Preparing physics teachers for 21st century

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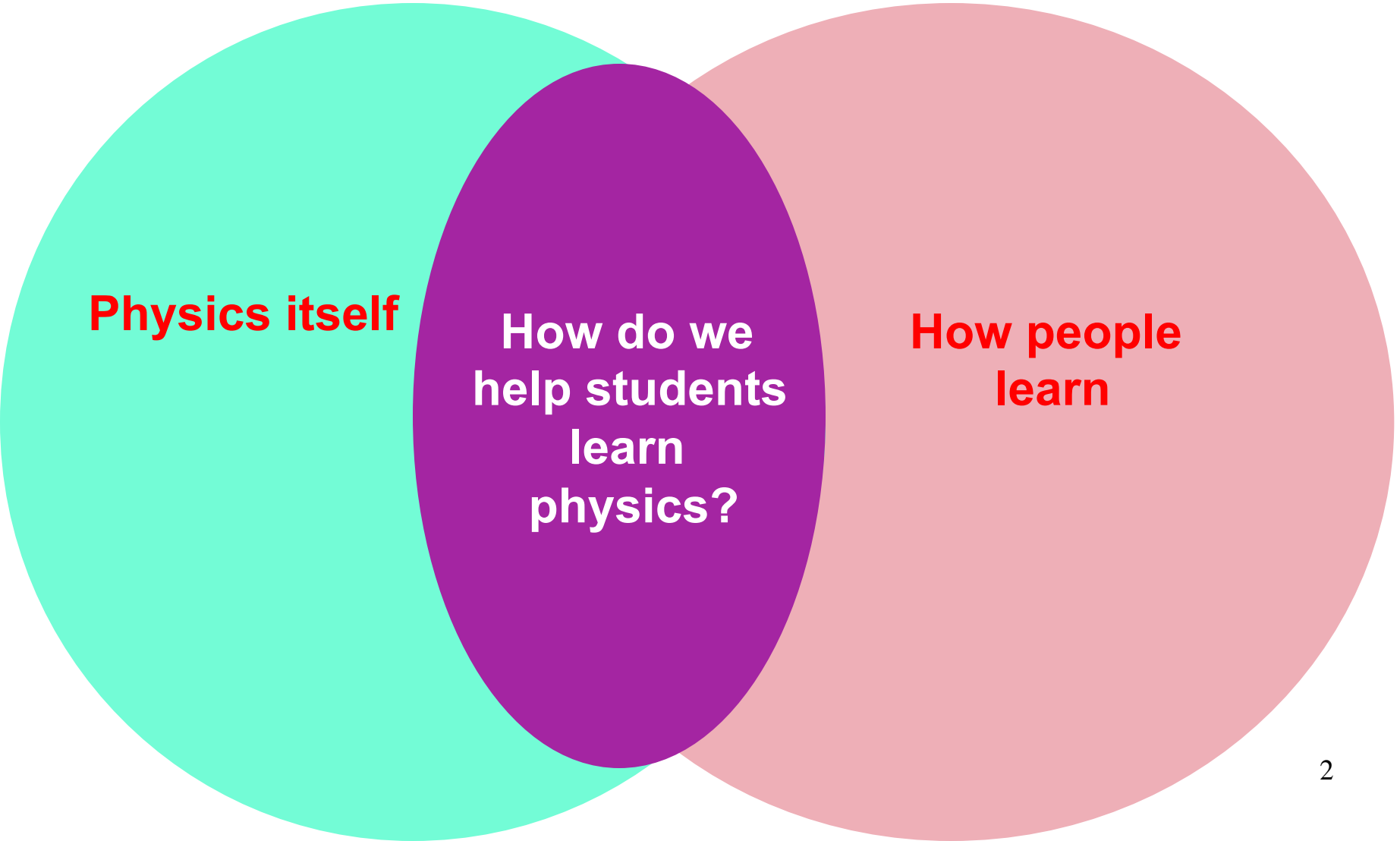
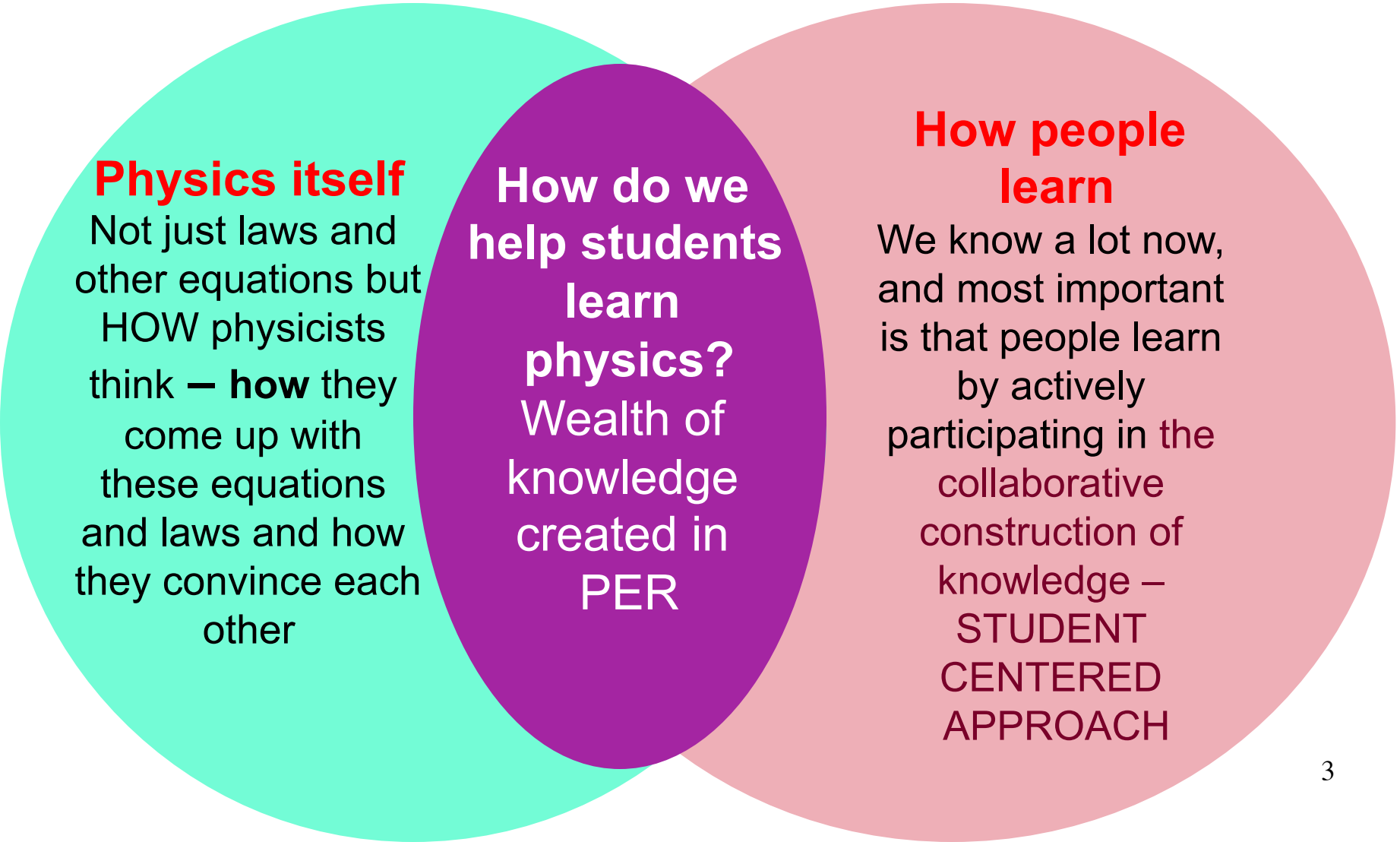
A teacher needs to know…



A teacher needs to know…



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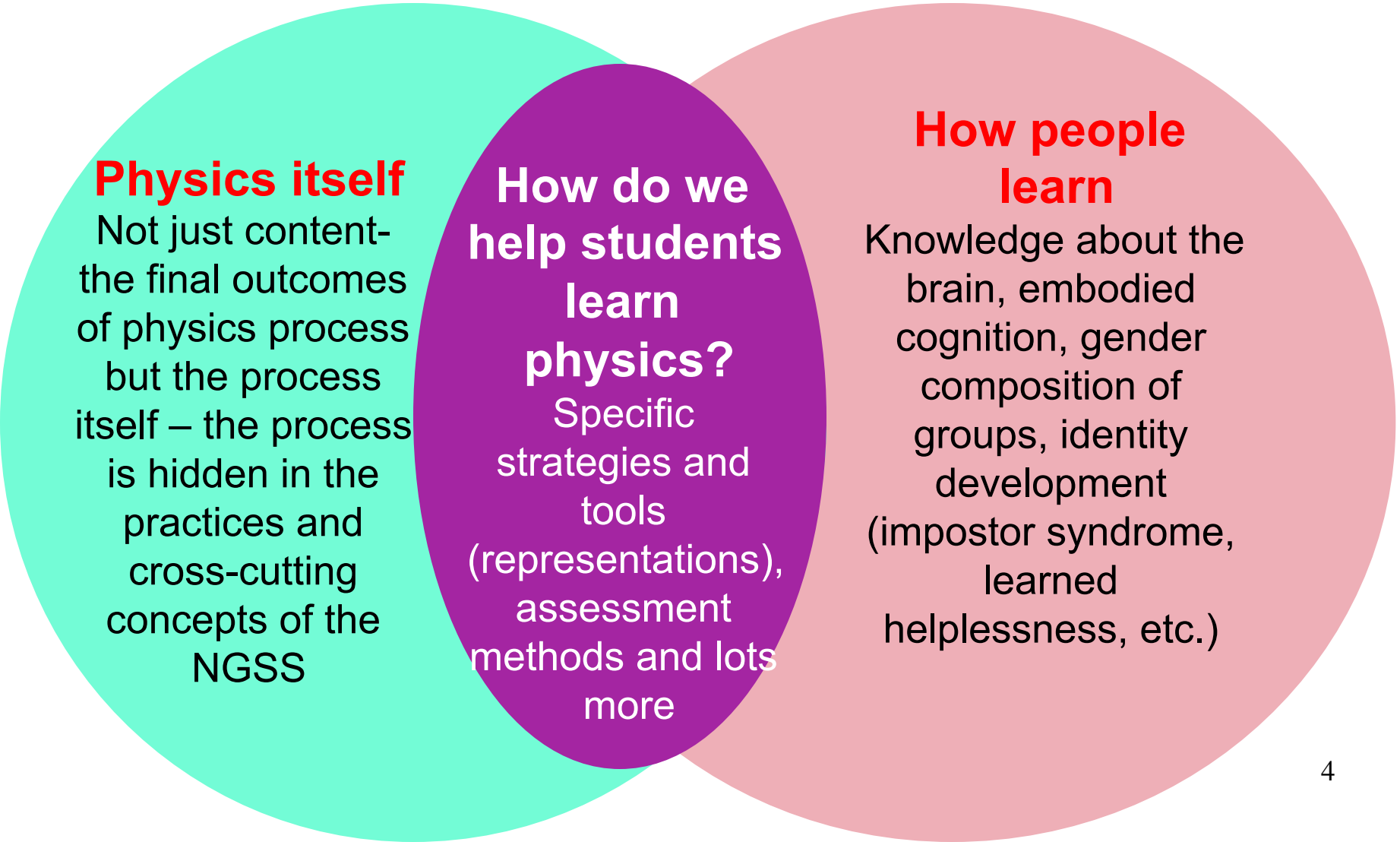

Three crucial issues

The only element of teacher preparation programs that can predict how new teachers will actually teach is the amount of experience with every day instruction relevant to the first year of their teaching received in the program (Boyd et al., 2009).

D. Boyd, P. Grossman, H. Lankford, S. Loeb, & J. Wyckoff, "Teacher preparation and student achievement," *Educational Evaluation and Policy Analysis,* **31**, 416-439, (2009).

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Teachers experience difficulty implementing student-centered teaching (*instruction consistent with NGSS*), despite being taught to do so during pre-service preparation (Simmons et al., 1999).

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What should we do?

Issue #1

The only element of teacher preparation programs that can predict how new teachers will actually teach is the amount of experience with every day instruction relevant to the first year of their teaching received in the program.

Preparation for every day instruction

Physics curriculum (order of topics)

What do we want students to learn and be able to do in each topic? Why?

How will we know that they actually learned it?

What do we know about students' ideas in this area?

What are productive representations and learning approaches for this particular topic?

What should students know "for sure" to be able to succeed today?

What are good resources? What aspects of those resources match my teaching philosophy?

What will happen in class today? Tomorrow?

Decisions on all of those depend on teacher's beliefs about teaching

Beliefs: can all students learn physics? Do they come to class full of misconceptions of productive resources? Is learning a quantum state: got it or did not get it?

These are just a few examples. These become as important as the knowledge listed above – EVERY DAY!

It takes time to learn all this, right?

How much time? How many courses?

Rutgers University Teacher Preparation Program has 6 courses over 2 years in which students who already have a physics degree learn to teach physics:

1. Every topic of the curriculum – at least twice
2. Technology, experimentation, assessment, curriculum design – all included

Course work in the Rutgers Physics Program in the Graduate School of Education

Master's Program (45 Credits)

5 semesters with 6 physics teaching methods courses
(two years with summer between)

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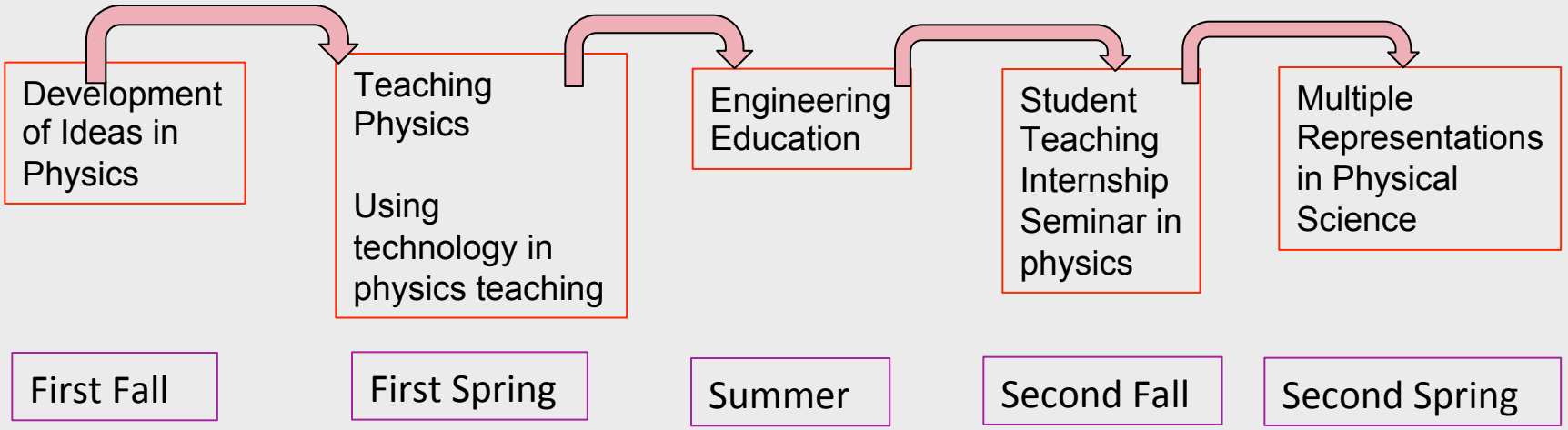
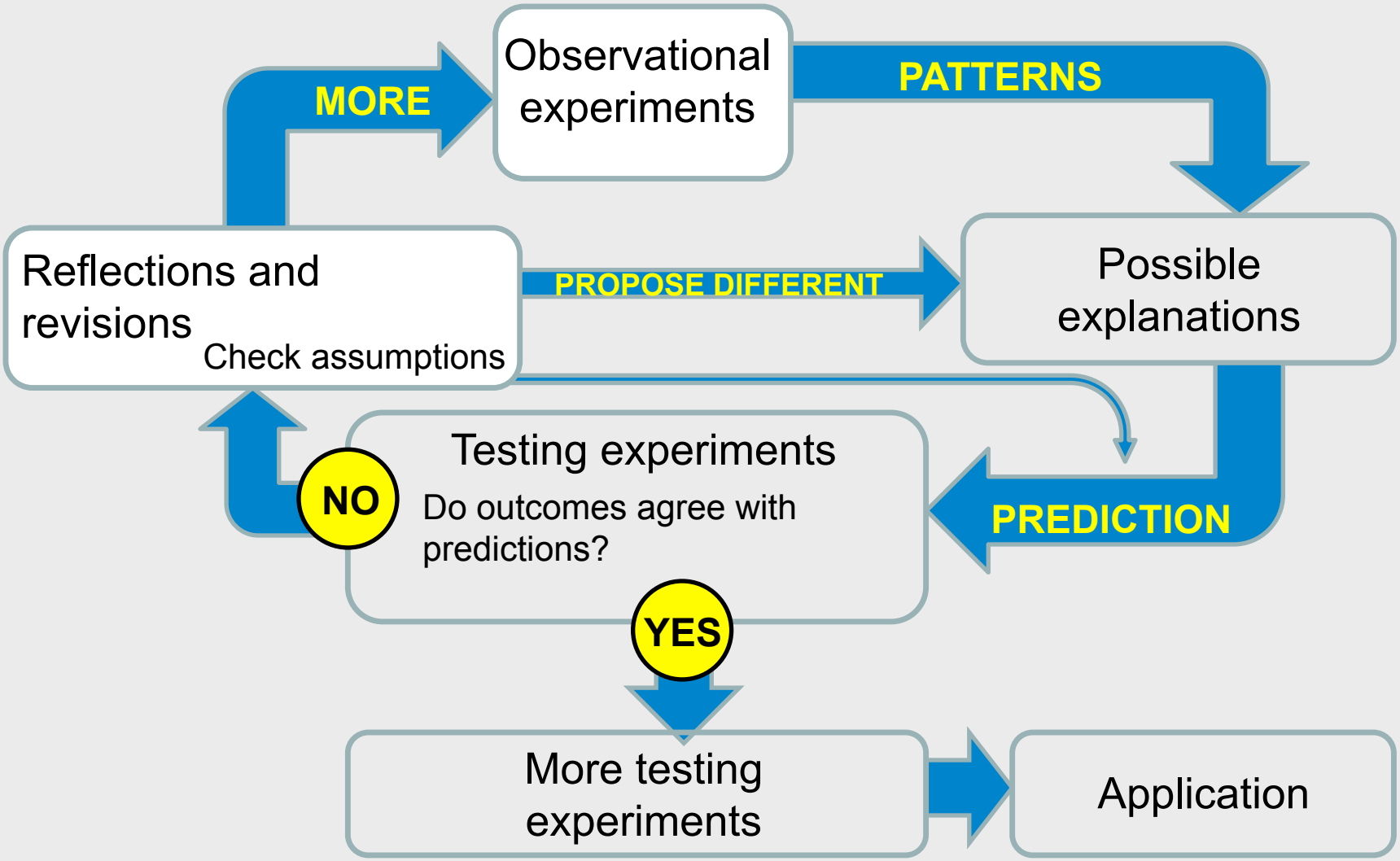
PHYSICS TEACHING METHODS COURSES



Same framework for all courses: Investigative Science Learning Environment - ISLE cycle



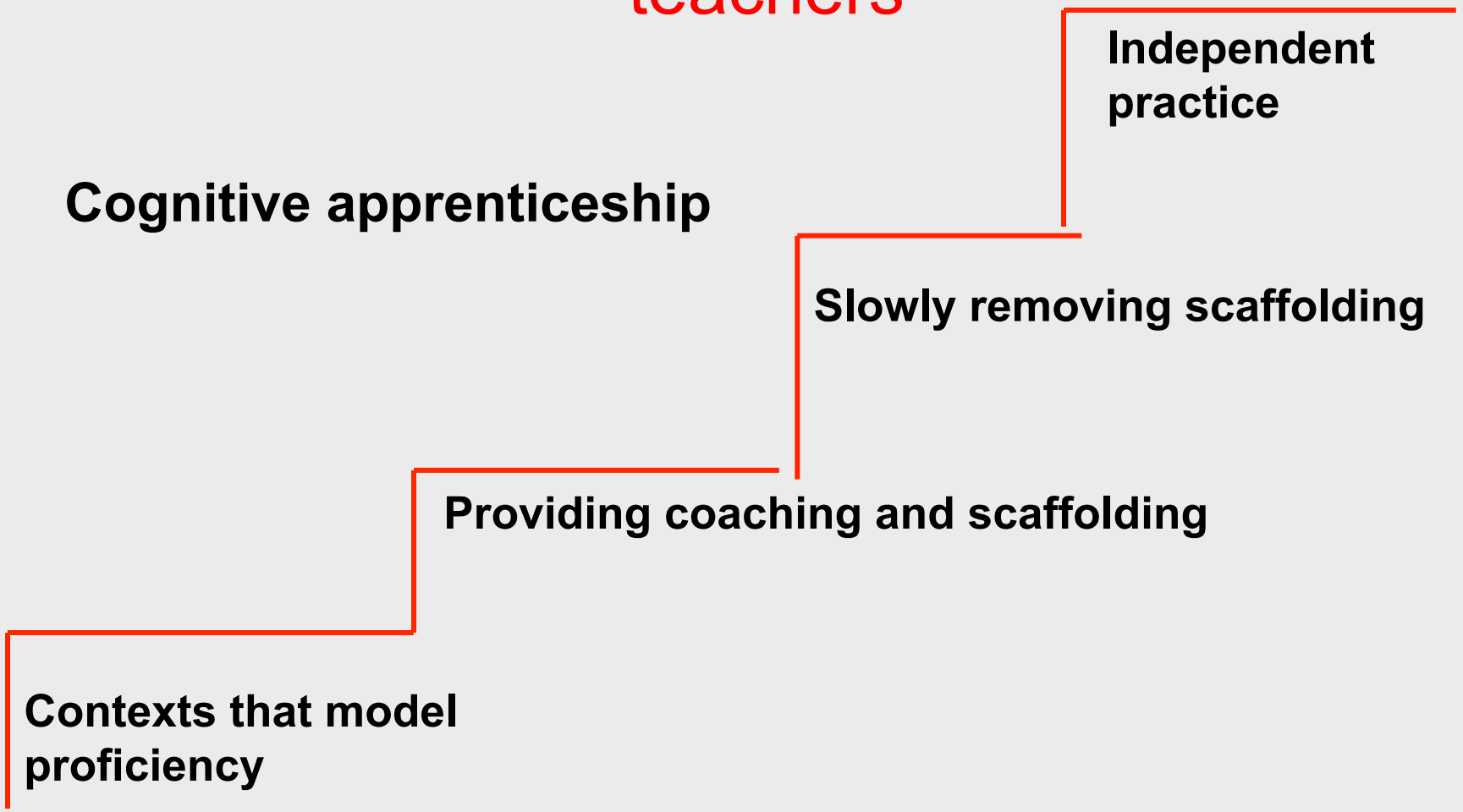
Etkina and Van Heuvelen, 2001 and 2007, Etkina, 2015

ISLE as a philosophy of teaching and learning physics naturally incorporates development of science practices into student learning of physics and “coincidentally” has the same cross-cutting concepts that are ubiquitous through the ISLE-based curricula that pre-service teachers use.

Issue #2

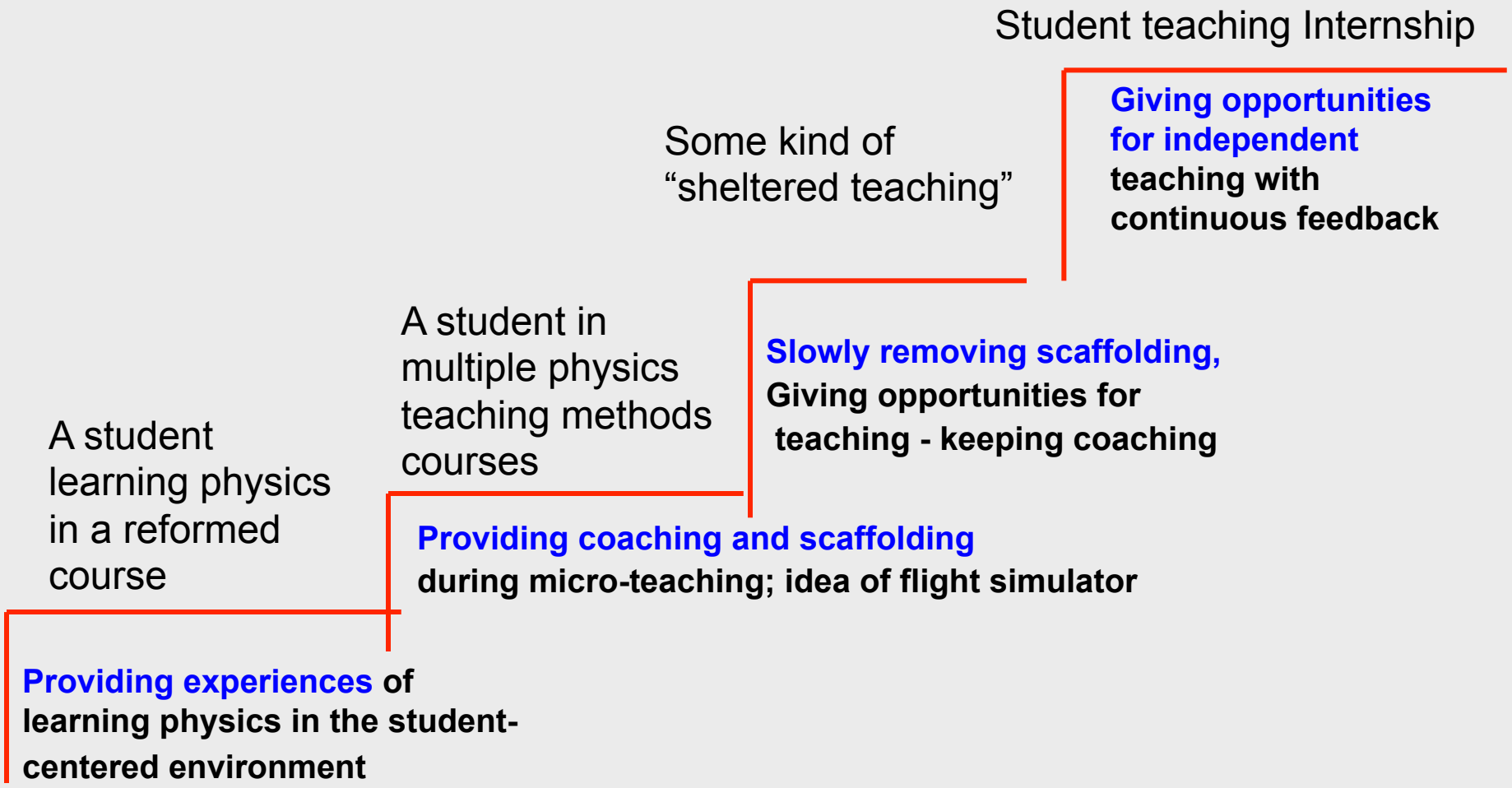
Teachers experience difficulty implementing student-centered teaching, despite being taught to do so during pre-service preparation (Simmons et al., 1999).

Making student-centered teaching a habit of new teachers

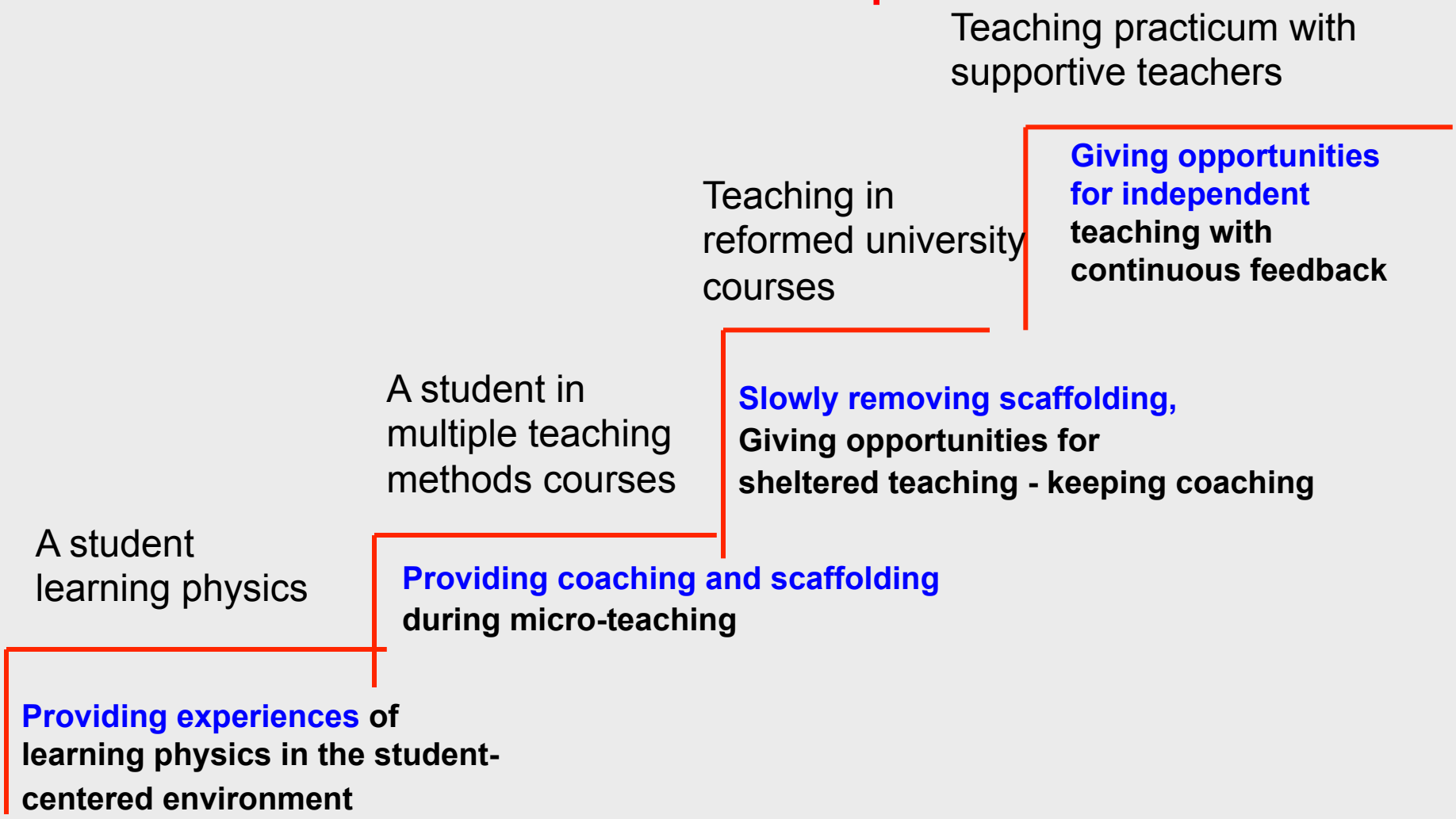


Collins, Brown and Newman, 1989.

Cognitive apprenticeship to become a new kind of teacher: course work and clinical practice



Cognitive apprenticeship approach to course work and clinical practice



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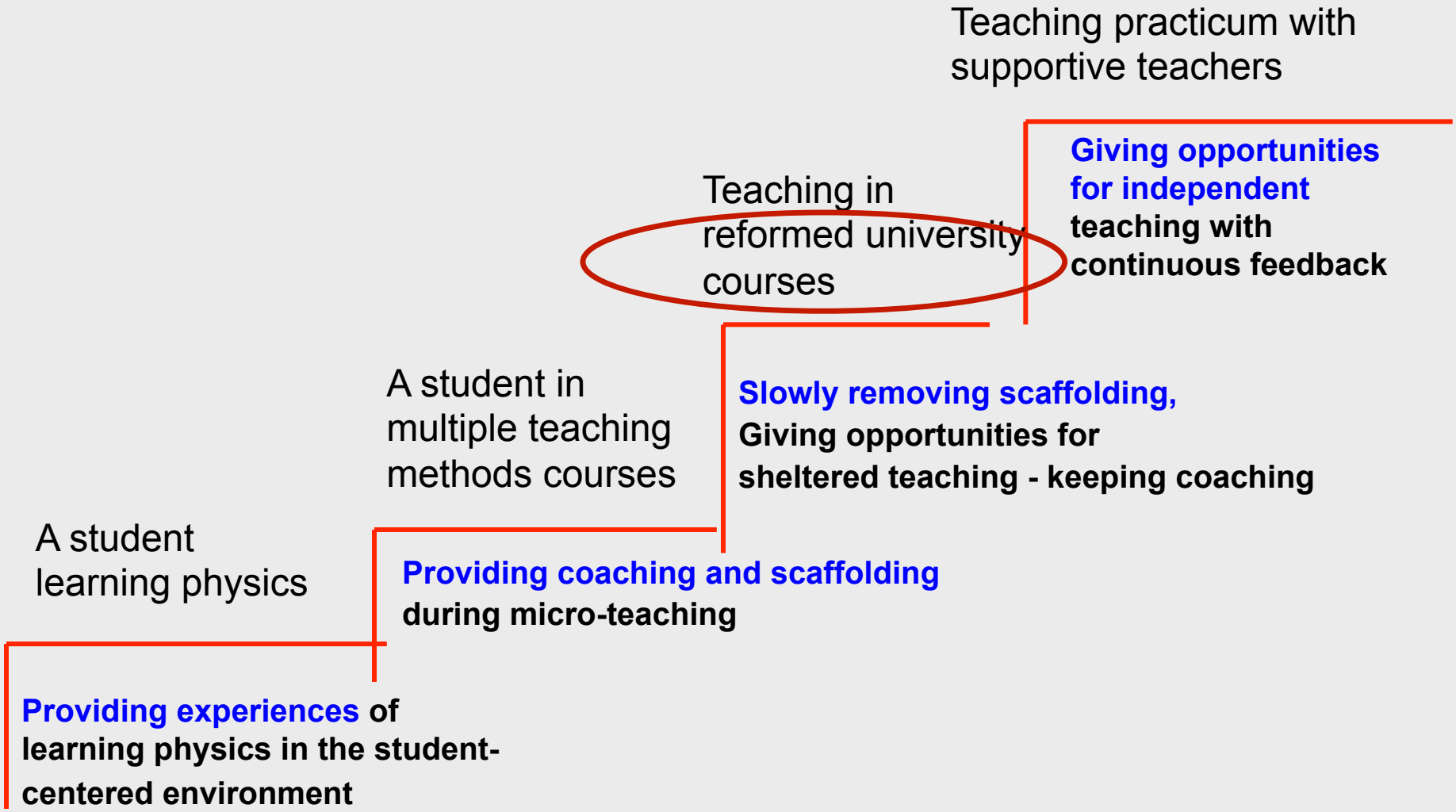

Reforms in undergraduate physics courses: creating an ISLE-based introductory physics course

Students learn physics by following ISLE process working in groups designing their own experiments

Examples of ISLE labs

Design an experiment to find a relation between a potential difference across and current through a commercial resistor.

Design an experiment to test whether this relation applies to an incandescent light bulb.

Design experiments to determine which of the 3 9-V batteries is better (one of them should be an Energizer battery).

Use the list of available equipment (xx, xx) to pose your own scientific question. Investigate the question and write a report.

Experiencing reformed teaching as a learner is a necessary condition but it is not sufficient.

One needs to practice it as much as possible.

How we make sure that student-centered teaching is practiced every day over 2 years

We reformed an intro physics course and let them practice teaching there for the first year and the second semester of the second year

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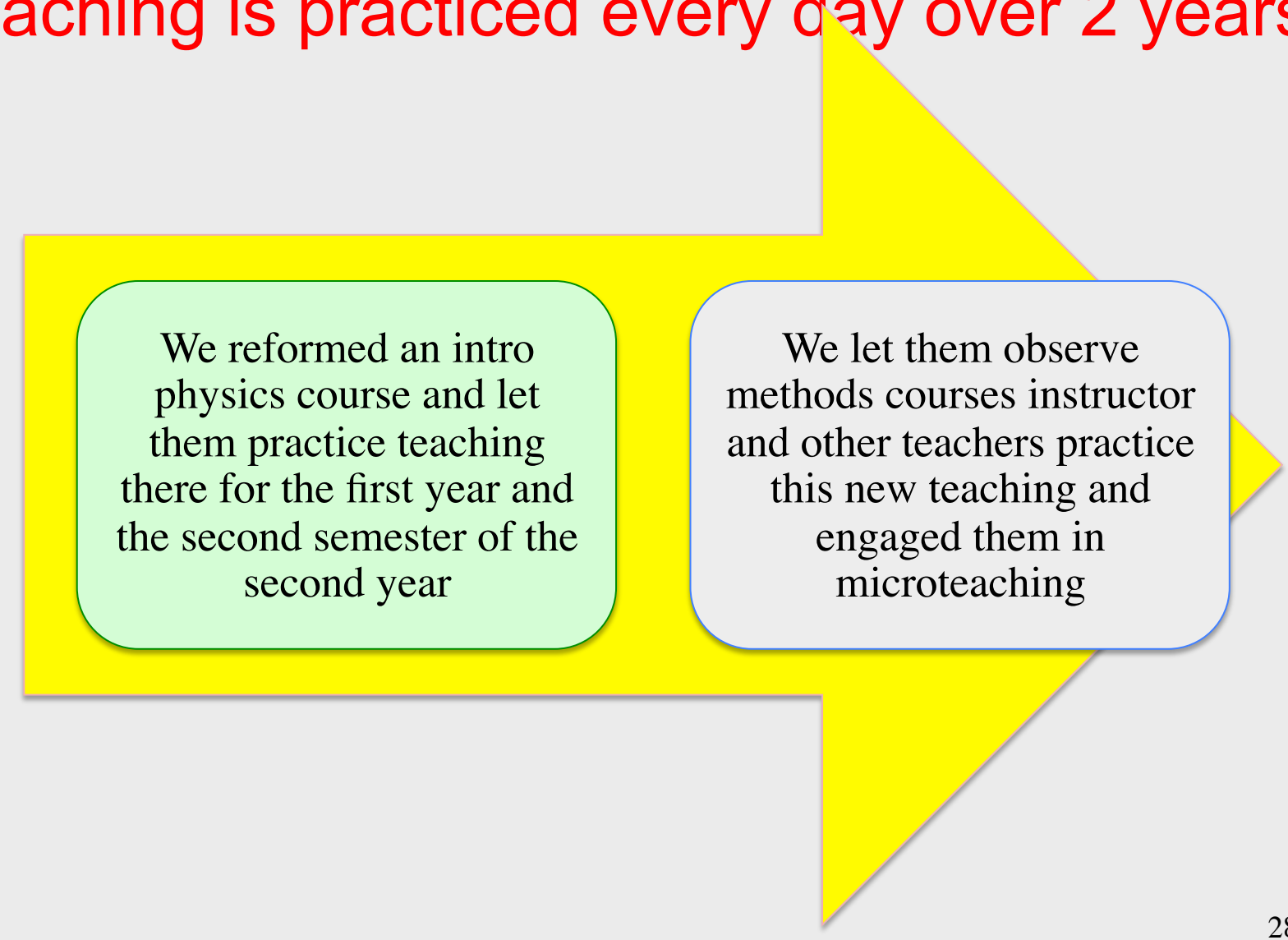

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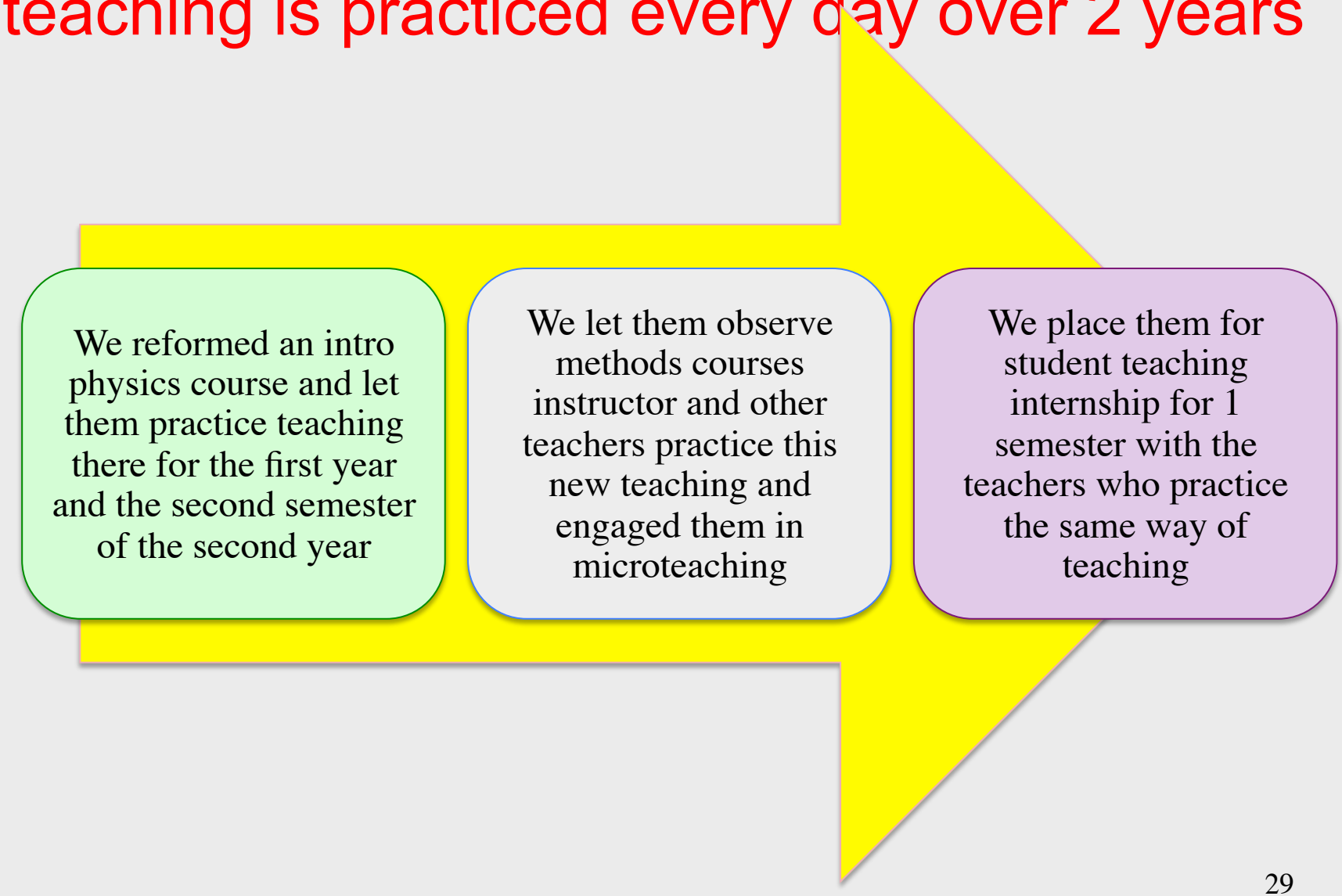
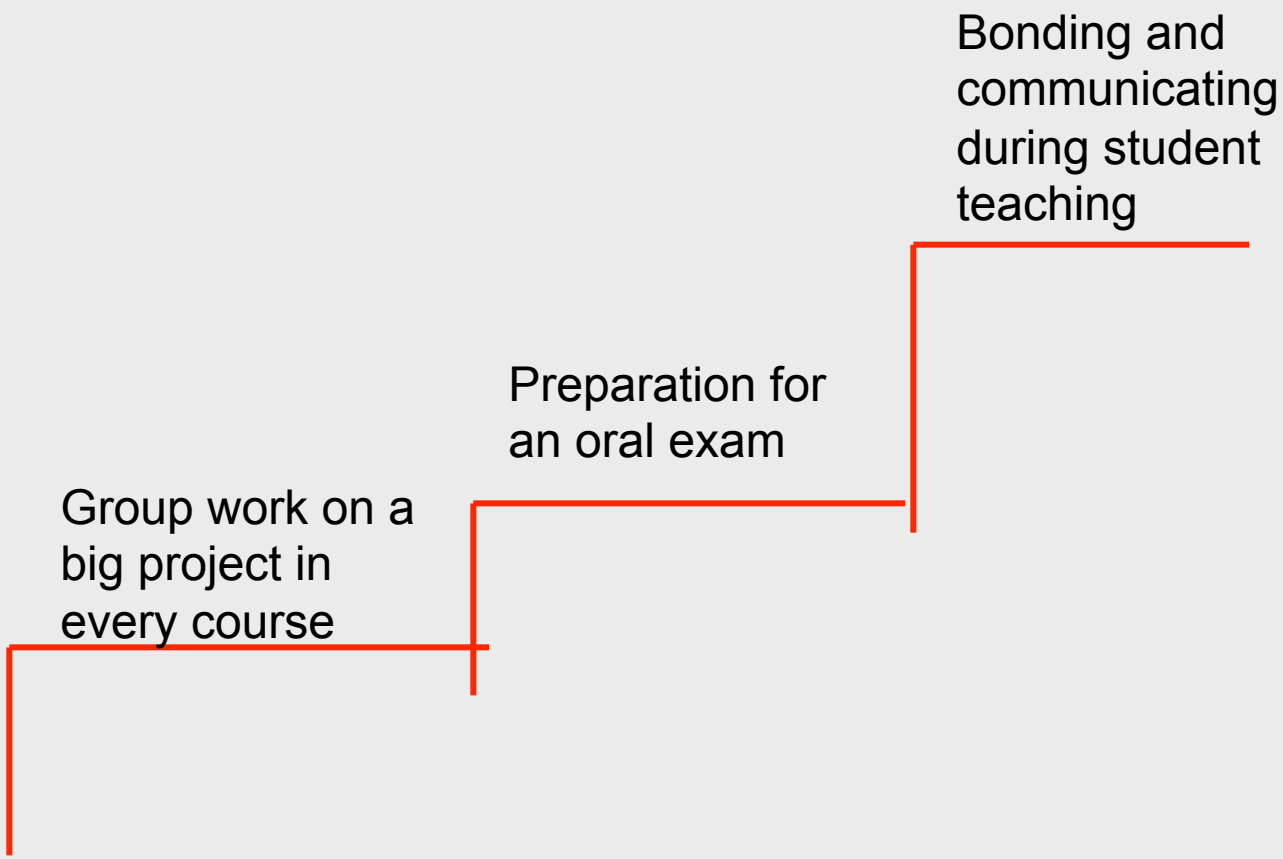
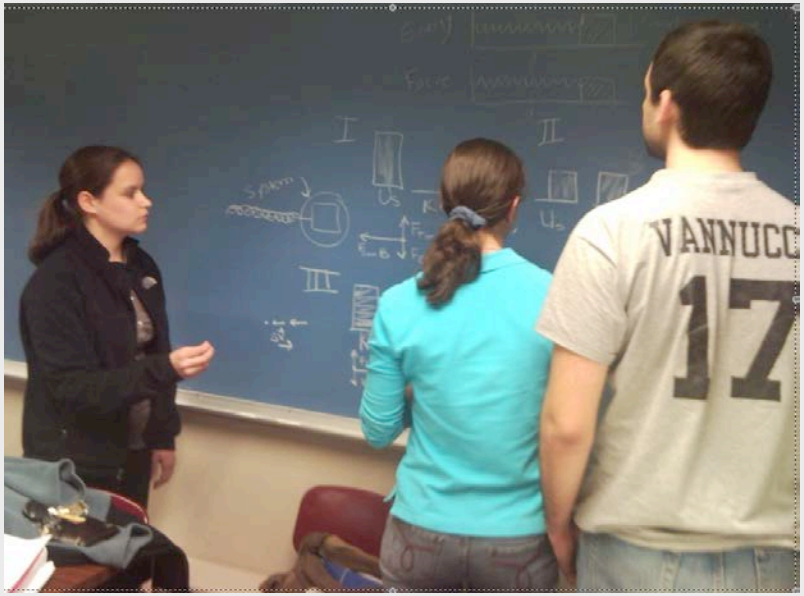


Issue #3

The feeling of isolation is one of the primary reasons for teachers to leave the profession (Darling-Hammond, 2001).

Building a Learning community

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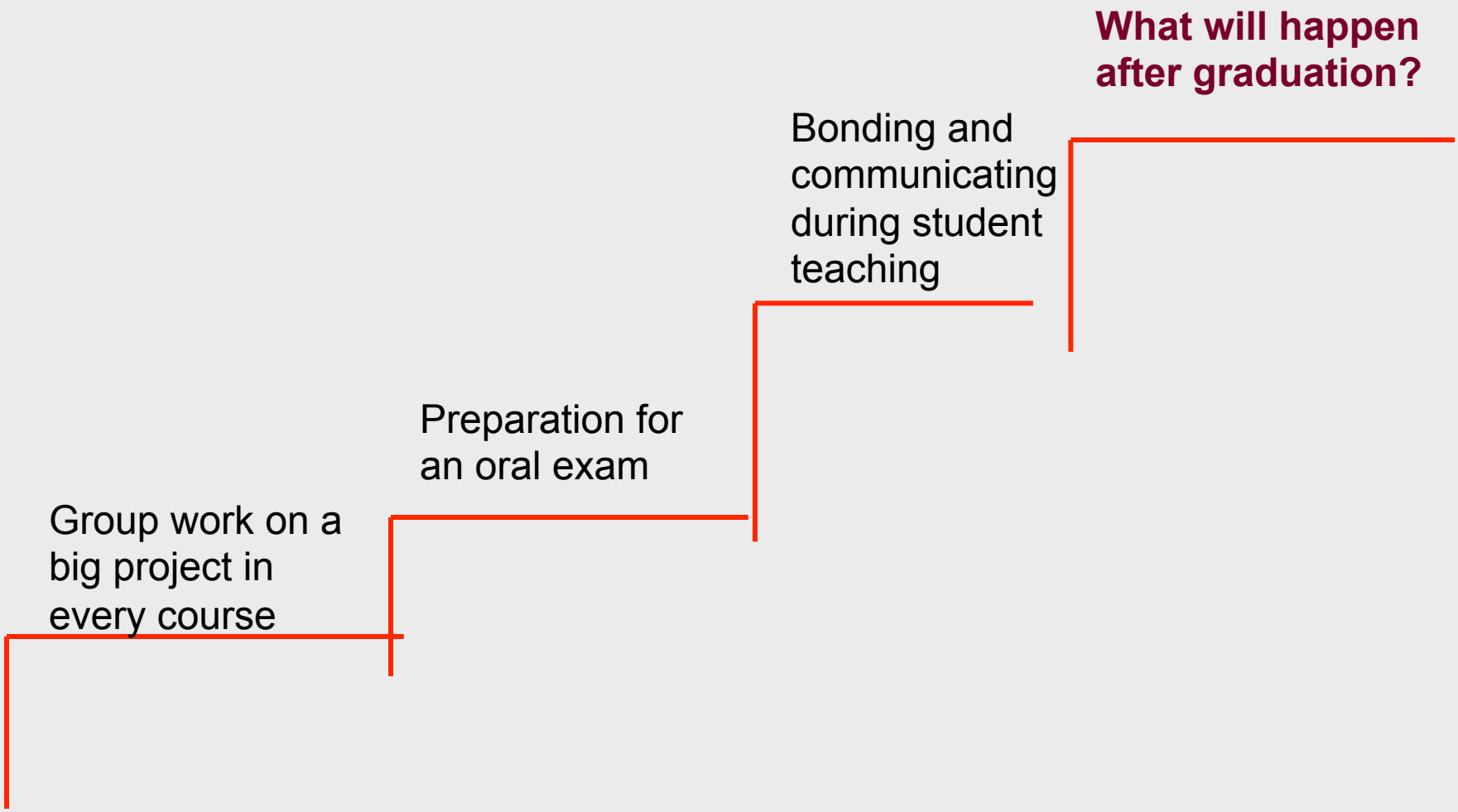
Building a Learning community



Helps new teachers survive

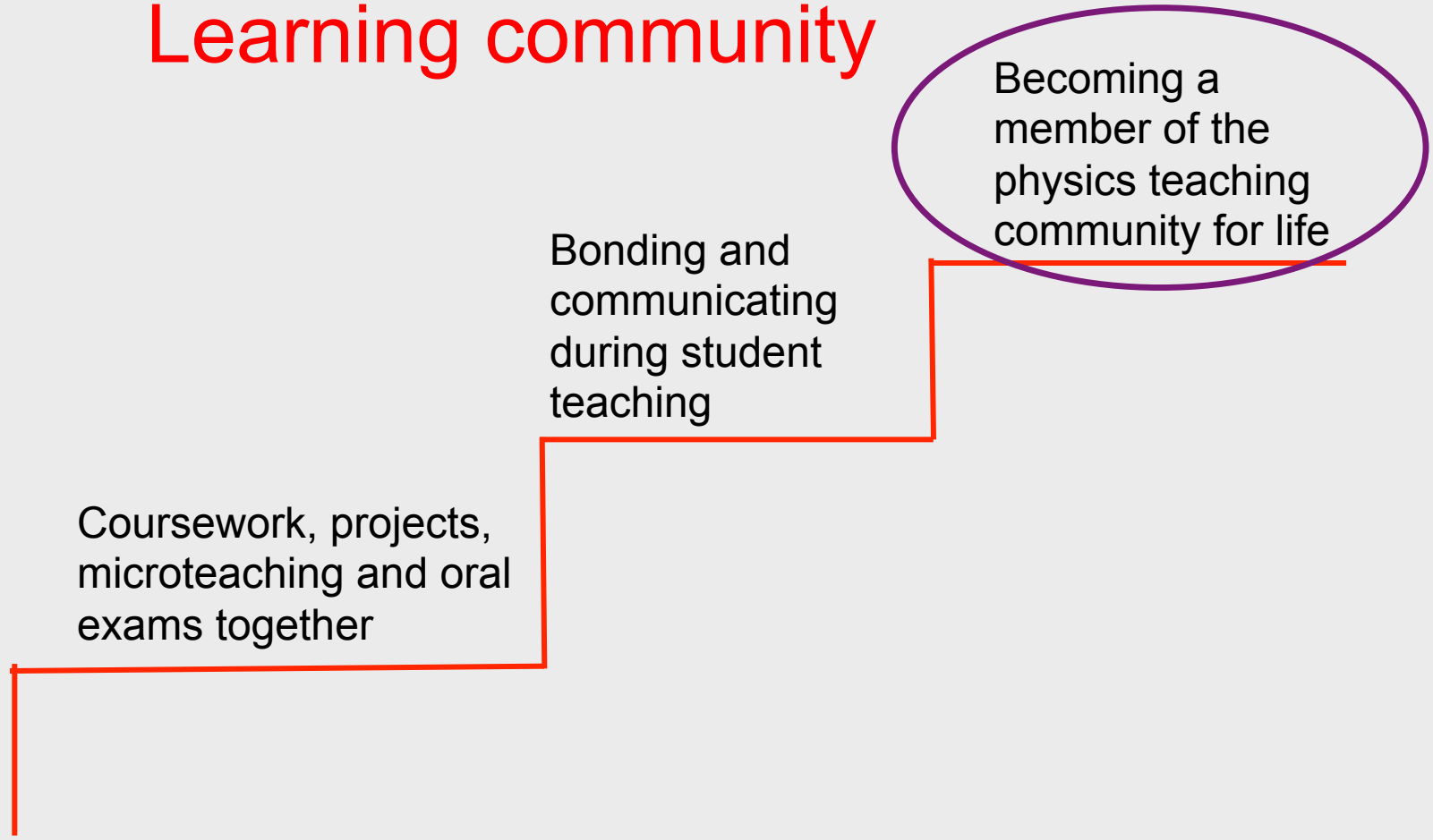
Builds relationships with them so when they are tenured they can become cooperating teachers

Creating a community of the graduates

Interns can practice during student teaching what they learn in the program

Cooperating teachers can reflect on their own teaching and also contribute to the development of the program

Learning community



How do you make a learning community?

Real? Virtual?

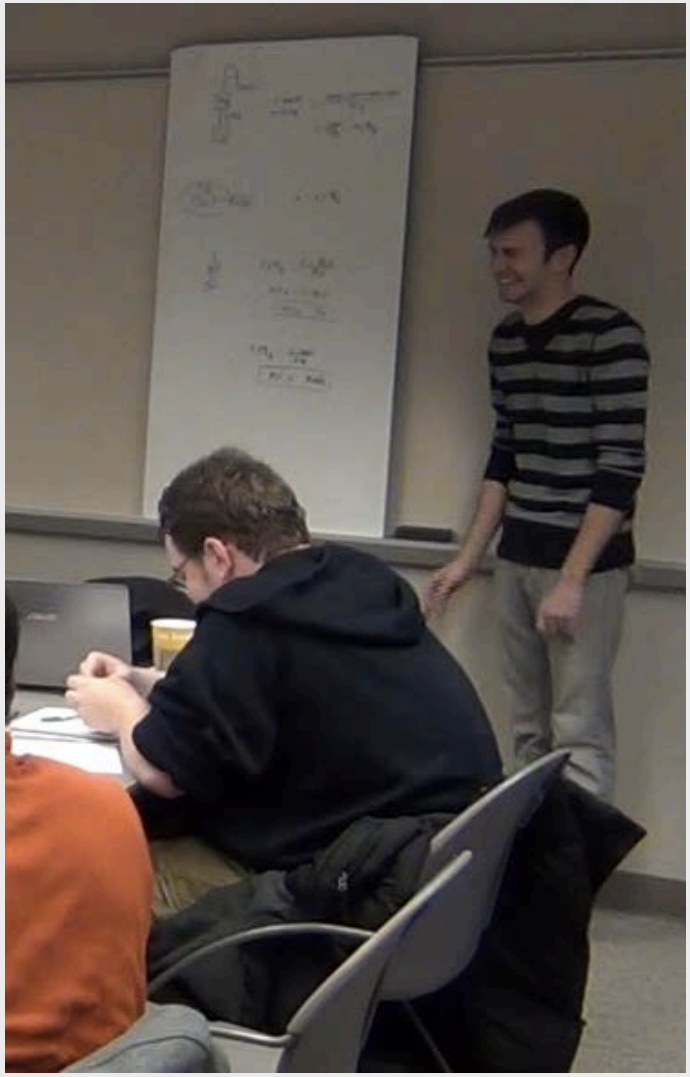
Funding?

Release time?

Teacher pay?

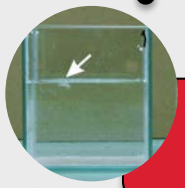
Meetings in person

Working together as they are used to



Evolution of the Meetings

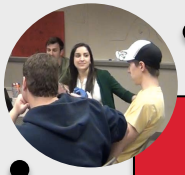
NEW: Analysis of student work



Physics

Pedagogical Discussions

Positive Attitude



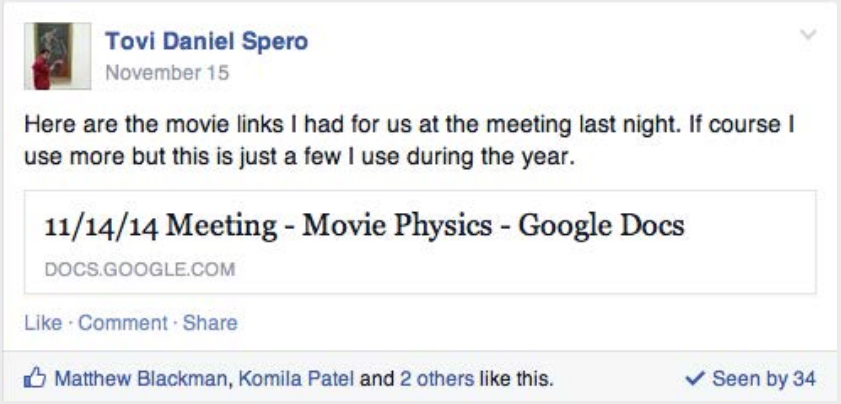
Classroom Experiences

Day of the Week

Teachers Miss Physics…

Why does a balloon make a loud sound when you pop it?

Physics: Teachers Contribute



2001 Space Odyssey
https://www.youtube.com/watch?v=52cu-8FX5OQ
https://www.youtube.com/watch?v=0iiXUeil5fQ

Spaghettification
https://www.youtube.com/watch?v=uNc-JLysk9Y

Interstellar
https://www.youtube.com/watch?v=iu7QDQPMq3Y
No noise
giant wave
GR time dilation
black hole entry velocity????

www.theuniverseandmore.com

Remote Attendance

- Skype
- Google Hangouts
- GoToMeeting

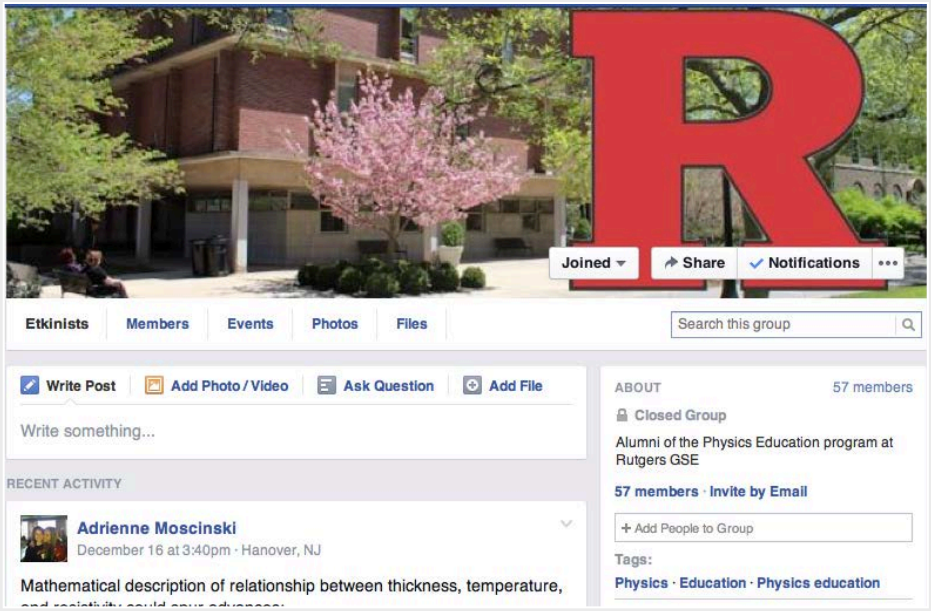
One of Friday night meetings

Teacher-Led Workshops: Standards Based Assessment

A long time ago I devised a method of teaching mechanics or rollerblades.

Not only do I practice this method in the classroom with future teachers but we also rent a rink once a year to help them learn technical details.

Virtual Community



Brian Mayer mayerbrian@gmail.com [etkinists] Details
[etkinists] Heat Engines Efficiency
November 12, 2014 10:33 PM Inbox - Verizon

I'm a little confused about heat engines. They've never been my strong point at all, and this is my first time teaching them in AP2.

According to the books, Efficiency is W done by the gas / Q in.

Work done by the gas then get defined as Qin - Qout.

I understand that, but it's not consistent with something else.

ari eisner arisafari50@yahoo.com [etkinists] Details
Re: Re: [etkinists] Heat Engines Efficiency
November 19, 2014 9:46 PM Inbox - Verizon 5

Brian, awesome discussion, this is how I see it:

for Qin = W + Q out, + W refers in this case to work done by the gas on the environment. The return of the gas to its original state is not considered.

Take for example a simple steam turbine. Steam in provides the Qin. W out is the spinning blades, Q out is contained in the exhaust steam.
Qin = W + Q out.

OVER 60 messages per month beginning 2004; over 80 members; meetings twice a month (from 4 to 25 teachers).

Just this past Friday I had 17 people staying from 4:30 pm to 7 pm. It was 1 am in Slovenia and they were in the School of Education in New Jersey or joining remotely

How do these experiences affect my teachers?

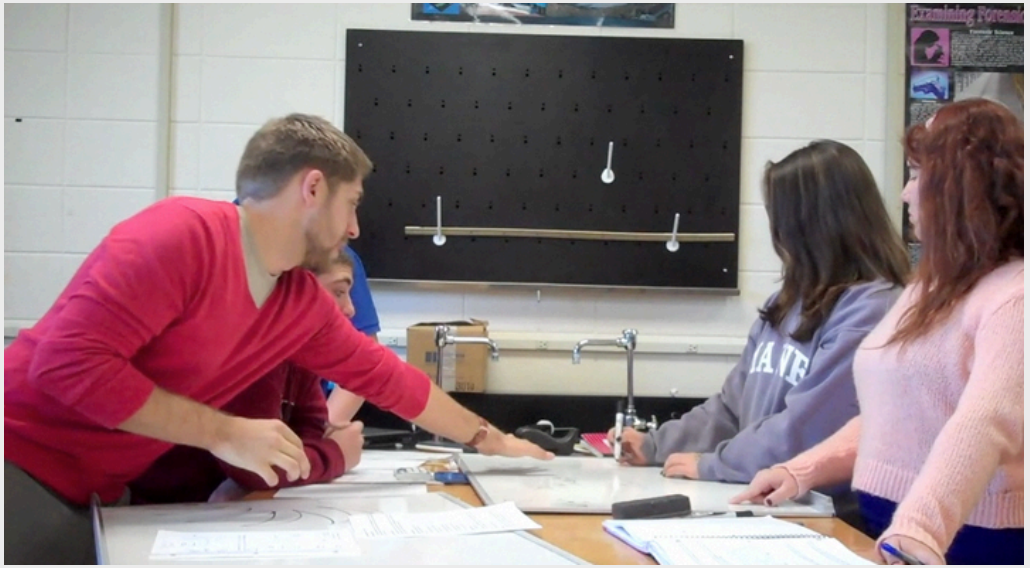
Danielle Bugge, graduate of 2010

Rich Therkorn, 2006 Graduate, her cooperating teacher during student teaching

Walter Zubrzycki, 2014 Graduate

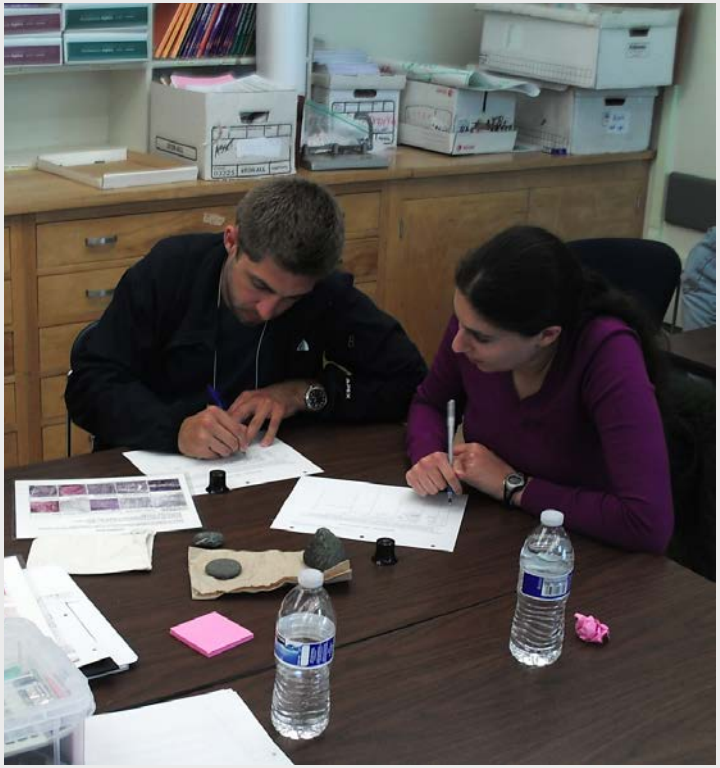
Danielle Bugge, 2010 Graduate

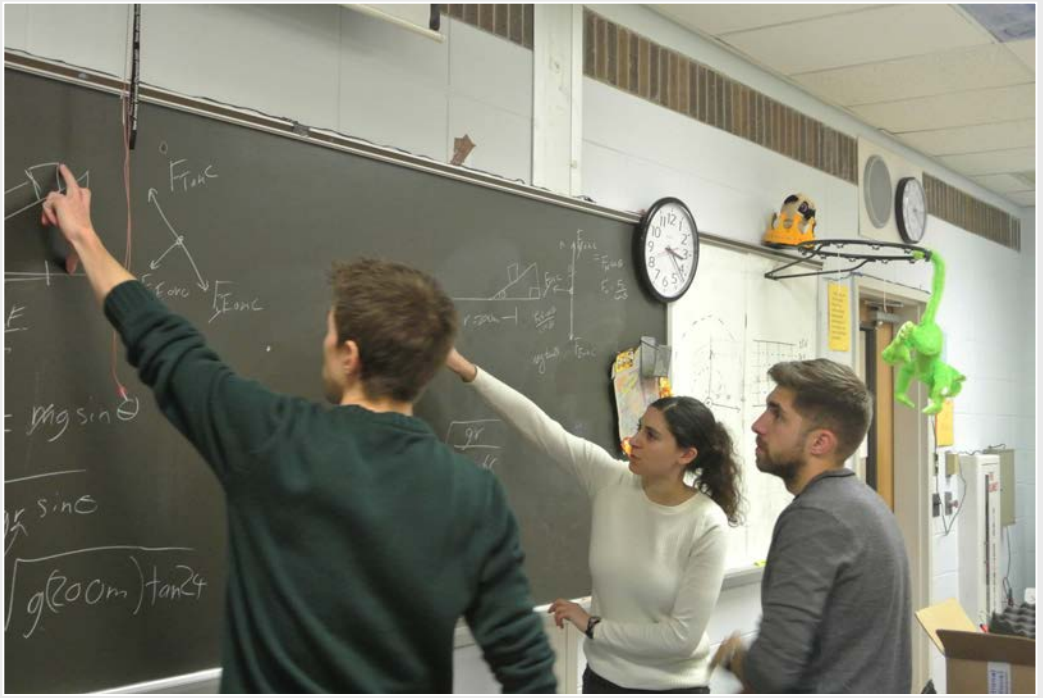
Tovi Spero, 2012 Graduate

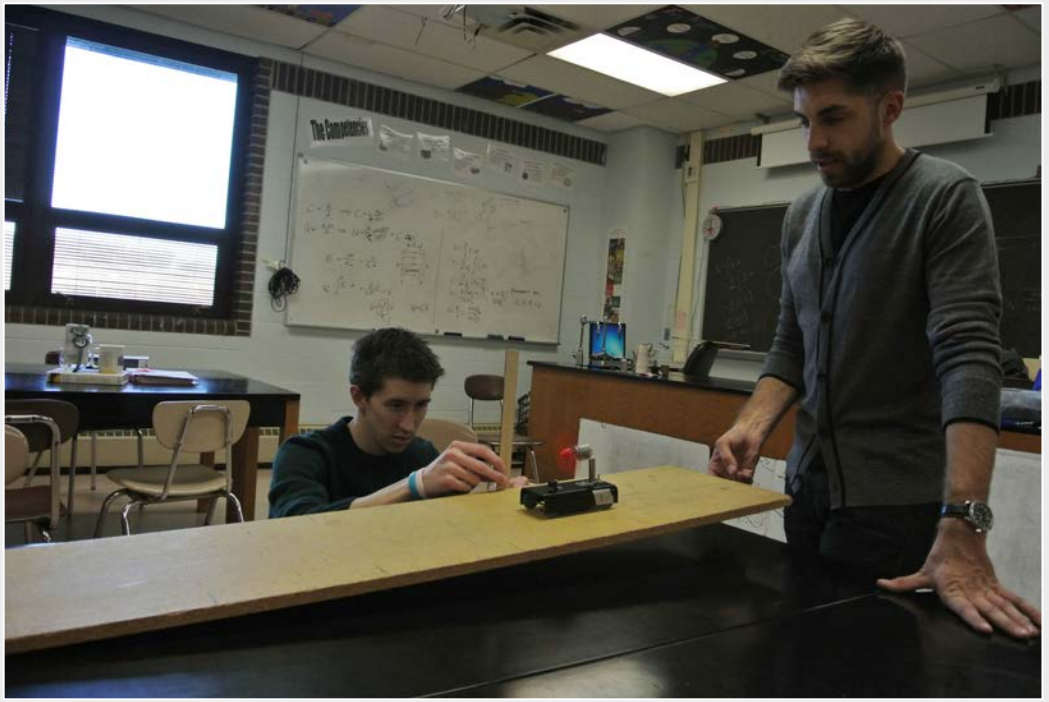


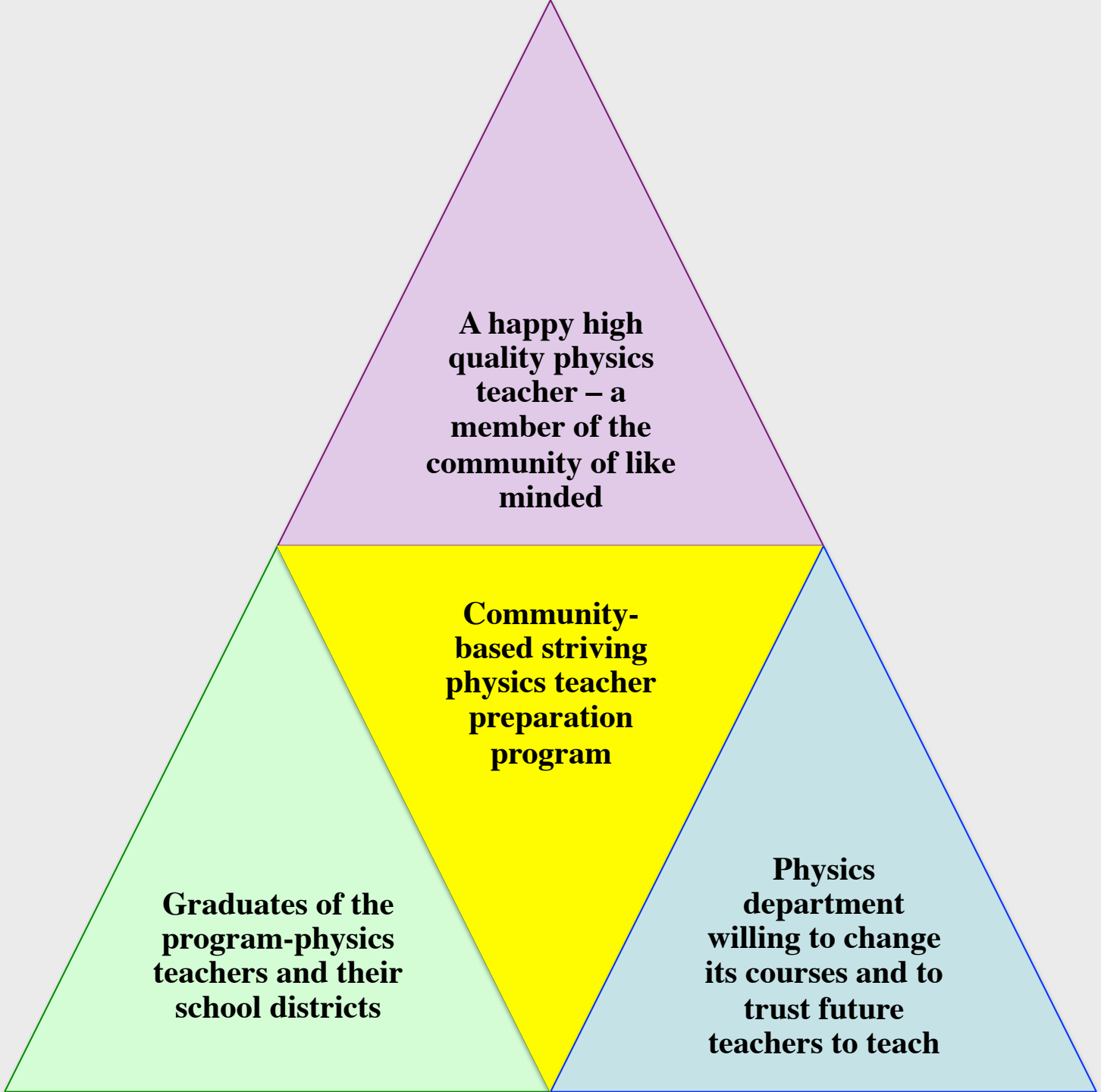
Danny Sierzega, 2011 Graduate

Creating a mini-community in their school








A happy high quality physics teacher – a member of the community of like minded
Community-based striving physics teacher preparation program
Graduates of the program-physics teachers and their school districts
Physics department willing to change its courses and to trust future teachers to teach

Rutgers program graduates 6.3 physics teachers every year since 2004

Is 6.3 physics teachers per year a small or a big number?

What is the US average?

0 - 1…..

Are they good teachers?

80 observations of their teaching in the schools – they do in fact PRACTICE STUDENT CENTERED INSTRUCTION! (we use RTOP)

They have excellent gains on standardized physics tests. (FCI and CSEM – H-gains of 0.4-0.6)

Enrollment in physics in their schools increases.

They participate in the development of new curriculum materials (http://pum.rutgers.edu) and teach some of the courses in the program.

AND THEY DO NOT QUIT – the retention rate is over 85% after 5 years.

What does it mean for us?

Yes, we can prepare teachers to teach physics in the 21st century.

But there is no end to teacher preparation program.

Thank you!

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http://pum.rutgers.edu

References

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