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EVALUATION OF A PRACTICAL EXPERIENCE WITH SMARTPHONES ABOUT NOISE POLLUTION

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A practical experience about noise pollution which involved the use of smartphones has been designed and evaluated with a pre-post questionnaire in order to check if the students' learning about this topic improves by performing a practical experience with smartphones. This questionnaire was filled in by 25 students enrolled in the "Physics" course of the non-compulsory last 2 years of high school (ages 16 to 18). The Wilcoxon signed-rank test was used to determine that the observed difference between the answers given by the students in the pre-post questionnaire was significant. Therefore, the proposed practical experience helps to improve the learning of the students about the problem of noise pollution.

Keywords: noise pollution, smartphone, practical experience

INTRODUCTION

The incorporation of technology in everyday learning activities has evolve rapidly in the last decades from learning assisted by computers to mobile learning (Vavoula & Karagiannidis, 2005; González et al., 2015). For example, physics teachers can use the interest of their students in mobile devices, such as smartphones and/or tablets, and take advantage of the sensors (accelerometer, gyroscope, light detector, etc.) these devices are equipped with to propose experiments that use them as measurement tools both in teaching laboratories and in everyday activities in order to increase the motivation of their students (Kuhn & Vogt, 2013a). Examples of practical experiences with smartphones in physics education can be found in recent literature (e.g., Kuhn & Vogt, 2013b; Klein et al, 2014; Sans et al., 2017). Besides, the use of smartphones allows to have teaching laboratories that are less expensive, and also allows students to make measurements outside the laboratory during their daily activities, where they can apply what is learned in class (González et al., 2015). Thus, the students can realize that what they learn in class is part of their everyday life and not far from their reality (Lozano & Solbes, 2014).

In this work, a practical experience about noise pollution which involved the use of smartphones was designed based on that proposed by Science on Stage Germany (Andrade et al., 2014). The main objective of this experience was to sensitize students about noise pollution, as well as working with concepts such as background noise, the decibel scale, and the inverse square law. Besides, an evaluation of this practical experience was conducted with a pre-post-design in order to address the following questions: are students aware of the problem of noise pollution? Is it possible to improve the learning of the students about sound and noise pollution with a practical experience with smartphones?

METHOD

The practical experience with smartphones about noise pollution was performed in 2 sessions of 1 hour each. During the first session, the decibel scale was defined, the sound meter app used in the smartphones was calibrated and the inverse square law was proved. During the second session, the students used their measurements to create a noise map of the school and a group discussion about the problem of noise pollution was held. An evaluation of this practical experience was conducted with a pre-post-design in order to evaluate to what extent the practice helped to improve what the students knew about noise pollution. Table 1 presents the questions of the pre-post questionnaire the students had to fill in, as well as the criteria used to analyze their answers. This questionnaire was filled in by 25 students enrolled in the "Physics"

course of the last 2 years of high school (ages 16 to 18), which are non-compulsory, from two different high schools in the province of Valencia (Spain).

Table 1. Questions and analysis criteria of the pre-post questionnaire.

Q1. We use the word *noise* to refer to an unpleasant sound, do you think that living surrounded by noise can affect you? Why?	
CORRECT	Affirmative answer that relates noise to health problems and psychological disorders.
PARTIALLY CORRECT	Affirmative answer that relates noise to either health problems or psychological disorders.
INCORRECT	Negative answer.
Q2. What sources of noise pollution do you know?	
CORRECT	Answer that cites more than 2 sources.
PARTIALLY CORRECT	Answer that cites 1 or 2 sources.
INCORRECT	Answer that cites 1 source or none.
Q3. What effects does noise pollution have on our health?	
CORRECT	Answer that cites examples of auditory and non-auditory effects on health.
PARTIALLY CORRECT	Answer that cites examples of either auditory or non-auditory effects on health.
INCORRECT	Answer that states that noise pollution has no effect on our health.
Q4. What are decibels? Explain their relationship with sound.	
CORRECT	Answer that defines the decibels as the logarithmic scale used to represent sound intensity and also cites the human hearing range (0 - 120 dB).
PARTIALLY CORRECT	Answer that either defines the decibels as the logarithmic scale used to represent sound intensity or cites the human hearing range (0 - 120 dB).
INCORRECT	Answer that doesn't relate decibels with sound intensity.

RESULTS

Figure 1 shows the answers given by the students in the pre-post questionnaire classified according to the analysis criteria from Table 1.

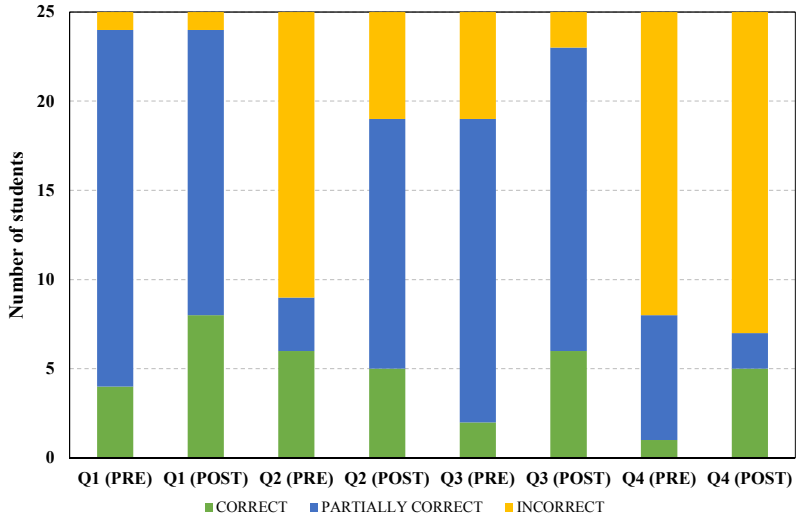

Figure 1. Answers given by the students in the pre-post questionnaire classified according to the analysis criteria.

Since the answers given by the students are paired samples (pre-post questionnaire) that don't follow a normal distribution (according to the Kolmogorov-Smirnov test), the Wilcoxon signed-rank test has been used to determine if there is any difference between the samples. Table 2 presents the p-value obtained in the Wilcoxon signed-rank test for each question of the pre-post questionnaire.

Table 2. Wilcoxon signed-rank test for the pre-post questionnaire.

question	p-value
Q1	0.000
Q2	0.000
Q3	0.021
Q4	0.000

DISCUSSION AND CONCLUSIONS

In the pre-post questionnaire, for question 1 (Q1), although the number of incorrect answers stays the same (1), the number of correct answers doubles (from 4 to 8), therefore decreasing the number of partially correct answers (from 20 to 16). Question 2 (Q2) is the one that changes the most, substantially increasing the number of partially correct answers (from 3 to 14) and decreasing the number of incorrect answers (from 16 to 6), while the number of correct answers stays approximately the same (from 6 to 5). For questions 3 (Q3) and 4 (Q4), the number of correct answers increases (from 2 to 6 in Q3 and from 1 to 5 in Q4) and the number of incorrect answers decreases (from 6 to 2 in Q3 and from 7 to 2 in Q4), while the number of partially correct answers stays approximately the same (17 in Q3 and from 17 to 18 in Q4). Moreover, the Wilcoxon signed-rank test shows that the observed difference between the answers given by the students in the pre-post questionnaire is significant since the p-value obtained for all the questions is < 0.05.

Therefore, the analysis shows that the proposed practical experience helps to significantly improve the learning of the students about the problem of noise pollution, which they are already aware of. However, further research is necessary. For example, more participants of different ages should be asked to fill in the pre-post questionnaire.

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REFERENCES

Andrade, M., Richter, J-L., & Gutschank, J. (2014). *Smartphones in science teaching*. Berlin: Science on Stage Europe. Retrieved from: http://www.science-on-stage.de/download_unterrichtsmaterial/iStage_2_Smartphones_in_Science_Teaching.pdf.

González, M. A., González, M. A., Martín, M.E., Llamas, C., Martínez, O., Vegas, J., Herguedas, M., & Hernández, C. (2015). Teaching and Learning Physics with Smartphones. *Journal of Cases on Information Technology, 17(1)*.

Klein, P., Hirth, M., Gröber, S., Kuhn, J., & Müller, A. (2014). Classical experiments revisited: smartphones and tablet PCs as experimental tools in acoustics and optics. *Physics Education, 49(4)*, 412-418.

Kuhn, J., & Vogt, P. (2013a). Smartphones as experimental tools: Different methods to determine the gravitational acceleration in classroom physics by using everyday devices. *European Journal of Physics Education, 4(1)*, 16-27.

Kuhn, J., & Vogt, P. (2013b). Applications and Examples of Experiments with Mobile Phones and Smartphones in Physics Lessons. *Frontiers in Sensors, 1(4)*, 67-73.

Lozano, O.R., & Solbes, J. (2014). *85 experimentos de física cotidiana*. Barcelona: Graó.

Sans, J. A., Gea-Pinal, J., Gimenez, M. H., Esteve, A. R., Solbes, J., & Monsoriu, J. A. (2017). Determining the efficiency of optical sources using a smartphone's ambient light sensor. *European Journal of Physics*, 38(2), 025301.

Vavoula, G., & Karagiannidis, C. (2005). Designing mobile learning experiences. In *Panhellenic Conference on Informatics* (pp. 534-544). Springer Berlin Heidelberg.