Student and Teacher Perspectives in Kerala on Integration of Instructional Strategies in Higher Secondary Physics

Mini Narayanan.,

&

Abdul Gafoor K.,

2017

Innovations and Researches in Education
Volume 7(1). 39-52. ISSN-2231-4148

Student and Teacher Perspectives in Kerala on Integration of Instructional Strategies in Higher Secondary Physics

Mini Narayanan* & Prof. (Dr.) K. Abdul Gafoor**

Abstract: Physics educators generally seek the best approach to make learning process effective for learners. The major objective of this study is to verify the extent of using inquiry-based instructional strategies in higher secondary physics classrooms, and to support the use of inquiry-based instructional strategies to effectively describe the nature of physics. Typical instructional strategies implemented in the higher secondary physics classrooms are explored, and their effectiveness is verified for improved conceptual understanding and positive attitude. Difference between perceptions of students and teachers about the currently adopted classroom practices, and lack of effective implementation of inquiry-based strategies are evidenced. Responses further reveal that most of the key issues that teachers face can be controlled by teachers themselves. Authors analyze perception, preference, and pros and cons on current instructional strategies qualitatively, and indicate the need of a modified strategy for better learning.

Students around the globe consider learning physics because it is included in the curriculum and is needed for graduation. A common tendency among students is to opt out of physics if they require to take two sciences only for graduation (Education Commission, 2017; Williams et al., 2003). The difficulty for students to grasp physics concepts stem from the way it is taught (Redish, 1994). The scenario is not entirely different in the case of students in India. A recent study on attitude toward physics among higher secondary school students in North India reveals that physics is taught as a theoretical monologue in India with significant emphasis on formulas and derivations (Sharma, Ahluwalia, & Sharma, 2013) and concluded that these students do not possess an expert's expectations even after

*Research Scholar, Department of Education, University of Calicut, Kerala State, India.
**Professor, Department of Education, University of Calicut, Kerala State, India.

instruction, leading to a deterioration in motivation. Educators are required to improve the teaching/learning environment by bringing a balance between traditional and research-based instructional strategies particularly at the higher secondary level.

Every teacher needs a repertoire of instructional strategies. Most of the strategies developed based on researches and theories that support the active involvement of students in the learning process were student-centered (Chang & Mao, 1999; Hakkarainen, 2003; Schwartz et al., 2004). An array of instructional strategies ranging from direct instruction to inquiry-based have been implemented for more than three decades to improve the learning environments (Brewe et al., 2010; Hodgson & Pyle, 2010; Kock, et al. 2013; McDermott, et al. 2000; Napoli, 2004; Schwartz et al., 2004). Efficient teachers use a broad array of instructional strategies depending on the nature and difficulty level of the content and the type of learner (Dancy & Henderson, 2010). Based on this background information, authors made an investigation on the pedagogical practices in the higher secondary physics classrooms in India. The study will create an awareness of inquiry-based instructional strategies among students, teachers, practitioners and researchers in physics education.

Rationale for the study: Wholesome learning requires integrated instruction

Learning physics concepts and enjoying the process is directly related to the ability to understand abstract ideas (Redish, Saul & Steinberg, 1998; Yerdelen-Damar&Elby, 2016). The lack of enjoyment in learning physics keeps students, especially for females, away from accepting careers and opportunities for higher education in related areas (Gafoor, 2013; Hazari, et al. 2010; Martin, Mullis, & Foy, 2008; Walper et al., 2014). For most students, learning physics is to simply get qualified in other science fields or for the years of their higher education (Erinosho, 2013). Suitable pedagogical practices can improve student performance and persistence in learning physics (Henderson, Beach & Finkelstein, 2011). However, the role of teachers in effective learning is a contentious issue as the relationship between teaching and learning is complex in the modern era of education. According to radical constructivists, teachers must never "teach" students; all knowledge must be constructed independently through their experience and interaction with the environment (Glasersfeld, 2006). On the other hand, science instruction has been found ineffective when students construct inaccurate knowledge without the appropriate involvement from their instructors. Teachers,

beyond becoming "facilitators", are required to design multiple possibilities for their students to create favorable results in achievement and attitude (Sliško, 2016).

What role do teachers have in effective physics learning? Teachers can overcome the mental barrier toward physics with appropriate strategies (Stokking, 2000; Lavonen et al., 2007) and judicious mix of approaches. Students acknowledge the value of activities that require higher cognitive skills over drill-type exercises. Large proportion of students favor multiple learning styles (Langley & Eylon, 2006). Effective teaching creates healthy and meaningful connections between students' prior knowledge and new understandings. A sound basis of factual knowledge and a flexible understanding is required to apply learning in novel contexts. Using an array of instructional strategies depending on the nature of content and learner can make the teaching/learning process proficient (Wilson & Peterson, 2006).

Objectives and research questions

This study aims at verifying the aforementioned weaknesses of the physics classrooms with reference to Kerala. In addition, this study by verifying responses of both students and teachers, seeks ways to implement the combination of instructional strategies in classrooms to create positive attitude and interest in physics learning. The authors gather perception, preference and difficulties on learning physics from both students and teachers. Responses from both students and teachers in India could verify the remarks made by overseas authors on the teaching-learning environment of physics in Indian higher secondary schools.

The research questions include:

1. Is there less interest toward physics, than other sciences, among higher secondary students opting science as elective in Kerala?

2. How frequent is inquiry-based instructional strategies in the physics classrooms in Kerala?

3. What perceptions do students as well as teachers possess on the effectiveness of currently adopted teaching strategies?

4. What barriers prevent educators from implementing inquiry-based instructional practices in classrooms?

5. To what extent, can teachers control the parameters of an effective teaching/learning environment?

Methodology

A qualitative approach with a structured interview as the data collection method is adopted for this study. Qualitative methods in exploratory research use of open ended questions and probing (Mack, Woodsong, MacQueen, Guest, & Namey, 2005). The participants have the opportunity to respond to the questions in their own words. The participants were teachers and students of physics in higher secondary schools that are randomly selected from three districts in Kerala. The questionnaire consisted both dichotomous and open-ended questions. Dichotomous responses from students and teachers were compared using Pearson Chi-square and the asymptotic significance (two-sided). Qualitative analysis was used in examining the responses for open-ended questions. During the interviews, students have been thoroughly explained what each of the instructional strategies are and how they are implemented in classrooms.

Perception, preference, and pros and cons in the implementation of various instructional strategies have been analyzed from perspectives of both students and teachers. The participants were the students of physics in five randomly selected higher secondary schools in the districts of Trivandrum, Thrissur and Kannur. A total of 121Grades 11 and 12 students (45 male & 76 female), who selected science as their optional subject participated in the interview. Eighty-two teachers of physics from the above districts were also interviewed to collect information on current practices, preferences, difficulties, personal opinions on physics instruction. The teachers chosen had experience ranging from one year to 33 years. Gender difference and years of experience were not considered for the teachers and students in this study.

Results and Discussion

There is less interest toward physics among students.

The student interest in physics is found to be significantly lower compared to their interest in science in general ($\chi 2 = 5.18$; $p < 0.05$), which is in favor of several research findings. Almost all (96%) students say they are interested in science, whereas, only 44 percent of them stated that they are interested in physics. Research in science/physics education all over the world describes that students perceive physics as a difficult subject and possess lower expectations of their ability (Checkley, 2010; Lavonen et al., 2007). Responses on open-ended questions reveal that students study physics as it is one of the science subjects in the curriculum and

is needed for graduation. Prime reasons indicated are ineffective instruction, lack of practical illustrations, inadequate coverage of required concepts, and lack of addressing complexities due to nature of the subject.

Teachers claim wide use of multiple instructional strategies; students perceive more lecturing

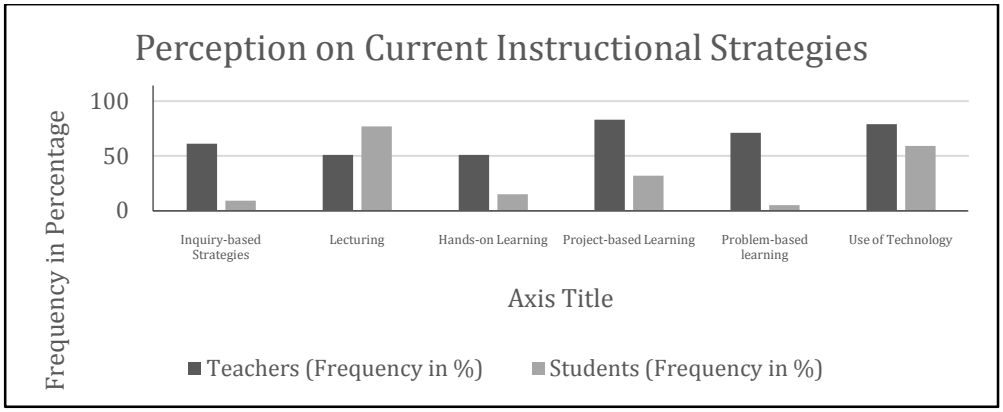

***Figure** 1.* Perception of students and teachers on current practice of instructional strategies

Teachers and students do not agree in the current implementation of instructional strategies. For example, 61% of the teachers express that they implement research-based instructional strategies in classrooms. However, students do not perceive them as innovative and inquiry-based strategies. The major strategy from student's perception is "Lecturing with note-taking. In addition, there is a huge difference, 40% and 82%, in perceiving problem-based learning by students and teachers. This disparity might be due to inconsistency in implementing the problem-based learning strategy in its real sense. Majority of teachers conceive working on problems under teacher guidance as problem-based learning. Figure 1 depicts that students and teachers disagree in perceiving the current classroom strategies.

Since students indicated instructional practices as one of the major deficiencies, the nature of the existing instructional strategies, responses from both students and teachers was verified. A list of the popular instructional strategies that are student-centered and inquiry-based were given to the students and teachers along with the traditionally teacher-centered strategies. The Chi-square analysis (Table 1) reveals that there is a significant difference between the responses from students and

teachers on the nature and scope of the currently implemented instructional strategies.

Table 1

Responses from students and teachers on instructional strategies

N = 203 (82 teachers and 121 students)

Measuring item	Teachers (Frequency in %)		Students (Frequency in %)		$\chi 2$
	Yes	No	Yes	No	
Familiar with Inquiry-based Instructional Strategies	61	39	9	91	62.6*
Lecturing	51	49	77	23	14.42*
Hands-on Learning	51	49	15	85	31.01*
Project-based Learning	83	17	32	68	50.4*
Problem-based learning	71	29	5	95	97.95*
Use of Technology	79	21	59	41	9.37*

Teachers can control most of the measures for improving physics instruction

Analysis of student and teacher responses calls for a thorough investigation of the current pedagogical practices. A common thread of preferred instructional strategies is found in their responses, emphasizing the role of teacher in making physics learning effective and motivating. Efficient student-centered instructional strategies that are inquiry-based with increased teacher participation are suggested. As shown in Tables 2 and 3, responses from both students and teachers are categorized into strategies under/beyond teacher control. The teacher responses are further categorized into measures that can be done within/outside curriculum. It is worth mentioning that most of them are common to students and teachers, and can be controlled and implemented by teachers on their own within the physics curriculum. However, a thorough justification and support would be necessary to convince teachers to have a modification on their perception of improving/modifying the present conditions in physics classrooms.

Table 2

Measures on improving student interest in physics: Students' perspective

Strategies under teacher control	Strategies beyond teacher control
Hands-on activities while lecturing	Slower pacing in explaining each concept
Problems to illustrate concepts in a concrete manner	Avoid confusing derivations and theorems.
Make students think about the application of a particular concept	More visuals and animations
Reproduce activities and experiments mentioned in textbook	
Use more than one textbook	
Teach the material with more ease rather than being serious.	
Materials should not be forced to memorize.	
Implement a strategy to develop love towards physics	
Lectures with student involvement	
Having a constant routine of instructional activities	

Table 3

Measures on improving student interest in physics: Teachers' perspective

	Strategies under teacher control	Strategies beyond teacher control
Measures that can be modified through instructional practices within curriculum	Reduce pacing	Reduce syllabus
	More activity-based instruction	Reduce class size
	Student-centered activities	Improved facilities
	Use Problem-based Learning	More use of technology for teaching
	Provide more demo with lecturing	More duration for class periods
	Introduce application of physics	Flexible syllabus
	Curriculum-based lab work	Provide adequate lab facilities
	Provide real life	Mathematics and physics

	examples	to be taught together
	Adopt different instructional strategies	More exposure to higher level mathematics
	Projects on recent developments in physics	Establish pre-requirements for opting science
	Deliver material in a simplified manner	Provide students guidance in selecting options
Measures that can be modified within and/or outside curriculum	Introduce self-learning strategies	Modify curriculum based on student level
	Encourage conceptual learning	Reduce breadth and focus on depth
	Awareness on current developments	
	Encourage students who are not motivated	
	Discourage memorization	
	Provide individual attention	
	Be friendly and consider student opinions	

Teachers demand infrastructural modification for implementing research-based instructional strategies

While students do not perceive the current practices as the best and most effective, teachers present their difficulty in implementing research-based instructional strategies due to infrastructural issues. Analysis of the responses reveal that there is an inevitable need of making teachers prepared to implement an inquiry-based platform in their physics classrooms within the limitation of these aforementioned concerns. As suggested by the research findings for the past few decades, teachers' instructional strategies make a substantial difference on the effectiveness of students' physics learning (Walper, et al.2014; Logan & Skamp, 2008; House & Telese, 2008; Mualem & Eylon, 2009). While majority of these measures can be controlled, modified and implemented by the teachers themselves, there seems to be a strong belief among teachers that these measures are mainly infrastructural

limitations. Time constraint, breadth of syllabi, modern technology in classrooms and class size are the major teacher concerns that are beyond their control.

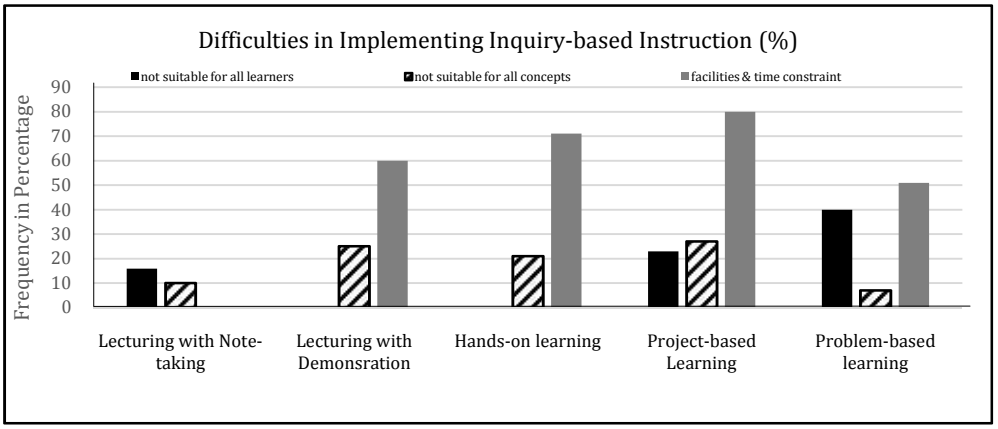

Figure 2. Difficulties presented by teachers in implementing Inquiry-based instruction

As shown in Figure 2, responses from teachers are found contradictory because they state that they use innovative research-based instructional strategies, but, at the same time, reveal the difficulties in implementing them. Data evidenced that teachers are aware of the effectiveness of the innovative strategies. Teachers explain their difficulty for adopting such research-based strategies widely is due to lack of facilities, time constraint, learner's difficulty to grasp, and inadequacy in teaching certain concepts. Further qualitative analysis of teacher responses reveal that teachers do not possess a profound knowledge on strategies like Problem-based learning (PBL), which has been widely used all over the world (Duch, Groh, & Allen, 2001;Perrenet, Bouhuijs, & Smits, 2000).

The major difficulties on implementing inquiry-based instructional strategies from teachers' perspective are listed in Figure 2. It is worth mentioning that students in India have three consecutive years of physics in high school and receive two more years of instruction at the higher secondary level. In the meantime, students from many other countries receive a maximum of two years of physics instruction during their 8^{th} to 12^{th} grades. Therefore, the authors make the argument that a properly designed curriculum with the implementation of more inquiry-based instructional strategies could make physics learning effective and enjoyable for students from earlier grade levels. A modified instructional approach that is a combination of activity-oriented, student-centered and inquiry-based strategies along with the

routine teacher-centered strategies like lecturing and lecturing with demonstrations is required to improve the learning scenario and spark motivation among students. The findings further imply that both students and teachers support such strategies and the change could be made possible by encouraging teachers to find out the applicability of varied instructional strategies without a noticeable modification in the infrastructure.

In this study, it is noteworthy that majority of strategies put forward by students as well as teachers are integrated in nature, which provides significance to student-centered strategies with a prominent teacher involvement. In addition, most of those integrated strategies can be controlled by teachers themselves in their classrooms.

Conclusion and Implications

This study attempted to evaluate the perceptions of students and teachers of higher secondary schools in Kerala regarding the teaching/learning difficulties and concerns of physics. The findings shed light on figuring out the key issues that teachers face in implementing student-centered instructional strategies in physics classrooms. Although teachers admit that they try to include innovative student-centered strategies, due to the breadth of curriculum, and limitation in time and facilities they are forced to use the traditional strategies more often. However, students disagree with the teachers' claim of using newer strategies in classrooms. In their perspective, the usual practices of lecturing, note-taking and problem-solving are dominant no matter what topic is presented. Both students and teachers identified similar teaching/learning difficulties and topics of difficulty.

Students call for more student-centered teaching strategies along with the routine traditional practices to improve the learning environment. The lab activities currently given are perceived as insufficient and uninteresting due to their "cookbook style" in spite of having inquiry-based activities. Many schools do not provide any hands-on experience to their grade 11 students due to time constraints despite the fact that "Mechanics" is extremely hard to understand without having hands-on activities. Students do not receive a concrete background of the related concept through lab activities as the concept taught in class and the concept learned through the lab activities are not correlated. The responses from students echoed the need to reinstate the nature of physics to students through the instructional tactics. The common concept of 'physics is mathematics' must be reconsidered upon providing teaching strategies by which students make concrete understanding of concepts.

As far as the teachers are concerned, students opting science lack the basic pre-requisites. Based on the interviews, authors realized that students do not receive proper guidance in mastering the concepts in earlier grade levels. Many students choose to take science even without enough fundamental knowledge or interest, or even without a proper academic goal. As only one type of physics course is allowed during their higher secondary level, physics given to a student opting engineering for higher education is the same as that given to a student opting for paramedical course. Teachers find it exceptionally difficult to teach a large group of students of various ability levels and academic objectives in a very short duration by integrating multiple instructional strategies.

Teacher's content knowledge and curriculum background can have a major impact on student attitude toward physics (House & Telese, 2008). As findings of this study indicates, despite exemplary knowledge in the content area, teachers' pedagogical knowledge and disposition in implementing various classroom practices are worth investigating. Hence, this study calls for the implementation of an instructional strategy which is effective, motivating, useful and manageable with the existing facilities. Such a thoughtful and properly designed instructional strategy based on students' perceptions on teaching and learning physics could benefit them in changing or modifying beliefs and attitudes toward the subject. These findings will be shared with the teachers, emphasizing that most of the difficulties could be controlled by themselves.

References

Brewe, E., Sawtelle, V., Kramer, L. H., O'Brien, G. E., Rodriguez, I., &Pamelá, P. (2010). Toward equity through participation in Modeling Instruction in introductory university physics. *Physical Review Special Topics-Physics Education Research*, *6*(1), doi: 10.1103/PhydRerSTPER.6.010106.

Chang, C. Y., & Mao, S. L. (1999). Comparison of Taiwan science students' outcomes with inquiry-group versus traditional instruction. *The Journal of Educational Research*, *92*(6), 340-346.

Checkley, D. (2010). *High school students' perceptions of physics* (Doctoral dissertation, Lethbridge, Alta.: University of Lethbridge, Faculty of Education, 2010).

Dancy, M., & Henderson, C. (2010). Pedagogical practices and instructional change of physics faculty. *American Journal of Physics*, *78*(10), 1056-1063.

Duch, B. J., Groh, S. E., & Allen, D. E. (2001). Why problem-based learning. *The power of problem-based learning*, 3-11.

Erinosho, S. Y. (2013). How do students perceive the difficulty of physics in secondary school? An exploratory study in Nigeria. *International Journal for Cross-disciplinary Subjects in Education (IJCDSE)*, *3*(3), 1510-1515.

Gafoor, K. A. (2013). Differences in students' interest in physics by gender and stage of schooling in Kerala. *Journal of Indian Education, 39* (2), 99-107.

Hakkarainen, K. A. I. (2003). Emergence of progressive-inquiry culture in computer-supported collaborative learning. *Learning Environments Research*, *6*(2), 199-220.

Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M. C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching*, *47*(8), 978-1003.

Henderson, C., Beach, A., & Finkelstein, N. (2011). Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. *Journal of research in science teaching*, *48*(8), 952-984.

Hodgson, C., & Pyle, K. (2010). *A literature review of Assessment for Learning in science*. Slough: Nfer.

House, J. D., &Telese, J. A. (2008). Relationships between student and instructional factors and algebra achievement of students in the United States and Japan: An analysis of TIMSS 2003 data. *Educational Research and Evaluation*, *14*(1), 101-112.

Kock, Z. J., Taconis, R., Bolhuis, S., &Gravemeijer, K. (2013). Some key issues in creating inquiry-based instructional practices that aim at the understanding of simple electric circuits. *Research in Science Education*, *43*(2), 579-597.

Langley, D., &Eylon, B. S. (2006). Probing High School Physics Students' Views and Concerns about Learning Activities. *International Journal of Science and Mathematics Education*, *4*(2), 215-239.

Lavonen, J., Krzywacki-Vainio, H., Aksela, M., Krokfors, L., Oikkonen, J., & Saarikko, H. (2007). Pre-service teacher education in chemistry,

mathematics and physics. *How Finns learn mathematics and science*, 49-68.

Mack, N., Woodsong, C., MacQueen, K. M., Guest, G., & Namey, E. (2005). *Qualitative research methods : a data collectors field guide.*USA: Family Health International.

McDermott, L. C., Shaffer, P. S., & Constantinou, C. P. (2000). Preparing teachers to teach physics and physical science by inquiry. *Physics Education*, *35*(6), 71-85.

Perrenet, J. C., Bouhuijs, P. A. J., & Smits, J. G. M. M. (2000). The suitability of problem-based learning for engineering education: theory and practice. *Teaching in higher education*, *5*(3), 345-358.

Redish, E. F. (1994). Implications of cognitive studies for teaching physics. *American Journal of Physics*, *62*(9), 796-803.

Redish, E. F., Saul, J. M., & Steinberg, R. N. (1998). Student expectations in introductory physics. *American Journal of Physics*, *66*(3), 212-224.

Sharma, S., Ahluwalia, P. K., & Sharma, S. K. (2013). Students' epistemological beliefs, expectations, and learning physics: An international comparison. *Physical Review Special Topics-Physics Education Research*, *9*(1),Doi:10. 1103/PhysRerSTPER. 9. 010117.

Sliško, J. A. (2016). Improving teaching design of active physics learning by using potentially helpful knowledge from other science fields. *Inovacije u nastavi-časopiszasavremenunastavu*, *29*(2), 1-14.

Smith, M.K. (1999). "The cognitive orientation to learning". Retrieved from http://infed.org/mobi/the-cognitive-orientation-to-learning/

Stokking, K. M. (2000). Predicting the choice of physics in secondary education. *International Journal of Science Education*, *22*(12), 1261-1283.

Von Glasersfeld, E. (Ed.). (2006). *Radical constructivism in mathematics education* (7) Springer Science & Business Media.

Walper, L. M., Lange, K., Kleickmann, T., & Möller, K. (2014). Students' physics-related interests in the transition from primary to secondary school–How do

they change and what instructional practices influence them. In *E-Book proceedings of the ESERA 2013 conference: Science education research for evidence-based teaching and coherence in learning. Part* (16).

Williams, C., Stanisstreet, M., Spall, K., Boyes, E., & Dickson, D. (2003). Why aren't secondary students interested in physics?. *Physics Education*, *38*(4).

Wilson, S. M., & Peterson, P. L. (2006). Theories of Learning and Teaching: What Do They Mean for Educators? Working Paper. *National Education Association Research Department*.

Yerdelen-Damar, S., & Elby, A. (2016). Sophisticated epistemologies of physics versus high-stakes tests: How do elite high school students respond to competing influences about how to learn physics?. *Physical Review Physics Education Research*, *12*(1), Doi: 10. 1103/PhysRerphysEducREs. 12. 010118.