ORIGINAL ARTICLE

Seeing Through My Lenses: A GoPro approach to teach a laboratory module

FUNG Fun Man[1]

[1] Department of Chemistry, National University of Singapore

Address for Correspondence: Fung Fun Man, Dept of Chemistry, Faculty of Science, National University of Singapore, Block S8 Level 3, Science Drive 3, Singapore 117543

Email: fun.man@nus.edu.sg

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ABSTRACT

The current video filming technique in the laboratory setting allows the students to understand the procedures from the third person's view. Students' connection with the demonstrator in such videos may not be as strong as if the first-person view (FPV) is used. As instructors in the laboratory, how do we capture students' attention in a manner that will make it an even more realistic demonstration? In this paper, we discuss the application of a small device, the GoPro camera, which empowers the laboratory demonstrator to teach his or her students in a new perspective and allows the student to see through the demonstrator's lenses. Students who have viewed the GoPro-made FPV instructional videos found this new technique to be engaging and useful in enhancing their knowledge and understanding of scientific experiments. Adopting the FPV technique with GoPro devices allows the instructor to break out of the banal and narrow scope which is characteristic of a single recording and in the process, make the learning journey in the laboratory more authentic.

INFORMATION TECHNOLOGY (IT) IN TEACHING

With the rising use of videos, the utilisation of moving pictures has never been so widespread before in classroom teaching. Salman Khan, the founder of the acclaimed Khan Academy, a free online education platform, says "let's use video to reinvent education" in his 2011 TED talk (Khan, 2011). Employing videos has never been better at increasing the effectiveness of the instructor (Barbier, Cevenini, & Crawford, 2012). For learners, this presents them with the opportunity of higher in-class engagement and output performance (Bravo, Amante, Simo, Enache, & Fernandez, 2011). In a research conducted by Greenberg and Zanetis (2012), it was found that that the impact of educational video on the learner can be explained by three factors: engagement, knowledge transfer and memory, as well as interactivity with content. Even so, laboratory (lab) module teaching has not deployed the video style due to various obstacles. In fact, there exists the apprehension in teaching a scientific lab module: every experiment is a new experiment. This belief still underlines the view towards the teaching of lab modules. Science students ought to experience on their own what it is like to perform a new experiment, and to do so, these undergraduates scan the lab manual for hours, trying their best to translate the scientific prose into actions which they have to perform. There are always variations in the level of English language proficiency amongst students, in particular, students for whom English is not their first language. Some students may therefore not fully understand the actions required by the lab manual and would follow their own perception and intuition. Sometimes, this is dangerous as scientific experiments can be hazardous if there is no proper understanding and awareness of the experimental steps involved. At other times, students who do not fully comprehend the manual would adopt a wait-and-see approach, that is, observe what their counterparts are doing first, and then copy the same moves. Again, this creates potential danger if the classmates whom they replicate the moves from execute the procedures incorrectly. One error may lead to another which will result in undesirable outcomes. Equipping students with pre-recorded first-person view (FPV) videos enables them to view the lab procedures in a more personalised way. They could even view the video in a way that will give them insight on what to expect in the actual experiments. Thus, when working on the experimental procedures, it will not be the first time that the students see the setup, so they are able to draw experience from what they learn in the FPV video. As Costa and Kallick (2008) put it in their book, *Learning and Leading with Habits of Mind*, "Intelligent humans learn from experience. When confronted with a new and perplexing problem, they will draw forth experiences from their past" (p. 28).

PEDAGOGICAL THEORY

To enhance teaching and learning in the lab setting, the use of video demonstrations was employed in teaching chemistry concepts. In the study by Velázquez-Marcano, Williamson, Ashkenazi, Tasker, and Williamson (2004), the team investigated whether video demonstrations or particulate animations helped the students' conceptual understanding. It turns out that the students showed improvement after each visualisation exercise and there was significant improvement in responses between the first and second visualisation. Furthermore, Burke, Greenbowe, and Windschitl (1998) noted that the use of animations of a short duration and the use of demonstrations with animations could be effective.

However, the most commonplace technique of filming lab demonstrations involves a video camera capturing the process from the third-person point of view. While improvements have been made over the years due to the enhancement in the pixel quality and frame rates, little has been done on the change of the viewer's scope. The viewer may not feel as connected to the demonstrator as compared to viewing the actual practical from the first-person view. In the case of a first-person view video, the viewer sees everything from the point of view of the demonstrator, which can include a view of the person's hands and equipment. With third-person view videos, the audience can see the demonstrator on-screen moving through the premises (Schleiner, 2001). The demonstrator is usually viewed from a point laterally away from him or her.

Studies on the FPV mode have been done by several groups. The benefits of this "real" experience has been tested via the use of first-person shooter (FPS) video games, whose players showed improvements in brain functions such as cognitive abilities and learning skills. Green and Bavelier (2006) found that nine non-gamers played *Medal of Honor: Allied Assault*, a FPS game, for one hour per day for 10 days, while eight non-gamers played *Tetris*, a non-FPS game for the same span of time. By training with the FPS game for less than two weeks, the non-gamers were able to improve their scores on three tests of visual attention—a skill that is vital for activities such as reading and driving. Additional research done on the quantifying effects of third- and first-person perspectives in virtual reality-based training also suggests that learning is enhanced with FPV (Salamin, Tadi, Blanke, Vexo, & Thalmann, 2010). Moreover, in a behavioural study evaluating performance on decision making, combining first-person video in training "provided insight into what was consciously noticed" (Szulewski & Howes, 2014, p. 2). As such, watching FPV videos allows the learners to see through the teacher's lenses, and in doing so, the facilitation of learning become more seamless.

GOPRO FOR LABORATORY (LAB) TEACHING

The first GoPro camera emerged in the market as early as 2005. However, it was only in recent years that this tiny photographic device grew in prominence in the world of sports and entertainment. There are numerous GoPro-made videos on the official website, but none on chemistry lab education. Having several friends who pursue adventure sports, the author was introduced to the robust GoPro device which measures a slim 60mm by 40mm by 20mm and weighs only 76 grams (Figure 1). It is a lightweight tool to wear on the demonstrator's head, filming the process of operating a machine, instead of having an IT personnel assisting with the filming from a third person's view. Many institutions faced the problem of having non-chemistry trained IT assistants to record the footage. Since the IT assistant is usually from a non-chemistry background, he or she may not appreciate the pedagogical focus of the chemistry videos. The zooming in and out of the view can only be managed by the chemistry demonstrator, and sometimes the pedagogical quality of the resulting footage leaves much to be desired. The outcome could only be better if the demonstrator is able to record what he/she wishes his/her students to see and think, with a particular focus on certain learning outcomes. Even if the IT assistant has a second vocation in chemistry, what the demonstrator wishes to record may not be perfectly aligned with that of the assistant. To sum up the experiences of colleagues, any person other than the instructor filming the event is usually someone from the IT department, and the instructor has to continually direct the individual to focus the camera correctly during the filming. This results in considerable editing of the video to achieve a polished final product. The video recording method adopted in my course as described here would potentially eliminate many of these issues.

Figure 1. The GoPro HERO3 silver edition cameras.

RATIONALE FOR USING GOPRO DURING LAB SESSIONS

The younger generation of students nowadays have gone through the transformative years in IT, where they have seen the rapid development of video games, from 2D games like *Tetris* and *Pac-man*, to 3D first-person games such as *Call of Duty* and *Team Fortress*. Such FPV technique has also been used in training simulations for pilots and army tank commanders. Educators should embrace IT and apply it to enhance the education of this new generation. This is significant because traditionally the method of recording instructional demonstrations for the lab is the third-person view. Using the GoPro is unprecedented as this gives students a more realistic view of the apparatus and instrumentation they will be working on in the lab. The sensory consequences of others' actions should therefore be derived effectively when seen from this first-person perspective, but less so when they are seen from a third-person view, which captures the typical viewpoint when watching the actions of others.

Flipped classroom and recording videos for teaching has been reported numerous times in the last few years (Davies et al. 2013; Missildine et al. 2013; McLaughlin et al. 2014). Even so, none reported the use of a first-person shooter technique to capture realistic motion images of the lab. Students have given feedback to the author that they have found current video recordings, though clear, to be inauthentic. This is because they are always watching these video recorded demonstrations from the third person's view (Figure 2a). In their own experiments, they would be looking at the setup from a first person view (Figure 2b). Thus this idea of using GoPro to ameliorate online lab teaching was crystallised.

Figure 2a. Third-person view of video recorded demonstrations (Click on the photo to go to the video link).

Figure 2b. First-person view of video recorded demonstrations using GoPro cameras (Click on the photo to go to the video link).

Currently there are many instructional videos on YouTube and other websites guiding students on the operations of an instrument. However, to our knowledge, very few instructional videos have looked at such an approach of using FPV videos to view lab procedures. In this pilot research study, we compare the usage of FPV videos versus live demonstration for chemistry lab teaching and report the findings by analysing the student feedback and pre-lab assessment results.

METHODOLOGY: SHOOTING A FIRST-PERSON VIEW (FPV) FOR LAB VIDEOS

CM3291 "Advanced Experiments in Organic and Inorganic Chemistry" is a compulsory module for all chemistry majors and deals with lab experiments on selected topics of advanced chemistry principles and theoretical content primarily selected from the core modules in Levels 1 and 2. This practical module is tailored for the chemistry students according to the types of experimental techniques they have learnt in their earlier years. In one of the experiments, students have to perform a purification method called the flash column chromatography. These students were first taught this technique in Year 1 and the majority of them would not have the chance to practice this skill in Year 2. By Year 3, most would have forgotten how to perform such a purification technique using the required glassware, and could certainly do with watching the instructional videos as a refresher. Previously, before the advent of videos, the class of 45 students would break out into three groups of 15 each. Each group would be guided by a graduate teaching assistant (GTA). The GTA could then choose to perform a standard procedure live for specific groups of students as a refresher activity. There are however three disadvantages with this method of instruction. One, the students would have to spend about 20 minutes of their dedicated practical session to revise by reading what the GTA was doing. Most of the time, they would rush into their experiments after reading and exhibit insouciant and careless behaviour since their primary goal was to complete the chemical synthesis in time. With this 20 minutes down time, students felt uneasy and flustered while trying to catch up on the time they felt they have lost. Moreover, each GTA may have their own way of conducting the various steps required to complete the flash column chromatography and thus the teaching would not be uniform. Even though these variations are not detrimental to the outcome of the experiments, they could cause confusion in students when they discuss the technique later. This accounts for the second demerit of live demonstrations. Lastly, even if the lecturer-in-charge performs a standard live demonstration, not all 45 students would have a clear view of the setup. Without the full view, certain steps may be missed by the students who are handicapped by a blocked view caused both by the classmates and the demonstrator.

Using the GoPro camera to record FPV videos, however, solves the aforementioned problems. In this trial, the demonstrator wore two GoPro cameras; one strapped onto the forehead (Figure 3a), the other strapped onto the chest (Figure 3b).

Figure 3a. The demonstrator wearing two GoPro cameras.

Figure 3b. The demonstrator standing beside the chemistry fume cupboard.

One might conjecture that using two cameras would produce a magnificent experience for the viewers. This hypothesis holds validity if and only if the cameras were positioned at the correct angle. In what follows, the challenges of adopting such a method of lab teaching will be discussed.

THE FPV OUTCOME

During the initial trial, the camera attached to the forehead would miss the bulk of the experimental setup, with only the upper portion of the device being captured (Figure 4). On the other hand, the camera strapped onto the chest provided another perspective. It could only provide a glimpse of the bottom part of the setup (Figure 5).

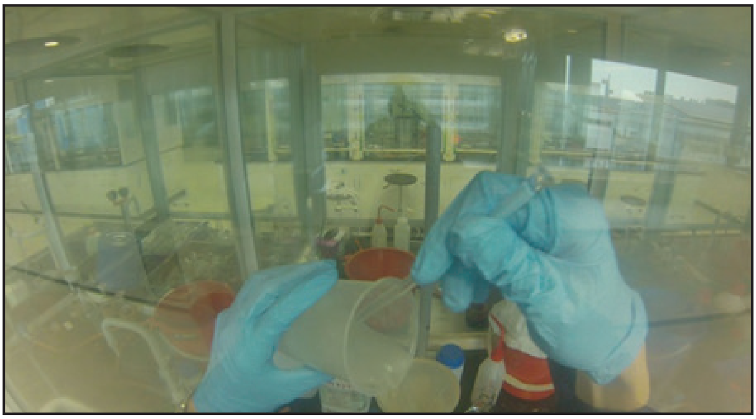

Figure 4. Demonstrator is seated on the stool. The GoPro at forehead level captures only a partial frontal view of the flash column and misses the bulk of the glassware.

Figure 5. Demonstrator seated on the stool. The GoPro at chest level captures only the lower view of the flash column and misses the big picture.

Additionally, the height of the demonstrator for this experiment posed another challenge. The upper camera filmed an awkward footage in which the fume cupboard was perpetually out of sight (Figure 6b). There are also times when the demonstrator bent forward to conduct some in-depth analysis of the experiment and the chest camera could only capture unusable shots (Figure 6a). From this experience, it is clear that the demonstrator has to be conscious of the environment and adjust the position of the cameras accordingly. Nevertheless, from the lessons above, the author managed to learn essential tricks to address the challenge.

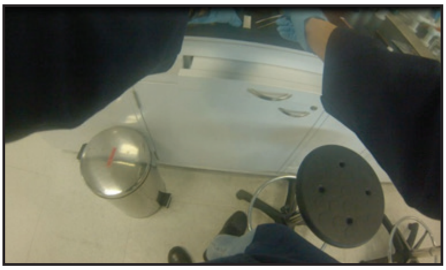

Figure 6a. The GoPro at chest level misses the target as the demonstrator bends over.

Figure 6b. The GoPro at the forehead misses the target as the demonstrator was standing up to transfer the reagents.

GUIDE TO USING THE SYNTHESIS LAB POLARIMETER

The instructional video was filmed to educate students on the operation of the automatic digital polarimeter (ADP). As the equipment in the scientific lab is expensive, it is important to maintain the machines well. Allowing amateur users to fiddle with expensive facilities would cause potential mishap to both the users and machines. This is where a good and clear instructional video can alleviate such problems.

As the sole demonstrator and film recorder of this guide, the author experimented with the GoPro camera strapped around the chest level. In the footage, the GoPro camera captured most of the scenes which was designed to be shown in the videos. During the first run, the footage revealed that part of the ADP was cut off from the screen, due to poor positioning of the GoPro at the chest level (Figure 7a). In the next scene, as the demonstrator transferred the solution into the polarimetry cell, the action was hidden as well (Figure 7b).

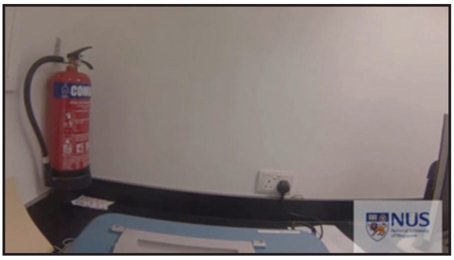

Figure 7a. The GoPro misses the ADP.

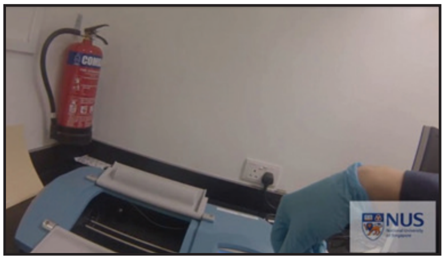

Figure 7b. The GoPro misses the solution transfer scene.

After readjusting the angle of the camera, the recording was redone and it yielded the desired result (Figures 8a and 8b).

Figure 8a. The GoPro successfully captures the ADP (Click on the photo to go to the video link).

Figure 8b. The GoPro successfully captures the separatory funnel (extraction) scene (Click on the photo to go to the video link).

STUDENTS' FEEDBACK ABOUT GOPRO

Many students who experienced this new learning mode have verbally given positive feedback to the author in the course of the module. They found this new technique to be engaging and useful in enhancing their knowledge and understanding of scientific experiments. Furthermore, in the teaching feedback collected at the end of the semester, there were two comments regarding the use of the GoPro camera for lab videos.

One student noted the following:

> Try to tie the GoPro on the forehead (wear a hat with the GoPro attached on it) instead of hanging it over the chest so that we could see what you see.

The other feedback given stated that:

> GoPro is a really good idea.

A voluntary questionnaire was given to the students regarding the use of the GoPro camera to see if they think this new approach has made a positive impact to their learning. The respondents would have gone through two years of chemistry experimental modules using the traditional teaching methods as mentioned earlier in this report. They would be experiencing the use of GoPro videos in the advanced experimental modules for the first time. The result in Table 1 showed that the students benefited from this new technological approach in learning lab skills. The total class size was 65, out of which 21 responded to the survey (response rate: 32%).

Table 1.
Results of the survey on GoPro lab video experience. (n = 21)

Item	Number of Responses			
	Strongly Disagree	Disagree	Agree	Strongly Agree
I find the GoPro video on experiments enhanced my learning.	0	0	8	13
I am eager to try the experiments after watching the videos.	0	0	11	10
I would have preferred to enter the laboratory *without* watching any video demonstrations	14	7	0	0
The GoPro videos improves my confidence in conducting the experiments on the actual day.	0	0	11	10
The GoPro videos improves my ability to operate the instruments and machine in the actual lab.	0	0	11	10
Overall, GoPro lab teaching is more effective than direct instructions from the lab manual.	0	1	9	11

To further investigate if there are improvements in assessment outcome, the comparison was conducted using the pre-laboratory assessment (Figure 9). The background for the assessment was that students were required to take this open-book quiz prior to coming for the practical sessions. Each individual experiment had its own pre-lab assessment and students who did not pass them would be barred from entering the lab. The class size in Semesters 1 and 2 was 93 and 95 respectively. The experiments (Experiments A, B, C, D in Figure 9) were conducted the same way over the two semesters. The only difference is, in Semester 2, GoPro videos were used in teaching.

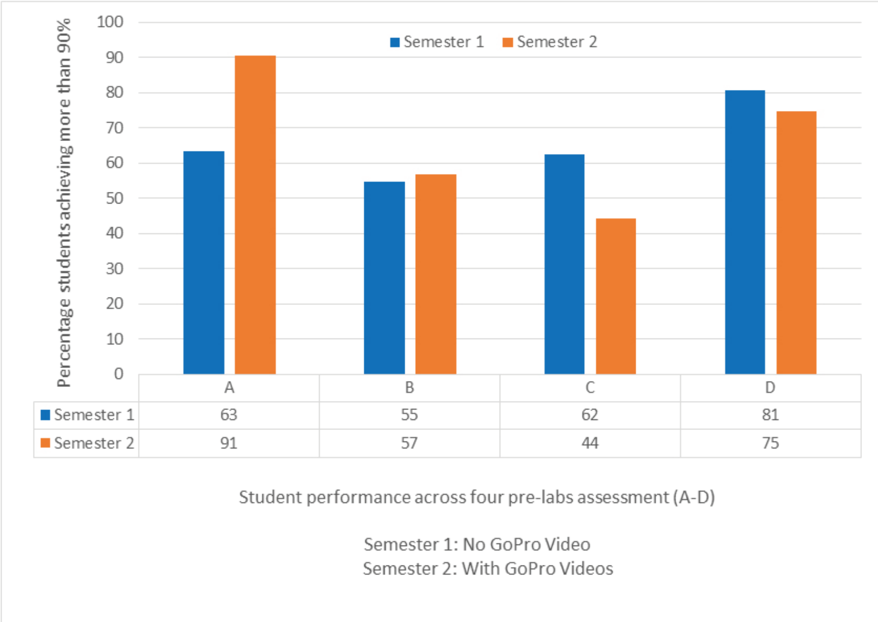

Figure 9. Student performance in the pre-lab assessment, with and without the assistance of GoPro videos.

From the analysis, based on the use of GoPro videos, Experiment A has almost 30% more students scoring greater than 90%. Whereas for Experiment C, the percentage is lower by 18%. As for the other two experiments, the results are comparable. On a closer look, Experiment A focuses on experimental techniques and use of machines, while for the other three experiments, there was more emphasis placed on chemical synthetic skills. This is consistent with the results of the questionnaire reported earlier; students feel more comfortable operating the hardware in the lab with the viewing of GoPro videos. The confidence they acquire before the actual lab session can be vital in determining their final result of the experiments.

Nevertheless, from the pre-lab result of Experiment C, one might postulate that the use of FPV videos may even diminish the learning as compared to non-usage. This could suggest that the success of the FPV learning depends on the context they are applied to. From the result of Experiment A, FPV was proven very successful as the videos instructed students on the standard operating procedures of using manned hardware. In contrast, where FPV was applied on teaching lab skills that did not involve an instrument (Experiments B, C and D), the results were inconclusive.

FINAL REFLECTIONS

Using GoPro with FPS technique in the teaching lab is a new breakthrough in virtual lab teaching for the flipped classroom. Students could identify with this initiative because their generation grew up in an IT environment where motion pictures are highly digitalised and video games have been transformed into many popular first-person shooter series. The view from the first person is certainly more real and exciting. The FPV is also more natural as the individual would understandably prefer to see things from one's own perspective.

As the founder of Facebook Inc., Mr Mark Zuckerberg said in a post on March 25, 2015,

> [Technology] opens up the possibility of completely new kinds of experiences …[and]… virtual reality was once the dream of science fiction. But the internet was also once a dream, and so were computers and smartphones. The future is coming and we have a chance to build it together. (Zuckerberg, 2015)

Let us embrace technology with open arms and enhance student learning in today's education.

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ABOUT THE AUTHOR

Fun Man FUNG is an Instructor in the Department of Chemistry at the National University of Singapore. He is an engaging educator with research interests in cinematic blended learning pedagogies. Fun Man believes in galvanising students with dynamic instructional videos. His work has appeared in the *Journal of Chemical Education* (ACS Publication).