Journal of Modern Education Review, ISSN 2155-7993, USA
April 2017, Volume 7, No. 4, pp. 231–241
Doi: 10.15341/jmer(2155-7993)/04.07.2017/001

http://www.academicstar.us

Teaching Physics with Blended Learning

Linghong Li, Hao Tony Tang
(Physics Department, the State University of New York at Potsdam, USA)

Abstract: Teaching physics with blended learning not only plays the leading role of a teacher but also meets the needs of independent learning. We share here the importance, practicality and efficiency of using blended learning in physics teaching. The aim of our developmental work is to design and test new ways of teaching physics. Our blended learning practice provides ideas for developing new ways of teaching to take advantage of everyday technologies and informs educators about the new technologies available for blended learning design, development, and implementation.

Key words: teaching physics, blended learning, design, development, implementation

1. The Theory of Blended Learning

"Connecting face-to-face teaching and learning with ICT (information and communication technologies) refers to blended learning, i.e., different ways to blend face-to-face teaching and different online tools" (Vesisenaho et al., 2010, p. 275). Blended learning based on an appropriate combination of learning theories such as behaviorism, cognitivism, and constructivism. The blended learning process includes five key ingredients: (1) Live Events: Synchronous, instructor-led learning events in which all learners participate at the same time, (2) Online Content: Learning experiences that the learner completes individually, at his own speed and on his own time, (3) Collaboration: Environments in which learners communicate with others, (4) Assessment: A measure of learners' knowledge. Pre-assessments can come before live or self-paced events to determine prior knowledge, and post-assessments can occur following scheduled or online learning events to measure learning transfer. (5) Reference Materials: On-the-job reference materials that enhance learning retention and transfer (Carmen, 2005). Blended learning focuses on optimizing achievement of learning objectives by applying the "right" learning technologies to match the "right" personal learning style to transfer the "right" skills to the "right" person at the "right" time (Singh & Reed, 2001). We all know the importance of the five "rights" in teaching, but how can we achieve them? Based on our practice of teaching physics with blended learning, we will present a concrete example of how these five key ingredients of blended learning have been used into practice to realize the five rights.

2. Implementation of Blended Learning in Physics Teaching

According to the blended learning process, an instructor can teach through a web-based classroom, and can

Linghong Li, Ph.D., Associate Professor, The State University of New York at Potsdam; research areas/interests: physics education. E-mail: lil@potsdam.edu.
Hao Tony Tang, M.S., Nutritionist. E-mail: h.tonytang@gmail.com.

also complete other teaching activities such as preparing lessons, assignments, grading, answering questions, etc. online. In addition to face-to-face classroom learning, students can freely finish other learning activities such as online learning, online homework, online questions, discussion and answering, etc. after class. We will show our practices from the following four areas: learning environment design, classroom teaching, online teaching and learning assessment.

2.1 Learning Environment Design

2.1.1 Platform Choice for Supporting Blended Learning

At present, the popular network-teaching platform includes: EduTools, Blackboard, Desire2Learn, and eCollege.com, etc. (Ko & Rossen, 2010, p. 411). What is already in place in your college or university? This question is the most important of all because you will choose the learning platform based on what the college or university already has. At our university, we use Blackboard. There is training in place for faculty, an orientation to prepare students for online learning and technical staff to support them. In addition, Blackboard provides a highly effective teaching and learning platform. By utilizing Blackboard solutions, academic leaders can improve the student's experience and promote greater achievement. While Blackboard provides students flexibility and help for different types of learners, faculty benefits from the efficiently afforded tools created to save educators time (Blackboard Inc., 2010). The Blackboard home page for one of our physics courses is shown in Figure 1: Blackboard home page. The home page includes: Announcements, Faculty Information, Syllabus, Course materials, Assignments, and Class Blogs. Announcements are used to notify students of assignment due dates, changes to course materials, exam dates, etc. Faculty Information provides students with quick access to instructor's contact information: name, phone number, office location, office hours, even photo and teaching and research works. Course materials include content such as handouts, PowerPoint presentations, images, Video, and any other course materials that the instructor wants to provide to students. Class Blogs created by the instructor is a place where the students can talk about anything that they want. They can exchange ideas and interpretations, ask questions, communicate and create their own materials, etc. All course members (students and instructors) can add blog entries and add comments to blog entries.

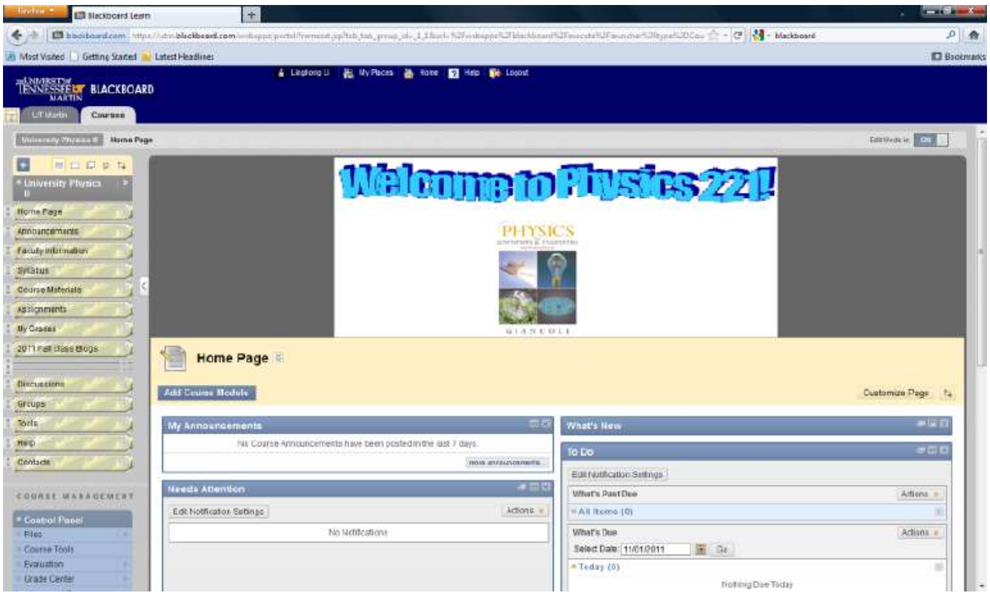

Figure 1 Blackboard Home Page

2.1.2 Resources Choice for Blended Learning Content

Popular textbooks used in U.S. and Canada written by Giancoli; Knight/Jones/Field; Rex/Wolfson; Walker; Wilson/Buffa/Lou; Young/Geller; Young/Freedman etc. (PearsonInc., 2011) include a supplementary electronic version of the textbooks, Test banks, online simulations, and online homework. All of them can be a useful resource for contents. We have been teaching physics with blended learning for many years. According to our students' characteristics, prior knowledge and learning preferences, we use the textbooks written by Giancoli (2009) shown as Figure 1. The text, which is written in a colloquial style, is an easy read. Each chapter starts with a page or two of the introductory theory and then immediately gets into the examples. It is an introduction to the basics of physics, which is suitable for students who have never taken physics before.

2.1.3 Design for Blended Learning

The selection, organization and primary presentation of course content as well as the design and development of learning activities and assessment are pivotal responsibilities for the instructor (Billigmeier, 2011). To effectively instruct, as an instructor, I attended many teaching activities to acquire knowledge and skills needed for my teaching job and myself. I attended the NSF (National Science Foundation] Sponsored Activity Based Physics Faculty Institute (ABPEFI) workshop (ABPEFI, 2011). I completed the course: How to Teach Online offered by the university and I took the i-Clicker Training (iclicker.com, 2011). After attending these activities, I gained the capacity to better connect with subject I am teaching. I adapted the new pedagogical knowledge and techniques into my teaching, forming a wide range of teaching strategies and interaction styles as follows: Online Lectures (Blackboard Tools: Study Guide, PowerPoint slides Presentation and Online Quiz); Interactive Demonstrations through Real-Time Vernier Hardware and Software; i-Clicker Concept Questions Practice; Virtual Laboratory Experiments (ActivPhysics^{TM}OnLine); Problem Solving (Online Homework: MasteringPhysics^{TM}, and Writing Project: lab report). All the above methodologies are used to promote student learning.

2.2 Classroom Teaching

Teaching each new topic/chapter starts with video as an introduction, each lecture will involve: live demonstration from Interactive Demonstrations Book, live examples with video clips from internet, and i-Clicker Concept Questions Practice from the textbook supplements.

2.2.1 Video

At the beginning of every new topic/chapter, we will let students watch a fifteen minute long DVD which is adapted from The Mechanical Universe, a video instructional series on physics. This series helps teachers demystify physics by giving students a visual representation to concepts. Dr. Richard Olenick, who spearheaded production of The Mechanical Universe, stated, "Instead of struggling over lifeless formulas, I wanted my students to experience the laws that govern the physical world. This method not only adds to the fun of teaching, but also enhances the joy of learning" (Olenick, 1993).

2.2.2 Live Demonstration

For the key concepts of each topic, we use Interactive Lecture Demonstrations (ILDs), which was created by a group of educational reformers known as the Activity Based Physics Group. ILDs are designed to enhance conceptual learning in physics lectures through active engagement of students in the learning process. For example, when we teach the topic of Circuits Containing Resistor and Capacitor (RC circuits), we use the following steps. First, describe the RC circuits and connect the circuits for the class without measurements displayed, shown as Figure 2: RC Circuits with voltage across the capacitor/bulb vs. time graph. Secondly, ask students to record their individual predictions on a Prediction Sheet. Thirdly, have the students discuss with their one or two nearest neighbors. Fourth, elicit common student predictions from the whole class. Next, have the students record their final predictions on the Prediction Sheet and lastly carry out the demonstration with measurement, with graphs collected with Real Time Vernier Hardware and Software, displayed on a multiple monitors shown as Figure 3: Voltage across the capacitor Vc (the bulb Vb) versus time graph. After, ask students to describe the results and discuss them in the context of the demonstration and students fill out the Results Sheet. Finally, Discuss analogous physical situation(s) based on the same concepts. We have presented our practice results: Using ILDs improved the student comprehension and the instructor's teaching in 2009 American Association of Physics Teachers (AAPT) conference (AAPT, 2009).

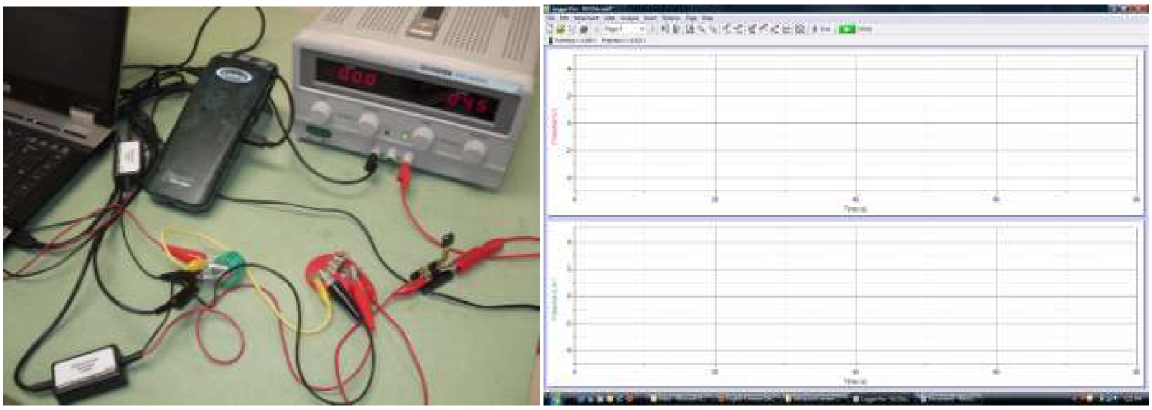

Figure 2 RC Circuits with Voltage across the Capacitor/bulb vs. Time Graph

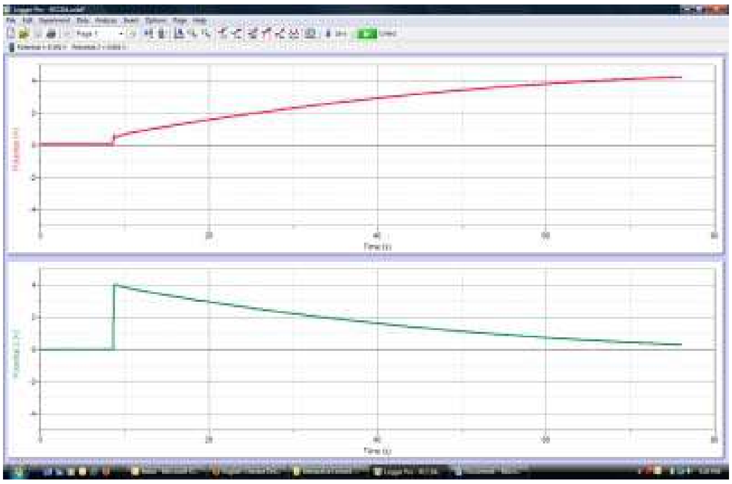

Figure 3 Voltage across the Capacitor Vc (the bulb Vb) Versus Time Graph

2.2.3 Live Examples with Video Clips

For the key examples, we inspire students with video clips found on websites such as YouTube. Students see a situation in action where the concept is involved. Binding the static question narrations with dynamic motion videos makes the question process clear. For example, when we taught Chapter 5.2 Example 5-15 (Giancoli, 2009, p. 127) Highway Curves, we connected to YouTube with the search words race car banked curves. We click the clip shown as Figure 4: Race car on banded curve (Roydpg, 2009). Showing this one minute videos for students before working on examples shows applicability of the concepts in order to form a more active classroom atmosphere and maintain the attention and interest of students.

Figure 4 Race Car on Banded Curve

2.2.4 i-Click Concept Questions

The i-Clicker (iClicker.com, 2005) is a wireless radio frequency system, shown in Figure 5: i-Clicker System, that keeps students' attention focused on course content. To save students money, our department has purchased two sets of clickers for use in many classes. For major concepts, we use i-Clicker Concept Questions Practice questions from the text book, and follow up with demonstrations. For example, in Conceptual example 33-1 (Giancoli, 2009, p. 869) Half-blocked lens, we modified it to i-Click questions, shown in Figure 6: Half-blocked lens (Sokoloff & Thornton, 2004, p. 335). More examples such as ConcepTest11.3 Spinning Bicycle Wheel, shown in Figure 7: Spinning bicycle Wheel, ConcepTest13.6 the Falling Bucket, shown in Figure 8: Falling Bucket (Giancoli, 2009) were taken directly from the ConceptTest Questions of the textbook (Young & Ottinger, 2009). The i-Clicker system is an easy to learn, easy to use, reliable, and dependable tool which promotes student engagement and peer learning (iClicker.com, 2005). I attended the i-Clicker ILDs research in 2010, which is a study conducted by the Activity Based Physics Group to examine how well the student basic physics concepts are taught through the use of i-Clicker ILDs strategies. Our result provides encouragement that the i-Clicker system can be very effective.

Figure 5 i-Clicker System

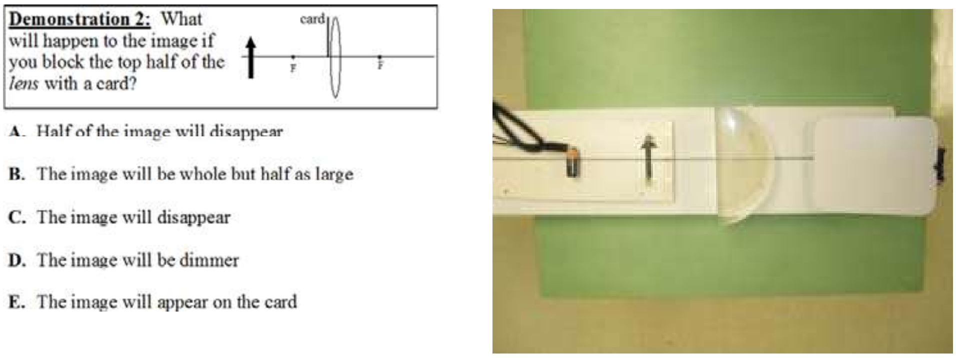

Figure 6 Half-blocked Lenses

Figure 7 Spinning Bicycle Wheel

Figure 8 Falling Bucket

2.3 Online Teaching

We use Blackboard for online teaching. Blackboard is a Course Management System (CMS) used to deliver course content to students on the internet. Blackboard allows teaching resources such as teaching notes and PowerPoint Presentations to be available to students outside of the classroom to facilitate independent catch-up and/or review. We label our main course content as course materials, which include: Official Starting Key Equations sheet, 17 minute Course introduction Video, and Chapter/Topic folders. Each Chapter/Topic folder is organized as: Lecture Outlines, Study Guide, Concept Test Review/Solution, and Active Physics Online. These materials are suitable for self-study. If a student miss a lecture or could not completely digest the materials from the lecture, they should still be able to complete assigned problems on their own. We will use the Study Guide and Active Physics Online as examples to explain in more detail.

2.3.1 Study Guide

The Study Guide is a learning path of content that leads students through the course. It is presented one screen at a time, and we place six different objects on each screen: Overview, Readings, Reading Quiz, What you'll learn in this chapter, lecture notes and Practice Quiz. We use adaptive release to release lecture notes. Adaptive Release is a feature of Blackboard that gives instructors the ability to release content to students based on a set of rules. The rules may be related to availability, date and time, individual users, group membership, scores or attempts on any Grade Center item, or review status of an item in the course. Here, our rule is that students must pass the Reading Quiz before the lecture notes will appear. Study Guide provides students a coherent and ease-of-use online study structure.

2.3.2 Active Physics Online

Active Physics Online utilizes visualization, simulation, and multiple representations to help students better understand key physical processes, experiment quantitatively, and develop student critical-thinking skills. It provides students with a suite of highly regarded applet-based self-study tutorials (Knight, 2008). Experiment is the basis for teaching physics and the history of physics tells us that physics is inseparable from the physical experiments. However, there are some experimental materials that because of conditions cannot be directly demonstrated, but with the help of Active Physics Online, this problem can be solved. For example, Relativity of Time simulation, shown as in Figure 9: Relativity of Time brings concepts that cannot be demonstrated in most laboratories, so that students can observe the purpose-made simulations/virtual physics labs. Virtual lab with combination of movement and illustration demonstrate physical processes, which can stimulate students to think, to imagine, and to innovate.

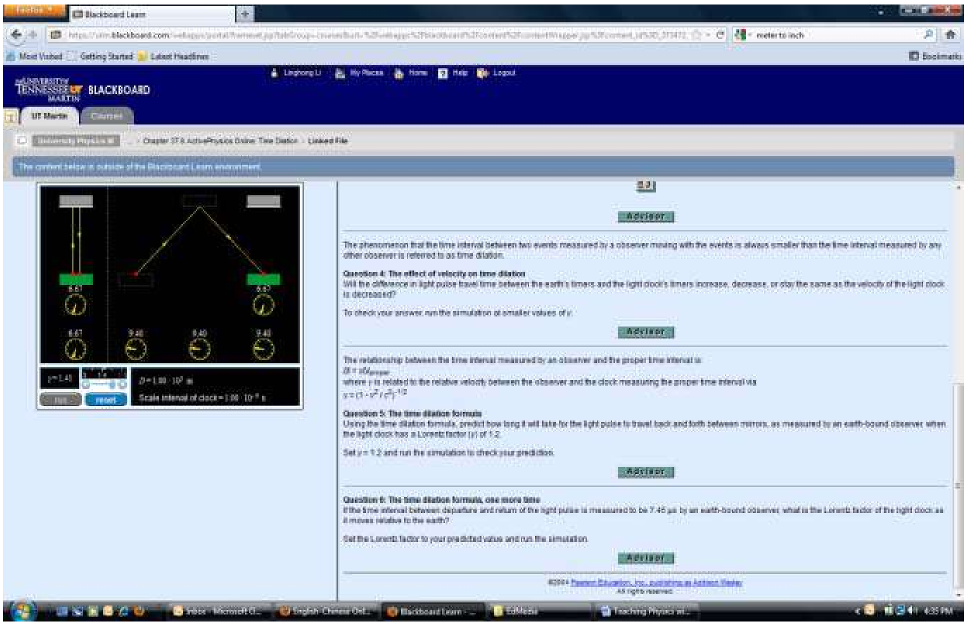

Figure 9 Relativity of Time

2.4 Learning Assessment

2.4.1 Online Homework: MasteringPhysics™

We use an online homework system with 24 hours availability every day: MasteringPhysics™, shown as Figure 10: Online Homework Systems. Just as Dr. Scott Hildreth spoke at the speaking about mastering conference, "It is also a tutorial system, helping students learn with a variety of media types. It is a learning system, as wrong answers are reviewed and hints/feedback developed to address student problems. It is a teaching system, providing diagnostics to me about my students" (Hildreth, 2011). We know that grading homework is incredibly time consuming, and of questionable value if students do not learn from it. After using online homework, we know how long my students spend on their homework, which my students miss, and why they missed. Based on that information, I have more time to focus on blended learning design and revise my blended learning content, and I can also use these time saved not grading to attend other teaching activities and do research.

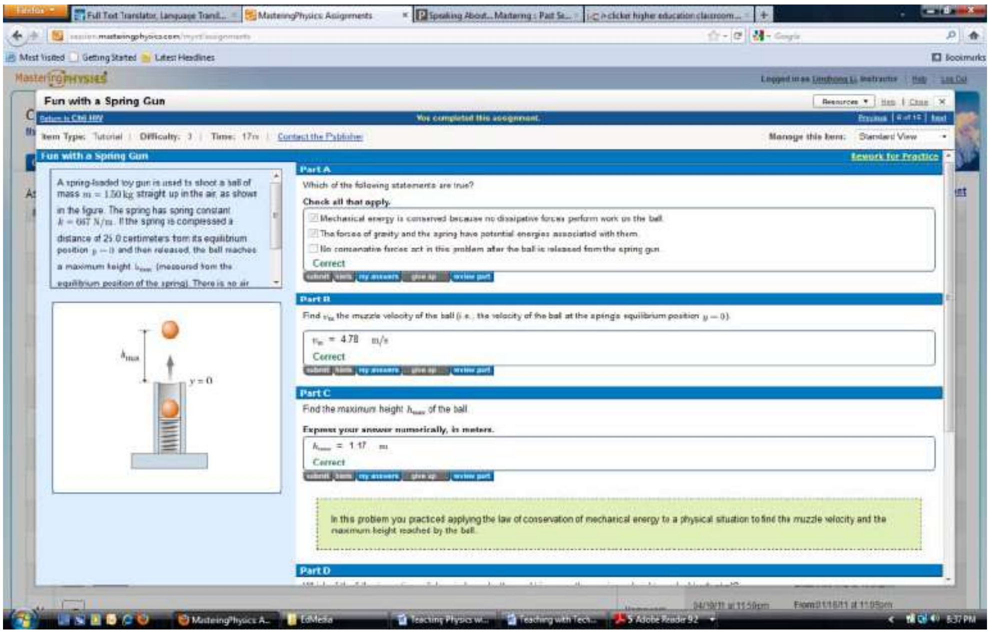

Figure 10 Online Homework Systems

2.4.2 Writing Project: Lab Report

We all know that writing not only improves students' communicative abilities in their disciplines but also helps students to learn. Just like the editors of the book, the New Directions for Teaching and Learning (No. 69), wrote, "Writing not only makes learning more visible, it makes teaching more visible and brings teachers' existing practices into the foreground. The result is often a movement towards more reflective, active, and collaborative teaching as well as learning" (Sorcinelli & Elbow, 1997). For physics, the main writing tasks come from writing the lab report, so we use Blackboard's assignment management tool. At the assignment location, students can review and turn-in their writing assignment. When the assignment is created, it automatically generates an item in the Online Gradebook. From the Online Gradebook, instructors can review, grade, download, and delete student assignments anytime. For example, at the end of the electricity and magnetism study, students are required to work in groups of two on the project: build the DC motor and writing the lab report. In the lab section, instructor gives the students lab materials (supplements for 30 groups), shown as in Figure 11: DC motor materials to the group and the group build the DC motor shown as in Figure 12: The working DC motor. After lab, the students are required to write the lab report to discuss the motor's components and functions, and to explain how the DC motor works using the concepts which they learned from the lecture. They can submit their lab reports electronically at any time and location before the due date. This technique makes the process of assigning, reviewing, and grading student assignments more manageable. We no longer have to search through piles of papers to look for a student's assignment.

Figure 11 DC Motor Materials

Figure 12 The Working DC Motor

2.4.3 Online Quiz

For each chapter/topic, we created an online 10-minute quiz in Blackboard, which automatically generates an item in the Online Gradebook. The online quiz includes multiple choice, multiple answers, true/false, matching, ordering, fill-in the blank and short answer, etc. The online quiz allows instructors to increase the frequency of assignments and keeps the students engaged with the material between exams. In addition, the students can obtain feedback on their performance by checking their answers against the correct ones which are displayed under the answer button. They do not need to submit their answers and wait for the instructor to return the results, which takes some time.

3. Conclusion

Because of the rapid development of modern science and technology, our society is in the information age. Not only are students carrying their mobile phones, laptops, and iPads everywhere, they are also familiar with different online environments. Instructors need to choose the right technologies to match students' learning style so that students can effectively learn more knowledge and skills inside and outside the classroom. Here we present the developments currently conducted at our university. The aim of this work is to design and test new ways of teaching physics. Our practice shows that blended learning is useful, powerful and realizable. Teaching physics with blended learning increases the teaching capacity, broadens the teaching "space", and extends the teaching "time", which allows instructors to easily teach and students to happily learn. Our physics teaching practice provides ideas for developing teaching and learning tools to take advantage of everyday technologies and to also inform educators about the new technologies available for blended learning design, development and implementation.

References

AAPT (2009). "AAPT 2009 Summer Meeting catalogue", available online at: http://www.aapt.org.

ABPEFI (2003). Activity Based Physics Faculty Institute (ABPEFI), available online at: http://physics.dickinson.edu/~abp_web/abp_homepage.html.

Billigmeier G. M. (2011). "Blended learning: Design and implementation", available online at: http://imet.csus.edu/imet10/portfolio/billigmeier_g/billigmeier/ROLFinal.pdf.

Blackboard Inc. (2011). "Improve the blended learning experience and promote learning outcomes", available online at: http://www.Blackboard.com/Markets/Higher-Education-%281%29/Solutions/Teaching-and-Learning/Blended-Learning.aspx.

Carman J. M. (2005). "Blended learning design: Five key ingredients", available online at: http://www.agilantlearning.com/pdf/Blended%20Learning%20Design.pdf.

Giancoli D. C. (2009). *Physics for Scientists & Engineers with Modern Physics* (4th ed.), Pearson Education, Inc.

Hildreth S. (2011). "Speaking about mastering", online conference on October 21, 2011, available online at: http://www.pearsonhighered.com/speakingabout/mastering/index.html.

Iclicker.com (2011). "I-clicker higher education", available online at: http://www.iclicker.com/Customers/education/highered.

Knight R. D. (2008). *Physics for Scientists and Engineers A Strategic Approach* (2nd ed.), Pearson Education, Inc.

Ko S. and Rossen S. (2010). *Teaching Online: A Practical Guide* (3rd ed.), Routledge, Taylor & Francis Group.

Olenick R. (1993). "The mechanical universe reviews and awards", available online at: http://www.learner.org/catalog/awards/mucomments.html.

Pearson Inc. (2011). "Books available: In the U.S. & Canada", available online at: http://www.masteringphysics.com/site/books/index.html.

Roydpg (2009). "Race car video from YouTube", available online at: http://www.youtube.com/watch?v=qxkVy01wk3Q.

Singh H. and Reed C. (2001). "A white paper: Achieving success with blended learning", available online at: http://chriscollieassociates.com/BlendedLearning.pdf.

Sokoloff D. R. and Thornton R. K. (2004). *Interactive Lecture Demonstrations Active Learning in Introductory Physics*, John Wiley & sons, INC.

Sorcinelli M. D. and Elbow P. (Eds.). (1997). "Writing to learn: Strategies for assigning and responding to writing across the disciplines", *New Directions for Teaching and Learning*, No. 69, Jossey-Bass Publishers, San Franciso.

Vesisenaho M., Valtonen T., Kukkonen J., Havu-Nuutinen S., Hartikainen A. and Karkkainen S. (2010). "Blended learning with everyday technologies to activate students' collaborative learning", *Science Education International*, Vol. 21, No. 4, pp. 272–283.

Young T., Ottinger M. B., Bennhold C. and Feldman G. (2009). *Instructor Resource Manual & Instructor Notes on Concept Test Questions*, Pearson Education, Inc.