

## TEACHING MEDICAL PHYSICS WITH MODERN EDUCATIONAL TECHNIQUES

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**Abstract—** This description of novel teaching techniques is an updated version of a summary of an introductory presentation in the focus session on educational techniques at the EFOMP ECMP2018 congress at Copenhagen that was published in the European Medical Physics News Autumn 2018

**Keywords—** Medical Physics Teaching

When you start teaching a Medical Physics course or just give a single lecture, it is wise to know a little bit about your audience, especially about their composition and pre-existing knowledge of your topic and, naturally, their interests. Besides having an oral self-presentation round of each individual (which is fine only for small groups) or filling out a questionnaire (works also for large groups), a quicker and more up-to-date way is to use one of those (usually anonymous) online-feedback tools via smartphone. I use such tools even in presentations like the one on this topic in the session on teaching Medical Physics at ECMP2018 at Copenhagen. During my talk, I could only evaluate and show some of the responses live during my presentation. But afterwards, I was able to analyze all responses offline. So I know now, that up to 40 participants responded to my questions via such a smartphone feedback tool, consisting of 60% male and 40% female participants. Among these, 11 are teaching in diagnostics, 3 in imaging, 9 in radiotherapy, 8 in radiation protection, 2 in nuclear medicine and even 5 are not teaching at all (it was possible to name multiple sub-jects as free text).

What is regarded as the “classic style” of teaching (not limited to Medical Physics subjects)? From my own experience of many lectures it is, that someone stands in front of a black or white board in an lecture hall and is often clicking through power-point slides, summarizing content from his or her favourite lecture book or review papers on the subject (Fig. 1). This is the case for almost any kind of audience like students, physicists, physicians, RTs, nurses... This can get very boring as can be seen even in special lectures such as shown in Fig. 1! If you are lucky, the lecturer is of the very old style, that is using the board or flipchart to develop the key points of the subject taught by writing and sketching in a dialogue manner together with the audience. As you may have

experienced yourself in such lectures, it is the involvement of yourself and especially your thoughts and ideas, that will keep you awake.



Fig.1: Teaching in the “classic style”: My Christmas lecture, where bored students are desperately awaiting the Glühwein to reach its drinking temperature. © M. Buchgeister

Times have changed and as already stated above, there are now more didactic tools available besides boards to write on. If you are teaching at a university or similar larger institution, you may have the chance to participate in didactic seminars, where new concepts and the use of new tools are presented. Already in 2010, the AAPM summer school “Teaching Medical Physics: Innovations in Learning” addressed this topic. This summer school presentations were recorded and videos are available for free at [vimeo.com/channels/ss2010](http://vimeo.com/channels/ss2010).

Fig. 2 – 4 are screenshots of titles of some of the presentations given there to get you even more interested to check out the videos yourself! Just one month before ECMP2018, there was again a workshop of AAPM at Nashville, TN, on “Improving the Teaching and Mentoring in Medical Physics”. The course director was Victor Montemayor, who is also the current chairman of the AAPM Committee on Medical Physicists as Educators (MPESC). I just list three titles of presentations given there for you: “What Neuroscience Research Has to Tell Us About the Effects of Learning on the Brain” (Laurie Cutting), “Best Practice: Project-based Learning

(PBL) in Medical Physics” (Rebecca Howell) and “Best Practice: Flipped Learning in the Medical Physics Classroom” (Matt Studentski).

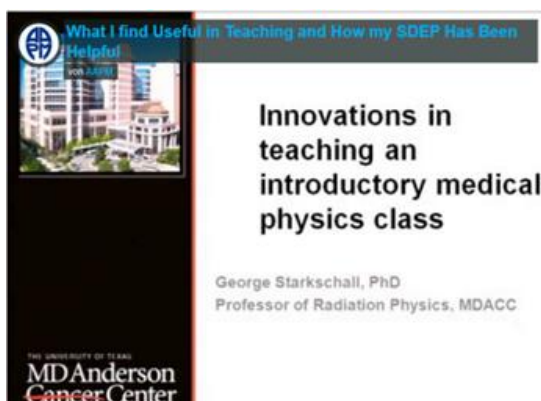


Fig. 2: Title slide of Georg Starkschall’s presentation on “Innovations in teaching an introductory medical physics class” at the 2010 AAPM summer school. © Georg Starkschall



Fig. 3: Title slide of Robert Beichner’s presentation on “Multiple Technologies to Address Multiple Instructional Needs” at the 2010 AAPM summer school. © Robert Beichner



Fig. 4: Title slide of Cindy Hmelo-Silver’s presentation on “Learning Through Problem-Solving” at the 2010 AAPM summer school. © Cindy Hmelo-Silver

Do you recognize the already known keywords of modern style teaching in these titles: Neuroscience, Project-(also: Problem-)based Learning and Flipped (classroom) Learning. If you have not heard about these, here is a very

brief (!) introduction to the basics of the later two teaching concepts:

Project-/Problem-based learning and/or the flipped classroom approach just introduces the audience to basic knowledge like facts, tables of data, formulas and hints on where to start searching for information on the subject in books, papers and on the internet. This is the longest time that you will spend in kind of the “old style” standing in front of the audience since the key mark of these new teaching techniques is the formation of groups, that work on a problem scenario or a set of problems on their own. The basic idea behind this approach is “peer instruction”: Based on pre-existing knowledge or understanding and continuation of your introductory information the correct solution or a reasonable approach to solve the problem will mingle out by arguments exchanged within the group. The teacher or lecturer is just an “accompanying expert”, that consults in a regular sequence with the group, preventing them to get too far off or to provide deeper specific information upon request if needed. The results of the groups are finally presented to the whole audience, so the new knowledge can be gathered by all.

Very important to this approach is the teamwork-aspect: if you can explain it to your fellow student, you got it! In the flipped- classroom approach, the basic information material is provided before the lecture in printed or electronic form (e.g. via learning management platforms like “Moodle”) and has to be studied in advance. During the time present in the class-room, a set of problems is worked on, mostly in groups as well. But very important: no basics are repeated in class, otherwise you end up in the old style! Most important again is the interaction of the audience (“peers”) with itself accompanied by an expert (“you”). If you got already interested and want to know more, start your search for publications on this topic by one of the pioneers of these teaching concepts in physics: Eric Mazur.

### What are the Pros and Cons of these “new style” teaching methods?

As you can easily see from the open approach in group discussions of solutions, it is the project and problem-solving competence, that is focused on, as well as the competence to learn and work in groups, enforcing team and communication skills. If you have worked in groups yourself, you surely know, that the composition of the group is an important key to its success. It always needs someone that did not get it on the first grasp, so it needs someone else in the group to explain and answer the “stupid questions” posed. Let me compare this to a dough that needs kneading (questions) to distribute the ingredients (answers/knowledge) evenly. A pile of flour, baking powder, raisins etc. will not make a cake on its own! While it was maybe plain luck in the past, if the composition of your group was good for its success, results of modern teaching analysis indicate, that a good

mixture or heterogeneity of the group is an important key to its success. It has to be paid attention to existing knowledge, as well as to social skill aspects among the group members when forming the groups. Special tools like questionnaires can facilitate the formation of such balanced groups as well as introduction of the group members to dedicated roles or functions of group members that have been commonly agreed on such as the speaker or team leader (contact for and reporting results etc. to the instructor), the protocol secretary (keeping notes on what has been worked on and what is planned for the next meeting that is digitally available to all members and facilitates very much the production of inter-mediate and final reports), the timekeeper (when to start and to make a break etc.), the police officer or judge (deciding on keeping the set rules of the group and agreed consequences if not being followed like by e.g. a round of coffee for all) and the “Feel-Good-manager” (organizing e.g. cookies or a nice setting for the meeting by a piece of decoration on the table identifying the group). Needless to say, that these roles can rotate among the group members, as long as everyone is informed and aware of them. I introduce this concept to my classes but leave it up to them to realize them. I just mention that the most successful project groups of previous classes picked up my suggestions as start configuration for getting organized themselves in the project.

When these modern techniques are introduced, students, as well as teachers, will have to get used to it. It requires discipline and self-control of your learning or teaching attitude. Since additional aims are addressed with these teaching techniques, you have to cut down the content of your lecture to the very essentials. That means most of the time fewer formulas and facts are taught in great detail. The main emphasis is put on the competences to solve problems and accomplish a new project. The questions and hurdles of the project will lead automatically to those details and additional facts that you intend to get into their brains. If you start a course from scratch, this is at no extra labour (except that you cannot copy your teacher of the past...), but if you have already set out your lectures in the “old style”, you will have to start over again. Or maybe not completely, as there might be an “intermediate style” of teaching, too.

Since a few years and as a result from own teaching experience, as well as input from didactic seminars, I created my own “mixture”. I use activating breaks of discussions of the students with their neighbors. This introduces a “change of view” so that the students look at some else than me and have to express their thoughts and ideas to someone besides listening to me. To catch misunderstandings or misconceptions, I have alternating students summarizing the content at the start, in the middle and at the end of the lecture. At the same time, the others get the content presented once more (varied repetition is a key to memory!). To train problem-solving competence, I have this person try to answer/solve a question/problem within 3 minutes. A clock bar shown by

the beamer is counting down. 3 minutes are more time than you may guess at first hand! To add a bit of team competence training, this is usually done with the help of another student acting like the telephone-joker in the “who wants to be a millionaire”-quiz on TV. Being a “telephone-joker” is limited to two times, so quickly the “good ones” are out of the game in the class.

With this example of a teaching concept, I have not even touched the field of good animations, videos or presenting original pieces of equipment during a lecture of a Medical Physics subject. All this together will make up the smart arrangement and activating interaction with the audience that will render your lecture a success in gained knowledge for the audience. This is even more important in the current situation of shutting down regular teaching at universities etc. due to the CoVID-19 virus lock-down when you have to use distance teaching tools like recorded lectures or open-source or commercial video-platforms like Jitsi, BigBlueButton, Zoom, Webex, GoToWebinar etc. just to list some for your live teaching or consultations with your class. This situation is even more challenging since the non-verbal contact present in the “normal” situation at class is now missing. You have to actively address your audience as much as possible by names and have them speak up, too, to get them used to the new teaching tools and situations. My current classes prefer to write questions and remarks through the chat function of the platform. By calling them up by name to use the microphone for a direct conversation, I am trying to get them used to “step out of the dark” of the class for verbal communication. Just to add another hint to get them involved in the organization of the lecture, too, for you: Since it is very hard for me to recognize the point where they need a break from mostly listening to me, I ask for a volunteer from the audience at the beginning to whom by private chat they can indicate if they need a break. He or she will tell me then as “speaker of the class”. Some of the mentioned video-platforms already have such a tool built in to indicate to the presenter to slow down or to repeat a topic. But this way, I do not have to concentrate also on this item but on my very topic and the questions and answers of my class. As mentioned before: this is about getting them involved as a peer in the organization of the lecture, too.

These concepts like the ones described above are regarded as an educational re-source, just like the animations or videos e.g. that you may use in your lectures, too. The goal of an initiative of the EFOMP Education and Training Committee is to establish a network of Medical Physics teachers, who are interested in and would like to share their concepts and materials as Open Educational Resources (OER) under the creative commons licensing (CCL or GPL) concept. EFOMP would like to create a teaching material repository to this end. At the start, already existing materials and concepts of teaching could be made available there. Preferably in English, but this is just a matter of translation. Foremost

is the creation of links between interested and active teachers in Medical Physics in Europe and maybe also beyond, as there exist already links to the AAPM MPESC mentioned in the introduction above.

**I have to show the other results of my smartphone feedback poll during my presentation at ECMP2018.**

Among 35 responders, 40% had already experience with some kind of “new style” teaching, while 60% did not. Asked, if they were satisfied with their teaching result, 53% out of 32 responders answered with yes, 47% with no. So at least for almost half of them, there might be an interest in improvement. Among 28 responders who are

teaching, 79% would be willing to try something new, 4% would refuse and 18% already teach in the “new style”. My resume of these figures in total is, that there is a change of style in teaching Medical Physics on the way in Europe. And I would like to make the Education and Training Committee of EFOMP as well as the European Congress of Medical Physics the place to exchange new concepts as well as tools/media and foster this change of teaching Medical Physics!

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