CAN LEARNING PHYSICS BE FUN? - WATER PARK PHYSICS

Vladimir Pasek, Peter Wright

ABSTRACT
Students enjoy going to the water park where they descend water slides and swim or jump around in a wave pool. Teachers work hard to make Physics enjoyable in a classroom situation. Since the 1980's, Amusement Park Physics has been used by many physics teachers. In Edmonton, Alberta there is a large shopping center that has a large Water Park. The author decided to integrate the learning of physics with a field trip to the Water Park. Students along with their teacher spend a morning reviewing kinematics, dynamics and the principles of waves while having fun. The students or the teacher wears a vest from Pasco (Xplorer Vest PS-2520) that contains a storage device (Xplorer Datalogger PS-2000) and a sensor (3-Axis Acceleration-Altimeter PS-2136) which measures acceleration in the three axes and the altitude. The students record the measurements while they are moving down the slides. Afterwards the data is downloaded into a computer that has a program (DataStudio). Students work in groups of four answering questions on worksheets and analyzing the graphs produced. At the end, students hand in their work for evaluation purposes. They can relate to physics in this activity because they are living and playing with the concepts.

KEYWORDS
ICT in education, Physics

INTRODUCTION

Physics teachers have to continuously determine ways to simplify the teaching of physics concepts. They have to use different strategies in their presentations to facilitate the understanding of the laws and principles of physics. A good strategy is to show the students the relevance of the concepts in their daily lives. One could use videos, simulations or just orally explain how the concepts are used everyday in the student's life. Field trips provide a way for the visual/tactile/kinesthetic student to embrace the concepts in physics.

Students have been performing Amusement Park Physics for many years. One of the first articles on this topic was written by John L. Roeder in *The Physics Teacher.* He wanted to determine the artificial gravity that is felt by the person during several rides (Roeder, 1975). Amusement Park Physics was performed by teachers, before 1975 but it was not officially written in an article. The author has been taking students to Galaxyland in West Edmonton Mall (WEM) which is located in Edmonton, Alberta since the mid ninety's. Galaxyland has the world's largest indoor triple loop rollercoaster. Students receive work sheets on the qualitative and quantitative aspects of the rides. They answer questions dealing with the physics concepts involved with each ride. At the end of the field trip they hand in their work for evaluation purposes.
WEM (Figure 1) also has a water park with many water slides and a large wave generator for its pool. In Alberta, students in the Physics 20 course cover kinematics, dynamics, energy and waves. The author decided to produce worksheets with qualitative and quantitative questions on the water slides and wave pool. The Physics 20 curriculum fits well with experiments that can be performed in the water park. The

start of Water Park Physics in Edmonton became a reality. Now, the students have a choice when they go on a field trip to WEM at the end of Physics 20.

Figure 1. The Water Park at West Edmonton Mall

FIELD TRIP

Preparation

In the Edmonton Catholic Schools, a month before the field trip the teachers have to fill out a form describing the trip in order to obtain permission for the field trip. Also, a permission letter for the parents to sign has to be filled out with all the necessary information dealing with the trip. Money has to be collected of the amount of $9.00 ($8.00 for the park and $1.00 for the school bus). Another field trip form has to be passed around and signed by the other students' teachers thereby they are aware of the absence and at the same time grant them permission to go. Two weeks before the excursion, the teacher phones WEM to let them know the number of students that will be attending the two sites.

Being a large high school, there are four or five Physics 20 classes attending the field trip. Normally, there are three chaperons attending the students to WEM. Two physics teachers and a technician. One physics teacher goes to Galaxyland for Amusement Park Physics and the other goes to the Wave Pool for Water Park Physics. Meanwhile the technician goes with whoever needs the most help. The tickets are bought the day before the trip.

Field trip

On the day of the field trip, which is always on a Friday, the students at 9:30 A.M. congregate in front of the school to wait for the buses. Once the two buses have arrived, they board them. Also, there is one teacher per bus. On the bus the supervising teacher takes attendance, hands out the tickets, the worksheets and the necessary equipment (stopwatches and a calibrated plank for those attending the

water park). The trip takes approximately 30 minutes. On arrival, the students and teachers part to their respective park to carry on the experiments.

The students who go to the water park have to obtain lockers and change into their bathing suits. Afterwards they can go and start their experiments. One of the slides is called the "Sky Screamer" (Figure 2). It takes about 6 seconds to arrive at the bottom of this very steep slide.

Figure 2. The sky screamer slide

The following is an example of the qualitative and quantitative questions that students have to answer:

Observations:
List the sensations at the following points in the slide. Use words like "no friction", "some friction", and "lots of friction".

1. At the beginning of the descent: _____
2. At about half way down: _____
3. At the bottom of the slide: _____
4. Why is the slide curved?
5. Why are the sides of the slide high?
6. If you had a "gravity meter", what part of the trip would read as zero?
7. Where would your "gravity meter" show its maximum reading?
8. Why is it at a maximum at that point?

Calculations:

1. Calculate your time, if you dropped straight down from the maximum height of the slide.
   (Show your work)

   $d = v_i t + (1/2)gt^2$

The next slide is called the Twister (Figure 3) On this slide it takes 31 seconds to arrive at the bottom. The following are a sample of the questions included in the experiment.

Observations:
List the sensations at the following points in the slide. Use words like “no friction”, “some friction”, and “lots of friction”.

1. At the beginning of the descent: _____
2. At about half way down: _____
3. At the bottom of the slide: _____
4. What do you feel during the turns?
5. Why are the sides of the slide so high?
6. Why do you move high along the side when you turn?

Calculations:

7. Calculate your time, if you dropped straight down from the maximum height of the slide.
   (Show your work)

   $D = v_i t + (1/2)gt^2$

8. Compare the calculated time to the time you measured. What is the difference and why?

9. How would you calculate the force of friction? List the steps necessary to determine the force of friction.

   $d = v_i t + (1/2)gt^2$

Figure 3. The “Twister” water slide

Figure 4 shows the teacher wearing the data gathering vest (Xplorer Vest PS-2520) that contains a storage device (Xplorer Datalogger PS-2000) and a sensor (3-Axis Acceleration-Altimeter PS-2136) which measures acceleration in the three axes and the altitude.

Figure 4. The teacher wearing the vest after a descent.

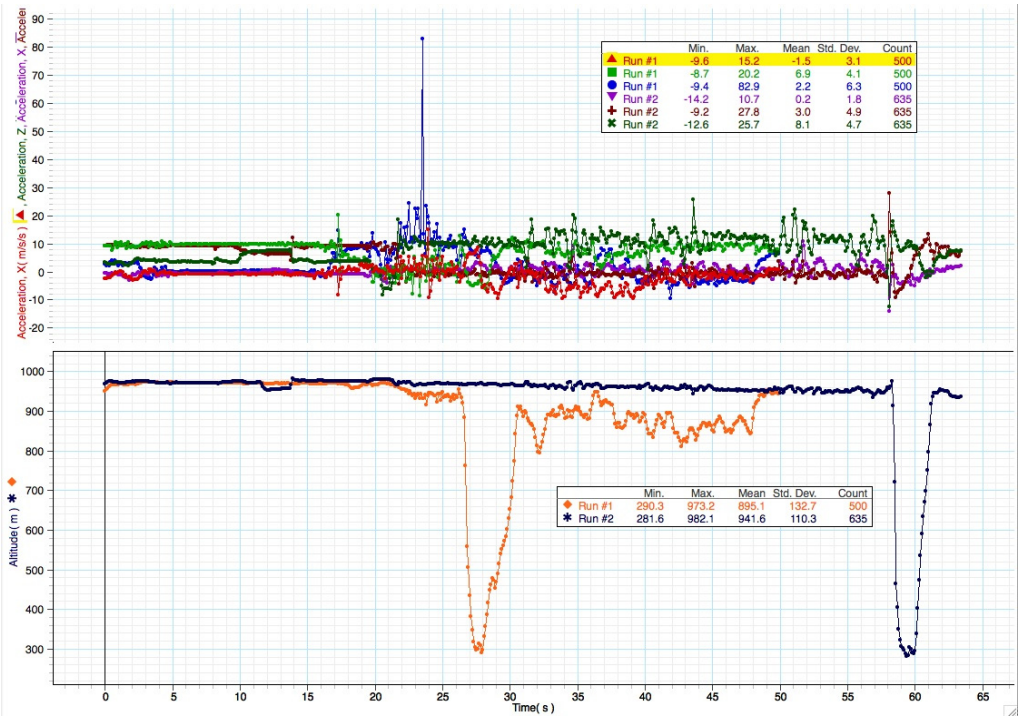

Figure 5. Graphs obtained from the datalogger.

The program DataStudio takes the data and places it in the graphs as seen in Figure 5. It also separates the graphs so that they can be studied individually. A problem occurred in that the readings were not accurate due to the fact that the equipment had to be wrapped in plastic in order not to get it wet. The author wrapped the equipment twice. In this way the safety factor was increased by a factor of two. But the readings were inaccurate because it was wrapped tight. For example, the graphs show a drop of several hundred meters which was definitely false. The meters use air pressure to determine the altitude and therefore they are being affected. Basically the time scale can be used to determine the time of the descent. Figure 6 shows the y-acceleration when descending the Sky Screamer.

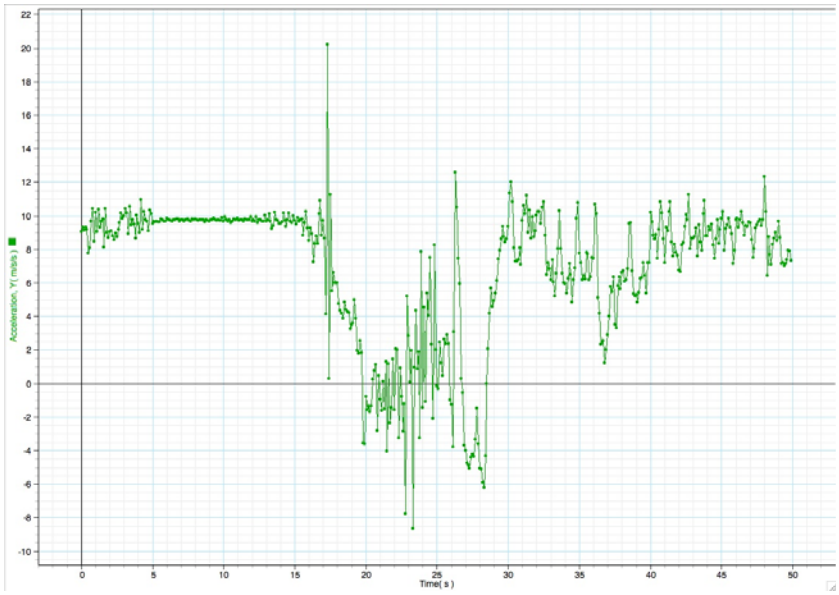

Figure 6. y-acceleration vs. time upon the descent on the sky screamer water slide

When the vest with the equipment is used without the wraps, such as on the “Mindbender” rollercoaster, the readings are fairly accurate (Figure 7)

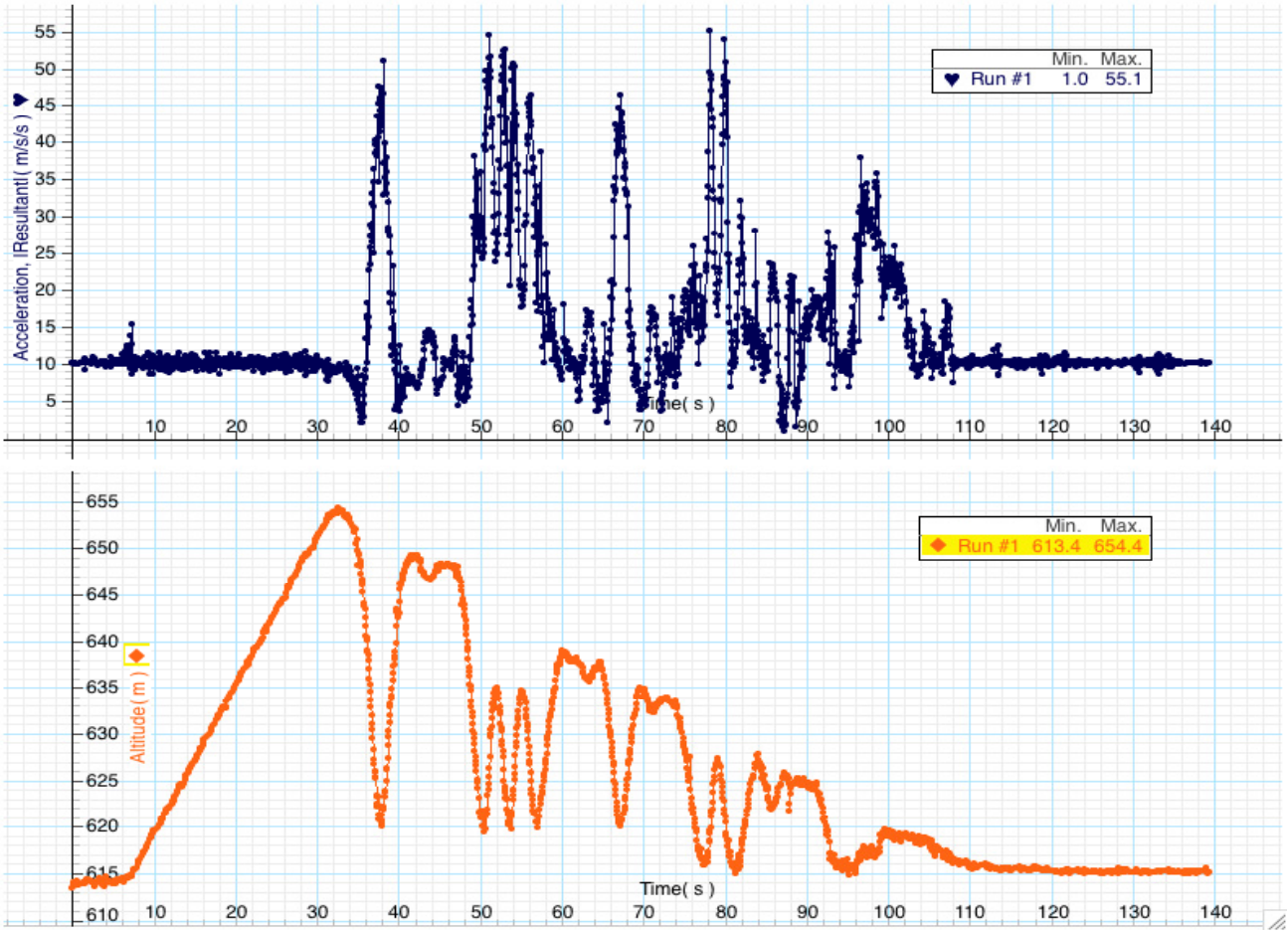

Figure 7. Altitude and resultant acceleration on the "Mindbender" rollercoaster

The last part of the worksheet was to determine the amplitude, wavelength, frequency, period and velocity of the waves. The following is an example of the questions:

Observations:

1. Place the calibrated plank in the middle of the wave pool at approximately 1.30 m depth. Make sure the plank is perpendicular with the floor of the pool. Measure where the water reaches when there are no waves. Measure the lowest and highest point that the water reaches on the plank when the waves are created.

   Still water _____ m
   Lowest point _____ m
   Highest point _____ m

   Determine the difference _____ m
   Amplitude of the wave _____ m
2. Measure the time between two of the highest points as the waves pass the plank.

   Time between peaks _____ s

3. Measure the time it takes for four peaks (highest points) to pass the plank.

Time elapsed _____ s

4. Measure the time it takes a wave to go from the beginning of the pool to the other end.

   Time elapsed _____ s

Calculations:

5. Calculate the speed of the waves.

   $v = d / T$

Students had a hard time with this section because they had to figure out a way of obtaining the necessary data. Figure 8 demonstrates the problems.

Figure 8. Students measuring the amplitude of a wave

ADVANTAGES

One of the main advantages of this field trip is that the students cover the main concepts (kinematics, dynamics and waves) in Physics 20 in Alberta. This could be used as a review of the course. Another advantage is that the student can relate what is happening to them to the physics they are leaning. In other words it is something that is visual and tactile. Also while they are learning, they are having fun. Students can choose what they want to do, Amusement Park Physics or Water Park Physics. One student made a comment on the way back on the bus "I enjoyed myself and also learned physics."

DISADVANTAGES

More students opt for Amusement Park Physics than for Water Park Physics. The ratio is usually 20% to 25% of the student body who decide to go to the water park. The factors that affect this lower turnout are the following: a) fear of water; b) sensitivity to chlorine; c) shyness; and d) body self-consciousness.

Some students don't want to be seen in a bathing suit due to the way they look. The ones that went were usually in good shape. The equipment such as the stop watches, altimeter, accelerometer, and the data logger have to be water proofed. It costs more for the students to go to the water park because they have to rent lockers and bring towels, shampoo, and soap. It is also more time consuming because the person has to change clothes twice and take a shower.

CONCLUSION

The Physics 20 classes will definitely continue performing these experiments. They will come close to the end of the course so that it is part of their review. It will fit well with the new Physics 20 Program of Studies in Alberta. These types of field trips help physics students understand the concepts because they relate them to everyday life. Its fits well with the author's philosophy "Physics is life, physics is fun"

REFERENCES

Roeder, J. L. (1975) "Physics and the Amusement Park". *The Physics Teacher* 13(6): 327-332

Vladimir Pasek
Department Head of Science
Archbishop O'Leary High School
8760 – 132 Avenue
Edmonton, Alberta
Canada
T5E 0X8
Email: pasekv@mac.com

Peter Wright
Department of Educational Psychology
Faculty of Education
University of Alberta
Edmonton, Alberta
Canada
T6G 2G5
Email: peter.wright@ualberta.ca