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Adapting smart phone applications about physics education to blind students

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Abstract. Today, most of necessary equipment in a physics laboratory are available for smartphone users via applications. Physics teachers may measure from acceleration to sound volume with its internal sensors. These sensors collect data and smartphone applications make the raw data visible. Teachers who do not have well-equipped laboratories at their schools may have an opportunity to conduct experiments with the help of smart phones. In this study, we analyzed possible open source physics education applications in terms of blind users in inclusive learning environments. All apps are categorized as partially, full or non-supported. The roles of blind learner’s friend during the application are categorized as reader, describer or user. Mentioned apps in the study are compared with additional opportunities like size and downloading rates. Out of using apps we may also get information about whether via internet and some other extra information for different experiments in physics lab. Q-codes reading or augmented reality are two other opportunity provided by smart phones for users in physics labs. We also summarized blind learner’s smartphone experiences from literature and listed some suggestions for application designers about concepts in physics.

1. Introduction

The current way of communication is mostly based on smartphones which includes applications like software programs of personal computers. These applications vary from navigation to documentation. On the contrary to push-button telephones, smartphones have no button and this seems unusable feature for blind users. With appropriate model of smartphone which includes current operating system of Android, fast and accessible interface, some applications such as talkback help blind users to control their smartphone with different type of touching. Although there is no button on the screen, different type of touching on the screen are defined in the applications for blind users.

Application stores via internet like Google Play includes lots of applications for different educational purposes. For instance, you may download painting apps or animations about solar system or human body from any application stores and use them without internet connection. In this paper, we only focused on educational applications related with physics education. We selected applications from different content of physics which physics teachers or students may use to gather data and analyze it. The smartphones with sensors and applications are kind of laboratory tools for users; however, with this study we aim to analyze if there is enough physics education applications for blind users and how should we transform these applications for inclusive learning environments where both sighted and blind users enroll in.

1.1. Previous studies

In this section, some projects about smartphone usages and other previous studies are given. Firstly N.E.T (New Media Experimental Tools) project which is located within the framework of situated learning theory is analyzed [1]. They provided an overview of possible usage of smartphones with example of production of an acoustic beats by Audacity or Cool Edit Pro, making infrared radiation visible and a free-falling smartphone emits a tone from a sound source by Spear. For gravitational
acceleration, doing the experiment in a recreation park with free-fall tower may be more appropriate than small distance from the floor [2]. Secondly in the document from the “Science on Stage” project there are different smartphone applications not only for physics but also other science disciplines. In the guide about using smartphones in science education which is the product of the project and named “smartphones in science teaching istage 2” includes distance measuring and parallax method by stellarium, theodolite, angle meter and compass, measurement of the heavens by angle meter, solar walk, star chart, GPS Essentials, Theodolite and analyzing spectral sounds by iAnalyzer Lite and sound spectrum analyzer [3].Out of these projects, measuring acceleration with a turntable [4], measuring period of pendulum [5] or measuring Doppler effect and illuminance of a light source [6] are some other examples for using smartphones in physics education but none of these smartphone projects are appropriate for blind learners.

2. Methodology
This study is a kind of survey for an instructional design and we investigated free smartphone applications with English key words from physics content in Google play application store according to their ratings from five star and number of downloads. These applications are compared with the possibility of usage by blind users and we tried to generate scenarios to enable the usage of application for bothsighted and blinds users.

3. Findings
In this section, we aim to share a table including selected applications according to methodology and some additional explanations about how to adapt for inclusive usage.

3.1. Applications for physics education
Although each day more and more applications are uploaded to application stores we collected some applications in Table 1 to give an overview about possible applications in physics education. There is no full or partially supported applications for blinds.

| Content in Physics | Logo of Application | Name of Application | Ratings | Number of Downloads | Sighted (Non-supported) | Blind (Full Supported) | Both (Partially Supported) |
|--------------------|---------------------|---------------------|---------|---------------------|------------------------|------------------------|---------------------------|
| Distance and area measurement | GPS Fields Area Measure | 4.3 | 10000 | + |
| Velocity measurement | Radar: Speed Gun | 3.5 | 50000 | + |
| Sound measurement | Sound Meter | 4.2 | 200000 | + |
| Light measurement | Light Meter | 4.0 | 50000 | + |
| Color Identification | Color Meter | 4.2 | 10000 | + |
| Magnetic Field Measurement | Gauss Meter | 4.2 | 100000 | + |
| Content in Physics          | Logo of Application | Name of Application | Ratings | Number of Downloads | Sighted (Non-supported) | Blind (Full Supported) | Both (Partially Supported) |
|-----------------------------|---------------------|---------------------|---------|---------------------|------------------------|------------------------|---------------------------|
| Vibration Measurement       |                     | Vibration Meter     | 4.2     | 1000000             | +                      |                        |                           |
| Lens                        |                     | Smart Magnifier     | 3.9     | 1000000             | +                      |                        |                           |
| Ruler                       |                     | Smart Ruler         | 3.9     | 1000000             | +                      |                        |                           |
| Night Vision                |                     | Night Vision Camera | 3.5     | 10000000            | +                      |                        |                           |
| Level                       |                     | Smart level         | 4.3     | 100000              | +                      |                        |                           |
| Stopwatch and Timer         |                     | Stopwatch and timer | 4.3     | 5000000             | +                      |                        |                           |
| Mirror                      |                     | Smart mirror        | 3.7     | 500000              | +                      |                        |                           |
| Hygrometer                  |                     | Physics Toolbox     | 3.8     | 1000                | +                      |                        |                           |
| Converter                   |                     | Unit converter      | 4.3     | 5000000             | +                      |                        |                           |
| Flashlight                  |                     | Flashlight          | 4.4     | 1000000             | +                      |                        |                           |
| Thermometer                 |                     | Thermometer         | 3.6     | 1000000             | +                      |                        |                           |
| Barometer                   |                     | DS Barometer - Air Pressure | 3.9 | 100000 | +                      |                        |                           |
3.2. Adaptations for inclusive usage

It is true that day after day a new sensor or/and applications are designed, using these smartphone applications in their lessons are helpful for physics teachers. With the help of these current applications and sensors in the smartphone teachers may transform anyplace to a laboratory. However, blind learners need some tactile and auditory support. In this section, two main adaptation are given; adaptations with a tool or without a tool. In both adaptations in inclusive environments, blind learners need sighted friend to vocalize data on the screen because none of these applications include screen readers.

3.2.1. With just smartphone. Each smartphone has front and back sides which a blind learner may define and change. Moreover, turning smartphones parallel to the desk also is a possible action for blind learners. These tactile skills let them to attend an experiment. For instance, if you put a wire near a smartphone and take its position parallel to that wire, after giving current to the wire magnetic field will be changed and compass in the smartphone will also be changed (fig 1.). Sighted friend may support blind learner by changing the direction of smartphone according to new north pole (from A position to B position).

![Fig 1. An adaptation for magnetic field perception of blind learner.](image)

With other tools. Most popular tool among smartphone users is selfie stick. Users control smartphone with remote button on the stick. With the help of this button and moving the stick may be controlled by blind learner (fig 2.) and sighted friend may read what he or she sees. For instance, blind learner may take one toy car in left hand and take the stick in right hand and move together. Then, sighted friend help reading the speed.

It is possible to create a role and an experiment for inclusive usage with all listed applications, for instance, put a car toy on the front side and draw up the stick to vertical position. After opening “smart level” application they may decide whether the car will fall down or not due to slope of smartphone under car toy.
In all laser pointers there is a lens and you may put this lens with iron hair pins behind the smartphone on the inner lens of it to get an optic magnifier. In this activity, blind learners should be user with finger movements and sighted user should direct the user and describe what he or she watches. If sighted learner cover flashlight with transparent tape and in each layer print the tape with blue before opening, sighted learner may read what blind learner draw on a paper with ultraviolet pen. In this scenario, blind learner is encoder and sighted learner is decoder.

4. Conclusion

Whether using selfie stick, other tools or without any tool, deciding the role of both sighted and blind users brings inclusive usage of smartphones. Generally sighted learner should read what he or she sees in the screen and transform graphs in the screen to tactual graphs [7]. However, blind learners may take other responsibilities and work cooperatively with their sighted peers during the application. Teachers should be careful to include blind learners to all activities and experiments. For instance, if a teacher want to measure the noise around, let sighted learner to read the screen and transform the graph to tactual version for his or her blind friend and let the blind create a noise. All more scenarios depend on teachers’ creativity and believes that blind learners also should be included in all activities and they may do any appropriate duty with correct directions.

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