

Restarting a High School Photonics Program

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Outline

- **Introduction**
- **Background**
- **Current status (2006-09)**
- **Future plans**
- **Conclusions**
- **[Problem-Based Learning / PHOTON PBL]**
- **Acknowledgements**

Introduction

- **Plainfield High School (PHS)**
 - Rural school
 - Medium size
- **Plainfield, Connecticut**
 - Old mill town
 - Northeastern CT
- **New physics teacher in 2006**
 - Certified for Tech Ed (but *not* Science)
 - Career nuclear submarine officer

Background

- **PHS *had* a successful photonics program**
 - Previous physics teacher set it up
 - Substantial involvement in early PHOTON projects
 - He moved on
- New teacher (*BKB*) inherited program (*but few resources...*)

What's the Problem?

- PHS photonics program stalled after new teacher's first year (2006-07)
 - Not taught second year: *insufficient enrollment*
- Why?
 - Teacher?
 - Students?
 - System?
 - Actually, *all three...*

Teacher Problems

- **Ill-prepared to teach Photonics**
 - **Trained / certified for Tech Ed, not Science**
 - **Lack of knowledge**
 - *Content / Equipment / Applications*
- **Wrong approach**
 - **Teach like he was taught**
 - *Lecture / End-of-chapter questions / Cook-book labs*
 - *Traditional tests – regurgitate the above*
 - **Failed to apply constructivist strategy (from Tech Ed)**
- **Gave higher priority to Physics, Integrated Science**
 - **Required vs. elective**
 - **Traditional (pure) vs. applied science**
 - **Content-based vs. applications**
 - **He had *taken* those courses**

Student Problems

- **Ill-prepared to learn Photonics**
 - Poor math skills
 - Poor problem-solving
 - Low motivation to work (want to be spoon-fed)
- **Unrealistic expectations**
 - “When do we get to play with lasers?”
- **Low connection to future use**
 - Teacher: “What do you want to do after high school?”
 - Student: “Get a nice job in a warehouse.”

System Problems

- **Insufficient prior knowledge / skills**
 - Math / science
 - Reading / writing
 - Critical thinking / problem-solving
- **Lack of rigor / accountability at lower grades (?)**
- **Few teaching resources**
 - Better-than-average lab kit
 - ...but *NO* textbook / written curriculum / lab manual / equipment documentation
- **Unclear course description**
 - Most staff / students uncertain what “*photonics*” is
 - Students arrive expecting to “*play with lasers*”
- **Wide diversity in students’ interest / ability levels**

The Result?

- **Students frustrated**
- **Teacher *very frustrated***
- **Bottom line: *NOBODY was happy!***

What to Do?

- *Fix it...*
- **...Or...**
- *...scrap it!*

How to Fix: Multi-prong Attack

- **Increase teacher knowledge**
- **Revise teaching approach**
- **Stimulate student interest**
- **Improve overall awareness**

Increase Teacher Knowledge

- **Courses**
- **Workshops**
- **Internet**
- **Textbooks**
- **Professional contacts**

Revise Teaching Approach

- **Inquiry-based learning**
 - UCONN course
- **Engagement through entertainment**
 - “Edutainment”
- **Constructivist strategy**
 - Problem-Based Learning (PHOTON PBL)

Stimulate Student Interest

- **Astronomy club**
 - Started in fall '08
- **Learn by teaching others**
 - Teaching optics to 5th graders
- **Field trips**
 - TRCC, Trumpf, Boston Museum of Science

Improve Overall Awareness

- **Article in local press after summer '07 PHOTON PBL workshop**
- **Conference participation (SPIE – *this one*)**
- **Sales pitch to junior class**
 - **College Career Pathways (CCP; formerly Tech Prep)**

Did It Work?

- ***YES!***
- **How well?**
 - **Ran expanded course in spring '09**
 - **Did two PBL Challenges**
 - **Took three field trips**
 - *TRCC Laser Camp (2x)*
 - *Trumpf, Inc.*

Are We Done Yet?

- ***NO!***
- **What's left to do?**
 - **Improve math readiness of incoming students**
 - **Show them how math connects abstract to concrete**
 - **Attract / motivate / engage students of varying abilities**
 - *Keep them interested in photonics AND science in general*
 - *Follow-on opportunities: workforce / military / further education*
 - **Improve students' understanding of scientific ways of viewing physical world (*scientific literacy*)**
 - **Demonstrate (through tangible evidence) that PHS photonics program supports school mission / vision**

How Achieve Objectives? (1)

- **Continue to address rising students on content / application of Photonics course**
 - **Earlier than junior year?**
 - **At Freshman Academy / Student Advisory?**
 - **At sending middle schools?**
- **Advertise expectations / needs / activities / successes via school / local media outlets**

How Achieve Objectives? (2)

- **Design / build large, visible project using photonics technology**
 - Scrolling light sign for announcements / other student interest items?
 - Place near school entrance / cafe / gym
- **Continue interscholastic partnerships**
 - CCP (TRCC)
 - Expanding Horizons (EASTCONN / TRCC / regional high schools)

How Achieve Objectives? (3)

- **Incorporate additional PBL Challenges / other interesting projects into Photonics curriculum and other science courses**
 - **Consider devising own challenges, using PHOTON PBL template**
 - **Friendly competition w/ partner schools?**
 - **Conduct professional development workshop on PBL for peers**
 - **Science dept? Others?**

How Achieve Objectives? (4)

- **Continue using PBL Challenges to present content knowledge**
- **Also place greater emphasis on universality of problem-solving approach used in PBL; show how it applies in:**
 - **Other science courses**
 - **Math and Tech Ed courses**
 - **College courses**
 - **“Real-world” scenarios**
 - **“Life” scenarios**

How Achieve Objectives? (5)

- **Take additional field trips so students can see photonics technology in action in “real world”. Consider:**
 - **U.S. Coast Guard Museum, New London, CT – lighthouse optics (lenses/prisms)**
 - **Submarine Force Library and Museum, Groton, CT – periscopes (World War II vintage) with attendant optics**
 - **Submarine Base New London, Groton, CT – periscopes, photonics masts, radio/radar/electronic surveillance systems, fiber optics, other non-visual uses of E/M spectrum**
 - **Naval Undersea Warfare Center (NUWC), Newport, RI – same as sub base, with access to scientists / engineers / technicians who design and implement them**
 - **Kollmorgen Electro-Optical, Northampton, MA – designer and builder of submarine periscope systems worldwide**

How Achieve Objectives? (6)

- **Work w/ career center to:**
 - Invite guest speakers from above sites
 - Arrange job-shadowing opportunities
- **Develop / expand astronomy club / add more activities**
- **Consider starting photonics club**
 - Combine with astronomy club (“astro-photonics club”)?
 - Become student chapter of SPIE?

How Achieve Objectives? (7)

- **Continue to refine Photonics curriculum / content delivery to more closely match interests, needs, and abilities of students**
 - **Stay attuned to needs of outside organizations (college / industry) for specific skills and abilities of program graduates**

How Achieve Objectives? (8)

- **Formalize Photonics curriculum, but keep flexible / responsive to needs of each particular class of students**
- **Introduce / incorporate school-wide rubrics for applicable Photonics assignments / assessments**
 - **Provides consistent “story” to our students as compared to other, more traditional classes**

How Achieve Objectives? (9)

- **Work toward more “authentic assessments” / away from traditional written quizzes / tests**
- **Do more hands-on activities / less “book learning”**

How Achieve Objectives? (10)

- **Seek ways to integrate Photonics w/ other science / math / Tech Ed courses (ultimately, do interdisciplinary projects across entire spectrum of course offerings)**
 - **Tech Ed: Investigate (and hopefully obtain) solar energy system to help reduce school's dependence on traditional sources of energy**
 - **Math: Teach algebra students to solve problems using physical quantities encountered in science classes (e.g., physics and photonics); science students then apply geometry / trigonometry / algebra in both these classes**

Conclusions

- **Today's students are not like 30 years ago**
- **People learn better when:**
 - **Actively engaged in learning process**
 - **Interested in material**
 - **See connections to:**
 - *Prior knowledge*
 - *Current / future applications*
- **Photonics program *is viable* in regular high school**
- ***It is CRITICAL to identify / locate / utilize outside resources!!!***

Acknowledgments

- **Some of *our* most important outside resources:**
 - **National Science Foundation / Advanced Technological Education (NSF/ATE) program**
 - **New England Board of Higher Education (NEBHE)**
 - *PHOTON / PHOTON2 / PHOTON PBL projects*
 - **Regional Center for Next Generation Manufacturing**
 - **Connecticut State Department of Education (CT SDE)**
 - **EASTCONN Regional Educational Service Center (RESC)**
 - *Expanding Horizons program*
 - **Three Rivers Community College (TRCC) – *many-fold!***
 - **College Career Pathways (formerly Tech Prep) program**
 - **SPIE, OSA, CORD, Trumpf, PHOTON partners**
 - ***...and all the wonderful people who make them function!***

Thank You!