Accuracy, uncertainty and new technologies

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Introduction

'Innovative Technologies for Engaging Classrooms', or iTEC (http://itec.eun.org/web/guest/home), is a major EU-funded project in which education ministries, technology providers, research organisations and European Schoolnet are working together to transform learning and teaching through the use of learning technology. Crucially, iTEC is very much focused on learning and teaching, and finding long-term solutions, not simply on introducing technology into the classroom. Teachers from across Europe are taking part in five iTEC cycles between 2010 and 2014, each of which sees them piloting innovative 'learning scenarios' in the classroom in a variety of subject areas.

Measuring with digital and analogue tools

During the third iTEC cycle in late 2012, teachers from a school in Odda, Norway devised an inventive mathematics activity which involved students working outside the school to measure distance using different digital and analogue tools, and then comparing the results.

Three teachers, including the headteacher of Odda ungdomsskole, worked together on a project which involved 80 ninth grade (14 year old) students in total. This cross-curricular team combined learning goals relating to geometry and measurements from the mathematics curriculum with elements of the geography curriculum, in particular the use of GPS (Global Positioning System). The impetus for the project came from the headteacher, who although not a mathematics teacher, has a keen interest in the use of new technology. He researched appropriate technologies; provided training on use of the GPS app for both the teachers and the students; made an instructional video which he posted on YouTube; and provided technological

support, as well as general encouragement.

The overall learning objective for this exercise was to compare measurements obtained using various digital and analogue measuring tools and apply these to calculate areas and perimeters. Through this activity, students would develop their skills in using a range of common, as well as specialist, measuring instruments. They would also practise selecting the correct units for distance and area, and develop an appreciation of the degree of accuracy needed to fulfil particular tasks. Although these topics are normally taught as part of the ninth grade curriculum, the approach taken for the iTEC project was different as it made substantial use of ICT, and involved students working outside the classroom and applying mathematics learning in new settings.

Collecting data

At the start of the activity, students identified as having a similar mathematical skill level were organised in small groups of four to six, and each group was assigned one of three tasks which required them to take measurements of two football fields located near the school. The tasks varied in their level of difficulty and in the measurement instruments which students were required to use. A variety of digital and mechanical instruments were used, including, a BOSCH laser instrument, a tape measure and students' iPhones with the MotionX GPS app (http://gps.motionx.com/iphone/overview/). In addition, one group, the 'media group', was given the task of documenting the other groups' activities.

An initial problem was encountered when it was discovered that the school's iPads could not be used for GPS tracking as originally planned because they are not equipped with SIM cards which are required outside the school's WLAN (Wireless Local Area Network). So instead of using iPads, some students brought their personal iPhones into school for the activity. Fourteen students had a compatible smartphone, so availability of phones was added as a criterion when forming the student groups. As this was not normal practice at this school, it involved a slightly bureaucratic procedure as the students needed to obtain written permission from home to use their phones. Each student received a small amount to cover purchase of the app and data traffic.

Analysing and presenting data

When they returned to the classroom, students again made use of ICT to analyse and present data. The measurements each group had taken were uploaded and shared in the school's learning management system (itslearning). The GPS groups uploaded the tracks to Kartiskolen, a high-resolution map application which has been devised for Norwegian schools (www.kartiskolen.no). They made a map layer on top of a satellite photograph of the area they had measured. They used this data in a number of ways. For example, they were able to compare the measurements they had taken with the satellite photograph using the built-in measurement tools for distance and area in the map application. Students also used screenshots from the map application to calculate the distance between two points using Pythagoras' theorem.

When comparing the measurements taken using different instruments, to the students' surprise, the most accurate were the tape measure and the laser, rather than the GPS device. Before the activity, they had expected that what they perceived as the most advanced technology would be the most accurate. They also found it difficult to use the Kartiskolen map with a sufficient degree of accuracy to record the distances they had measured. By comparing distances and areas calculated by the map software with those they obtained using mathematical formulae, students developed a better understanding of the level of accuracy of the technologies they had used, rather than simply assuming that technology would provide the most accurate result.

Crucially, through this exercise, students discovered ways to use technology to obtain more accurate results. In one exercise, they compared the circumference of a circle as calculated in the Kartiskolen map tool with that calculated manually using the radius measurement. They initially found that the circumference calculated by the map tool was shorter than that obtained using the formula, but through experimentation, they discovered that the closer the distance between every point they entered in the map tool, the more accurate the calculation became.

Wider benefits for students

Students clearly enjoyed this activity. They felt it was interesting to learn mathematics in a more practical way and in a different environment. New learning environments which go beyond the classroom and the use of new tools were both found to be motivating for students. Another aspect of this activity which made it different for students was that several classes took part in the activity and students were able to mix with groups did not normally work with.

Access to technology was a crucial factor. The project could not have completed without the use of students' own mobile devices. These allowed them greater flexibility than school-owned devices and meant they were free to work outside the boundary of the classroom. Encouraging students to use their own smartphones in school led to learning about the effective use of these devices for mathematical learning for both students and teachers. The fact that students' smartphones were an integral part of this activity particularly encouraged those with practical and technological skills. Some of the students with iPhones are not particularly skilled in mathematics, but they are highly skilled in the use of smartphones. The ability to use a smartphone effectively was acknowledged as an important skill to have in the group, making some students feel more confident in a subject where they often struggled. The school has reflected on the practicalities of greater use of BYOD (Bring Your Own Device) as a result of the project and considered introducing new policies which would allow for this.

Conclusion

Through this practical activity, which took learning into a new environment and made use of new technologies, students gained a more in-depth understanding of notions of accuracy and numerical precision in a practical context. More specifically, they were able to reflect on the appropriate number of significant figures to use in different contexts. They also learnt how to improve the accuracy of calculations by increasing the number of data points. Finally, when they compared results obtained using formulae with those recorded in a practical exercise, students gained a greater appreciation of the differences in accuracy and uncertainty between practical and theoretical mathematics.

Further information:

Teacher's multimedia story: http://files.eun.org/itec/imms/NO_Venke%20Nesse.pdf

Video: http://youtu.be/7ntStOued5E

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