Incorporating a Flight Simulator Based Laboratory for Physics of Motion

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Traditional physics laboratories for physics of motion can involve air tracks and air tables to investigate 1D and 2D phenomena, respectively [1]. These are typically coupled with ultrasonic, optical, or vision sensors for the purpose of data logging. While these offer great benefits in terms of the training of experimental techniques, they can lack practical appeal and result in "ineffective and uninspiring" activities [2]. Conversely, simulations of such activities have been shown to facilitate students' understanding of the underlying concepts [3]. Importantly, real-world, authentic, laboratory activities result in higher student engagement [4]. An authentic real-world simulation then represents an ideal laboratory activity.

Laminar Research's X-Plane is a flight simulator engine. While Microsoft Flight Simulator is the most well know software, X-Plane implements an actual aerodynamic model called blade element theory. The advantage of this "physics engine" over those used by traditional flight simulators, is that actual meaningful aerodynamic parameters are calculated continuously to model the flight of an aircraft, realistically. X-Plane can be set to provide data for time, velocity, displacement, weight, lift, drag, density, angle of attack, and many other useful parameters. These parameters can be logged up to 50 times per second, down to more sensible sub-Hz options. These types of parameters make it very easy to investigate simple cases of aircraft performance, directly applicable to the physics of motion. For example, a simple take-off run can be used to show the relationship between speed and displacement and enables students to calculate simple parameters such as acceleration during the run. This can be achieved by exporting the data as a text file and analysing it in Microsoft Excel. Importantly, the software can be run on a simple machine, for example an i3 with 8GB of ram, and a graphics card with only 512MB of dedicated memory. The software itself is relatively low cost, at $60 USD for a digital copy.

We present results of student perception of laboratory activities using X-Plane 11 flight simulation. Comments suggest students found the activity engaging and authentic, providing a real-world example of the underlying teaching and learning material. In the next iteration of the activities, students will fly in virtual reality, providing a more immersive and authentic experience.

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[3] A. Jimoyiannis and V. Komis, *Comput Educ* **36** (2), 183-204 (2001).
[4] J. K. Robinson, *Anal Bioanal Chem* **405** (1), 7-13 (2013).