INSPIRING STEM EDUCATORS:
THE NASA PHYSICS AND ENGINEERING COLLECTION ON VITAL/TEACHERS' DOMAIN

SUMMATIVE EVALUATION REPORT

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EXECUTIVE SUMMARY

In response to the national warning call that the United States must increase the number of college graduates in the fields of science, technology, engineering, and math (STEM), WNET (New York's flagship public media provider) and the WGBH Education Foundation received a grant from NASA to assemble a collection of approximately 70 digital resources from NASA's digital archives and to develop supporting resources. In addition, the grant enabled the project team to create three online professional development modules (PDMs), providing educators with concrete models of effective practice to inspire and enhance media-enriched STEM teaching while improving student comprehension and engagement.

This collection, known as the *NASA Physics and Engineering Collection* (NPEC), is intended to bring a range of topics to high school physics and physical science classrooms, inspiring the imaginations of diverse students and motivating them to pursue more advanced coursework in science and other STEM fields.

EDC's Center for Children and Technology (EDC|CCT) was hired to conduct the formative and summative evaluation of the NPEC grant. This report presents findings from the summative evaluation study on the impact of one of NPEC's online professional development modules. This self-paced module, *Powerful Learning with Digital Media in the Physics Classroom,* focuses on teachers' lesson-planning approaches and is designed to help teachers better integrate digital media into their teaching.

Research Methods

Using an Objectives-Oriented Evaluation Approach,[1] researchers examined two questions relating to the *Powerful Learning with Digital Media in the Physics Classroom* PDM:

1. To what degree does the module meet its stated goals and outcomes**?**
2. To what degree does the module impact teachers' ability to prepare substantive physics lessons using the NPEC resources?

Forty-two teachers from 25 states participated in the study. Teachers participated in six research activities including 1) completing an intake survey, 2) designing a lesson plan using a digital video from NPEC, 3) completing the *Powerful Learning with Digital Media in the Physics Classroom* PDM, 4) redesigning the original lesson plan, 5) participating in a phone interview, and 6) completing a final online survey.

Researchers catalogued and coded teachers' revised lesson plans to determine which revisions related to the objectives of the PDM. Lesson plan questionnaires and participant interviews were coded for the same outcomes as the revised lesson plans as well as an additional set of codes. These data provided evidence for the study's key findings.

[1] Smith, E. R., & Tyler, R. W. (1942). *Appraising and recording student progress.* New York, NY: Harper & Row.

Descriptive statistical analysis was conducted on the intake survey and the final survey, which provided background on the participant sample as well as teachers' perceptions of what they learned from the Professional Development Module.

Findings

Based on the analysis of teachers' lesson plan revisions, and supported by interview and survey data, the PDM very effectively introduced teachers to one strategy in particular- the Frame, Focus, Follow-up (FFF) approach integrating digital media into the classroom. Findings related to Frame Focus and Follow-up strategies include:

- The majority of teachers adopted the Frame, Focus, and Follow-up approach.
- Teachers already familiar with framing, focusing, or follow-up strategies learned new ones or reaffirmed current practices.
- Teachers came to see video as a more valuable teaching and learning resource as a result of working with the Frame, Focus, and Follow-up approach.
- The majority of teachers plan to incorporate Frame, Focus, and Follow-up into their teaching

The study yielded additional findings in several areas:

- Teachers used a wider range of student groupings, adding small group and partner discussions to parts of their lesson plans
- A small number of teachers adopted new strategies for differentiating instruction, assessing students, and promoting student collaboration
- When teachers used new strategies and resources from the PDM in their classes, they saw a positive impact on students, including better retention of material and better comprehension of concepts.
- A number of teachers are using more video in their classes as a result of the Professional Development Module, and some are using video in new ways.

Participant Feedback

At different stages of the study, teachers shared their thoughts and opinions on both the Professional Development Module and the Teachers' Domain website. While not the principal focus of the study, this information may prove useful to WNET and NASA in the development of new resources, collections, and professional development opportunities.

Summary of teacher's feedback on the PDM

- Participants thought that the PDM addressed a broad range of teacher needs and particularly appreciated the overall approach and design, the interactive nature, and the flexibility of the module.
- Teachers found the videos demonstrating how their peers used challenging pedagogical approaches and the document "Effective Video-Based Lessons" especially useful.
- Teachers suggested reducing the overall length of the module, allowing editing in the note-taking feature, and embedding links to additional resources at the end of

the PDM. They further suggested reducing the number and length of video examples in the module, and including more sophisticated videos.

Summary of teacher's feedback on Teachers' Domain website

- Teachers thought the website was well-organized and easy to search and use, valued the supporting resources, and appreciated that everything was available free of charge
- Teachers appreciated that the downloadable videos could be used with a weak or non-existent Internet connection.
- Teachers proposed linking Next Generation Science Standards to video resources and providing closed-captioning for all videos, additional sort categories for searching, and more explicit instructions to help orient users to the Teachers' Domain website.

Conclusion and Recommendations

The online teacher professional development module, *Powerful Learning with Digital Media in the Physics Classroom,* effectively introduces teachers to the Frame, Focus, Follow-up (FFF) strategies for integrating digital media into the classroom, and provides reinforcement for teachers already familiar with the strategies. Study participants demonstrated that they gained an understanding of how to apply the strategies in their teaching. A number of teachers used the strategies with their students and reported a positive impact; teachers also reported a greater appreciation of the instructional value of video.

Recommendations for future professional development modules:

- Develop additional PD modules that focus specifically on using video to differentiate instruction, assess student learning, and promote student collaboration.
- Include short videos of teachers implementing each aspect of a new strategy.
- Include examples of high quality lesson plans.
- Add reflection questions similar to those in the study's lesson plan questionnaire (see appendix).
- Embed links to additional resources in the PDM.

Recommendation for further research:

- Examine the degree to which changes in teachers' planning translate into changes in classroom practice.

Recommendation for promoting the use of video in the classroom:

- Conduct professional development with principals and other instructional leaders on the ways that video and other digital resources can support teaching and learning.

INTRODUCTION AND OVERVIEW

In response to the national warning call that the United States must increase the number of college graduates in the fields of science, technology, engineering, and math (STEM), WNET (New York's flagship public media provider) and the WGBH Education Foundation received a grant from NASA to assemble a collection of approximately 70 digital resources from NASA's digital archives and to develop supporting resources, such as background essays, guiding discussion questions, and alignment with state learning standards. In addition, the grant enabled the project team to create three online professional development modules (PDMs), providing educators with concrete models of effective practice to inspire and enhance media-enriched STEM teaching while improving student comprehension and engagement.

This collection, known as the *NASA Physics and Engineering Collection* (NPEC), is intended to bring a range of topics to high school physics and physical science classrooms, inspiring the imaginations of diverse students and motivating them to pursue more advanced coursework in science and other STEM fields.

EDC's Center for Children and Technology (EDC|CCT), was hired to conduct the formative and summative evaluation of the NPEC grant. During the formative evaluation, EDC|CCT conducted two sets of focus groups with high school physics and engineering teachers. Participants in the first focus groups reviewed the relevance and usability of the NPEC's video resources and support materials. Participants in the second focus groups discussed the design and utility of one of the online PDMs, *A Modeling Approach to Physics Instruction*. Teacher feedback was positive overall, and the groups generated useful recommendations that WNET used to inform the production of the rest of the collection.

This report presents findings from the summative evaluation study on the impact of another of NPEC's online professional development modules. This module, *Powerful Learning with Digital Media in the Physics Classroom,* focuses on teachers' lesson-planning approaches,. This self-paced module is designed to help teachers better integrate digital media, specifically videos, into their teaching. The module features secondary school science teachers demonstrating effective uses of digital resources in the science classroom. In addition to these "snapshots of practice," the module introduces a set of strategies for maximizing the impact of video, invites teachers to reflect on their own practice, and provides concrete steps to help teachers apply what they've learned in their own classrooms.

Research Methods

Using an Objectives-Oriented Evaluation Approach,[2] researchers examined two questions relating to the *Powerful Learning with Digital Media in the Physics Classroom* PDM:

3. To what degree does the module meet its stated goals and outcomes?
4. To what degree does the module impact teachers' ability to prepare substantive physics lessons using the NPEC resources?

Forty-two teachers from 25 states participated in the study. Research activities and data analysis are described below. For more about teacher recruitment and sample selection, see Appendix A.

Research activities

Teacher activities included the following:

- *Recruitment: Completing an intake survey*
  During the recruitment and sample selection process, teachers provided details about where they worked, their teaching experience, and their level of interest in integrating digital media into their classroom. See Appendix B for the complete intake survey.

- *Weeks 1–3: Designing a lesson plan using a digital video from NPEC*
  Researchers provided teachers with a list of 14 videos that fell into four categories related to physics: (1) Energy, (2) Engineering Design, (3) Matter and Its Interactions, and (4) Motions and Instability: Forces and Interactions. Researchers also provided a lesson-planning template, which included fields for target grade level, time allotment, learning objectives, materials, and activities (see Appendix C). Teachers used the template to design a lesson plan around one of the NASA videos. Teachers were told that they would design a second lesson plan after completing the PDM.

- *Week 4: Completing the Professional Development Module*

- *Weeks 5–7: Redesigning the original lesson plan*
  Once participants had completed the PDM, researchers instructed them to review and revise their original plan, rather than create a new one. Teachers tracked changes and occasionally annotated their revisions. They also filled out an online questionnaire, explaining changes they made to each section of their lessons and whether they attributed those changes to their experience with the PDM. See Appendix D for the complete lesson plan questionnaire.

[2] Smith, E. R., & Tyler, R. W. (1942). *Appraising and recording student progress.* New York, NY: Harper & Row.

- *Weeks 8 and 9: Teacher interviews*
  Twenty-three teachers from the sample were selected to participate in a 30-minute semi-structured phone interview. Teachers were selected based on changes they made in their lesson plan and comments they made in the accompanying online questionnaire. More specifically, teachers were chosen if they had already implemented the lesson, if they had used the Frame, Focus, and Follow-up (FFF) strategies modeled in the PDM, if researchers needed clarification, if the teacher worked with a unique group of students, if the teacher was critical of the PDM or the Teachers' Domain website, or if the teacher integrated additional technology into his or her lesson.

  During the interview, teachers were asked a series of questions about their experience completing the module, including what they gained and what was most helpful to them as a learner. Researchers also asked about teachers' use of both video and the FFF approach before and after participating in the study. Teachers who had been able to use all or part of their revised lesson plan with their students shared observations around implementation and student engagement. For a complete list of interview questions, see Appendix E.

- *Final survey*
  All participating teachers were asked to report on what they learned from the Professional Development Module, the effectiveness of the module, and their use of the revised lesson plan, as well as the make-up of their school and district. Teachers who had not been interviewed answered an additional set of questions that paralleled the interview protocol, such as what they thought they had learned from the PDM, what aspects of the PDM were most and least effective, and whether they had used their lesson plan or specific techniques from the PDM with students. See Appendix F for the complete final survey.

- *Payment*
  Participants who completed all of the research activities received a stipend of $250. In total, 42 stipends were distributed.

Data analysis

Researchers catalogued and coded teachers' revised lesson plans to determine which revisions related to the objectives of the PDM. Specifically, lesson plans and questionnaires were coded for incorporation of the FFF methodology, changes in classroom viewing approach, use of digital media to differentiate classroom instruction, use of digital media to encourage student collaboration, use of digital media for assessment purposes, and use of digital media to encourage student reflection. These data provided evidence for the study's key findings

Lesson plan questionnaires and participant interviews were coded for the same outcomes as the revised lesson plans. In addition, these data were coded for the following:

- Use of differentiated learning
- Affirmation of teachers' current instructional practices
- Teachers' perceptions of the impact of the FFF approach on students
- Feedback on the PDM
- Feedback on the Teachers' Domain website

- Any additional themes that might emerge based on participants' experience and perspectives

These self-reported data served to further illustrate the key findings.
Descriptive statistical analysis was conducted on the intake survey and the final survey, which provided background on the participant sample as well as teachers' perceptions of what they learned from the Professional Development Module. Using a grounded theory approach, researchers analyzed teachers' open-ended responses to questions about what they gained, the effectiveness of the module and its components, classroom implementation (where relevant), and recommendations for development of future PDMs.

Participants

Demographics

Our study sample included 42 teachers from 25 U.S. states. Demographic data were gathered from both the intake survey—which was administered as part of the sample selection process and included details about where teachers worked, their teaching experience, and their level of interest in integrating digital media into their classrooms—and the final survey. The largest number of participants came from Michigan, with five teachers. There were also 4 from Florida, 3 from Iowa, and 3 from California; the remaining 27 teachers were spread across 25 states. For a full list of teachers' geographical locations, see Appendix G.

Table 1 below presents information about teachers' subject and grade level, teaching experience, and district and school size.

Table 1: Teaching Experience

Teaching Experience (n = 42)		Percentage
Subject Area	Physical science	50%
	Chemistry	31%
	Biology	24%
	Earth science	19%
	Environmental science	17%
	Other	26%
Grade Level	9th grade	43%
	10th grade	48%
	11th grade	76%
	12th grade	76%
	Other	5%
Teaching Experience	Less than 3 years	19%
	4–7 years	17%
	7–10 years	19%
	10–15 years	19%
	More than 15 years	26%
Physics/ Engineering	Less than 3 years	43%
	4–7 years	26%

Teaching Experience	7–10 years	5%
	10–15 years	12%
	More than 15 years	14%

Nearly all teachers (91 percent) teach multiple subject areas; 79 percent teach in multiple grade levels, with 19 percent teaching across all four high school grade levels. In addition, one teacher is a dual-credit instructor and one teaches K–12.

Eighty-six percent of teachers indicated that they teach physics or engineering. Half of the sample also teach physical science, and 31 percent teach chemistry. Two teachers teach astronomy, two teach math, two teach technology, and two teach forensics science.

More than half the teachers (52 percent) have been teaching physics or engineering their entire teaching career; one-third of those teachers have been in the profession less than 3 years, and 27 percent are veteran teachers of 15+ years.

The types of districts in which teachers work are fairly evenly represented, with 28 percent reporting that they work in a mixed urban and rural district. Approximately half the teachers work in large districts with more than 5,000 students, and half work in schools with 1,001–3,000 students. Table 2 provides further details about the districts and schools where teachers in the sample work.

Table 2: District and School Demographics

Demographics (n = 42)		**Percentage**
District Type	Urban	24%
	Suburban	26%
	Rural	17%
	Mixed	28%
	Other	5%
District Size	0–1,000 students	26%
	1,001–3,000 students	12%
	3,001–5,000	10%
	More than 5,000	52%
School Size	0–500 students	22%
	501–1,000	26%
	1,001–3,000 students	50%
	More than 4,000	2%

Summary of teachers' participation

Of the 14 resources offered to teachers, 11 were used in at least one lesson plan. Fourteen teachers (33 percent) chose to use the *Mass vs. Weight: Air Power Mass* video, and nine chose

the *Teaching from Space: Centripetal Force* video. Lesson plans were designed for use in a variety of courses across a range of grade levels, from middle school through high school. Sixteen teachers (38 percent) designed a lesson plan to be used with 11th and 12th grade students. The majority of teachers (30) designed a lesson for a physics or engineering class (71 percent), six of which were honors-level courses. The remaining 12 teachers designed their lesson plans to be used in physical science, astronomy, or chemistry classrooms. On average, teachers designed a lesson plan that would be used over two to three class periods, about 162 minutes of instructional time.

Teachers reported spending between 30 minutes and 8 hours completing the PDM.

Of the 42 teachers participating in the evaluation, 36 made changes to at least one section of their lesson plans after completing the PDM. Five teachers made no changes at all, and a sixth only made changes that were not related to the Professional Development Module (in the online questionnaire, teachers noted whether they attributed those changes to their experience with the PDM). Table 3 shows the types of changes and number of teachers who made them.

Table 3: Lesson Plan Revisions

Lesson Plan Section	Made Changes	Made Changes Because of PDM
Activities	32	28 (88%)
Materials	17	11 (65%)
Overview	15	10 (67%)
Planning resources	10	4 (40%)
Learning objectives	7	3 (43%)
Standards	1	1 (100%)

FINDINGS

Based on the analysis of teachers' lesson plan revisions, and supported by interview and survey data, researchers concluded that the PDM very effectively introduced teachers to the Frame, Focus, Follow-up (FFF) strategies for integrating digital media into the classroom. For teachers who were already familiar with these concepts, the PDM helped reinforce them. As of the close of the study, the majority of teachers planned to use the strategies in their teaching, and a number had already done so.

The PDM was also effective in providing teachers with new strategies for grouping students when working with digital media. While only a few teachers actually changed student groupings in their revised plans, additional data suggest that for the majority of participants, the PDM influenced their thinking in this area.

There is evidence that the PDM had limited impact on teachers' approaches to differentiating instruction, assessing students, and promoting student collaboration.

Finally, while not the focus of the study, the data suggest that the PDM had a positive impact on teachers' use of video in the classroom, and those teachers who implemented new strategies in their classes reported a variety of positive impacts on students as well.

As evidenced by the numerous quotes included in this report, teachers were articulate about the reasons for including the strategies in their revised lesson plans and in explaining why they believed the changes would contribute to improved student learning.

Teachers adopted the Frame, Focus, and Follow-up approach

The most significant finding is related to teachers' use of the FFF strategies. Twenty-seven teachers (64 percent) added some aspect of FFF to using video in their revised lesson plans, and several applied the strategies to other kinds of activities (such as labs) and to their overall lessons. In the lesson plan questionnaire, interviews, and final survey, teachers indicated that they believed the strategies would make their lessons more coherent and promote student learning by helping students engage more actively in viewing the digital media and attend more closely to and think more critically about key concepts:

> I added a frame and focus section for viewing the digital clip… because I frequently show digital clips with little explanation beforehand. I like the idea of telling students what to look for in the clip, as it encourages them to be active rather than passive learners, which probably improves student gains from watching clips.
>
> *—11th–12th grade physics, physical science, and earth science teacher from Vermont*

> I work with English language learner students, so I think the focusing and framing is really important, in that I'm really making sure that they understand . . . what it is they're supposed to be gaining from that.... Otherwise it just becomes this activity that they do. And they kind of remember the activity but they don't remember what the point of it was.
>
> *—9th grade physics, physical science, biology, and environmental*

science teacher from Washington

The Frame, Focus, and Follow-up approach has influenced how teachers think about the value of using video

Some teachers reported that the Professional Development Module, and the FFF strategies in particular, influenced their thinking about the value of incorporating digital resources into their lessons:

> In general, the idea of using Frame, Focus, and Follow up strategies to provide purpose and meaning for watching videos in the classroom made me re-think my use of video and the true purpose of using video in my classroom. I realized that students need a reason to watch a video, as well as ways for students to interact with the video, rather than doodling or napping during the film.
>
> *—9th–12th grade physics and mathematics teacher from Arizona*

> I did not realize how many different aspects of teaching and learning could occur with the use of digital media. This one short video clip, when used with the "frame, focus, and follow up" method, will allow students to think critically, create unique associations with material, and thoughtfully reflect all while practicing their communication and writing skills.
>
> *—11th–12th grade physics and honors astronomy teacher from Florida*

Teachers already familiar with framing, focusing, or follow-up strategies learned new ones or reaffirmed current practices

Many teachers were familiar with FFF strategies before participating in the evaluation, though they didn't use those terms. Twenty-two teachers (52 percent) used some of the strategies in their original lesson plans, but 14 of those teachers (33 percent) added new FFF strategies in their revised plans. In most cases, teachers had been implementing one or two elements of the approach, but discovered additional elements through the PDM:

> I was definitely doing the Focus and Follow-up but I could use to be a little more disciplined in the choices I make about Framing.
>
> *—9th grade physics and math teacher from Michigan*

> I kind of use . . . the acronyms of WALT and WILF. WALT—We Are Learning Today. WILF—What I'm Looking For. But the follow-up side, that's going to be an important part of my lesson plans. . . . There was missing that third character, the follow-up. So that is something. My lessons will be better for having done your training.
>
> *—12th grade physics, biology, chemistry, and forensic science teacher from Rhode Island*

Further, teachers who were already familiar with the pedagogical approach of frame focus and follow-up reported that the PDM served to validate that the strategies were sound instructional practice:

> The lessons shown in the PD module were not new concepts and were very similar to what I already do. It is always good to have reminders, however, and to have validation that I am still using best practices.
>
> *—10th–12th grade physics and physical science teacher from Iowa*

> The main thing that stood out for me from doing that professional development module was particularly the process that I've used in class but have never articulated, which is the Frame, Focus, Follow-up procedure for presenting digital media in class. But I never really put it in those terms and now I have, and I've actually used that in presentations at our own school of this exact topic, you know, integrating digital media into your classroom across the curriculum, not just in science.
>
> *—11th–12th grade physics, physical science, chemistry, and environmental science teacher from Illinois*

Among those teachers who used FFF strategies in their original plans but did not include new strategies in their revisions, six labeled their original strategies with the new terminology:

> I'm actually not sure whether this is going to substantially alter how I deliver the lesson, but I figured it could be clarified a bit following the Frame-Focus-Follow-up framework.
>
> *—9th grade physics and math teacher from Michigan*

Teachers plan to incorporate Frame, Focus, and Follow-up into their teaching

Regardless of whether they had used FFF strategies in the past or were new to the approach, the majority of teachers indicated that they were more likely to use FFF in the future – and several reported already doing so – as a result of the Professional Development Module:

> I am using it now. It's not polished by any means, but I'm trying to use it more and more often as the weeks go by. I think I am seeing an improvement.
>
> *—9th, 11th, and 12th grade physics, physical science, and chemistry teacher from Iowa*

> No one had ever told me about that, the Frame, Focus, Follow-up. That was really a cool thing, and that was probably something that I've actually incorporated since doing this module.
>
> *—11th–12th grade physics and honors astronomy teacher from Florida*

> And from those, definitely, I created an entire framed document for the kids to hand out to them. We've used a couple on waves and sound so far this year, and we'll use a lot more next year as I incorporate it into my other courses, and especially focusing on the idea of framing the lessons, which I found was very effective.
>
> *—11th–12th grade physics, physical science, chemistry, and environmental science teacher from Illinois*

Teachers are using a wider range of student groupings

The majority of teachers used more than one approach to student groupings in their original lesson plans, and only three changed student groupings in their revised lesson plans. Nonetheless,

in the final survey, 35 teachers (83 percent) agreed that the Professional Development Module helped them think differently about how they grouped students when using media in their lessons.

When teachers did change student groupings in their revised lesson plans, it was not around the use of the Teachers' Domain resources. In a lesson that originally had students filling out worksheets individually following an online lab activity, the revised version gives students the option of working in pairs. In another case, a teacher revised the lesson so that one whole-group discussion became a series of conversations, first between partners, then in small groups, and finally with the whole class. The third teacher revised a whole-group exploration of the relationship between Bernoulli's Principle and Newton's Third Law to individual work:

> Instead of doing this on the SmartBoard at the front of the room, I want to have students do this individually on their laptops. When watching some of the videos on Teachers' Domain, it seemed that some individual work would help more students . . . I'm starting to think that maybe if I can split them up and let them watch these videos individually, it might have an effect where I might get more questions either asked of me as I walked across the room or e-mailed to me. Or there might be more opportunity for me to answer misconceptions or something that students aren't quite understanding.
>
> *—9th, 11th, and 12th grade physics, physical science, and chemistry teacher from Iowa* _____

A small number of teachers adopted strategies for differentiating instruction, assessing students, and promoting student collaboration

Three teachers indicated that changes in their lesson plans were attempts to accommodate a wider range of students' learning needs. The teacher quoted above switched a whole-group discussion to individual work for this reason:

> In the [PD] module, the students were able to proceed through some of the material at their own pace. I am hoping this frees me up to address individual or groups' questions as they occur. It also allows for some students to spend more time on an activity if needed.
>
> *—9th, 11th, and 12th grade physics, physical science, and chemistry teacher from Iowa*

Others used resources to differentiate instruction, assigning students to review digital media outside of class to better understand a concept, and giving students the option of using additional online resources:

> I really liked learning about the importance of having a lot of different ways that students can learn as well as including more technology, especially since that is familiar with them. I thought the professional development was very important for me, as it showed me how easy it is to add more technology to your lessons and the benefits of diversifying.
>
> *—11th–12th grade physics and biology teacher from Rhode Island*

Three teachers added assessment components to their revised lesson plans. As one explained:

> I do find it very useful to focus prior, then to go over it after. It really does help to figure out if they had the wrong idea.

—9th–10th grade physical science and biology teacher from Missouri

Finally, one teacher reported that the PDM provided new ways to promote student collaboration:

> I took away the idea that kids could learn from each other; the teacher could be a facilitator. It was one of the videos that I saw in the module.
>
> *—9th–11th grade physics and physical science teacher from South Carolina*

The Professional Development Module had an impact on teachers' use of digital media with their students

About one-third of teachers reported having used video with their students frequently before participating in the study, another third said they used video approximately once a month, and the remaining third had used video only once or twice a semester. After completing the study, the majority of teachers said that they were more likely to use video with students as a result of the PDM:

> Since doing this I have been incorporating more video into my physical science notes, and the students really respond positively to that. They like short clips that help them really understand the concept.
>
> *—9th–10th grade physical science and biology teacher from Missouri*

The PDM inspired several teachers to explore using video in new ways:

> I like the idea of using and stretching the way we use videos, and stopping the video, and drawing on it, and using it not so much as *we're going to watch a video in class* but *we're going to learn this concept and the video is just the tool*. And even if the video's only five minutes long, if you're stopping and using it as a tool to lead your lecture at that moment, then it works out. It's nice to think of videos in a different way.
>
> *—9th grade physics and technology teacher from Florida*

> Using more than one video clip could be a good thing. The one that I had chosen from NASA was centripetal force in space. And I felt like that was kind of a wrap-up topic, like they needed more background before we got into that. So I ended up incorporating a lot more activities and video clips.
>
> *—10th–12th grade physics and chemistry teacher from California*

Some teachers in the study had not considered using short video pieces in their classes:

> I always thought of showing videos as a separate entity and talked about them after the fact, but pausing, showing snippets, using video throughout the lesson, I hadn't thought about it. I don't know too many teachers who would do that. That idea of using it piecemeal throughout a lesson and taking time to hit on what we really want [our] students to gain.
>
> *—9th–12th grade physics and mathematics teacher from Arizona*

> For whatever reason I had never considered short four- or five-minute videos before I had gone through the module. I guess every time I thought of, okay, we're going to use a

video in class, it's going to be this episode, and it's going to be forty-three minutes. Do I want to give up one day of instruction? Is the video worth that? . . . And after seeing some of those shorter videos, I thought, you know what, maybe there are some more things out there like this that I could utilize.

—9th, 11th, and 12th grade physics, physical science, and chemistry teacher from Iowa

When teachers used new strategies and resources, they saw a positive impact on students

By the end of the study, twelve participants reported using their revised lesson plan with students (29 percent), and 26 had implemented some aspect of what they learned in the PDM (62 percent). Eight teachers reported having done both. In follow-up interviews, researchers asked open-ended questions about whether teachers saw any impact on students. For teachers who were not interviewed, the final survey included specific items about student impact. Fifteen teachers reported that their students were more engaged as a result of the new strategies and resources:

My astronomy class is a tough class. It's, like, 36 kids, and 31 of them are boys, and they're all seniors, and all on lacrosse team together, so it's kind of a tough crowd. They're just not the best behaved. But they were all, for the most part, really into it. So I was like, oh, okay, this can be an effective way of teaching. They're more into this than some of the other stuff. And that's something that I did view in the module. I saw the students being more engaged than I've found previously, in that class specifically.

—11th–12th grade physics and honors astronomy teacher from Florida

If you randomly said, "This is the subject of this video," [the students] would just watch and not focus in on any part in particular. Now they pay attention to the speaker's definition, or to the animation of this happening. They're more critical, rather than just watching for fun.

—11th–12th physics, physical science, and earth science teacher from Vermont

Fourteen teachers (33 percent) found that the new strategies and resources helped their students understand the concepts better:

And so then I would get into the framing. And then I say, "Okay. Now, during the lesson, this is what I want you to focus on." And at the end when we do the follow-up, they seem more involved in it. They can answer a lot more of the questions in depth than I've had in the past. Before it was like, "Uh, okay." Maybe we're doing gas laws or something like that and they could probably tell me the gas laws, but they couldn't tell me why.

—12th grade physical science teacher from Tennessee

But I have a large percentage of my physical science class right now that their grades have them in what is known as our success center. That's where they have to go for extra help. It's for struggling students. And I was running anywhere from twelve to fourteen students that were consistently in there first semester this year. And [in] the exact same class… I think I'm down to only having three or four in there, because of the physical science grade.

—9th, 11th, and 12th grade physics, physical science, and chemistry teacher from Iowa

Thirteen teachers (31 percent) believed that their students asked better and more frequent questions:

> The biggest impact that it's had on students is it kind of establishes the culture of asking questions after the video because I take time to try and form a discussion. It's something I didn't do before. It's more like a communal understanding that you can ask questions about anything you didn't understand in the video or that you were wondering about. So by taking time after the video to have a discussion, it opens up the floor to the students and let the students voice their opinions or any concerns or any questions they might have.
>
> *—11th grade physics teacher from California*

> Questions that they asked, that kind of feedback, things that … in the past I've had to go over and over, I didn't have to with this group. And they're not better or worse than any other group I've had.
>
> *—10th–12th grade physics and physical science teacher from Iowa*

Twelve teachers (29 percent) reported that their students enjoyed the lesson more than previous lessons on the same topic:

> This was a better way of teaching Bernoulli's Principle. It was certainly a faster way. My kids enjoyed it. According to feedback, they liked it a lot better.
>
> *—10th–11th grade physics, physical science, and chemistry teacher from New Jersey*

Eight teachers (19 percent) also reported that their students engaged in a higher level of discussion, and seven found that students retained information better. Finally, one teacher reported that students' grades on a quiz and a chapter test were higher than when that teacher previously taught the same topic.

PARTICIPANT FEEDBACK

At different stages of the study, teachers shared their thoughts and opinions on both the Professional Development Module and the Teachers' Domain website. While not the principal focus of the summative evaluation, this information may prove useful to WNET and NASA in the development of new resources, collections, and professional development opportunities. The feedback is predominately positive, though teachers did offer thoughtful suggestions for improving resources and making them more useful, useable, and teacher friendly.

Feedback on the Professional Development Module

Overall, teachers had a positive experience with the online PDM, *Powerful Learning with Digital Media in the Physics Classroom*. On the final survey, all but one participant reported that they learned something useful from the PDM.

Teachers appreciated the approach and design of the professional development. One 9th-12th-grade physics teacher said, "The structure was actually an easy format to follow . . . it kind of spelled it out for you. Exactly what you needed to do to go step by step." Another grade 9 physics teacher shared, "I admire the way the PD module was put together technically, incorporating the videos, resource documents, and note-taking ability."

Teachers particularly liked the interactive nature of the module:

> [On] the truly terrible end of the spectrum, there's been just a little, ". . . click here to go to the next PowerPoint slide" that we'll read to you, and this was a lot more interactive than that. So that was good, and it did a relatively good job of incorporating a variety of kinds of resources to think about.
>
> *—9th grade physics teacher from Michigan*

Most teachers also appreciated the fact that they did not need to finish the module in one session. A teacher in grades 11–12 offered, "That's one of the big benefits was this [module] where I can show some people, hey, you can do this in a couple of nights, you know, a little bit here and there, and it'll take you a long way."

Participants thought that the PDM would address a broad range of teacher needs, including those of both novice and first-time teachers and more seasoned veteran educators:

> I think the PD module would be great for beginning teachers. Many beginning teachers don't think through certain aspects of the lesson thoroughly enough before implementing. One of these aspects that requires much reflection is the effective use of digital media. The PD module makes it clear that you can't just pop in a video. If you want students to get the most out of it, they need the introduction, focus, follow-up, etc. Since I've been teaching for a while, I've learned these lessons through trial and error. I wish I had the PD module 10 years ago—it would have saved me a lot of headaches.
>
> *—10th–12th grade physics teacher from North Carolina*

> When our department heads sent an e-mail and I thought, "Well, digital, this is something that an old dog needs to learn; a new trick." So I thought, "Well, I'll give it a shot." And I really enjoyed it. I mean, as much as a teacher that's been in it this long can enjoy professional development. But it was very, I would say, not entertaining, but enlightening. I was able to gain quite a bit from it.
>
> *—12th grade physics and physical science teacher from Tennessee*

In fact, over the course of the study, 13 teachers recommended the PD to their colleagues—including fellow teachers at their schools (physics, physical science, and math teachers), several department heads, and a county education director—and 3 more said they intended to recommend it to others but had not yet had the opportunity. Further, one teacher reported conducting a faculty in-service training and incorporating strategies from the PDM:

> The PD module gave me valuable framework to use in presenting to my colleagues on the topic of integrating multi-media in the classroom. In a relatively short period of time, I garnered a ton of resources that were immediately applicable to my classroom and was provided with a nice framework to use in presenting a PD workshop to my own colleagues.
>
> *—11th–12th grade physics, physical science, chemistry, and environmental science teacher from Illinois*

Most effective elements of the professional development module

On the final survey, teachers indicated which components of the PDM were most and least effective in helping them learn (see Table 4 for teachers' ratings).

Note: Answer choices for this question were drawn from the formative research and from interviews with teachers participating in this study.

Table 4: Most and Least Effective Components of the PDM

PDM Components		Most Effective	Least Effective
Videos	Video clips of teachers teaching	26	3
	NASA video clips	22	4
	Video clips of students interacting with digital resources	10	1
	Video clips of student interacting with one another	5	3
Other Elements	Downloadable PDF templates and guides	18	3
	Reflection questions	10	0
	PhET simulation video clips	8	4
	Text on the slides	7	4
	Ability to go back and review sections	7	0
	Pacing	4	1
	Note-taking feature	1	8

Video resources

Twenty-six teachers (62 percent) reported that the video clips of real teachers teaching were most effective for a variety of reasons. In general, teachers liked seeing how their peers used challenging pedagogical approaches, how they integrated technology and video, and how they interacted with students. The videos modeled good teaching practices and helped teachers visualize how the techniques in the PDM might actually unfold in a classroom setting. The excerpts below highlight some of the ways in which these kinds of video clips helped further participant learning:

> I guess seeing how somebody actually uses them, like, another teacher and how they use videos was probably the most helpful for me. How they followed that format, because, I mean, I'm still in my first year. I'm still trying to learn how to be a teacher, and seeing somebody else use media and the way they use it helped me, you know, as a model.
>
> *—11th grade physics teacher from California*

> For me, the best thing was the short videos of the two teachers who co-taught physics, who were both teaching the same unit but were using the videos in different ways. That was really kind of a powerful example, that they both were using the same materials, the same content, but in totally different ways. And that was really beneficial for me.
>
> *—11th–12th grade physics and astronomy teacher from Florida*

Twenty-two teachers (52 percent) identified the NASA video resources as most useful, largely because these resources helped them visually present difficult-to-teach concepts.

Eighteen participants (43 percent) considered the downloadable PDF templates and guides effective. In particular, they thought that the document "Effective Video-Based Lessons" provided clear strategies for structuring a lesson:

> I do not have a chance to write up formal lesson plans like I did when I was doing student teaching, or when I was in grad school . . . So the planning template is a really powerful way to have to reference on why you are doing what you're doing, what's the purpose of it. And it's manageable, as a teacher. It's not like more paperwork. I like the part where it said how the students view the digital media, large group, small group, individually. That part of the template's good because, like I said, it kind of inspired me. Oh, I could do this for homework. I never would have thought to do that.
>
> *—11th–12th grade physics and astronomy teacher from Florida*

Ten teachers (24 percent) found that the reflection questions incorporated into the PDM helped them examine their own pedagogical approaches. Finally, two participants pointed out that the PDM used the same pedagogical methods it was designed to teach.

Suggestions for future professional development modules

Teachers identified challenges with certain aspects of the PDM. Suggestions reported in this section were mentioned by more than one teacher and are included here in the event that they are useful in the development of future online modules:

1. *Reduce the number of video examples included in the module.*

One criticisms teachers had about the PDM was that there were too many videos:

> I feel like there was a couple slides where it had several video links to it, like it would be one slide and then it would have several links. And to me that seemed a little bit overwhelming at first . . . having to watch one video after the other after the other, and then reflect upon them, I almost sometimes forget what I saw in the first video.
>
> *—11th grade physics teacher from California*

> There were lots of clips to watch, didn't necessarily do something with every single clip, not necessarily knowing why or how it was going to be useful.
>
> *—11th–12th grade physics, physical science, and earth science teacher from Vermont*

2. *Reduce the overall length of the module.*
   Similarly, other teachers felt that the module was too long overall and required too much time to complete:

> Maybe make it shorter, less text-based . . .Teachers are inundated constantly with educational theory, you know. . . . With these professional development things, you don't need to convince me that this is good. Like, you don't need to give me all this background information. But you can give me bullet points a little more. Give me some resources. Give me some tools. Give me some structure, and just let me implement it.
>
> *—10th–12th grade physics and chemistry teacher from California*

3. *Allow editing in the note-taking feature.*
   Teachers were frustrated when notes would disappear or when they could not go back and edit notes once they switched slides:

> The only thing that I didn't like was I couldn't figure out how to go back and maybe change some of the notes that were made when it asked questions. I couldn't figure out right away how to do it, and I haven't gone back to try to figure it out. But I did see that you could print them out. So, you know, push comes to shove, I could go back, print them out, and just make, write my changes on it.
>
> *—11th–12th grade physics and physical science teacher from Massachusetts*

4. *Include more sophisticated videos.*
   A small number of teachers thought that the content of the science videos was not at the appropriate level for their students and wanted more depth on certain topics:

> I was really underwhelmed by the Snell's Law video that they spent so much time on. It was essentially an animated PowerPoint. I feel like if I am going to use a video in my class, it should do something—it should bring something into my classroom that I cannot do at a chalkboard, and that video did what I could do at a chalkboard in a slightly animated, but less interactive and responsive to the particular needs and levels of my students, kind of way!

—9th grade physics and math teacher from Michigan

5. *Reduce the length of the videos included in the module.*
   A small group of teachers suggested that some of the videos could have been shorter and still have conveyed the same content.

In the final survey, researchers asked teachers about what other kinds of professional development resources would be useful to them. Seventy-one percent of teachers said they would have liked links to additional resources, suggesting that they most likely did not download the PDF embedded in the last page of the module. This desire for supplementary resources supports findings from the formative research, where teachers found these links to be very useful. Embedding the resource links in the module slides as well as in a PDF document would make it that much easier for teachers to visit those sites.

Half the teachers in the study agreed that they would like to see more video clips of teachers modeling specific strategies, while 43 percent noted that they would like more specific strategies for using digital media with students.

Table 4: Useful professional development resources

	Percent
Links to additional resources	71%
Video clips of teachers modeling specific strategies	50%
Specific strategies for using digital media with students	43%
Videos of students interacting with digital media	24%

Feedback on the Teachers' Domain website

There was an overwhelmingly positive reaction to the Teachers' Domain website from participants, many of whom were not aware of the site prior to participating in the study. They used such words as "quality," "valuable," "well done," "worth using," 'immediately applicable," "exciting," "legitimate," "reliable," "safe," "well developed," "cool," and "helpful" to describe both the website and the resources embedded within it. As of the end of the study, 62 percent of the teachers had recommended Teachers' Domain to colleagues and/or school and district administrators (as reflected in several quotes in the sections that follow).

Teachers appreciated learning about a new online repository of high-quality, pre-vetted, reliable resources. Furthermore, the fact that the website and the accompanying resources are available free of charge is a great advantage for teachers in schools with limited budgets who are unable to purchase the expensive equipment and simulations advertised in catalogues and magazines.

Teachers' Domain resources

A number of teachers commented on the time-consuming and challenging task of searching the Internet for relevant and appropriate digital resources. They thought that the Teachers' Domain website alleviated some of that stress and made efficient use of teachers' time by providing a

collection of ready-to-use trustworthy curricular materials that were easily integrated into their lessons:

> This is a great site . . . it's kind of what teachers who utilize [and] like the digital media are looking for. It's a nice central spot where you can look at things that are reliable and that are well-vetted and that you know will work . . . [you] know the information that you'll be getting and that you're going to then transmit to your students isn't clouded and is reliable.
>
> *—10th–11th grade physics, physical science, and chemistry teacher from New Jersey*

> Being able to get the videos already classified, broken down into the right-size chunks, and I can start where I need to start, end where I need to end, is fantastic. And I have shared this with my Professional Learning Community here and the district. And everybody really loves that site.
>
> *—10th–12th grade physics and physical science teacher from Iowa*

Teachers also found value in the supporting resources provided by the Teachers' Domain website, including the discussion questions, background essays, and links to state standards:

> I really like the questions they tack on the end of the videos. I'm not real good about how to do questions and discussions following a video sometimes. And so that really helped me to follow through and get the kids to thinking more in terms of what's going on and more in-depth.
>
> *—9th–12th grade physical science, biology, earth science, and environmental science teacher from Arkansas*

> The fact that the state standards that are being met are immediately accessible is wonderful and very teacher friendly. I shared the website with my principal, who in turn shared it with our entire staff.
>
> *—9th grade physics teacher from Michigan*

Navigability

In addition to the quality of the resources themselves, teachers liked the ease with which they could navigate the Teachers' Domain website. They thought it was well-organized and easy to search and use. Teachers also appreciated that the downloadable videos can be used with a weak or non-existent Internet connection. The comments below illustrate how the ease of navigability benefited planning and teaching:

> I don't have hassles or problems with [Teachers' Domain]. It is easier to use in general, and specifically it is easier to find stuff, to download videos, to write my own questions, and to integrate it into my lesson plans.
>
> *—9th–12th grade physical science, biology, earth science, and environmental science teacher from North Carolina*

> I am also pleased that the videos are so well categorized and easy to locate. I've shared this resource with many other science teachers in the district.
>
> *10th–12th grade physics and physical science teacher from Iowa*

Teachers' Domain challenges and recommendations

A small subset of teachers offered suggestions for improving the Teachers' Domain website:

1. *Link Next Generation Science Standards to video resources.*
   Teachers thought it would be easier to find relevant lesson plans and activities if they were linked to the Next Generation Science Standards.

2. *Provide closed-captioning for all videos.*
   One teacher of hearing-impaired students suggested having closed-captioning for all videos. In fact, she said it would be "breaking the law" in her state to show videos without captions. While the videos without closed captioning do provide a transcript, that delivery mode is more time consuming and not preferred by students.

3. *Provide additional sort categories for searching.*
   One teacher wanted additional search functions on the Teachers' Domain website that would allow them to search by 'explanatory' videos and 'phenomenological' videos. They wanted to be able to distinguish between videos that teach and those that support students in figuring something out on their own.

Teachers' responses from the final survey suggest that they would like more explicit instructions to help orient them to the Teachers' Domain website. Fifty-five percent of teachers wanted a description of the kinds of resources available on Teachers' Domain, 41 percent wanted guidance on how to find resources on the site, and 36 percent indicated that a general tour of the website would have been useful.

CONCLUSION AND RECOMMENDATIONS

The online teacher professional development module, *Powerful Learning with Digital Media in the Physics Classroom,* effectively introduces teachers to the Frame, Focus, Follow-up (FFF) strategies for integrating digital media into the classroom, and provides reinforcement for teachers already familiar with the strategies. Through their revised lesson plans, study participants demonstrated that they gained an understanding of how to apply the strategies in their teaching. A number of teachers quickly began using the strategies with their students, and reported a positive impact. Furthermore, after completing the PDM teachers had a greater appreciation of the instructional value of video.

Recommendations for Future Professional Development Modules

Develop additional PD modules that focus specifically on using video to differentiate instruction, assess student learning, and promote student collaboration. These important topics are addressed in *Powerful Learning with Digital Media in the Physics Classroom,* but with less emphasis and less impact on study participants than the Frame, Focus, and Follow-up strategies. Creating a concise and narrowly focused module for each of these other concepts may prove more effective.

Include short videos of teachers implementing each aspect of a new strategy. Participants in this study (and in previous focus groups) were particularly interested in seeing how other teachers managed specific situations, such as asking students guiding questions.

Include examples of high quality lesson plans. Consider using a lesson plan that does not use the strategies addressed in the PD and revising it to include them, tracking changes to demonstrate how teachers can adjust their own existing lessons.

Add reflection questions similar to those in the study's lesson plan questionnaire (see appendix). The questionnaire asked participants to describe each change they made in their revised lesson plans and explain why they thought it was an improvement. Several study participants commented that this process required them to reflect on their choices in ways that they would not otherwise have done, and that this reinforced what they had learned through the module.

Embed links to additional resources in the PDM. As noted in Feedback on the PDM, above, study participants felt this would be more convenient, and it is possible the resources will be more effective if users can access them at the time that they are working on a particular concept or strategy, rather than when they complete the module.

Recommendation for Further Research

To what degree do changes in teachers' planning translate into changes in classroom practice? The evaluation measured changes in teachers' planned lessons. It would be

useful to study the degree to which teachers are able to implement such changes in their classroom practice.

Recommendation for Promoting the Use of Video in the Classroom

Conduct professional development with principals and other instructional leaders. Several study participants mentioned that their school leaders did not value video as an instructional tool. Online or conference based PD sessions can help them understand how video and other digital resources can support teaching and learning.

APPENDICES

Appendix A: Teacher Recruitment and Sample Selection

To recruit study participants, researchers used several outreach strategies targeted to high school physics teachers with an interest in learning how to integrate digital media into their practice.

Strategies included:

New York area physics teachers conferences
EDC researchers spoke briefly and distributed flyers at the annual meeting of the New York State Section of the American Association of Physics Teachers (NYSS-AAPT) and the Long Island Physics Teachers Association fall conference.

Listservs and online forums
Researchers posted on four National Science Teachers Association (NSTA) listservs including the list for physics, physical science, pedagogy and general science. In addition, they posted a notice on NSTA's online Physical Science Learning Center Community Discussion Forum .

Flyers and posts invited interested teachers to fill out a brief online survey indicating their location, teaching background, and experience with digital media.

Of the 155 teachers who responded to the initial survey, 58 met basic selection criteria:

- Taught 9th, 10th, 11th, and/or 12th grade
- Taught physics, engineering or physical science[3]
- Indicated a novice or intermediate level of digital media use
- Indicated infrequent or moderate use of digital media

It was not clear whether another 58 respondents met the criteria for digital media use, and researchers asked these teachers to provide an example of how they typically used digital media in their classes. Twenty-five responded to this request and 16 of them met the criteria, leaving researchers with a pool of 74 potential study participants.

Researchers sent a formal invitation to those 74 teachers, along with a letter of agreement to participate, which 47 teachers signed and returned. Five teachers dropped out of the study, leaving a final sample of 42 teachers.

[3] One teacher included in the study was an exception to this criterion. This chemistry teacher was included because of an expressed interest in using simulations and video that engage students in science learning.

Appendix B: Intake survey

Inspiring STEM Educators Intake Survey

HIGH SCHOOL PHYSICS AND ENGINEERING TEACHERS WANTED!

EDC's Center for Children and Technology (CCT), a non-profit research and development company, is conducting an evaluation of a collection of digital teaching and learning resources for high school physics and engineering classes. The collection was developed by WNET, and includes a series of online, self-paced professional development modules for teachers.

The evaluation will take place in January and February, 2013. Participating teachers will write two lesson plans, review one of the professional development modules, and participate in a phone interview, and will receive a stipend of $250.

If you are interested in participating in the evaluation, please answer the questions on the next page. Teachers with little or moderate experience using digital media objects will be the best fit for the study. We will contact you shortly with more information.

1. Do you teach high school physics or engineering?
___Yes
___No

2. How many years have you been a teacher?
___3 years or less
___4-6 years
___7-10 years
___10-15 years
___more than 15 years

3. How many years have you taught physics or engineering?
___3 years or less
___4-6 years
___7-10 years
___10-15 years
___more than 15 years

4. What grade levels do you teach?
___9th
___10th
___11th
___12th
___Other (please specify)

6. Are you interested in learning how to use digital media more effectively with your students?
___Yes
___No

7. How would you rate your current ability to integrate digital media into your teaching?
___Highly proficient
___Approaching highly proficient
___Somewhat proficient
___Not proficient

8. On average, how frequently do you integrate digital media into your lessons?
___Daily
___Weekly
___Monthly
___Once or twice a semester
___Never

9. Please describe a typical lesson in which you use digital media with your students. Tells us what types of video or simulations you use (if any) and the steps involved in these kinds of lessons.

10. Please share some background information with us.
Your name:
School name:
School city/town:
School zip:
Your Email address:
Your Phone number:

11. How did you hear about the Inspiring STEM Teachers study?

Appendix C: Lesson-planning template

Inspiring STEM Educators:
The evaluation of an online professional development module

Lesson Plan Template

Note: The text boxes expand. Their size should not dictate how much or how little you write. They are included merely to indicate that you should write your lesson plan directly into this document.

YOUR NAME

LESSON TITLE

GRADE LEVEL

TIME ALLOTMENT

Specify the number and length of class periods.

DIGITAL RESOURCE USED

Identify the NASA resource you chose from the list provided, and briefly explain why you decided to use it.

OVERVIEW

Provide a brief description of the lesson and how it fits in your curriculum.

LEARNING OBJECTIVES

List specific curriculum objectives and student outcomes.

Students will know/be able to:

- Objective
- Objective
- Etc.

STANDARDS (optional)

If you typically reference standards in your class planning, list national or state standards that are addressed in the lesson. Indicate the source of the standards used in your lesson and provide the URL, if possible.

MATERIALS

List the resources required for the lesson. For digital resources, aside from the one you chose from the list for this assignment, include sources and/or URLs.

ACTIVITIES

Divide each activity into numbered steps.

Include Introductory, learning, and culminating activities, as appropriate, as well as any extensions and/or variations for differentiation.

Provide as much detail as possible, especially around the use of the digital resource. For example, if an introductory activity is a discussion with the whole class, how would you facilitate the discussion and what kinds of questions would you ask? If an activity involves small group work, how would you assign groups and organize their interactions? In addition to the resource from Teachers' Domain, specify any other digital resources, technology tools, websites, etc, that students would use.

PLANNING RESOURCES

List any teacher resources you used in planning your lesson.

Appendix D: Lesson plan revision instructions

Email instructions for revising the NASA lesson plan

Thanks for completing the PD module. Now it is time for the next step!

Rather than writing a new lesson plan, your assignment is to revisit the lesson plan you created for task 1 (attached). Now that you have completed the professional development module, *Powerful Learning with Digital Media in the Physics Classroom,* would you do anything differently?

Please revise your original lesson plan accordingly, using ***track changes*** (in the Microsoft Word Tools menu) so we can follow your thinking.

When you have finished your revisions, fill out this online questionnaire https://www.surveymonkey.com/s/56GDFMN.

The deadline for completing the questionnaire and sending us your revised lesson plan is **Monday, February 18.**

As always, be in touch with any questions.

Appendix E: Lesson plan questionnaire

Inspiring STEM Educators Questionnaire

Welcome to the fourth step in the Inspiring STEM Educators study!

Once you have finished the professional development module, reviewed your lesson plan, and completed any changes you want to make, please answer the following questions.

1. First and last name: _____

2. Grade level your lesson was created for:_____

3. Name of the class your lesson was created for:_____

4. Time allotment: _____

5. Digital resource used:
___Beyond Einstein
___Colliding Neutron Stars Create Black Hole and Gamma-ray Burst
___Einstein's Cosmic Speed Limit
___Blacker than Black
___Dust-Proofing the Mars Rover
___Fluid Dynamics
___Counting Neutrons on the Moon
___Mass Spectrometry 101___Meet Carrie Anderson: Taking on Titan
___Thunderstorms Produce Antimatter
___Mass vs. Weight: Air Powered Mass
___Teaching from Space: Centripetal Force
___Teaching from Space: Surface Tension
___Teaching from Space: The Bernoulli Principle

6. Did you make any changes to the OVERVIEW section of your lesson plan?
___Yes
___No

7. Please explain your changes to the OVERVIEW section and why you think they are an improvement:

8. Did you make the changes because of something you saw or learned in the professional development module, Powerful Learning with Digital Media in the Physics Classroom?

___Yes
___No

9. If yes, what in the module prompted you to make the changes?

10. Did you make any changes to the LEARNING OBJECTIVES section of your lesson plan?

___Yes
___No

11. Please explain your changes to the LEARNING OBJECTIVES section and why you think they are an improvement:

12. Did you make the changes because of something you saw or learned in the professional development module, Powerful Learning with Digital Media in the Physics Classroom?

___Yes
___No

13. If yes, what in the module prompted you to make the changes?

14. Did you make any changes to the STANDARDS section of your lesson plan?

___Yes
___No

15. Please explain your changes to the STANDARDS section and why you think they are an improvement:

16. Did you make the changes because of something you saw or learned in the professional development module, Powerful Learning with Digital Media in the Physics Classroom?

___Yes
___No

17. If yes, what in the module prompted you to make the changes?

18. Did you make any changes to the MATERIALS section of your lesson plan?

___Yes
___No

19. Please explain your changes to the MATERIALS section and why you think they are an improvement:

20. Did you make the changes because of something you saw or learned in the professional development module, Powerful Learning with Digital Media in the Physics Classroom?

___Yes
___No

21. If yes, what in the module prompted you to make the changes?

22. Did you make any changes to the ACTIVITIES section of your lesson plan?
___Yes
___No

23. Please explain your changes to the ACTIVITIES section and why you think they are an improvement:

24. Did you make the changes because of something you saw or learned in the professional development module, Powerful Learning with Digital Media in the Physics Classroom?
___Yes
___No

25. If yes, what in the module prompted you to make the changes?

26. Did you make any changes to the PLANNING RESOURCES section of your lesson plan?
___Yes
___No

27. Please explain your changes to the PLANNING RESOURCES section and why you think they are an improvement:

28. Did you make the changes because of something you saw or learned in the professional development module, Powerful Learning with Digital Media in the Physics Classroom?
___Yes
___No

29. If yes, what in the module prompted you to make the changes?

30. Please share any additional thoughts you may have about the Inspiring STEM Educators study, the digital resources, or your lesson plans here:

Thank you so much for completing this questionnaire!

Please be sure to send your revised lesson plan to Elizabeth Pierson: epierson@edc.org.

We will contact you shortly to schedule a follow-up telephone interview.

Appendix F: Interview protocol

Name:
School:
Interview Date:

General questions for all interviews

1. How long did it take to complete the PD module?
2. Overall, what would you say you gained from the module?
3. What was most helpful about the PD module?
    - What was most effective in helping you learn?
    - What concepts were most useful?
4. What about the PD module did you find least useful?
5. How often did you use video in your classes before participating in this study?
6. Since viewing the PDM, are you more likely to integrate digital media objects into your teaching? Please explain your answer.
7. Did you use any part of FFF in your teaching pre-PD module?
8. Since viewing the PDM, are you more likely to FFF in your teaching? Please explain.
9. Did you learn anything that is not reflected in your lesson plan?

Lesson plan specific questions

1. [To be drawn from the teachers' lesson plan revisions]

Questions for teachers who have utilized their lesson plan.

1. Have you been able to use the lesson yet with students? If yes, follow questions from below. If no, do you plan on using it? When? Is there any reason in particular that you have chosen not to implement it yet?
2. When or how long ago did you use your revised lesson plan with your students?
3. How did it go? Did it change your thinking about what you learned from the PD?
4. How did the lesson compare to similar lessons you've done in the past? Did student react differently?
5. What was easier or more challenging to implement than similar lessons you've done? Why?
6. What was the impact on students? [probes: were they more/less engaged than usual? In conversation, did they offer more sophisticated/accurate/comprehensive understanding? Did they retain more information? Etc.]

Wrap up

1. Is there anything we haven't asked about that you would like to tell us?
2. [If there's time] Do you have any recommendations to improve the PD?

Appendix G: Final survey

Inspiring STEM Educators Study-Final Teacher Survey

Thank you for all your hard work on the evaluation study of the online teacher professional development module, Powerful Learning with Digital Media in the Physics Classroom! This survey is the last step in the process. It should take ten to fifteen minutes to fill out, and it will provide us with important information on the effectiveness of the PD module. We encourage you to use the text boxes to include as much detail as possible in your responses. Thanks, again! Elizabeth and Laura

1. First and last name: _____

2. Please indicate how much you agree or disagree with each of the following statements regarding the online teacher professional development module, Powerful Learning with Digital Media in the Physics Classroom (PD module):

	Totally disagree	Disagree somewhat	Agree somewhat	Totally agree	I don't know
I learned something useful from the PD module.					
The PD module helped me to think differently about how I group students when using media in my lessons.					
As a result of the PD module I am more likely to integrate digital media into my teaching.					
As a result of the PD module I am more likely to use the Frame/Focus/Followup approach when using digital media with students.					
As a result of the PD module I will provide more opportunities for my students to collaborate.					

3. Have you been interviewed by the EDC evaluation team (Laura Jeffers or Elizabeth Pierson)?

Yes___ No___

4. About how long did it take you to complete the PD module?

___Under half an hour
___30-60 minutes
___60-90 minutes
___90-120 minutes
___More than two hours

5. Overall, what would you say you gained from the PD module?

6. Which components of the PD module were <u>most</u> effective in helping you learn? (check all that apply)___The video clips of teachers teaching
___The video clips of students interacting with digital resources
___The video clips of student interacting with one another
___The downloadable PDF templates and guides
___The NASA video clips
___The text on each slide
___The Phet simulation clips
___The pace
___The reflection questions
___The note-taking feature
___The ability to go back and review sections
___Other (please specify)

7. Which components of the PD module were <u>least</u> effective in helping you learn? (check all that apply)

___The video clips of teachers teaching
___The video clips of students interacting with digital resources
___The video clips of student interacting with one another
___The downloadable PDF templates and guides
___The NASA video clips
___The text on each slide
___The Phet simulation clips
___The pace
___The reflection questions
___The note-taking feature
___The ability to go back and review sections
___Other (please specify)

8. If you checked any of the answer choices in question 7, please explain.

9. On average, how often did you use video in your classroom before participating in this study?
___Daily
___Weekly
___Monthly
___Once or twice a semester
___Never

10. Since completing the professional development module are you more likely to use video in your classroom?
___Yes
___No

Please explain.

11. Before participating in this study, did you use any part of the "Frame, Focus, Follow-up" approach in your teaching?
___Yes
___No

12. Since completing the professional development module, are you more likely to use any part of the "Frame, Focus, Follow-up" approach in your teaching?
___Yes
___No

Please explain.

13. Have you used your REVISED lesson plan with your students?
___Yes
___No

14. Have you used any of the strategies or resources you learned about in the PD module with your students?
___Yes
___No

15. How did the lesson(s) compare to other lessons you have done on the same topic? (Check all that apply)

___It was about the same
___It was easier to implement
___It was more challenging to implement
___Students enjoyed the lesson more
___Students were more distracted
___Students were more engaged
___Students were more confused about the concept(s)
___Students understood the concept(s) better
___Students retained the information better
___Students asked better questions
___Students engaged in higher level of discussion
___N/A
___Other (please specify)

16. If you were to do the lesson(s) again, would you do anything differently?
___No
___N/A
___Yes- please explain

17. Have you recommended the PD module to others?
___Yes
___No
If Yes, to whom did you recommend the PD, and why?

18. Have you recommended the Teachers' Domain website to others?
___Yes
___No
If Yes, to whom did you recommend Teachers' Domain, and why?

19. What other kinds of professional development resources would be useful to you? (Check all that apply)
___Specific strategies for using digital media with students
___Video clips of teachers modeling specific strategies
___Videos of students interacting with digital media
___A general tour of the Teachers Domain website
___A description of the kinds of resources available on Teachers Domain
___Guidance on how to find resources on Teachers Domain
___Links to additional resources
___Other (please specify)

20. Which of the following best describes your school district?

___Urban
___ Suburban ___Rural
___Mixed
___Other (please specify)

21. Approximately how many students are in your district?

___0-250
___251-500
___501-1,000
___1,001-2,000

___2,001-3,000
___3,001-4,000
___4,001-5,000
___Over 5,000

22. Approximately how many students are enrolled in your school?

___0-250
___251-500
___501-1,000

___1,001-2,000
___2,001-3,000
___3,001-4,000
___4,001-5,000
___Over 5,000

23. Please share any additional comments or suggestions you may have about the PD module, about Teachers' Domain, or about the research study.

Appendix H: Full list of teachers' geographical locations

Teacher geographical locations

State	Number of teachers
Alabama	1
Arkansas	1
Arizona	1
California	3
Florida	4
Georgia	1
Iowa	3
Illinois	1
Massachusetts	1
Maryland	1
Maine	1
Michigan	5
Missouri	2
Mississippi	1
North Carolina	3
New Jersey	2
New York	1
Rhode Island	2
South Carolina	1
Tennessee	1
Texas	1
Vermont	2
Washington	1
West Virginia	1