Mobile phones in physics teaching – an overview of development and research activities

G Rath
University College of Teacher Education and Karl-Franzens-University Graz,
Universitätsplatz 5, A-8010 Graz, Austria

gerhard.rath@uni-graz.at

Abstract. In Graz, a lot of activities concerning the implementation of mobile phones in physics teaching have been carried out on different levels during the last years. These activities can be regarded as exemplary for the common progress in the field of teaching and learning with digital media: Videos of experiments, motion analysis, measurements with internal sensors, WhatsApp and finally the technology of the smartphone itself. All of the presented results have been developed and partially evaluated within final theses on different levels.

1. Didactical frame
The German Dagstuhl declaration [1] postulates that education in the recent digitally linked world must be seen from three perspectives:

- The application. How do I use it? Concerning mobiles this means for example the usage of apps.
- The impact on society and culture. What does the usage of smartphones provoke, e.g. for teaching and learning in common?
- The technological perspective. How do the systems work? What are the basic underlying concepts?

![Figure 1: The Dagstuhl framework [1]](image)
What is the additional educational value of mobiles in schools? A short insight in research topics and teaching goals using the Dagstuhl triangle is given:

- **Application:** Students should learn to use the Smartphone for investigations, measurements, documentation and communication in a suitable way. Here we can find a lot of examples mainly using the smartphone as a measuring tool and also some research has been carried out about the impact [2], [3].
- **Society & Culture:** The students should reflect about the consequences of the usage of mobiles for their learning in general and keep in mind the dangers. Some research has been conducted so far, but hardly any studies for physics teaching [4].
- **Technology:** Students should know about the physics and technology of a smartphone. This aim has a strong relation to physics, but we could find very few teaching materials and examples, and no studies about the implementation so far. Although this competence is claimed in several models, like the UNESCO ICT competency framework [5].

2. **Videos**

Working with videos in physics classes started in Graz about ten years ago. In the project mobile@classroom videos were integrated in cycles of inquiry based learning: The students had to explain their own experiments in so called “I did it” videos. They were uploaded to a learning platform, after a discussion of the videos in the classroom the next turn started. The aim of an accompanying investigation (30 students, age of 12 to 14) was to find out the impact of self-made videos on experimental and language skills. The analysis of the oral comments in the videos showed that a lack of observation and language skills could partially be compensated by the use of videos [6].
3. Motion Analysis

With the development and improvement of smartphone technology the use of applications in class became more and more interesting, in particular to support measurements. The high school student Richard Sadek developed an app for motion analysis using videos as a part of his final exam in the Kepler Gymnasium Graz. This app was the first in this field for Android smartphones [7].

Using this tool the whole process of motion analysis can be done on the phone: to film the motion, to set up the calibration, to mark the moving object frame by frame and to compare the resulting data and diagrams with mathematical functions. The site at Google Play shows more than 10,000 downloads so far. And a lot of feedback from teachers attests the usefulness for learning mechanics and which enforces further development. [8]

![Motion analysis of a falling ball with VidAnalysis](image)

Figure 3: Motion analysis of a falling ball with VidAnalysis

4. Measurements

Another possibility for motion analysis is to use the internal acceleration sensors of a smartphone. A corresponding investigation (25 students, age of 15) performed by Angela Oswald within her diploma thesis at the University of Graz has been presented at GIREP 2016 in Krakow [9]. The students had to determine the maximum acceleration at high jumps, comparing the classical jump-and-reach method with an acceleration measurement using a mobile phone during the motion. The results of classroom observations and interviews showed a wide range of beliefs concerning the reliability of smartphone data, similar for interest and motivation.
5. WhatsApp for homework

WhatsApp is very common for adolescents, and it seems to be increasingly used in school. But we have a lack of research on the usage of instant messaging in physics lessons. For this reason Julia Sorschag performed a study (22 students, age of 16) on the impact of WhatsApp on the delivery and quality of homework assignments within her diploma thesis [10]. After a questionnaire on the usage of WhatsApp in common, in school and in physics lessons the class was divided in two groups. One group got a printed task and had to submit their results classically on paper. The other group received the same exercise via WhatsApp and the answers had to be submitted in this way too. For the second homework task the groups switched the methods.

The results showed positive attitudes of the students using WhatsApp in general, but no increase in the amount of submitted homework compared to classical written forms. Furthermore, using WhatsApp generates some questions touching the social/cultural perspective in the Dagstuhl framework, for example privacy and language issues.

6. Smartphone technology

The third aspect of the Dagstuhl framework represents the technological perspective. Here we can ask: What is a smartphone at all? It can be seen as a kind of a mobile computer system, with units for input, output and data processing, and ability for communication on different channels. Each of them represents a lot of physics, mostly on a high, technological level. Digital competences include knowledge about the technology itself, not only about how they are used. To prepare appropriate teaching materials, Thomas Lichtenwagner did an online survey with the aim to find out about the needs...
of physics teachers in this area [11]. The answers of 30 physics teachers showed that the consciousness about the importance of the technological aspects was not very distinct.

Figure 6: The technological structure of a smartphone
The majority of teachers were interested in suitable applications, rather than in technological aspects. Nevertheless, they expressed the wish to get information about any component of recent mobile phones. Therefore, the main part of the diploma thesis was focused on explanations about different components on a high school level. It showed that it was hard to find relevant current data as the smartphone companies do not seem to be very generous with that.

7. Conclusions
In relation to the three perspectives of the Dagstuhl framework we may summarize:

   Application: Smartphones are powerful gadgets, they offer a lot of possibilities to use them in schools. Especially in physics teaching they can be seen as a multiple measurement tool, disposable every time and everywhere.

   Society & Culture: There is a lack of critical attitude about results of measurements or investigations. We can see positive attitudes for the usage in the school on average, but disagreement in detail. There is always a minority of students who does not like to work with mobiles.

   Technology: We may expect little knowledge about the physics and the technology of smartphones on the level of students and teachers they are seen more or less as black boxes. Just as well we could find little awareness about the differences concerning the contributions of the hardware itself, the operating system, the applications and the representation on the display.

8. References
[1] Dagstuhl declaration 2016 https://gi.de/fileadmin/GI/Hauptseite/Themen/Dagstuhl-Erkla_rung_2016-03-23.pdf (28.10.2018)
[2] Kuhn J and Vogt P 2013 Applications and examples of experiments with mobile phones and smartphones in physics lessons Frontiers in Sensors vol 1 p 67 (www.seipub.org/fs)
[3] Hänsel U, Schlunk S and Schulze J ed 2014 iStage2 – Smartphones in Science Teaching Science on Stage Germany (Berlin)
[4] Bouhnik D and Deshen M 2014 WhatsApp goes to school Journal of Information Technology Education: Research vol 13 p 217
[5] UNESCO ICT Competency Framework for Teachers 2011 http://unesdoc.unesco.org/images/0021/002134/213475e.pdf (28.10.2018)
[6] Freytag E 2011 Experimentelle Kompetenzen im naturwissenschaftlichen Unterricht am Beispiel Papier Final exam paper (University college of teacher education) Graz Austria
[7] http://vidanalysis.com (28.10.2018)
[8] https://play.google.com/store/apps/details?id=com.vidanalysis.free (28.10.2018)
[9] Oswald A, Rath G and Haagen-Schützenhöfer C 2018 Smartphones as measuring instruments in
the physics classroom – what do students think? GIREP 2016 proceedings (University of Krakov)

[10] Sorschag J 2016 „WhatsApp, Prof?“ – Usage of instant messaging services for Physics class. Diploma Thesis (University of Graz)

[11] Lichtenwagner T 2017 Smartphone Technology in physics lessons Diploma Thesis (University of Graz)