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Abstract

Covid-19 forced nearly all U.S. schools to switch to virtual instruction in March of 2020. With students around the country and world now "Zooming" into class, it begs the question, does this new learning environment impact student learning? Conceptual assessments and observations were used to make conclusions about the differing effectiveness of instructional methods for professional development programs. Although results may indicate in-person instruction is more effective, I believe the most effective method of instruction is hybrid as it takes advantage of both virtual and in-person methods.

In-Person Summer Programs

From 2006-2008 and 2009-2011 UNI held professional development programs for secondary science teachers looking to complete a physics endorsement. Many teachers had limited physics and math courses prior to joining either program. In these programs, the UNI Physics Department, with support of external funding, provided summer workshops, courses during the academic year, and resources, adding to the department's rich history of supporting Iowa science teachers through professional development programs. In the summer workshops, teachers engaged with their peers in laboratory investigations, discussions of pedagogy, and much more.

Above Photos:
Teachers collaboratively engaged in laboratory investigations

Left:
Teachers sharing their data and resulting models in whiteboarding sessions

Virtual Summer Courses

In order to continue to support teachers seeking a physics endorsement without the funding previously available, the UNI Department of Physics offers two professional development courses through UNI Continuing Education on a continual basis, one focused on mechanics and one focused on electricity and magnetism. The courses are taught in alternating years. Originally, the courses were designed to include one week of face-to-face labs and three weeks of virtual meetings, but due to the Covid-19 pandemic, the 2020 and 2021 courses were taught entirely online. Twelve 3-hour Zoom sessions were held with the teachers during the summer. To help complete the modules virtually, videos, data, and online simulations were shared with the teachers.

A screen capture of the 2020 virtual mechanics class

PRISMS PLUS and Modeling

Physics Resources and Instructional Strategies for Motivating Students (PRISMS PLUS) and Modeling Instruction consist of learning and Modeling cycles that engage students in learning about forces, light, and electricity as well as many other topics using methods aligned with physics education research.

The teachers completed selected learning and Modeling cycles in PRISMS PLUS and Modeling and reflected with their professors and peers on how to effectively implement these curricula in their own classrooms.

AMTA
Transforming STEM Education

PRISMS PLUS

Conceptual Assessments

The teachers in each of these programs and courses were given pre and post conceptual assessments. The Force Concept Inventory (FCI) assesses student understanding of mechanics. To compare the scores from these three programs, the average gain and average normalized gain were found using the equations shown below.

$$average\ gain = average\ post\% - average\ pre\%$$

$$average\ normalized\ gain = \frac{average\ gain}{100 - average\ pre\%}$$

(Hake, 1998)

The teachers of the in-person programs were also given the Conceptual Survey of Electricity and Magnetism (CSEM) and the 2021 virtual course participants were administered the Basic Electricity and Magnetism Assessment (BEMA). The scores from the Electricity and Magnetism 2021 virtual course's conceptual assessment are not yet available as the class is still in progress.

Results

The table below includes the Force Concept Inventory data.

Instruction Method	Year	Pre-test Average	Post-test Average	Average Gain	Average Normalized Gain
In-Person:	2006	54%	71%	17%	36%
	2009	51%	67%	15%	30%
Virtual:	2020	58%	66%	8%	6%

After analyzing data and observing virtual instruction, I believe both modes have distinct advantages.

Advantages of In-Person Instruction:

- Hands-on labs can be completed fully by the teachers
- Demonstrations can involve and engage students
- Teachers can easily share information and data with fellow classmates
- Whiteboarding sessions and discussions can be done efficiently and effectively

Advantages of Virtual Instruction:

- Teachers can complete the course from home, making it more accessible for participants
- Provides the teachers with virtual instruction skills to take back to their classes
- Teachers gain experience using online resources

Conclusions

The positive gain shown in the table for the in-person and virtual programs show that both of these instructional methods are effective. One reason why the gain is much larger for the in-person programs could be because of the time spent in class or the backgrounds of the teachers. Another reason could be because of the virtual or in-person instructional method, but I don't feel that there is enough data to definitively conclude this. Based on the observed advantages and data, I believe that in-person instruction may be slightly more effective. But, in order to take advantage of the strengths of both methods, I believe that a hybrid instructional method would be most effective, combining in-person and virtual instruction, which the future summer courses plan on utilizing.

References & Acknowledgements

American Modeling Teachers Association. (2021). *AMTA instructional resources.* https://www.eweblife.com/prm/AMTA/membership-page/view?record=23

Conceptual assessment summary: PRISST program, 2006-2008. (2008).

Cooney, T. M., Escalada, L. T., Unruh, R. D. (2008). *PRISMS PLUS.* University of Northern Iowa Physics Department. Cedar Falls, IA.

Escalada, L., Morgan, J. (2010, February 15). *Iowa Physics Teacher Instruction and Resources (IPTIR)* [PowerPoint Slides].

Escalada, L. T. (2008). *MSP final performance narrative report: July 31, 2008.*

Hake, R. R. (1998). Interactive engagement versus traditional methods: A six-thousand student survey of mechanics test data for introductory physics courses. *American Journal of Physics, 66*(1), 64-74. https://doi.org/10.1119/1.18809

Hestenes, D., Swackhamer, G., Wells, M. (1992). Force concept inventory. *The Physics Teacher, 30,* 141-158.

Knight, R. D. (2004). *Five easy lessons: Strategies for successful physics teaching.* Addison Wesley.

NGSS Lead States. (2013). *Next generation science standards: For states, by states.* Washington, DC: The National Academies Press.

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