girep

Laboratory Based Teaching in Physics (LabTiP)

Groupe International de Recherche sur l'Enseignement de la Physique

Laboratory Based Teaching in Physics (LabTiP)

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Laboratory Based Teaching in Physics (LabTiP)

Panel discussion on

Learning goals and their assessment in physics labs

Groupe International de Recherche sur l'Enseignement de la Physique

Panel discussion on learning goals and their assessment in physics labs

Paul LOGMAN (1), Ian BEARDEN (2), Micol ALEMANI (3), Sergej FALETIČ (4)

(1) Leiden University, The Netherlands

(2) University of Copenhagen, Denmark

(3) University of Potsdam, Germany

(4) University of Ljubljana, Slovenia

Panel discussion

1. Open questions on learning goals

   Intro by Micol Alemani

2. Open questions on rubrics and grading

   Intro by Sergej Faletič

3. Open questions on the interplay between learning goals and their assessment

4. Future discussions

Panel discussion – **part 1**

Open questions on learning goals

Intro by Micol Alemani

Goals of lab courses in the past century

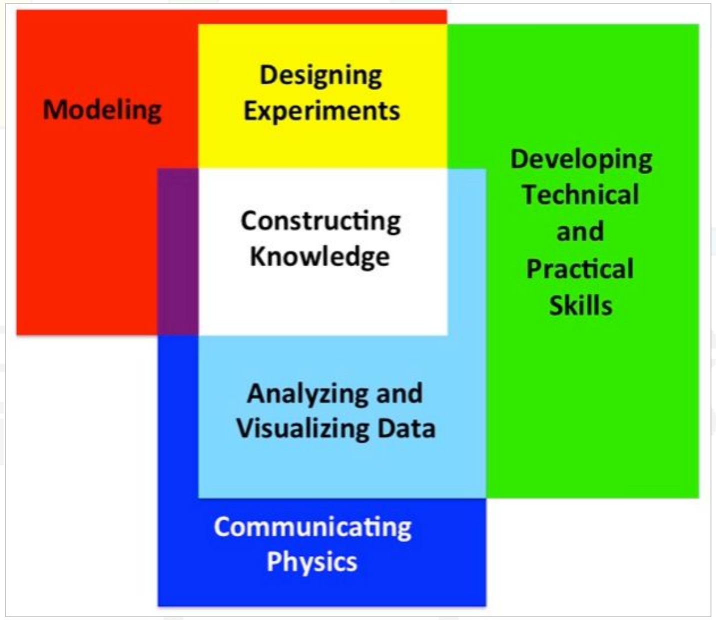
- Understanding of scientific concepts
- Interest and Motivation
- Scientific practical skills and problem solving abilities
- Understanding of the nature of science
- Scientific habits of mind

Hofstein, A., & Lunetta, V. N., *Review of Educational Research*, 52(2), 201–217 (1982)
Hofstein, A., & Lunetta, V. N., Science Education 88 (2004)

21st century: Reevaluation of lab goals and practices

AAPT PHYSICS EDUCATION

AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum



Report prepared by a Subcommittee of the AAPT Committee on Laboratories
Endorsed by the AAPT Executive Board
November 10, 2014

Research results on laboratory courses

PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH **13,** 010129 (2017)

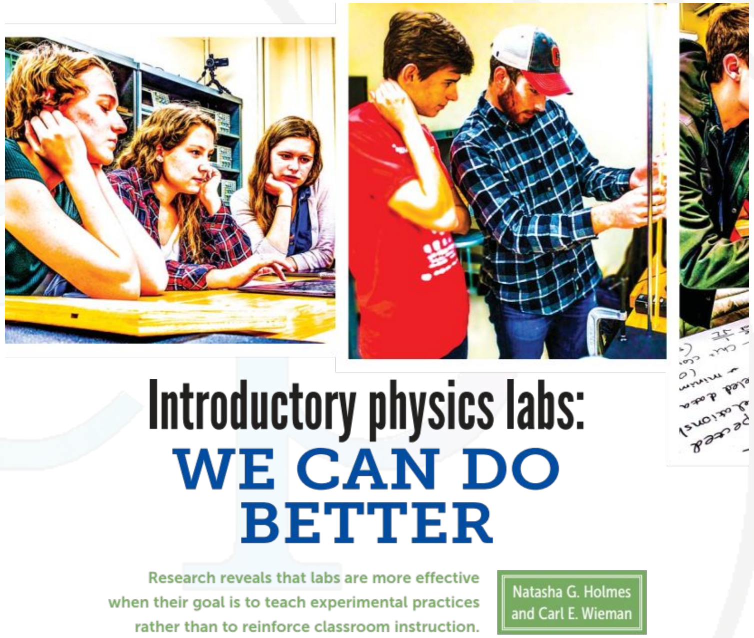
Value added or misattributed? A multi-institution study on the educational benefit of labs for reinforcing physics content

N. G. Holmes*
Laboratory of Atomic and Solid State Physics, Department of Physics, Cornell University, Ithaca, New York 14853, USA

Jack Olsen
Department of Physics, University of Washington, Seattle, Washington 98195, USA

James L. Thomas
Department of Physics and Astronomy, University of New Mexico, Albuquerque, New Mexico 87131, USA

Carl E. Wieman
Department of Physics, Stanford University, Stanford, Califonia and Graduate School of Education, Stanford University, Stanford, California 94305, USA
(Received 15 March 2017; published 30 May 2017)

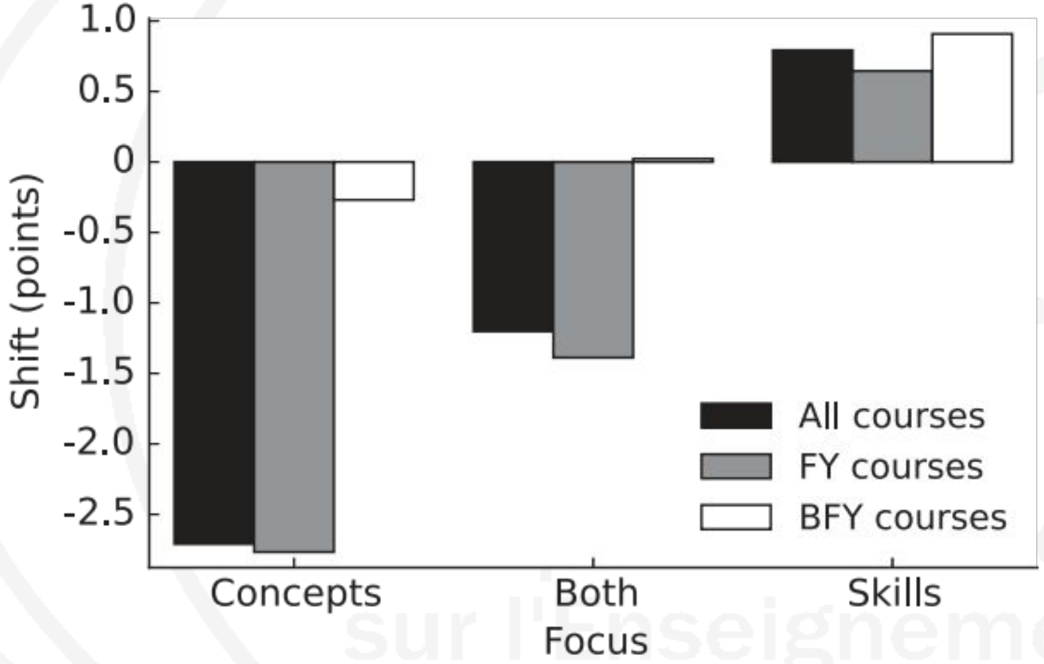


*Traditional lab courses **do not** provide a measurable added value to learning course content*

N. G. Holmes, Jack Olsen, James L. Thomas, and C E. Wieman, Phys. Rev. Phys. Educ. Res. 13, 010129 (2017)

N. G. Holmes and C. E. Wieman, *Physics Today* 71 (1), 38–45 (2018)

Research results on laboratory courses



Students' views and attitudes towards experimental physics ***degenerate*** *in lab courses aiming to reinforce concepts*

Zwickl et al., Phys. Rev. ST Phys. Educ. Res., 10, 010120 (2014)

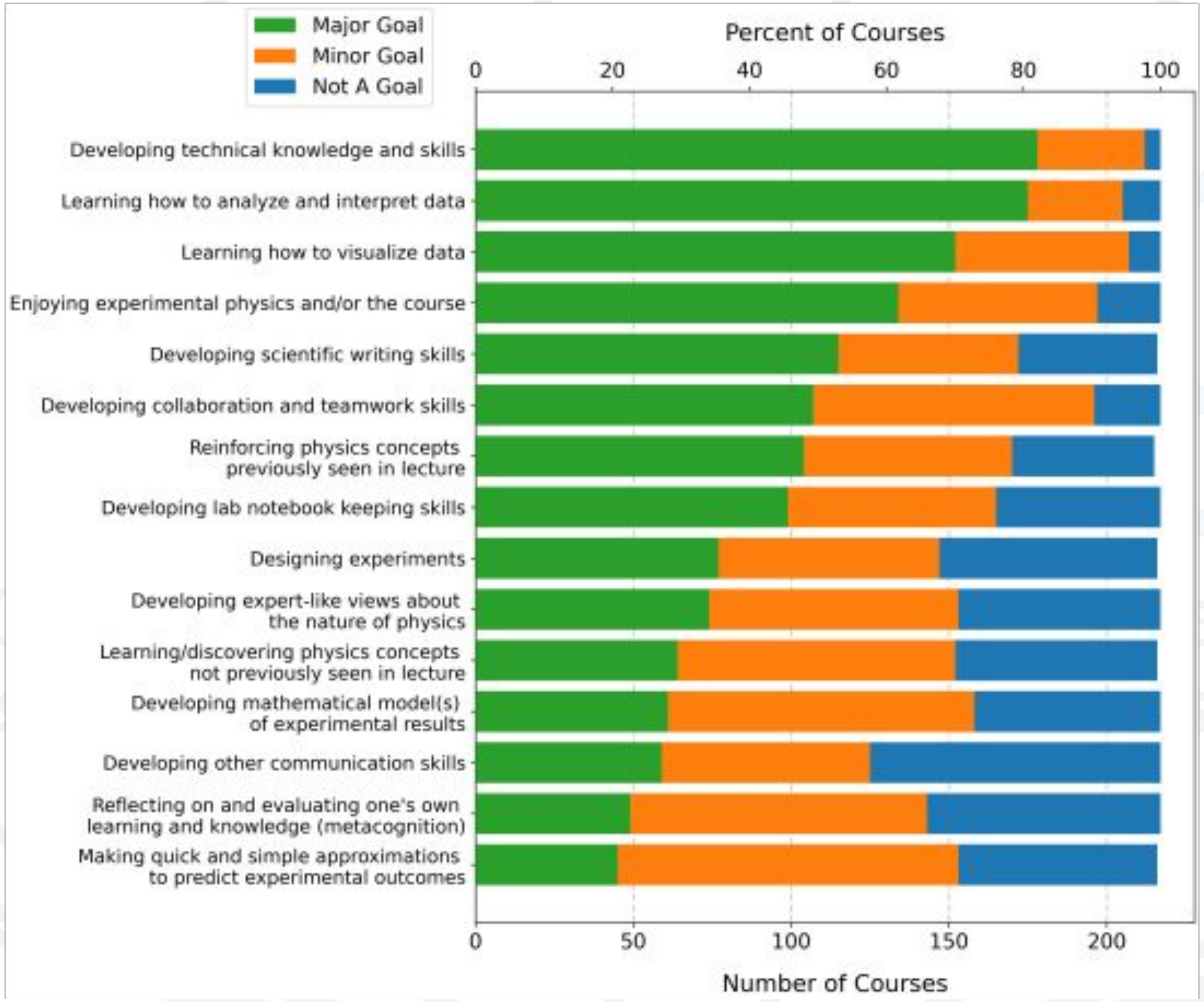
B. R. Wilcox and H. J. Lewandowski, Phys. Rev. Phys. Educ. Res.13, 010108 (2017)

Recent goals (and research fields) in lab courses

- Experimental processes (inquiry), skills, and reasoning (critical thinking, sense making)
- Computation, virtual simulations, and remote instruction
- Measurement uncertainty
- Equity, attitudes, collaboration, and agency

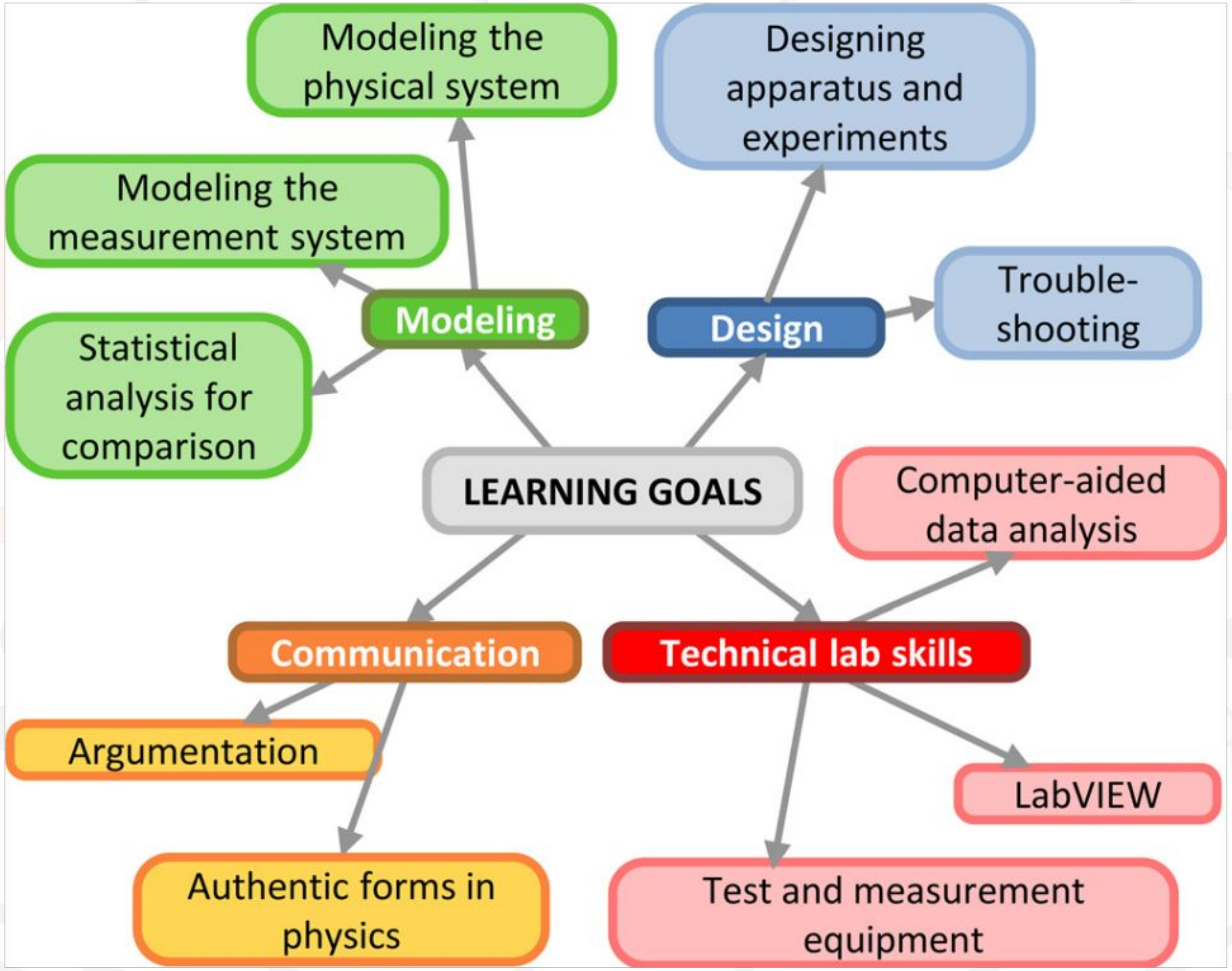
J. M. May, *Phys. Rev. Phys. Educ. Res.* 19, 020168 (2023)

New insights on goals from a worldwide survey



G. Geschwind et al., in print Phys. Rev. Phys. Educ. Res.

Example of learning goals of a lab



B. M. Zwickl et al. *Am. J. Phys.*, 81, 63 (2013).

Learning Goals → Learning Objectives → Learning Outcomes

Specificity

„Student will be able to“ scheme

As a result of participating in **(educational unit)**, students will be able to **(measurable verb)** + **(learning statement)**.

Examples

As a result of participating in **session 3**, students will be able to **distinguish between good and bad graphs.**

As a result of participating **to the lab course in the first semester**, students will be able to **produce clear, informative and complete graphs.**

Open questions on learning goals

- How can we implement lab goals in a bottom-up approach? (Sebastian Schellhammer)

- What should be a good proportion of the various types of learning goals?

- Is there an ideal way of how the proportions should change as the student progresses?

- Other questions from the room?

Open questions on learning goals

- What is the role of labs in physics?
- Does my lab focus on concepts, skills, or both and why?
- How do I make sure that students’ activities foster the achievement of my learning goals?

Panel discussion – **part 2**

Open questions on rubrics and grading

Intro by Sergej Faletič

Assessing lab work

- Assessment is the guide for learning. People will learn that which will be assessed.
- Assessment should therefore be in line with the goals.

Hallmarks of good assessment

- In line with learning goals.
- Efficient in time consumption for instructor.
- Efficient in feedback (feedforward) for students
- Transparent, objective (inter rater reliable)

Various assessment methods

- Students' oral presentation or defense of their work.
- Instructor's comments on written work.
- Rubrics
- (some other?)

Various assessment methods

- Students' oral presentation or defense of their work.
- Instructor's comments on written work.
- **Rubrics**
- (some other?)

Rubrics

Scientific abilities rubrics: https://sites.google.com/site/scientificabilities/rubrics
ISLE-bases labs: https://sites.google.com/site/scientificabilities/isle-based-labs

Rubrics

RUBRIC G: Ability to collect and analyze experimental data					
	Scientific Ability	Missing	Inadequate	Needs improvement	Adequate
G1	**Is able to identify sources of experimental uncertainty**	No attempt is made to identify experimental uncertainties.	An attempt is made to identify experimental uncertainties, but most are missing, described vaguely, or incorrect.	Most experimental uncertainties are correctly identified. But there is no distinction between random and experimental uncertainty.	All experimental uncertainties are correctly identified. There is a distinction between experimental uncertainty and random uncertainty.
G2	**Is able to evaluate specifically how identified experimental uncertainties may affect the data**	No attempt is made to evaluate experimental uncertainties.	An attempt is made to evaluate experimental uncertainties, but most are missing, described vaguely, or incorrect. Or only absolute uncertainties are mentioned. Or the final result does not take the uncertainty into the account.	The final result does take the identified uncertainties into account but is not correctly evaluated. The weakest link rule is not used or is used incorrectly.	The experimental uncertainty of the final result is correctly evaluated. The weakest link rule is used appropriately and the choice of the biggest source of uncertainty is justified.
G3	**Is able to describe how to minimize experimental uncertainty and actually do it**	No attempt is made to describe how to minimize experimental uncertainty and no attempt to minimize is present.	A description of how to minimize experimental uncertainty is present, but there is no attempt to actually minimize it.	An attempt is made to minimize the uncertainty in the final result is made but the method is not the most effective.	The uncertainty is minimized in an effective way.
G4	**Is able to record and represent data in a meaningful way**	Data are either absent or incomprehensible.	Some important data are absent or incomprehensible. They are not organized in tables or the tables are not labeled properly.	All important data are present, but recorded in a way that requires some effort to comprehend. The tables are labeled but labels are confusing.	All important data are present, organized, and recorded clearly. The tables are labeled and placed in a logical order.
G5	**Is able to analyze data appropriately**	No attempt is made to analyze the data.	An attempt is made to analyze the data, but it is either seriously flawed or inappropriate.	The analysis is appropriate but it contains minor errors or omissions.	The analysis is appropriate, complete, and correct.

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One specific skill

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Rubrics

Description of the skill:
Is able to record and represent data in a meaningful way.

RUBRIC G: Ability to collect and analyze experimental data

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Rubrics

Descriptors for adequate proficiency level:
All important data are present, organized, and recorded clearly. The tables are labeled and placed in a logical order.

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Rubrics

Descriptors for intermediate levels, with **common indicators** of inadequate proficiency

	Scientific Ability	Missing			…e
G1	Is able to identify sources of experimental uncertainty	No attempt is … identify exper… uncertainties.		… uncertainty.	…rimental …nties are correctly …d. There is a …on between …ental uncertainty and random uncertainty.
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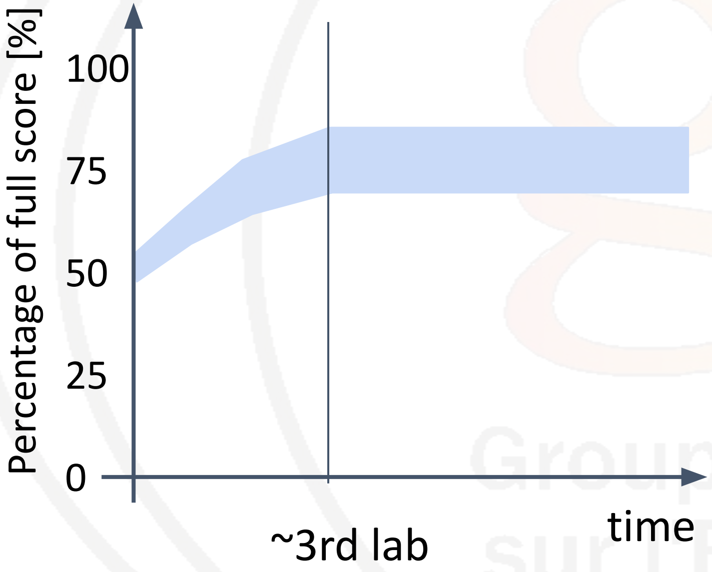
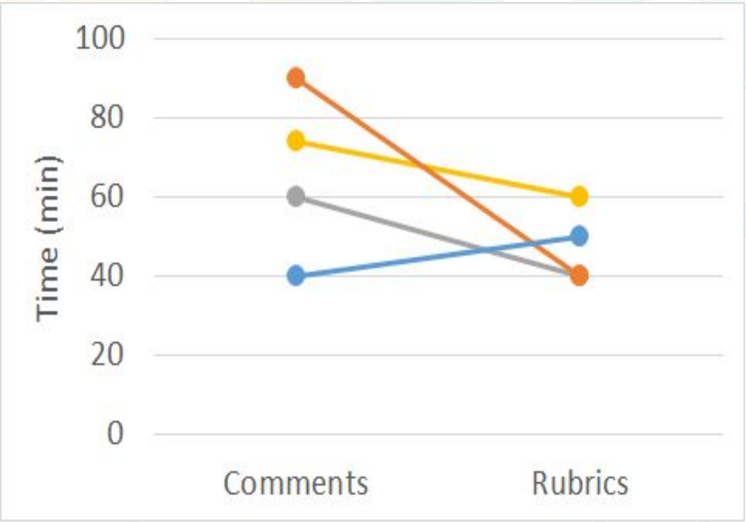
Why rubrics?

Efficient skill transfer



E. Etkina et al., *Phys. Rev. ST Phys. Educ. Res.* 4, 020108 (2008)

Lower time consumption



S. Faletič, G. Planinšič, *Phys. Rev. Phys. Educ. Res.* 16, 020136 (2020)

Improved students' reflection

we only received numbers and a few characters in front of them. Which is not necessarily a bad thing, because it forces you to think about where did you go wrong and what needs to be fixed and with this offers you a new dimension.

Assessment with rubrics

- Students know the rubrics.
- Students present their work (reports, oral defense…).
- Instructors score students' work on rubrics. (Only a subset? Also comments?)

1) Students improve the report until acceptable

2) Students improve the report a fixed number of times

3) Students move to the next lab without resubmission

4) ?

Assessment with rubrics 2

- Students work in the lab.
- Instructors score the students during the lab

Open questions on assessment

- How can we resolve difficulties that students have with rubrics and related assessment issues? (Olga Gkioka)

- Other questions from the room?

Open questions on assessment

- How do you make your assessment of students' work efficient?
- How do you stimulate reflection by students on the given feedback?
- Do you make use of a research-based assessment survey to assess students' learning?

Panel discussion – **part 3**

Open questions on the interplay between learning goals and their assessment

Interplay between learning goals and assessment

- Constructivism:

  learner's activities are central in creating meaning

- Instructional design:

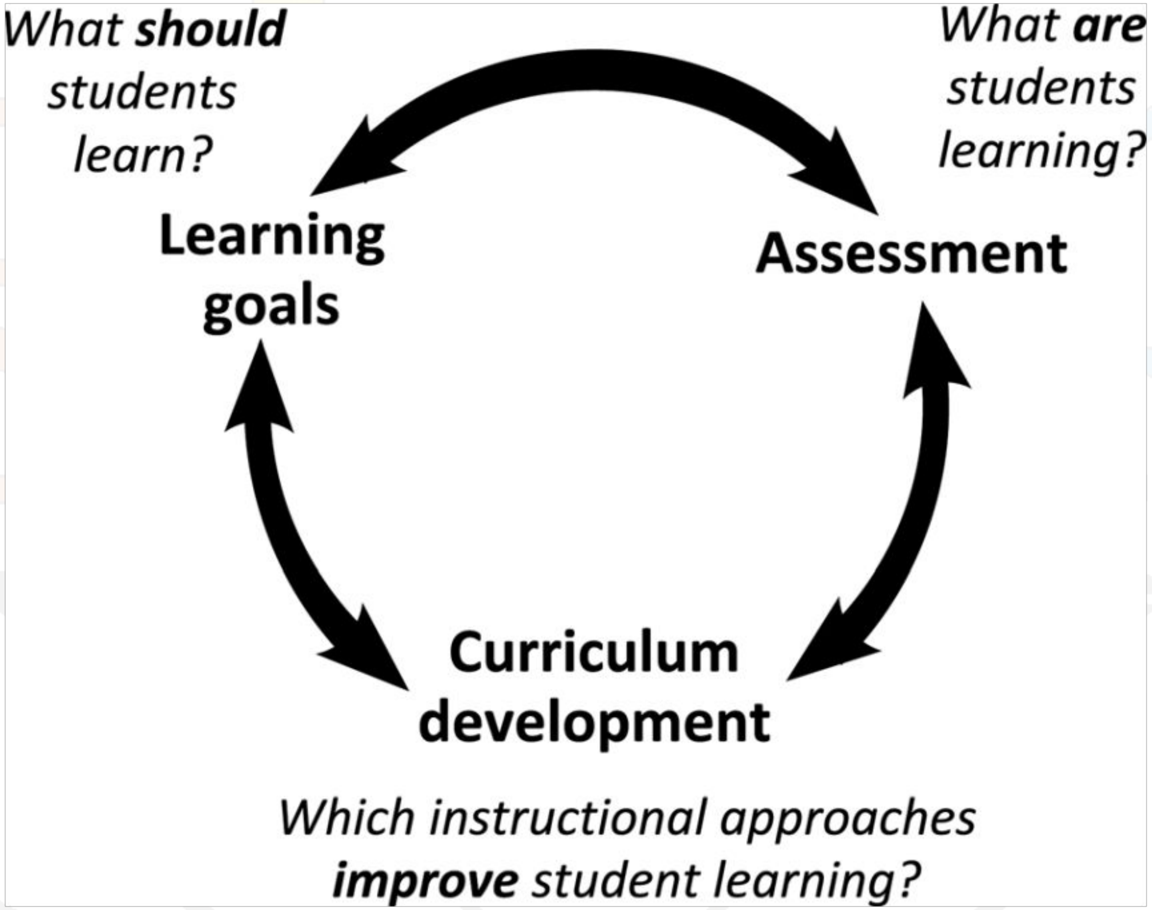
  alignment between the objectives of a course or unit and the targets for assessing student performance

- Constructive alignment:

  assessment and instructional design should therefore be in line with the goals

Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher Education*, *32*(3), 347–364. https://doi.org/10.1007/BF00138871

Model for lab courses reconstruction



B. M. Zwickl et al. *Am. J. Phys.*, 81, 63 (2013).

*Constructive alignment type of approach

Reflection

Doing things is not enough to learn something

Reflection is needed

Dewey, J. (1944). Democracy and education: An introduction to the philosophy of education. New York, NY: The Free Press.

Reflection

Reflection is a social enterprise

Feedback plays an essential role

Rodgers, C. (2002). Defining Reflection: Another Look at John Dewey and Reflective Thinking. Teachers College Record, 104(4), 842-866. https://doi.org/10.1111/1467-9620.00181

Feedback

Reflection is a social enterprise

Feedback needs to be received:

- Feed up
- Feedback
- Feed forward

Quick feedback is most effective

Hattie, J., & Clarke, S. (2019). *Visible learning: Feedback.* Routledge.

Van den Berg, E., et.al. (2008) Teaching, Learning, and Quick Feedback Methods in Classical and Modern Physics. GIREP biennial Conference, Nicosia, August 18 – 22, 2008.

Interplay between learning goals and assessment

- Must students' in-lab work be formally assessed and graded or can they evaluate and decide on their own development and learning? (Kirsty Dunnett)
- How do learning goals and assessment change while the student progresses?
- What kind of goal-assessment pairs do you use? How well does it work?
- Other questions from the room?

Interplay between learning goals and assessment

- How do you make sure your learning goals are properly assessed?
- What will the future look like?
- Which opportunities and challenges does AI pose to physics lab instruction?

Future discussions - part 4

https://forms.gle/YLXf19MEBt5RSVSj6

Playbook open inquiry labs & Lab taxonomy survey

Playbook: https://maken.wikiwijs.nl/200332/
Rutgers Scientific abilities rubrics: https://sites.google.com/site/scientificabilities/rubrics
Rutgers ISLE-bases labs: https://sites.google.com/site/scientificabilities/isle-based-labs

For laboratory course instructors:
To participate in the **survey to classify existing labs** around the world: