Using Scalextric to teach Primary School Children about Taking Corners at High Speed

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Summary:

The Department of Engineering are developing three activities for Scifest 2012, a science festival to be held at the University of Wolverhampton between 26th June and 30th June. The activity that is being developed for Key Stage 2 pupils from local primary schools involves the use of Scalextric to ascertain how tracks can be adapted to allow cars to take corners at high speeds. Other aspects of the session involve getting the schoolchildren to think about how the tracks can be adapted so that there are no unfair advantages provided for cars sticking on the inside of tracks. Also, the sessions are designed so the schoolchildren understand how to calculate the average speed of the cars completing circuits of the track, and how these speeds can be up-scaled to provide an indication of how fast a full-size car would be able to travel on the track.

Background

Scifest 2012 is a science festival that has been established by the University of Wolverhampton to showcase the teaching of, and research into, science and technology that takes place at the institution. The promotion of this is though activities led by University academics assisted by postgraduate students and undergraduate students. The project is intended to provide an opportunity for academics, postgraduate students and undergraduate students to become involved with public engagement activities and promote the science and technology as interesting areas of study to potential future students.

There are five days of activities planned for Scifest 2012. The first day is targeted at GCSE students, providing workshops in science, technology, sports and health. Activities for the GCSE day include: architecture and town planning; forensics; artificial intelligence; and microcontroller programming. The engineering activity for the GCSE day investigates how aerodynamics, shape, size and mass affect the distance travelled of objects fired by an air pressure gun.

The second day is targeted at A-level science students. For this day, workshops are being provided that cover areas such as biomedical sciences, biology, forensics, environmental science and pharmacy. The third day, targeted at A-level technology students, provides workshops on use of 3D modelling in architecture, skyscrapers and bridges, data encryption and looking at the statistics behind Olympic records. The engineering activity for that day challenges students to build an electric car using a motor, a 9 volt power supply, gears, wheels, Lego blocks, belt transmissions, hooks and string.

The fourth day is targeted at primary school children, in particular children from years 5 and 6. Activities for the primary school day include a mobile planetarium for exploration of the Solar System, putting together life-sized models of the human body, surveying buildings on campus and demonstrations of the magic of science using practical experiments. The engineering activity for the primary school day involves the use of Scalextric track to discover why corners cannot be taken at high speed, amongst other concepts. This is the activity that the author has been tasked with for the science festival.

The final day of Scifest, Saturday Scifest, is an Open Day, where a selection of the activities from the preceding four days are made available for the general public to visit and explore at the institution's city centre campus.

Project Highlights

The main focus of the Scalextric activity is to enable the year 5 and year 6 primary school children to think about the reasons why a car cannot take a flat corner at high speed and to consider what adaptations can be made to the track to allow high-speed cornering to take place. Where the school children are able to determine the answer to this problem before the end of the session, there are supplementary questions held in reserve for the school children to consider.

The first supplementary question is that for a normal oval track, the car on the inside lane will complete laps of the track faster than the car on the outside lane. The pupils will be asked to think about how the track can be adapted to ensure each car spends an equal amount of track length on both the inside lane and the outside lane, thus making the track fair.

The second supplementary question is that if the pupils know the length of the track, and the time it takes for a car to complete ten laps of the track can be measured, for example, whether it is possible to determine the average speed of the car around the track. If the pupils can determine the average speed of the car around the track, further questions to be asked include whether the figure they have for average speed can be changed into a figure that represents the speed in both kilometres per hour and miles per hour, and how this could be achieved.

Should the pupils be able to determine the speed of the car, whether in metres per second, kilometres per hour or miles per hour, then the idea of scaled models of cars is introduced. If the pupils are told that the Scalextric cars are 1:32 scale, or 1:43 scale, they will be asked to see whether they can determine the speed at which a full-size version of the cars would travel at around a full-size version of the track.

A final supplementary question, should the pupils be able to answer the initial question and the preceding supplementary questions, would be whether the pupils could design a track that provides optimum incline at the corners and allows for optimum speed around the track.

The length of time allocated for the activity is 45 minutes, and the activity will run four times during the primary school day. A maximum of 30 pupils will attend each session, and allowing for five minutes to settle down at the start of the session and five minutes for the pupils to disassemble their tracks and leave at the end of the session, there will be 35 minutes during which the activity will take place.

There is enough Scalextric track available to allow three separate tracks to be constructed during the activity; therefore it is envisaged that there will be a maximum of ten pupils per group during the activity. For the first part of the session, each group will be provided with two straight pieces of track and four 90-degree corner pieces of track to allow the pupils to build a simple track and check that the cars will work on the tracks. One of the straight pieces provided to each group will have connection points for the power supply and the controllers for each car. When the pupils consider how the tracks can be adapted to allow the cars to take corners at high speed, four extra straight pieces of track will be made available to each group, along with bricks and supports to raise each corner of the tracks.

For the first supplementary question regarding cars spending equal time on the inside lane and the outside lane of the track, two extra 90-degree corner pieces of track and two bridge supports will be made available to each group. It is hoped that the pupils come to the conclusion that a “figure of eight” track is a fair track that ensures that each car spends an equal amount of track length on both the inside lane and the outside lane.

For subsequent supplementary questions, stopwatches will be made available for each group to time the cars on the tracks. Hosiers’ tape measures will also be made available: it will be at the discretion of the pupils whether to measure the length of each piece of track prior to construction, and then add the values together for the straights and the corners, or whether to attempt to measure the full length of the tracks when constructed. Pupils will also need to think about how to measure the distance around a corner: for the simple tracks, the inside edge represents the car on the inside lane and the outside edge represents the car on the outside lane, however for a “figure of eight”, pupils will be asked to think about the average length around the corner, and how it can be determined.

Where speed and up-scaling have to be calculated, it is hoped that this can be a paper exercise rather than relying on calculators, thus enhancing the mental mathematical capabilities of the pupils. However calculators will be available should the need arise for their use. It is envisaged that there will be three undergraduate students at hand, one to assist each group with their deliberations as to how to solve the problems asked of by the activity without divulging the solutions. The undergraduate students will also assist the groups with the mathematical calculations, and will know how to convert from metres per second (the units in which the speed calculated by the pupils should be derived in) to kilometres per hour, and also how to convert from kilometres per hour into miles per hour, which the pupils should hopefully be familiar with from the speedometers in their parents’ cars.

For the final supplementary question, if time allows, on designing a track that provides optimum incline at the corners and allows for optimum speed around the track, it is envisaged that the three groups will be able to merge and use their pieces of track to construct a larger track with extra 90-degree corner pieces being made available to include as many corners and straights in the track as possible. Two cars can then be timed to ascertain how long it takes to complete a lap and determine the average speed, and whether this track optimises car performance.

Project Outcomes

There are several intended outcomes that the author hopes can be achieved by the pupils undertaking the activities detailed above. As the activity will be group-based, it is hoped that the pupils develop team-working skills, in particular in relation to role delegation amongst a group of pupils. For example, it is envisaged that out of a group of ten pupils, it is feasible that two would construct the track, two would control the cars, two would time the cars using the stopwatches, two would measure the length of the track and two would make the calculations for speed and up-scaling for each car.

The second outcome would be that the pupils would leave the activity with an increased awareness of how speed and forces work. In particular, it is hoped that the pupils will understand the basics of centripetal force after this activity, and reasons why motorcyclists have to lean into corners when they drive through them. Some of the suggestions for the pupils to take away from this session are to investigate banked turns, circular motion and centripetal forces.

The third outcome is that there would be an increased engagement between the institution and new audiences. With the advent of the higher fees regime, there is more incentive for universities to be marketing their courses and their activities to increase student recruitment. In particular, getting the ideas into the view of earlier age groups such as year 5 and year 6 at primary school pupils could be more fruitful to future recruitment than delivering activities to GCSE or A-level students, who may have already made up their minds as to what career paths they intend to follow.

The final outcome is that the pupils walk away from the activity with an increased capability in mathematics. For the calculation of the average speed and the up-scaling, the author hopes to steer clear of the use of calculators and encourage the pupils to work out the speeds using pen and paper. There are several key calculations that the pupils would need to be comfortable with. The first is the ability to convert the minutes and seconds information from a stopwatch into seconds only. The second is being able to convert from centimetres into metres (and the use of decimal points), as a result of measuring track length. Using the track length and time to calculate the speed in metres per second, the pupils would then need to understand converting from meters per second into kilometres per hour, i.e. 3600 seconds in an hour, 1000 metres in a kilometre. If the miles per hour value is required, pupils would need to understand the conversion between miles and kilometres (1 mile = 1.609344 kilometres exactly; 1.6 kilometres as an approximation would be used in the activity). Finally for the up-scaling, if the car is 1:32 scale, pupils would need to understand that multiplying the speed value they have calculated by 32 gives a value of speed for a full-size car. All of these calculations involve basic multiplication and division, within the scope of the age group at which the activity is targeted.

Benefit

The main benefit attained from planning the activity and attending the adopter seminars has been the use of the learning cycle and the enquiry question to think through the planning of the activity, what the pupils would be expected to achieve and be challenged by, and how to ensure all pupils are engaged with the activity. The original intention for the Scalextric activity was to have a track already constructed and for the academic to lead on the activity whilst the pupils observed. As a result of attendance at the seminars, the activity has been altered to make it more interactive. Instead of the track already being built, the pupils will break into three groups and build their own tracks as part of the activity. Thus the pupils will be more immersed in the activity than if they were standing at the side watching what the academic was doing and listening to the academic. This would have resulted in the pupils becoming bored and switching off from the activity. The use of supplementary questions and activities also means the groups can be sub-divided further so each pupil (or pair of pupils) undertake specific roles during the activity to ensure a successful completion of the activity and provide an answer to the original question.

Another benefit has been the introduction to the different activities that can be used with the pupils and the introduction to the generic learning outcomes and generic session structures that can be utilised to create activities for delivery to primary schools. It was interesting to note the difference between what are classed as generic learning outcomes in a university environment and what are classed as generic learning outcomes for primary school children. It has also been beneficial to understand that the aim of public engagement with school children is to ensure learning outcomes are focused upon, as opposed to just meeting, the objective of the activity. Although a “double-diamond” approach has been utilised for the Scalextric activity, the author is now aware of other session structures that can be used for other offers and activities.

The introduction to the critical skills toolbox, and the different tools and approaches for developing the activity session, facilitating discussions and activities with the overall activity and how to sum up the activity and obtain evaluation data have also proved invaluable.

Institution

The main issue that proves to be an obstacle back at the institution for public engagement is that of workload allocation. Many science and engineering academics would not consider public engagement activities to be an important part of their workload commitments. In the past, academics considered their responsibilities to be restricted to teaching, learning, assessment and the administration that this involved, but are now expected to perform extra academic-related activities. Given the increased workload undertaken by academic staff, it is feasible that they lack the time to undertake public engagement activities. The only way to encourage them to engage in public engagement may be to re-allocate workload, enabling public engagement activities to be incorporated into the capacity of some academics by obliging others to carry the burden of existing activities.

Conversely, the fact that the institution has organised Scifest can be taken as an indication that selling what the institution does to various audiences has become an important part of the institution's outlook. As stated earlier, with the advent of the higher fees regime, there is more incentive for universities to be marketing their courses and their activities to increase student recruitment. Therefore this may link back to the issue of workload allocation mentioned in the previous paragraph and time may be made available for some academics, with the assistance of both postgraduate students and undergraduate students, to become active in public engagement. A caveat to this, however, would be to ensure that only academics and students who are capable of delivering public engagement are utilised, otherwise the institution may not benefit in the long term from public engagement activities if unsuitable "ambassadors" are utilised.

Next Steps and Sustainability

The next objective is to run the activity at Scifest 2012 on 29th June. The activity is scheduled to take place four times during the course of the day, twice during the morning and twice during the afternoon. The author will adapt the session as necessary after each run to take account of anything that worked particularly well during the activity and to iron out anything that may have gone astray or may not have worked well. Should the activity work well on the primary school day, the author may contact primary schools within the local area who were either not invited to Scifest or who could not make the primary school day, and investigate whether the local primary schools would be interested in the author taking the Scalextric activity out to their schools, and how this would fit in with their lessons and curriculum.

Regarding sustainability, the author should be able to introduce the package and deliver the public engagement training to colleagues at the institution. It is expected that the learning will be adopted through running the training as part of an on-going public engagement programme each year, therefore embedding the practice which, in turn, sustains the activity within the institution. A decision has already been made to embed public engagement activities into the Department of Engineering as part of staff development and as part of the recruitment activities when working with colleges and secondary schools. Each activity will be rolled out as the project develops, with the trained academics working with local colleges and school to develop long-term relationships where each year new students are engaged. Thus the public engagement training will be adapted to cater for pupils in secondary schools and FE colleges. The Department of Engineering also intends to train first year and second year undergraduate students, with a view to these students providing an increased number of group project activities for use with colleges and schools.

Institution-wise, future occurrences of Scifest will depend upon the success of this year's inaugural event. Should Scifest become an annual event, the public engagement training will be embedded into the preparation of future iterations of the event, for academics, postgraduate students and undergraduate students who will be delivering the Scifest activities.

Key Highlights and Outcomes

As the Scifest activity does not take place until 29th June it has not been possible to run through the activity yet to ascertain whether the activity is OK as it stands or whether more supplementary questions are required. However the author has discussed the activity with the headmaster and lead science teacher at the primary school where the author is a parent governor, to determine whether the activity has been pitched at the right level for year 5 and year 6 pupils. Feedback from the headmaster and lead science teacher suggested that the activity provides a useful exercise in the understanding of speed and forces, and the use of supplementary questions to challenge the pupils who solve the initial questions fairly rapidly is recognisable as good practice. The intention of steering away from use of calculators when calculating average speed, conversion to kilometres per hour and up-scaling of average speed was also received positively as an incentive to develop the mathematical skills of the pupils.

This activity was undertaken as a part of the National HE STEM Programme, via the South West Spoke. For more information on South West Spoke projects, please see www.hestem-sw.org.uk. For more information on the overall national programme, please see www.hestem.ac.uk.