Smart’em APP. Incoraggiamento all’uso degli smartphone nella didattica della Fisica.

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Title (in English)

Smart’em APP. Encouraging Mobile Phone Use in Physics Instruction.

Abstract

L’uso degli smartphone e dei tablet si è diffuso tra adulti e studenti di scuola superiore. La ricerca di metodologie innovative e di nuove opportunità di apprendimento sta spingendo gli insegnanti a ridisegnare l’insegnamento della scienza introducendo gli smarphone in classe.

Studi pilota in Fisica mostrano che l’uso di questi dispositivi come strumenti per l’attività sperimentale favoriscono la motivazione e l’apprendimento concettuale (Countryman,2014; Ercolino et al., 2016; González, 2017; Kuhn & Vogt 2013; Kuhn & Vogt, 2012; Shi, W., et. Al, 2016; Torres, 2015).

La gran parte degli smartphone oggi sono accessoriati con sensori che possono misurare accelerazione, orientamento, volume audio, intensità luminosa e intensità di campo magnetico.

App per smartphone quali Sensor Kinetics, Physics Toolbox and Science Journal possono rilevare e registrare dati da questi sensori per ulteriori analisi.

Questo lavoro presenta alcuni aspetti positivi dell’uso degli smartphone in classe e una panoramica sui possibili esperimenti realizzabili in classe.

Abstract (in English)

Smartphone and tablet use have proliferated among adults and high school students. Research into innovative methodologies and learning opportunities is pushing educators to reshape science instruction by introducing smartphones in the classroom.

Pilot studies in Physics show that using these devices as experimental tools fosters motivation and conceptual learning (Countryman,2014; Ercolino et al., 2016; González, 2017; Kuhn & Vogt 2013; Kuhn & Vogt, 2012; Shi, W., et. Al, 2016; Torres, 2015).

Most smartphones today come equipped with internal sensors that can measure acceleration, orientation, audio volume, light intensity and magnetic field strength. Smartphones apps like Sensor Kinetics, Physics Toolbox and Science Journal can record and store data from these sensors for further analysis.

This paper provides positive aspects of using smartphones in the classroom and an overview of possible experiments with mobile phones in Physics lessons.

Introduction

Eight-two percent of people in the world use a smartphone (Deloitte, 2017). On average, adults text, tweet or go online 47 times a day. Seventy-three percent of teens use smartphones and they check it 86 times a day; even at school.

In today's classrooms many teachers perceive smartphones as a distraction to learning and education. In contrast, some teachers (Diprose & McTier (cited by D. Russell);Ken Halla, (cited by E. Graham)) and education researchers (Countryman,2014; Ercolino et al., 2016; González, 2017; Kuhn & Vogt 2013; Kuhn & Vogt, 2012; Shi, W., et. Al, 2016; Torres, 2015) are experimenting with the possibility of using smartphones as a tool in the classroom to enhance students learning.

In addition, mobile devices often are cheaper than laboratory equipment and less bulky than regular computers.

The aim of this paper is first to show the positive aspects of using smartphones in the classroom. In the second part, this article provides practical examples of how to integrate smartphones in Physics lessons.

Smartphones have a variety of sensors such as accelerometers (force sensor), gyroscopes (angular velocity sensor), touch screens, light sensors, proximity sensors, magnetometers, barometer and microphones. Many quantitative school experiments can be conducted using freeware applications (apps) easily available online to collect and record data being reported by these sensors.

Starting with the assumption that the cognitive and motivational learning success of the learners is greater if a physical phenomenon is explored with experimental tools used every day, we show some applications of these media in physics lessons.

The last part of the document describes the features of three apps that I have used in my teaching practice: Sensor Kinetics, Physics Toolbox and Science Journal.

Content

Schools all over the world have their own guidelines for mobile phone usage. In Italy there is a ban on mobile phone usage from primary to high school across the country. For students up to the age of 18, this means they will be allowed to take their phones to and from school, but they will not be permitted to use their devices during their classes.

According to Elizabeth Diprose (cited by D. Russell) there are four reasons behind a school's choice to limit the use of mobile phones during school hours (even at break times): social interaction among students, cyber safety, the need for down time and encouraging student engagement with the world around them.

However, Head of Science Mark McTier of Science School in Melbourne encourages students to bring their smartphones to lessons as a learning device. For example McTier (cited by D. Russell) explains that students are required to have a computer and an additional device such as a tablet or phone. They use these devices to take notes, set reminders, perform video analysis, and take photos of notes or instructions on whiteboards.

McTier says that this new policy is beneficial for students and teachers. Using sophisticated data-logging software, students can connect their devices to sensors that capture, measure, analyze and present their data from scientific experiments or they can use video analysis software to record projectiles (e.g. balls or weights) for studies of motion. Students also can use a large range of sensors in various experiments to accurately record pH, temperature and dissolved oxygen.

McTier stresses that it is the student's responsibility to ensure their smartphone is correctly updated, charged and managed and that there is regular monitoring of the use of the devices.

Ken Halla, a US teacher (cited by E. Graham), has the same perspective. Halla thinks that smartphones have all the tools necessary to boost student learning thanks to their easy internet access and a multitude of education-friendly apps.

Halla gives some tips for using mobile devices effectively in the classroom. First of all, to ensure that students use their devices for educational purposes, he roams around the room to help students with their work to keep them and their devices on task.

Secondly, Halla suggests allowing students have some fun with their devices. He was surprised to discover that his students were quieter and more focused on their assignments when they were allowed to listen to their music during individual classwork, provided they use headphones and the music did not distract their classmates.

Educators should use mobile technologies to enhance and personalize learning (Torres, 2015). He underlines the fact that while schools debate whether or not using smartphones in the classroom is beneficial, students are already using them and learning organically along the way. So why not create new learning opportunities in class? For example, let students use apps to store and write their notes or review audio or video-based lessons. In addition, as teachers embrace more interactive lessons utilizing mobile technologies, student engagement will rise.

In Italy monitoring the responsible use of mobile phones by students, is a big issue. Vigilance must be maintained to prevent cyberbullying and invasion of privacy. Even so, in 2017 Italian education Minister Valeria Fedeli (cited Santarpia) encouraged the teachers to let students use their devices during lessons as a learning tool to improve students' results.

The use of mobile devices in teaching Physics can be relevant to a student's daily life. The shortage of Science, Technology, Engineering and Mathematics (STEM) students can be attributed to student's lack of interest in a subject and their performance in it. Improving student's attitude towards Physics by introducing mobile devices will imincrease student interest in the subject (González).

During the GIREP-ICPE-EPEC 2017 conference in Dublin on the theme "Bridging Research and Practice in Physics Teaching and Learning", González, et al. have analyzed difficulties, advantages and disadvantages as seen by both students and teachers using smartphones to learn Physics. In their surveys they interviewed 19 teachers from 5 different high schools. For Normal Baccalaureate students, the use of the smartphones motivated those who were more interested in Physics, while the rest tended to do the minimum required. González, et al. think that this was due to the low number of experiments that they did.

STEM reinforced baccalaureate students underwent a more complex and challenging course developed for three running years, from 2014 to 2017, including face-to-face and autonomous work, explanations of the experimental technique and tools, supervised lab work with smartphones, several sessions performing experiments, sessions for discussing results and improving the analysis, final writing of a report describing all the experiments and discussing their results.

Eighty-five percent of the teachers enrolled in the survey found smartphones useful for learning; 60% thought that they improve assimilation of knowledge; 95% said that it increases interest in Physics; and 80% said that it is possible use these devices in classroom. Also, students were interested in this technique because they thought that it allows more participative learning and increases interest.

However, adoption of smartphone in Physics education remains limited. (Shi, W., et. Al). The current methodology in most Physics courses is still the lecture in which the teacher introduces the experiment and responds to student questions about the experiment's theoretical or practical concepts. Then the students do the experiment by following, step-by-step, the procedures without thinking about what is being done, or why. (Shi, W., et. Al). Shifting from this traditional methodology to student-centered learning, for example by using smartphones, develops creativity and active learning in the classroom, leading students to higher-order thinking skills. (Shi, W., et. Al).

The mobile phone and its different functions can be used in various ways in Physics lessons for documentation purposes. The dictation function, for example, enables the user to record measurements, problems or suggestions during the experiment. The camera function makes it possible to record information written on the board and experiment set-ups. (Kuhn, Vogt 2013).

Physics education researchers Jochen Kuhn and Patrik Vogt (cited by Maciel, T.) think that using such devices as experimental tools fosters conceptual learning. Since 2010, Kuhn and Vogt have surveyed groups of both high school and undergraduate physics students and found that the groups using smartphones as experimental tools seem to have a better conceptual understanding of physics. (Kuhn, Vogt 2013).

In order to highlight the use of the smartphones in introductory Physics labs, The Physics Teacher journal in 2012 started the iPhysicsLab column. The first article, by Kuhn and Vogt, described a simple way to study free fall and gravity by dropping a smartphone onto a cushion and recording data during the fall.(Kuhn, Vogt 2012)

An overview of possible experiments with mobile phones in Physics lessons can be found in an interesting article of Kuhn et Vogt (2013). Experiments with mobile phones for measuring the acceleration of gravity, for visualizing diffraction phenomena of infrared remote controls, and experiments to analyze acoustic beat quantitatively (i.e. frequency, interference) are described in this article.

Education researcher Lanz Countryman (2014) highlights the need for students to understand how their phones actually measure physical quantities. Smartphones are equipped with a number of sensors such as microphones, acceleration sensors, field strength sensors, light intensity sensors, GPS receivers, cameras. All the sensors can be read out by appropriate data collection apps, that become more creative and user-friendly daily.

According to Ercolino I.et al.(2016), the use of smartphones is becoming essential in science teaching. When used as a powerful piece of high-tech laboratory equipment smartphones create a positive classroom environment that engages students with hands on activities Thanks to the smartphone, students answer questions, make decisions, and solve quests.

Teachers who want to use apps in their Science teaching can find a source of inspiration in the brochure iStage 2 by Ercolino et al..

iStage 2 is a guide for performing experiments step by step that was created by Science teachers for teachers with the aim of fostering the enthusiasm of students. It is a handbook with three big topics:

- Eyes- focused on the smartphone camera and sensors (activities: Smart Astronomers, Smart Measurements, How Deep is your Blue).
- Ears- focused on smartphone microphone (activities: Spectral Sounds, Noise Pollution, Going for a Song, Fast and Curious).
- Hands- focused on smartphone' apps like gyroscopes, camera and other sensors (activities: Measuring the World Around Us, A Smart Accelerometer, Spot the Physics, The Earth's Magnetic Field).

Each unit comes with a complete list of apps for Android and iOS and detailed descriptions of the procedures. In the "How Deep is your Blue – Colored Chemistry with Smartphones" activity, for example, students can use a smartphone to measure the amount of copper that is dissolved in an aqueous solution of nitric acid. This is possible using a colorimetric method and an app named "Color Grab". Students' scientific inquiry, learning and social interactions can be improved using another app, QR Codes reader. When scanning the QR code at the end of the activity, students will automatically be taken to a site where they can understand more about the topic.

In the last part of the article I want to suggest three apps that I have used in my teaching practice.

Physics Toolbox Suite app, available for free on Android, iPhone and iPad devices (Android version is more powerful than the iOS version), uses device sensor inputs to collect, record, and export data through a shareable comma separated value (.csv) file. Data can be plotted against elapsed time on a graph or displayed digitally. Users can export the data for further analysis in a spreadsheet or plotting tool. A variety of usage ideas for students and teachers in STEM education are available on https://www.vieyrasoftware.net/browse-lessons.

Science Journal app is available for free on Android, iPhone, iPad, and compatible Chromebook devices. With the Science Journal app it is possible to measure light, sound, acceleration, air pressure, take notes and photos to document science experiments, to export recorded sensor data as csv files and to connect to external sensors using select Bluetooth-enabled Arduino and Vernier devices.

Science teachers can find a list of experiments based on this app at:

https://makingscience.withgoogle.com/science-journal/activities and at:

https://www.sciencebuddies.org/blog/google-science-journal-app-tutorial-part2-sensors

Sensor Kinetics helps students to monitor and understand the behavior of the standard sensors available in their phone or tablet. Each sensor is attached to a sophisticated chart viewer. The app includes comprehensive help files which are intended to provide students with hands-on knowledge of how these sensors interact with smartphones and suggests numerous experiments.

APP	**Features**	**Sensors** **(Dependent upon the user's mobile device capabilities)**
Science Journal	· Take notes and photos to document. · Connect to external sensors using select Bluetooth. · Export recorded sensor data as CSV files. · Create automated triggers for recording data and taking notes.	Available on iPhone and on Android: 1. Accelerometer X 2. Accelerometer Y. 3. Accelerometer Z. 4. Brightness (iOS) or Ambient light (Android). 5. Compass. 6. Linear accelerometer 7. Magnetometer. 8. Sound intensity. 9. Barometer. 10. Pitch.
Physics Toolbox	· Recording data · Saving data in folders. · Exporting data via e-mail or shared in Google Drive or Dropbox.	Available on iPhone and on Android: 1. G-Force Meter. 2. Linear Accelerometer. 3. Barometer. 4. Proximeter. 5. Magnetometer.

		6. GPS. 7. Inclinometer. 8. Color Detector. 9. Spectrum Analyzer. 10. Tone generator. Available only on Andrioid: 11. Roller Coaster - G-Force Meter, Linear Accelerometer, Gyroscope, and Barometer. 12. Gyroscope, and Barometer Hygrometer 13. Thermometer. 14. Ruler. 15. Compass. 16. Light Meter. 17. Sound Meter. 18. Tone Detector. 19. Oscilloscope. 20. Spectrograph.
Sensor Kinetics	· Recording data. · Exporting data. · Sensor Information.	1. Accelerometer. 2. Gyroscope. 3. Magnetometer (Magnetic field sensor). 4. Linear Acceleration sensor. 5. Gravity sensor. 6. Attitude (Rotation) sensor.

Conclusions

As smartphones become more widespread, the benefits of allowing students to actively use mobile phones as learning devices in school is being actively explored.

Many teachers (Diprose & McTier (cited by D. Russell);Ken Halla, (cited by E. Graham)) and education researchers (Countryman,2014; Ercolino et al., 2016; González, 2017; Kuhn & Vogt 2013; Kuhn & Vogt, 2012; Shi, W., et. Al, 2016; Torres, 2015) recognize the importance and the positive effects that technology shows on students in the classroom and suggest the integration of mobile devices into lesson plans. When we combine the modern smartphone with wireless internet access and the remarkable number of cheap and free mobile apps now available, we find that they are truly amazing and powerful pocket-sized learning devices.

Mobile devices allow students to access educational resources, connect with others or create content both inside and outside the classroom.

Often students reject STEM because they have a lack of confidence in the subjects, perhaps because they view science as external to their personal experience. Mobile devices allow students to have a STEM experience that is essential for building that confidence.

The use of tablets and smartphones can be an alternative to current mainstream (and old fashioned) didactical practice and it presents an opportunity for educators to design educational methods, activities, and materials for the modern classroom. As teachers embrace more interactive lessons utilizing mobile technologies, student engagement will rise.

The influence of using mobile devices in teaching Physics can be relevant. Various experiments can be readily carried out using the sensors available in smartphones. Several recent works have proposed the use of smartphones for laboratory experiments on mechanics, electromagnetism, optics and waves (Ercolino I.et al.,2016; Kuhn, Vogt, 2013; Kuhn, Vogt, 2012). With the thousands of free apps and resources available, there is no shortage of mobile tools for increasing student engagement and learning.

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