implementation of emerging technology and active learning strategies. These workshops provide extensive and intensive hands-on, collaborative experiences for participants with workshop materials that make it easy for participants to implement the workshop ideas, adopt or adapt them, and acquire necessary skills to use them effectively in their classroom. The team aspect provides someone local that can share in the implementation of these strategies.

The objectives of these workshops are targeted to provide physics teachers with:

- knowledge of, and solid experience with, recent major advances in the applications of microcomputers and curriculum developments in physics;
- a means to identify the appropriateness and role of these workshop ideas in meeting the needs of TYCs, and to see models of how it has been done at other TYCs;
- an opportunity to develop, adapt, share, and incorporate suitable materials into TYC physics courses and programs; and
- a chance to enhance their understanding and appreciation of the needs of students, educational programs, and workforce needs in areas dealing with advanced technology.

There are no fees or costs directly associated with participation during these workshops, due to the support of the National Science Foundation, Joliet Junior College, and Lee College. In addition, there are travel funds available for high school physics teachers.

These workshops will consist of over 35 hours of scheduled activities over three or four days, of which most time will be spent doing hands-on activities in two or three hour work sessions. Workshop sessions start at 8:30 AM and will end each day around 9:30 PM, except for Saturday when the last session is scheduled to end around 4:00 PM.

Participants will be provided a shared room for the evening before the workshop through Saturday evenings at a nearby hotel. Meals will be provided the first morning of the workshop through Saturday evening. If requested, individual rooms will be available at extra cost.

Participants will be given materials needed for each workshop. This includes background materials prior to the workshops, as well as a substantial amount of materials for use during and after the workshops.

For the list of the first three workshops see the back page of this newsletter. More information about the workshops and updates are available at http://tycphysics.org/ or contact us.

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For High School and Two-Year College Physics Teachers

Physics Workshops for the 21st Century 2002 Schedule

February 14-16, 2002
Physlets (physics applets) and TIPERs at Lee College in Baytown, Texas (near Houston)

April 18-20, 2002
Microcomputer-Based Laboratories (MBL) at Vernier Software and Technology in Portland, Oregon

June 27-29, 2002
Introductory College Physics-21st Century at Joliet Junior College in Joliet, Illinois (near Chicago)

for more information visit http://tycphysics.org/

CaFD is a component of the networking, follow-up, and dissemination process of the TYC Physics Workshop Project supported by the National Science Foundation. The opinions, statements, findings, recommendations, or conclusions expressed in this newsletter are those of the author(s) and do not necessarily reflect the views of the National Science Foundation, Joliet Junior College or Lee College. Readers are encouraged to submit articles and responses to articles. They should be sent to Curtis Hieggelke, Natural Science Department, 1215 Houbolt Road, Joliet Junior College, Joliet, IL 60431, or e-mailed to curth@jjc.cc.il.us