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Proceedings of the 20th International Conference on Multimedia in Physics Teaching and Learning

Edited by Lars-Jochen Thoms and Raimund Girwidz

Proceedings of the

20th International Conference on

Multimedia in Physics Teaching and Learning

European Physical Society

Proceedings of the
20th International Conference on
Multimedia in Physics Teaching and Learning

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Preface

We are delighted to publish the Proceedings of the 20th International Conference on Multimedia in Physics Teaching and Learning (MPTL'20). This conference was held at the Ludwig-Maximilians-Universität München, Munich, Germany from September 9th to 11th, 2015.

MPTL conferences provide an international forum for the discussion of recent developments and advances and ensure that knowledge and experience in new methods and approaches are shared throughout the physics education community. Innovations as well as challenges for teaching and learning physics with modern media are discussed. Material for primary schools is included as well as topics for universities.

The scientific program of the 20th edition consisted of five plenary talks, 66 single talks and 25 posters. All of the proposals were reviewed, blind, by two or three reviewers from an international scientific advisory board. The meetings were organized in thematic symposia, parallel sessions, parallel talks, workshops and plenary sessions.

The conference provided insight into three main issues concerning the effective use of multimedia in teaching and learning physics:

- new hardware and software technologies,
- concepts for teaching and learning scenarios with innovative ideas, and finally
- empirical studies on important factors for learning with digital media and students' assessments.

In addition, 14 special teacher workshops on the use of modern media were offered.

The authors were asked to produce updated versions of their papers and take into account discussions that took place after the presentation and suggestions received from other participants at the conference. Overall, the proceedings present a comprehensive overview of ongoing studies in research on multimedia in physics education in Europe and beyond. This book represents the current areas of interests and emphasis in the MPTL community as of the end of 2015. The Proceedings contain ten parts that correspond, for instance, to invited symposia and thematic parallel sessions. All formats of presentation (plenary, symposium, workshop, single oral, poster) used during the conference were eligible to be submitted to the Proceedings. All submissions were reviewed a second time by at least two referees before being accepted for publication. Nevertheless, the authors are responsible for their contributions. All revised and accepted papers are collected in the electronic proceedings. Furthermore, reviewers were able to suggest excellent and inspiring articles for the book of selected papers. Hence, high ranked contributions are also available in a printed book version.

This conference was made possible thanks to the work, sponsorship and interest of many people and institutions. First, we want to thank the Ludwig-Maximilians-Universität München (LMU Munich) for hosting the events (plenary talks, invited symposia, parallel sessions, and poster sessions, among others). The LMU Munich provided some of its facilities in the form of assembly halls and lecture rooms, and provided monetary support to organize this conference. Second, we gratefully acknowledge the extraordinary support of MPTL'20 by the German Research Foundation (DFG). In addition to monetary support, we appreciate the recognition of MPTL'20 in the scientific community, even though we discuss very specialized topics. Equally important has been the support of the European Physical Society (EPS), the main sponsor of the MPTL conferences, year after year. Furthermore, we want to thank the German Physical Society (DPG), the Wilhelm und Else Heraeus-Stiftung, and the city of Munich for their support.

We owe a great debt of gratitude to the members of the Scientific Advisory Board, the International Program Committee, and the National Organizing Committee, the staff from the LMU Munich, and all other people who have contributed significantly to this conference.

Finally, yet importantly, thanks are also due to the well-known five plenary speakers Jochen Schieck, Michael Dubson, Christian Hackenberger, David Lowe, and Wouter van Joolingen as well as to all participants that attended MPTL'20. Without you, the conference would not have been possible.

We would like to thank all the authors that contributed their papers to this book and all the referees whose critical feedback helped to improve the quality of the content.

Raimund Girwidz

Lars-Jochen Thoms

SIMULATIONS AND VISUAL REPRESENTATIONS IN PHYSICS EDUCATION

The Impact of ICT and Multimedia Used to Flip the Classroom (Physics Lectures) via Smart Phones and Tablets

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Based on the conclusions of my previous research, it has become clear that natural sciences education is in crisis around the world (OECD, 2000, 2001, 2005). Physics lectures need to be made more attractive and interesting. Unfortunately students are not really involved in hands-on experiments, because the infrastructure of schools and university laboratories differ greatly (Jarosievitz, 2011).
If we want our students to leave universities, colleges or even secondary schools with an adequate knowledge-base and applicable skills in physics, we need to take advantage of ICT, multimedia (text, pictures, animation, sound, video and interactivity) and new devices along with their applications (Jarosievitz 2011, 2009). All of these new possibilities require a well-constructed hypothesis for meaningful use which is also researched here along with new educational methods. In order to use the new methods and tools, I have formulated the goal of the activity. During implementation, all activities should be controlled by the teacher and the cooperation method should be combined with the ICT and Multimedia (Vaughan, 2011). We believe that the use of these resources in physics lectures will strengthen the positive impact, and change the students' attitude.

1 Introduction

Globalization and technological advancement have accelerated enormously in recent years; accordingly, the use of Information Communication Technology (ICT) in education has become a common requirement (Punie et all, 2006). ICT is a diverse set of technological tools and resources used to communicate, as well as to create, disseminate, store, and manage information electronically. This can be done via computers, Internet, broadcasting technologies (radio and television), or telephones. The effective integration of ICT into the educational system is a complex process that involves curriculum and pedagogy, institutional readiness, teacher skills, and long-term financing, among other factors.

The effective use of Information and Communication Technology (ICT) in Hungarian secondary schools began in 1998 when the majority of schools were connected to the internet. The idea to connect the schools – the first Hungarian Schoolnet project – was announced in 1996.

In 2013, a new national report on ICT in Education was published on Insight from the EMINENT Conference 2013 (Insight, 2013). The report led to the following results:

"The Digital Renewal Action Plan 2010-2014 provides the guidelines for the strategy of the Hungarian government. The action plan includes 83 specific recommendations within four action plans:

1. Ensuring equal opportunities for citizens;
2. Increasing the competitiveness of enterprises;

Jarosievitz, B. (2016). The Impact of ICT and Multimedia Used to Flip the Classroom (Physics Lectures) via Smart Phones and Tablets. In L.-J. Thoms & R. Girwidz (Eds.), *Proceedings of the 20th International Conference on Multimedia in Physics Teaching and Learning* (pp. 357–363). European Physical Society.

3. The introduction of modern ICT measures in public administration;
4. The improvement of the ICT infrastructure in the country.

The report's plan is in line with the recommendations and goals of the Europe 2020 Digital Renewal Action Plan strategy, and reflected the input of several hundreds of opinions and contributions via a "Digital Consultation" (EUN, 2013) process.

During my educational career I also became convinced that it is impossible to adequately teach some parts of physics without the use of computers or video files and simulation programs —for example, Chain reactions (Jarosievitz, 2006), or exponential decay laws (Jarosievitz, 2015), among other related natural sciences. There are even some universities that do not have enough equipment to show real experiments, let alone secondary schools. In the latter case, the problem is exacerbated by the fact that students often cannot be divided into small groups for laboratory work due to a lack of rooms and incompatible time slots. There may be several subjects in which the use of ICT can aid STEM teachers seeking to refresh their lectures.

There is a widespread view that computers are not necessary if good teachers are available. Others fear that teachers will no longer instruct if they begin using computers. These objections are understandable, but it can no longer be denied: computers are essential to even moderate levels of instruction in the world (OECD, 2000, 2001, 2003, 2004). We also see that many universities already run accredited Massive Open Online Courses (MOOC) instead of bringing students to lectures.

The benefits of computer simulation programs must not be misinterpreted to mean that a computer can be the sole provider of instruction for students of physics and natural sciences! Nothing can replace the experience and the personality of a good physics teacher.

However, interactive, multimedia-based computer simulation programs offer a unique opportunity for students to experiment and work with systems and materials that they would rarely, if ever, be able to actually work with in practice.

Dangerous substances and situations, expensive equipment, and theoretical - even fantastical - ideas can be explored in a way that is more thorough than practical teaching has ever been able to do before. Never before has there been a situation in which the creative mind could be so safely and precisely indulged in these important areas of education. Well-written simulation programs help students to understand better the phenomena or physics laws.

Another advantage of simulations is that students, who are slower or faster, have the benefit of working on less advanced or more challenging experiments, regardless of the pace of the class. This is particularly helpful for students who need to practice material that the class has already covered. Slower learners can continue to explore previous experiments without needing the classroom instruction to be repeated again and again. These students can then replicate experiments until they actually see the correct results. Conversely, advanced learners have the freedom to experiment on subjects that may not be understood by the majority of the class yet. In both cases the slower, and the faster students of a class benefit from combining the power of the computer with the wisdom of the teacher.

We are confident that the role of the teachers and students should be changed. Students should be involved in the lectures, and the peer instruction method should also be very helpful (Mazur, 1997).

Using new learning methods students are kept active by the teachers and will think and learn during the courses, together with the teacher's explanation. Everybody from the audience will leave the lecture room with some impressions about the topic heard on the lecture, and start processing their thoughts afterwards. With the traditional frontal lecture transmission method, students often leave the room with no impact and no idea about what was going on during the course —sometimes they do not even remember the topic discussed in the lecture.

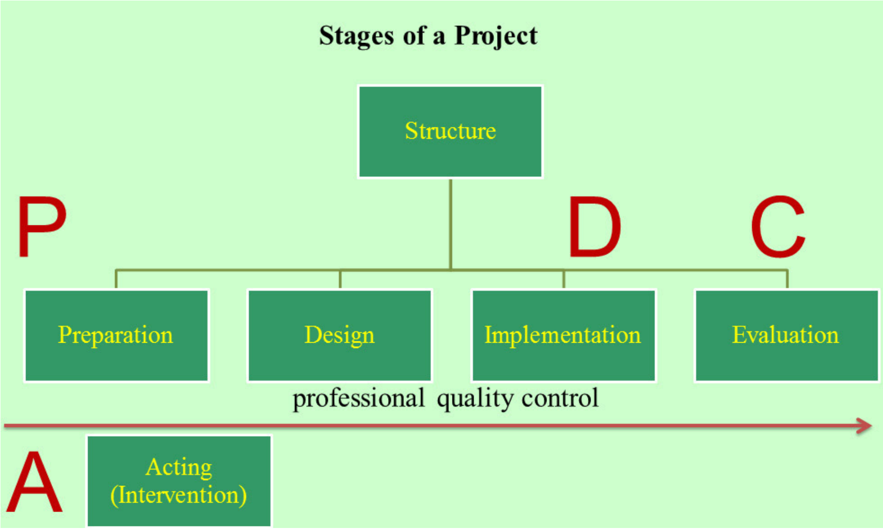


Fig. 1. Stages of the project.

2 Formulated hypothesis

Before testing the new learning methods presented in this paper, I formulated the following hypotheses based on many of the previously published articles:
Using the new methods I expect to:

- improve the memory of students,
- improve their understanding,
- create interactive lectures,
- make the lessons more enjoyable (Jarosievitz, 2005)
- flip the class, „lecture room",
- improve concentration of the students,
- increase my students' interest,
- motivate students for coming evaluations.

3 Flipped classroom implementation

Considering different possibilities and methods the implementation of the flipped classroom I have done using the project method (fig. 1).

In the beginning of the implementation I have created a project plan based by constructivism: a theory based on observation and scientific study. I initially defined the stages of the project.

3.1 Preparation

In the preparation part I determined my first aim: to create a Sharable Content Object Reference Model (SCORM) eLearning (Henson Gawliu Jr, 2012) online training material for my students.

Why do I used SCORM?

The main benefit of SCORM is that the content can be created in an eLearning authoring tool, using tools like Articulate, Captivate, Camtasia etc., and then published by the tool in a SCORM conformant way. Finally the content can be uploaded into any SCORM-compliant Learning Management System (LMS) and then delivered out to learners.

The topic of the content in my case was Electricity, a 5 credit course I taught for BSC students.

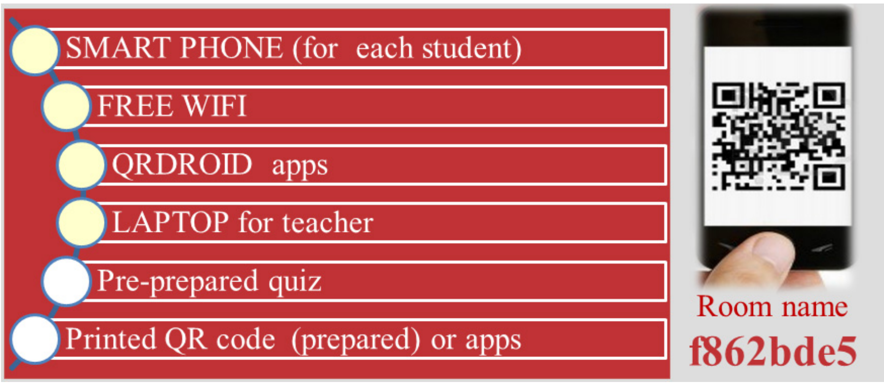


Fig. 2. Requirements.

3.2 Design

In the second stage of the project, the design part, I created the planned content, which contained 1029 slides. This SCORM content I have prepared with Adobe Captivate authoring tool, and finally the package was uploaded to Dennis Gabor College server.

This Electricity course could be seen only by students enrolled to the lecture using intranet, ILIAS (one of the first Learning Management Systems to be used in universities), (ILIAS, 2016).

My online course has 4 major chapters and many subchapters with self-made videos (26) presenting different electricity experiments. Students have access to all materials in advance, and they can watch the videos before the lectures.

In this course students have some quiz questions after each chapters, which they can use for self-evaluation.

In this SCORM content I also created 150 physics exercises with formulas and derivations. Students can prepare themselves and do a lot of exercises before the courses.

3.3 Implementation

The idea to implement a flipped classroom came from a video interview watched by students taught by professor Mazur (Julie, 2012).

The video shows that involving the students actively occurs by the use of cooperative method: pairs of students or groups of students have a voting system in their hands allowing them to express their opinion on a topic or on a question of the professor. Students watch the question, start to discuss (cooperate) and use the voting tool, vote, and see online the anonym answers.

This way students, are well-motivated, since they have to think first, then communicate, cooperate, and be involved in the lecture.

Analyzing the video, and reading several papers I decided to start a research year and implement this method in my Electricity course.

The novum of my implementation consists in the following:

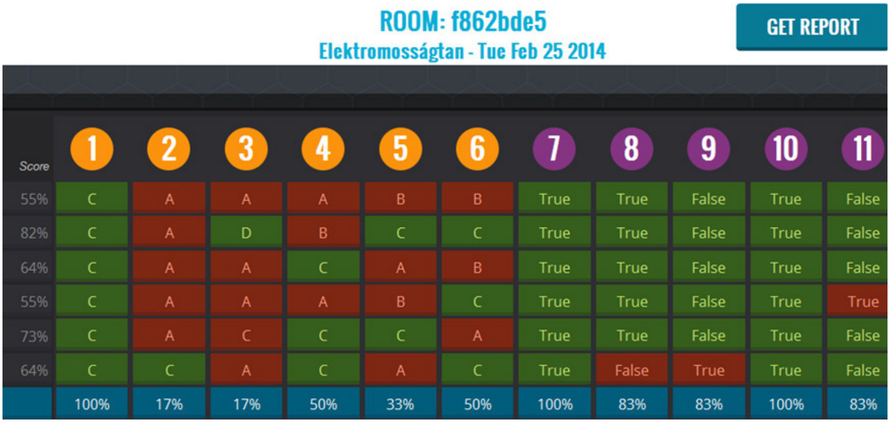
Since we do not have a commercial voting system in the college, I choose a different solution: students used their own devices (smart phones, tablets or laptops) for voting.

I have created all questions in advance, using free online programs. During my lecture the results of the students' vote were also shown online.

I used the flipped classroom method in two different ways during my course:

Firstly I used the prepared questions related to one topic after teaching the full chapter. In this case students have to vote, answering the questions for the whole chapter

I was curious if students understand the material, or I still need to give extra explication of the topic.



ROOM: f862bde5

Elektromosságtan - Tue Feb 25 2014

GET REPORT

Score	1	2	3	4	5	6	7	8	9	10	11
55%	C	A	A	A	B	B	True	True	False	True	False
82%	C	A	D	B	C	C	True	True	False	True	False
64%	C	A	A	C	A	B	True	True	False	True	False
55%	C	A	A	A	B	C	True	True	False	True	True
73%	C	A	C	C	C	A	True	True	False	True	False
64%	C	C	A	C	A	C	True	False	True	True	False
	100%	17%	17%	50%	33%	50%	100%	83%	83%	100%	83%

Fig. 3. Correct and incorrect answers that students provided to the questions.

On the other hand I used the flipped classroom method when I started to explain a new topic or chapter, to my students.

I used Padlet (https://padlet.com/my/dashboard), when I was curious if students turning to each–others could give good suggestion about a phenomena, and I also wanted to know if they were able to use brainstorming together.

During my course I used the following free online programs: http://www.socrative.com/; https://padlet.com/my/dashboard; https://quizlet.com/.

In both cases, student had access to my previously prepared online SCORM course before my lectures – as mentioned earlier. Some of the students who do not have any devices, they turned to their neighbor's and discuss the topics, before they click and answered the questions.

3.4 Some details of the "Use of the voting system" with own devices

Step 1

First I have created a teacher account, and I have created the quizzes online.

Step 2

As a second step I have prepared QR codes for the students, give them also the URL of the site used: https://b.socrative.com/login/student/, and give them the room number. This code I have given to my students in a paper format, which looks like a name card.

Step 3

Firstly students had to scan the QR code that was provided —thus, they needed to have a free app installed to read the QR code, and they also needed an internet connection).

The free app, called: QRDROID program can be downloaded from Google Play.

See summarized the requirements of the "Use of the voting system" (fig.2).

Students used their own devices —usually their smart phones or tablets. During the lecture they followed my instructions and really turned to their neighbor's to discuss the topic based on the quiz questions provided, before answering them.

3.5 Evaluation

Using the quiz questions I evaluated the students using two methods. Sometimes I asked the students to give anonymous answers, other times I asked them to give their names. Since I wanted to assess the effectiveness of the method and not the individual performance of the students, the answering with names, or without was not important for the assessment, but it was important only for different aspects of my research activity. I think that the students took the test more seriously when they had to include their names (fig. 3).

In fig. 3 a screenshot of the online interface is provided. This figure has been projected online during my course.

This table is just one of the examples from the vote, represents the correct and incorrect answers that students provided to my questions. The advantage of this online representation is that I can immediately find out which part of the material was too hard for the students, and where I should spend more time giving explanations. They also can conclude how well they understood my explanation, the physics phenomenon, or the experiment.

3.6 Feed-back

From anonymous personal interviews with my students I can conclude that my students like the peer instruction and innovative teaching method very much, and that they feel it is very useful and that it motivates them more to attend lectures. They also like very much the idea of bringing and using their own devices to lectures. They feel that they are better prepared, and they are more active learners during the lectures, not only passive listeners.

Using the "flip the classroom" method has more advantages: students became more active and motivated to read, and to watch the video given in the e-learning material before my lecture.

I also observed a few disadvantages of the method, however: first, adaptation of this method requires more preparation work by the lecturer. Second, if only a few students are enrolled in the course no comparison can be made for the test group, since no control group can be formed.

Finally, this online SCORM course was prepared in Hungarian, since that is the teaching language in our university. This means that unfortunately, the course cannot be compared to other similar courses used in other countries.

3.7 Acting

I think that in the future, a major goal will be to further increase the motivation of students to join the course, to study in advance, and to join the flipped classroom to increase its impact.

4 Conclusion

I presented some results of my research work using ICT and multimedia and the flip classroom method in Electricity. My results show that this combined method has significant impact and contributes toward:

- modernizing teaching,
- increasing students' motivation and interest,
- catching up with the mobile revolution,
- using mobiles effectively,
- following different high-tech developments.
- Finally I think that using the new methods I was able to
  - improve the memory of students,
  - improve their understanding,
  - make the lessons more enjoyable (Jarosievitz, 2005)
  - flip the class, „lecture room",
  - improve concentration of the students,
  - increase my students' interest,
  - motivate students for coming evaluations
  - create interactive lectures.

I am confident that the formulated hypotheses have been verified and tested. The impact of ICT and multimedia used to flip the classroom (Physics lectures) via Smart phones and tablets could be seen analyzing the student's marks getting on the examination period. Using the flip the classroom method, student's got better mark, and they were attending the courses much more motivated.

It also became clear that if we use only the same old strategies, methods and techniques we will never engage our students, nor will we motivate them or change their attitudes. This method shifts the role of the teacher, and increases audience engagement.

„The future cannot be predicted, but the future should be invented". (Dennis Gabor)

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