Education and Training for Inter- and Multidisciplinary Applications: Methods and Techniques for Educational Outreach for Inspiring Photonics Careers

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Abstract: The work tries to support middle school-age students in Ireland with the possibility of promoting technology careers in the future. The paper will explain the guide of suggested innovative digital storytelling and the detailed presentation which might help presenters and give them some techniques for engaging students and create an interactive environment.

1. Introduction

With the new era of quantum and photonic technologies, there is still the substantial impact of the engineering on the science developing and related effects on the course of humanity.

Indeed, the rapid acceleration of technological advances, in the present time, seems faster ever before in human history. Yet, there are remain many challenges to improve society and create a more sustainable, equitable as well as an enjoyable future for all humankind especially in the field of light and their wide applications.

One approach that can in school education focused on inspiring stories and interactive simple experiments which can provide more explicit knowledge transfer. For this reason, the Interactive Digital Storytelling (IDS) platform can be improved based on real and modern examples embedded with the narrative approach, as well as some in-class experiments using individual take-home theme packets.

The suggested activities in this work can include different categories that arranged and designed to make it easy and understandable for students in school classrooms and excite young people about careers in technology using experimental techniques that can be customized to highlight the presenter's interests, job, and work environment.

The first part of the paper will involve with the knowledge transfer emphases on the interactive inspiring presentation, while the second part includes the optics suitcase that includes both reusable and giveaway supplies as shown in Figure 1(a), where the optics suitcase is an educational outreach tool developed by Dr. Stephen D. Jacobs and the OSA Rochester Section (OSA-RS) with the busy professional in mind [1,2].

(a) (b)

Fig. 1: (a) photograph of the optics suitcase and its contents [3], (b) example take-home flyer.

2 Preparation for interactive classroom visit

In the present study, St. Fiacc's National School in Carlow was select to complete the planned activities. Earlier contact was done with the school to arrange the visit, where some procedures are recommended to obtain the information from the coordinator/classroom teacher. Few days before the visit, it will be better to check the showcase details and the best scenario for each part. And it will be necessary to ensure there are enough flyers, as shown in Figure 1(b), (included a digital copy that can be projected as part of the presentation and to find time to practice the presentation).

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3. Demonstrations and characterizations procedures

As usual, the presentation times limit based on the class period (it is around 45 minutes). The first important point should focus on grab the student's attention and then the second issue can construct to maintain an understandable pace for the presentation story which can include some pictures of virtual lovely characters to create equilibrium between the advanced scientific contents of photonics engineering and/or related applications and fun storytelling at the same time.

3.1. Innovative digital storytelling

One of the new approaches which try to involve computer facilities for learning can describe as "it is precisely about fun and engagement, and the coming together and serious learning and interactive entertainment into a newly emerging and highly exciting medium" [4]. Photonics and light-based technology now becoming important especially, as a cross-field of new frontiers of engineering as well as in sciences.

In this part, the interactive digital storytelling will be explained especially inside the group discussion of multidisciplinary students. The main presentation topics are about research methodology and famous arguments in photonics and some related real applications. There are two main approaches in this show, one is according to the time sequence of some historical events as well as academic and scientific applications and the other is according to merge the narration story's theme with some enjoyable cartoon characters.

The class might include students' group with different background: (1) some might need additional theoretical information and detailed understanding of basic principles, and (2) other who need more practical training and skills. Therefore, the show should have more simplicity that can help to attract the attention of students and breaking the ice, additionally to maintain a quick pace for the entire presentation.

Every slide was followed by a demonstration with the information provided with images and related movies, where Figure 2 give an example regarding that. In such a situation, all presenter's competence and expertise and all pedagogical skills (to diagnose and analyze the situation, to know digital storytelling methods and to know to apply appropriately) are vital and each supported teaching tools and didactical equipment that will create the interesting lesson.

The class was ended with a conclusion that many students asked several and different questions that can reflected presentation outcomes and it seems they liked the presentation and enjoyed reviving known facts. Additionally, inspiring ideas through teamwork and then some keys to success in any scientific and practical field was introduced.

After the storytelling of photonic engineering and related some applications, the students can engage to discover more practical details, the innovative and simple experiments, that illustrate optical engineering, will include in the second part. The following two experiments explain different ways to understand and see the colors in the visible light spectrum.

Fig. 2: Part of digital storytelling show-time.

3.2. Optics Suits in Carlow

To draw the attention of school students (or pre-university students in the future) to some additional photonics technology and related contents, the portable demo kit (i.e., optics suitcase) was used, which developed at the Institute of Optics in Rochester [3].

Firstly, the initial examined was did to select useful experiments that can be as a didactical tool. The efforts will focus on brief descriptions of some "visible light phenomena (i.e., white light)" that might not be obvious or understandable to some students. As well as, in the demos, often, the aspect of "secret" or "trick" might work well to keep students in continuous attract. Then, the time might be suitable to present the take-home flyer, as shown in Figure 1b, which can help to explain some initial information about optics and photonics techniques. The selected experiments that can the students discover it are: The rainbow peephole™ - color by redirecting (i.e., diffraction) and magic stripes - color by polarized transmission (i.e., polariscope).

3.2.1. Color by Diffraction (Rainbow Peephole experiment)

These kinds of simple experiments might help the students and their curiosity to discover some scientific questions. When they hold the peephole up to their eye and look at the flashlight through it, the first question might arise "where does the color come from?" it is from the peephole or from the white light in the flashlight. This will open the door for different explorations regarding; Do we see a regular pattern? and, How can describe it, or what are the similarities/differences in colors and patterns when used different light sources?

The packet includes an image that is created using an atomic force microscope (AFM) of one side of the transparency plastic. It might be useful to explain the purpose and applications of AFM that used by the engineer to help see very tiny objects at high magnifications where the scale on the paper can observe in micrometers.

Some scientific explanations regarding the bumps across the peephole are only two microns high if compared with human hair wide which is around 30 to 80 microns. Therefore, the bumps work to breaking up the light coming into the peephole, and this call diffraction effect that can be observed when visible photons travel through apertures such as small slits or holes.

The next step will be best to link this effect with related applications such as telecommunications which used fibers and lasers to divide the visible light from one beam into many where this is the first key to build systems of unlimited phone-calls over the world at the same time as illustrated in Figure 1b. And to spread the knowledge, the students can reveal a rainbow from white light through diffraction to their family members.

3.2.2. Color by polarized transmission (magic stripes experiment)

To make the second experiment more understandable to the students, one volunteer will be required to hold the end of the slinky and the presenter should keep more than one meter away and then begins to shake the slinky randomly (such as in a circle or up and down) where the presenter can create a standing wave with a few nodes. As a fact, the students should know the visible light has a wave nature as well as a color spectrum, where using some explanation poster for a different wave of the light can help to illustrate that.

Some useful guide, regarding educational outreach presentation, can help the presenter and even the students to investigate more information about each experiment [5], The simple setup depicts in Figure 1b can show the students the demonstration procedure of this experimental layout as well as to give an explanation regarding the colors they are seeing that indicate how much stress (i.e. optical retardance) that exist in this transparent material.

As done with the previous experiments, the students have a chance to share these pieces of knowledge with their families and friends regarding how to construct a polariscope.

4. Conclusions

The initial goal of these efforts is to introduce an interactive demo presentations and lessons by scientists and/or engineers to students at the school classrooms.

One of the important outcomes from these activities might help to motivate the students to take science and math courses, thereby "keeping the door open" for finding further training after school to enter and increase the knowledge in new technological fields.

The following few suggestions and general recommendation might help to next future works;

- Earlier arrangements with the teacher regarding some technical issues (i.e., screen or overhead projector, and tables) can help for a better time organization.
- The interactive and simplified presentation for some advanced technologies is most useful and successful when giving to the 6^{th} grades or higher.
- Forty minutes could be enough time to do the presentation with the students' questions.

Interestingly, the initial feedback from students gave a positive impression where the presentation design of all activities and discussion has been accepted and appreciated by the school as well as the students.

References

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