BRIGHTON GRAMMAR SCHOOL INCREASES STUDENT LEARNING BY INCREASING ENGAGEMENT IN SCIENCE

CASE STUDY: MELBOURNE, AUSTRALIA
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MELBOURNE, AUSTRALIA
ENGAGEMENT AND LEARNING ACROSS THE SCHOOL

Dan Belluz, Director of Teaching and Learning
Brighton Grammar School
School
1,280 boys
Early learning center
Junior school (prep-grade 6)
Middle school (grades 7–8)
Senior school (grades 9–12)
https://www.brightongrammar.vic.edu.au/

Challenges
Older, unreliable sensors and equipment
Inaccurate data

Solutions
PASCO digital sensors
SPARKvue® science learning application

Implementation
Grades 7–12
Physics
Chemistry
Biology

Results
Accurate, reliable data
Increased student and teacher engagement
Increased student learning
Brighton Grammar is an all-boys school in Melbourne’s southeastern suburb of Brighton. When physics teacher Dan Belluz started the shift to inquiry-based instruction with his grade 11 physics students, he wanted to find a better way for students to visualize data.

“My goal was to connect physics theory to practice with data that was accurate and meaningful,” he said. “The problem was that the school’s science equipment had been pieced together from different companies, and it was outdated and unreliable.”

Since then, Belluz has implemented a variety of PASCO science solutions, including digital sensors and the SPARKvue science learning application.

“Before, it was almost impossible to measure the kinds of things that we needed to measure to show conservation of energy and conservation of momentum,” said Belluz. “With PASCO equipment, including Force Sensors with their carts and tracks, we’ve been able to gather data that’s meaningful and accurate and that demonstrates the theories very well for the students.”
Involving students in hands-on, inquiry-based science

At Brighton Grammar School, several middle and high school classes now use PASCO sensors for accurate, real-time data collection. Available for over 80 measurements, the rugged, reliable sensors combine advanced technology with plug-and-play usability for easy use in and out of the classroom.

Students also use the sensors for real-time quantitative measurement and analysis. By incorporating these technologies into their instruction, teachers are creating student-centered learning environments where students drive the experiments, make predictions, and collect and analyze data to see how their predictions compare to actual results.

In his grade 11 physics class, Belluz typically takes five minutes at the beginning of the period to give a conceptual overview of the activity, and then five minutes at the end to wrap things up. During the rest of the period, students are immersed in doing their own experimental work, while Belluz moves from group to group addressing questions.

“Because PASCO equipment is so easy to assemble, my students don’t ask mechanical questions about how the equipment fits together, as they did in past lab experiments. Instead, they ask questions about the concepts and theories underlying the experiments they’re conducting,” he said.
Connecting science to the real world

For each major topic of study in grade 11 physics, Belluz gives students activities that demonstrate real-world applications. “As students solve problems using PASCO sensors and SPARKvue, they learn that the things around them (such as respiration, heart rate, water quality, and electronic signals) can be measured and evaluated,” he said.

As a result, Belluz has observed dramatic changes in students’ visualization of physics phenomena. “There are things we can now measure that we couldn’t measure in the past, such as the photoelectric effect. Using PASCO equipment, I can now actually show students what I’m talking about. Graphs of real-time data are automatically generated in front of them, and the results are instantaneous, so they can see exactly what’s happening,” he said.

Increasing student engagement and motivation

According to Belluz, the most obvious impact has been on student engagement and motivation. “In a traditional lecture model, students’ attention would fade in and out. But when they’re actually doing science, they’re fully engaged;” he said.

For example, with PASCO’s Motion Sensor, students can use their bodies to demonstrate real-time graphing. “They can see a real-world experience being translated into data that they can analyze immediately. This makes scientific inquiry more authentic to them because they can see it has an application outside the textbook and classroom,” said Belluz.
With PASCO, we get the “wow” factor because students can focus on the activity, not the equipment. In fact, the number of times I’ve heard them say “Wow, this theory actually works!” is extraordinary.

**Increasing student confidence**
In the grade 12 physics class, all students are required to do an extended practical investigation in which they are assigned a problem, and then they must design and conduct their own experiment to solve it.

“Students can use any equipment from school or from home,” said Belluz. “Since our students use a lot of PASCO equipment in grade 11, they often ask to use it for their investigations because they know it’s easy to set up and use, and they know that they can get accurate, reliable data.”

During the 2014-15 school year, Belluz’s grade 12 physics class examined factors that affect the efficiency of solar panels. “Students used Light Sensors and Voltage/Current Sensors in their investigations and were able to get spot-on measurements. That shows that they have confidence in the equipment and what they can do with it,” he said.

**Experiencing the “wow” factor**
“My students learn really well when they can relate theoretical knowledge and concepts to practical, real-world applications,” said Belluz. “They need to be able to see how things work. Otherwise, the concept will remain abstract to them. With PASCO, students know that they can accurately measure something, without having to worry about equipment failure. This reliability allows them to concentrate on the theory and on reproducing it and seeing it work in real life. In contrast, if they’re trying to get an older piece of equipment to work or if they’re worried about the accuracy of their data, they lose sight of the theory. With PASCO, we get the ‘wow’ factor because students can focus on the activity, not the equipment. In fact, the number of times I’ve heard them say ‘Wow, this theory actually works!’ is extraordinary.”
Increasing student learning

To determine if all of this really had an effect on student learning, Belluz conducted a research project comparing his physics class to one that did not use PASCO tools. Analysis of videotapes from each class showed an increase in student engagement, as well as a deeper understanding of physics in the class using PASCO technology.

Belluz also used two evaluation instruments to assess student understanding in each class: the Force Concept Inventory\(^1\) and the Mechanics Baseline Test\(^2\). “There was significant improvement between the pre- and post-tests for students using the PASCO equipment over the others using traditional methods and older tools. Since then, I’ve continued to see these gains in the classes using PASCO equipment, so I’m confident that it’s continuing to improve students’ conceptual understanding,” he said.

Additionally, an in-class survey indicated that Belluz’s students reported greater feelings of confidence, engagement, and understanding of the task during activities using PASCO science solutions, compared to activities that did not include them.

As a result, the use of PASCO products is increasing across the school. “Our biology department now uses PASCO when students are studying respiration. They have found that it’s simple to set up and monitor plant respiration over extended periods. They’ve also found that it’s easy to use the Oxygen and Carbon Dioxide Gas Sensors,” said Belluz. “The chemistry people have gotten onboard, using the Temperature and Gas Sensors. We’ve also invited the junior school to begin using the equipment.”

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A commonly used statistical tool to describe the significance of the difference between two groups is the calculation of effect size. In educational research, an effect size of 0.4 or greater is said to be significant and noticeable. This suggests that the intervention being measured has improved learning. While we cannot compare these two groups directly (as they are different sets of students from the same study), the effect size calculations are significant.
Shifting students’ and teachers’ thinking
As other teachers have transitioned to PASCO science solutions, Belluz has found three distinct areas that are impacted by the shift in instruction:

- Student engagement has increased learning.
- There has been a positive impact on teachers as the tools and processes have changed their pedagogy.
- The style of questioning has changed for both students and teachers, which has led to much deeper learning.

“Students’ questions changed almost overnight. Before, the majority of their questions focused on, ‘How do we do this?’ ‘How do we make this equipment work to get the numbers we’re supposed to get?’ Now, with the PASCO equipment, they’re asking, ‘Why am I getting this result?’ ‘What would happen if this changed, or that?’ Those are much better questions,” said Belluz. “The difference is that with PASCO tools, students can make a change and measure the results instantaneously. They don’t have to reconfigure the equipment or take repeated measurements to see if their measurements are accurate. They can make spontaneous changes and answer their own questions as they go.”

“Teachers are also asking better questions, and asking students to apply their knowledge to unknown situations. They’ll say, ‘Here’s the equipment. Now answer this question or solve this problem by creating your own experiment.’ This type of hands-on science is much more engaging for students and it deepens their learning,” he said. “Even better, teachers are more engaged now, too. When you have done the same thing the same way for a long time, it’s easy to become stagnant in your teaching. Our use of PASCO has reignited teachers’ interest because it allows us to look at new ways of teaching, which reenergizes our classes and makes them more exciting for everyone.”