New Approaches
Нови подходи

A COMMENTARY ON THE GENERATION OF AUDIENCE-ORIENTED EDUCATIONAL PARADIGMS IN NUCLEAR PHYSICS

Baldomero Herrera-González
Universidad Autónoma del Estado de México, Mexico

Abstract. This paper presents the outline and description of simple steps for creating new teaching paradigms targeting specific audiences, in the field of nuclear physics education. The presentation encompasses a commentary on the complete procedure for the generation of knowledge, from the choosing of the topic until the final stage of publication. Each of the steps is explained by the use of several practical examples, with the intention to provide a better understanding of the described approaches and useful recommendations to overcome the associated difficulties intrinsic to the overall process.

Keywords: nuclear physics, exact sciences, teaching techniques, didactic method

Introduction

The creation of new teaching techniques and didactical models represents a challenge in every area of the human knowledge. The difficulties associated with this process are particularly accentuated when dealing with the domain of exact sciences; such is the case of physics. This arises from the rigorous and abstract nature of this particular subject.

Nuclear physics is the branch of physics centered in the study of atomic nuclei and its related phenomena such as radioactive decay, nuclear fission and fusion, radiation detection and so on. Being a relative new area of study (dating from the beginning of the 20th century), its teaching is still confined to the classrooms of specialized scientific oriented degrees. Nevertheless, some researchers have recently published interesting papers to introduce new teaching techniques in the nuclear science field (Constan, 2010; Whittaker, 2013).

By creating new ways of teaching that are audience-oriented, is possible to open seemly obscure and difficult areas of human knowledge to new students and social groups. This may contribute to enrich, not only the curricula of the education programs worldwide, but also the general culture of the average human being.

General outline

The use of a simple approach to create innovative teaching paradigms is proposed as a step by step procedure in the following way: (1) Choosing a topic to work within

the nuclear physics boundaries; (2) Studying and gathering all the relevant information about the chosen theme; (3) Creating new knowledge taking in consideration the targeted audience; (4) Configuring the new teaching model in a formal presentation; (5) Publishing the final work in the most suitable channels available.

Choosing the topic

This task might be one of the hardest things to accomplish. As an advice, the selection of the raw theme to work should be a very specific one. This allows focusing on a concise and well defined area of nuclear physics. For instance, the topic radioactive decay is so broad that in order to make a transcendent contribution, one would require a lifetime of study in attempting to expand current theories and then present the findings in a new comprehensive didactic way.

On the other hand, topic selections such as basic visual representations of a nuclear fission chain reaction (Herrera-González & Rosendo-Francisco, 2010), proves to be a better choice. First of all, is restricted to a well-defined theme namely, the nuclear fission process. In addition, the selection of audience is implied by the idea that a basic visual representation might target an audience not formally educated in advanced nuclear physics.

Gathering information

Once the subject of study is perfectly defined, the next step is to accumulate a respectable amount of peer-reviewed articles, book references and reliable information from websites related to the chosen topic. These materials should be read carefully. Afterwards it's recommended to write a monographic compilation of the most relevant and useful information contained in them.

Creation of new knowledge

Based on the gathered information the creation process can occur when fueled by the imagination and creativity of the author. There is no unique methodology for doing this, but several words may be associated to help with the task. These words are: adaptation, reinterpretation and expansion.

Adaptation means to use the information on the main topic and model it in a different way while targeting a new audience. For instance, a formal analysis used to explain the production of plutonium is based on the understanding of nuclear reactions and decay processes (Problem 45).[1)] However, a lighter and equation-free version of this topic can be proposed to be taught for example, to high school students. In this case the researcher adapts an existing knowledge to be presented to a whole new audience, using a logical path based on the age and level of education of this specific group.

Reinterpretation consists in changing the point of view of the main topic so that a different interpretation of it arises. For example, if the chosen theme is momentum of the photon and the task is to generate a useful equation to obtain it, then a basic starting point to accomplish this would be to examine the classical expression for the momentum of a massive particle and then to apply several experimental or theoretical considerations in order to get an adequate equation. In this case, the author reinterprets an existing method or set of facts by applying them to an indirectly related object of study, obtaining in the end a scientifically compatible and valid result.

The idea behind the word expansion is based on taking the chosen topic and then adding a new line of research to it, aiming to cover new frontiers of application, or using other branches of science to tackle the information from an innovative perspective. For instance, let's suppose that the chosen theme is the thorium-232 natural series of decay, and that the objective is to create an easy-to-remember technique to memorize the whole series including the types of decay involved. In this case, the researcher is said to expand the traditional limitations of the analyzed topic by adding mnemonics-type techniques to it in order to accomplish the planned objective.

Configuration of a new teaching model

Once that the new knowledge is set, done and properly written, the next step is to create a suitable way to teach it to the chosen audience. For instance, if the topic was adapted to high school students, a good way to present it could be the addition of pictures and other type of audiovisual resources in order to keep the young students interested.

Another related example would be the following. Suppose that the chosen topic is the cooling system of a commercial nuclear fission reactor to produce electricity. In the opening of the presentation, the inclusion of a diagram or animated picture showing the flow of coolant in the reactor would be a great choice to summarize the lecture and to focus the students' attention. Visual imagery has proven to be an effective technique as a didactic resource for young students (Stokes, 2002).

Publishing

The most important part when creating a teaching model is to publish it so that the whole community of teachers and speakers may pick the benefits of the research. A wise choosing of the journal or periodic publication is very important to guarantee a fair and successful peer-reviewing process.

In the case of teaching techniques, methods or didactic findings in nuclear physics the publication options are not so specific, namely there is no journal (until August 2013) solely focused on this subject. However, there are other respectable options such

as the regular journals of physics or the teaching science magazines. When the topic is strongly focused on theoretical mathematical aspects, then the journals of mathematics might be also listed as possibilities.

Most of the journals will have a policy of submitting the paper to only one publication at the time, therefore is better to contact the editors with all the questions and concerns before entering in the peer-reviewing stage. Since this process may take up to several months is very important to meet all the requirements in the format and in the presentation of the paper. Every respectable journal has a set of publishing guidelines that should be fulfilled before submitting the paper to the editors. The webpages of the journals usually contain this information.

Another option to publish the teaching model is to include it as part of a book. The book may be completely written by the author of the paper or by him and a team of collaborators. This will depend on the publication project and the funding available. In this case there are several options, from the universities publishing houses to the online press companies.

It should be mentioned that most journals have several fees associated to the publication process. For instance, when the journal is printed on paper there will be an additional cost for every attached graph or image in color. Other criteria of financial compensation may apply depending on the chosen journal.

Conclusion

Nuclear physics is a very important branch of science and new teaching methods should be created in order to disseminate and promote the wealth of knowledge it represents. By applying the steps outlined in this paper is possible to accomplish the latter task in a more efficient way.

The discoveries in science are vital but more important are the channels by which these discoveries can be introduced to the general audience: from the young students to the more advanced learners. Further study and systematization should be done to design better teaching techniques in the area of nuclear physics, aiming to a greater didactic value. This will not only open the nuclear science to a greater population and increase its understanding, but also will inspire other researchers to configure innovative methods in their own areas of expertise.

NOTES

1 http://www.lulu.com/shop/baldomero-herrera-gonz%C3%A1lez/problemas-resueltos-en-f%C3%ADsica-nuclear/ebook/product-21029493.html

REFERENCES

Constan, Z. (2010). Learning nuclear physics with marbles. *Physics Teacher*, *48*, 114-117.

Herrera-González, B. & Rosendo-Francisco, P. (2010). Modelo didáctico de una reacción en cadena [Teaching model of a chain reaction]. *J. Sci. Educ.*, *11*(2), 96-99.

Stokes, S. (2002). Visual literacy in teaching and learning: a literature perspective. *Electronic J. Integration Technology in Education*, *1*(1), 10-19.

Whittaker, J. (2013). Hands-on nuclear physics. *Physics Teacher*, *51*, 166-168.

✉ **Baldomero Herrera-González**
Facultad de Ciencias
Universidad Autónoma del Estado de México,
Instituto Literario 100,
50000, Toluca, Estado de México, México
E-mail: soybaldomero@gmail.com