Revista Práxis, v. 12, n. 24, dezembro, 2020
ISSN online: 2176-9230 | ISSN impresso: 1984-4239
Submetido em: 21/04/2015 Aprovado em: 21/05/2018

Technological products generators of purposes for the Physics teaching

Produtos tecnológicos geradores de propostas para o ensino de Física

[1] José Cláudio Reis Santiago jclaudiofisica@gmail.com

RESUMO

Nas últimas décadas, a preocupação em empregar produtos tecnológicos para o desenvolvimento e aplicação de metodologias de ensino já é uma realidade bem estabelecida nas pesquisas de Educação em Ciências e, em algumas situações, nas escolas. Neste trabalho, apresentamos algumas reflexões sobre o uso de produtos tecnológicos enquanto geradores de propostas para o ensino de Física. Trata-se de uma pesquisa de natureza empírica, qualitativa e bibliográfica em que analisamos alguns trabalhos publicados entre os anos 2012 e 2015. Foi possível constatar que, atualmente, há uma categoria diferenciada de produtos tecnológicos, não necessariamente sofisticados, que têm sido objeto de atenção dos autores-docentes com vistas a despertar a motivação e o interesse do aluno pela Física. Os processos motivacionais associados a esses produtos têm sido propostos como elementos que catalisam suas ações pedagógicas, predominantemente, por meio da experimentação, sendo que há uma tendência em associá-la à simulação computacional.

Palavras-chave: Educação. Ensino de Física. Tecnologias.

ABSTRACT

In the last decades, the worries on applying technological products to the development and application of teaching has already been a reality in the science teaching researches and, in some situations, in the schools. In this work, we present some reflections on the use of technological products as generators of purposes for the Physics teaching. It is about an empiric, qualitative and bibliographic research in which we have analyzed some articles published between 2012 and 2015. It was possible to verify that there is, currently, in the Physics teaching researches, a differentiated category of technological products, not necessarily sophisticated, that has been object of attention of authors toward wake up student´s motivation and interest for the Physics. The motivational processes associated with those products have been purposed as elements that catalyze their pedagogic actions, predominantly, by means of experimentation, and there is an incline to associate them with computing simulation.

Keywords*: Education. Physics Teaching. Technologies.*

1 Universidad Americana-PY.

1 INTRODUCTION

Since the second half of the twentieth century, several authors have undertaken efforts to introduce a universal and fully acceptable introduction to the technology. In many cases, the differences and similarities related to scientific knowledge guide the arguments found in the works, as we can easily note. One of the pioneers in these attempts, Bunge (1958 *apud* CUPANI, 2006, p. 354) explains the technology as “the scientific study of artificial”. Another reference with significant interfaces with technology is the study of technique in which the same author emphasizes the practical activities supported by knowledge that would not have reached the scientific stage.

Different approaches can be used to discuss the nature of technology. Mitcham (1994 *apud* CUPANI, 2006, p. 353) highlights the approach to technology from artifacts, the technological knowledge, the set of activities associated with the production of artifacts and form of manifestation of the human will.

Another contribution often found in research contexts on Technological Education is those who consider different levels of meaning for technological practice. According to Pacey (1990), technological practice consists of technical, organizational and socio-cultural aspects. This author considers that there is a limited significance when we consider only the technical dimensions of technology. On the other hand, there would be a more general meaning, when taken into account, organizational and cultural aspects, too. Thus, the technological activity would be considered as part of life and not only as applied scientific knowledge.

After these points, we can recognize the existence of difficulties for finding boundaries between products and processes limited to technological domains. Thus, we chose to restrict our analysis to products, technological objects and material devices, but not necessarily sophisticated. From the educational point of view, the more specifically concerned is with the interest in the adaptation or re-use of these products for the teaching of physical sciences. Assuming some flexibility in trying to better define our object of study, some of the *technological products* are: the seat belt, the refrigerator, radio, antennas, microwave oven, mobile phone, air conditioning, microphone, stereo system and Ferris wheel. It would be excluded from that universe the product or device already didactic and traditionally implemented in science teaching. It would be some examples: the electric motor, the lamp, thermometer, Croocks tube, the U-tube, the telescope, the four-stroke engine and the computer.

Considering these aspects, from now on, we refer to these materials only as *technological products.* In this paper, we discuss teaching strategies resulting from the use of these *products* in the teaching of physical sciences.

2 LITERATURE REVIEW

In order to perform a bibliographic review we initially consulted the approved papers in three events: XV Meeting of Research in Physics Teaching (2012 and 2014), XXI National Symposium on Physics Teaching (2013 and 2015) and XI Research Symposium in Physical Education (SIEF, 2012). The goal was to find out papers discussing the use of *technological products*, not necessarily sophisticated, and in transition to the context of the physical science teaching. Subsequently, the survey was carried out from reading the titles and abstracts of the following journals published between 2012 and 2015: Caderno Brasileiro de Ensino de Física; Investigações em Ensino de Ciências; Ciência & Ensino; Ciência e Educação; Science & Education and Revista Electrónica de Enseñanza de las Ciencias.

As you can see, we seek to situate the technological products in a very current period. Regarding the symposium that took place in Argentina we could not find even articles focused on discussing sophisticated products. It should be noted also that we did not consult the SIEF-2014 publications because their memories were still not available during the period in which the research were been developed.

3 METHODOLOGY

We have built our theoretical point of view about methodological aspects from some elements situated on the *Content Analysis* understood as

> a set of communications analysis techniques to obtain, by systematic and objective procedures of the description of the content of the messages, goals indicators (quantitative or not) that allow the inference of knowledge related to the conditions of production/reception (inferred variables) of these messages (BARDIN, 2011, p. 48). (Author´s translation).

As mentioned above, the *inference* of knowledge allow us achieve information on the *inferred variables*. In addition, at another time, the author also points out that it is through the *inference* that is carried out controlled passage from *description* to *interpretation* (BARDIN, 2011, p. 45).

Considering the investigated articles, we seek to know which propose the use of *technological products* as a way to expand the availability of resources for teaching and research of the physical sciences.

At first, reading of the titles and abstracts was applied as parameter to decide on the need of complete reading of the work. Then, the selected articles were coded and described according to the *product* in focus.

In order to evaluate some methodological aspects, three sets of issues were raised: the first, related to the subjects of research and the proposed material resources; the second, on the teaching strategies and investigation line that the article belongs to, and the third, related to the author´s arguments. So, for better understanding of the methodologies identified in articles we have asked:

On the subject of research and resources. *1.1 Does the work raises questions about the research subject? 1.2 Is there interaction of the subjects with* ***technological product****? 1.3 Describes how to prepare materials, helping to enrich the education with resources? 1.4 Is the suggested* ***technological product*** *inexpensive or easy to access?*

On the strategies. *2.1 Is there a teaching strategy? 2.2 Does it apply or describe some teaching sequence? 2.3 Does the work mention inclusive teaching strategies? 2.4 What is the corresponding research axis? Experimentation, computer simulation, teaching by investigation, teaching by projects or other?*

About the author´s arguments. *3.1 Do they argue about learning of physical content? 3.2 Do they argue about the occurrence of motivation or interest of students, resulting from the developed activity? 3.3 Do they argue about the result on political, cultural or social aspects associated with the individuals involved?*

One of the elements of the *content analysis* applied was the search for *inferences* from questions and observations, from the questions above. In this sense, Franco (2012, p. 18) highlights the growing use of *content analysis* to achieve *inferences* from verbal data (oral or written). These data, in general, are obtained from questions and comments of interest of the researcher.

The titles of published papers by the EPEF - 2012 and the SNEF - 2013 were:

A.02 *Experimental purpose for the refrigeration cycle* ***B.02*** *A proposal for teaching the ideal gas supported by experiments: the pressure sensor MPX2010DP*; **C.02** *The Use of optical instruments as didactic resource in physics teaching: building a low cost slide projector* **; D.02** *Weapons: security or insecurity ": an experience in the physics teaching*; *E.02 An experience of using pedagogic robotics articulating physical concepts in the grounds of the theory of personal constructs ; F.02 The use of milk box in the manufacture of curtains ; G.02 Exploring simulated controversies in the classroom: a proposal to work radio waves with STS emphasis ; H.02*

Brazil flag: interdisciplinary class on history, philosophy and science; **I.02** *Physics in tablets: Newton´s second law*; **J.02** *Construction and using of a strobe disc applied to the study of mechanical phenomena in high school* (Translated by the author).

As it can be seen, each work has been encoded from the title itself. The letters served to maintain correspondence with their respective descriptions (showed later). The number, next to the letter, served to indicate the corresponding step to the organization of information. Note that this coding step was limited to the *pre-analysis*, and did not extend to the *exploitation of the material.*

Some methodological aspects relating to the articles published in EPEF - 2012 and SNEF - 2013 were described as follows:

A.03 *Propose to employ the cooling system of a refrigerator as experimental didactic module for study of thermodynamics;* ***B.03*** *Propose the use of a pressure sensor for experimental study of the gas laws. It features traditional didactic report style;* ***C.03*** *Explain how to set up a low-cost slide projector and present an instructional script for its construction;* ***D.03*** *Report that the lessons were prepared on the basis of "three teaching moments" proposed by the author Delizoicov D and others. The objective: to work with the theme "Weapons: security or insecurity?"****E.03*** *According to the authors: "The experience of using the Robotics experience proved to be a powerful tool for teaching physics, obtaining a more meaningful learning and better contexts;* ***F.****03 Project in which was used milk box as raw material in the manufacture of curtains for the classroom of the class. The use of contextualization allowed some reflections on optical and thermal physics content, according to the authors;* ***G.03*** *The authors report that: a) the methodological choices were: teaching by investigation and the use of simulated controversies in the classroom, b) students travel a path of reading and research, so as to produce a simulated controversy as a debate, c) they will can explore, both theoretically and the practically, the interference phenomenon. It is a literature research with STS approach. The products would be a FM transmitter and a radio receiver;****H.03*** *The authors created a hemispherical cap ceramic with holes at positions corresponding to the flag stars. The position of each hole has been enerated from the 3D software Blender, which projects the flat image onto a faceted hemisphere. They point out that this piece of ceramic helps in understanding the sky represented in Flag of Brazil - the sky seen from space - and is a resource of significant didactic value especially in the education of the visually impaired.* ***This is a study that reports the experimental work carried out by the authors themselves; I.03*** *The authors report an experience that had used a tablet to collect data on the acceleration of a mechanical system composed of two bodies****.*** *This is a study that reports the experimental work carried out by the authors themselves. They suggest the use of widespread mobile devices as a platform for conducting experiments;* ***J.03****; The authors explain how to build a strobe and describe the use in an application as experimental activity.*

Unlike readings from other articles, the contents of steps 02 and 03 - and also 04 and 05 later - were organized from the full reading of each of the works. Before building the sample, however, were adopted as criteria for selecting the works: a) have been prepared directly targeting the science teaching and b) explore some *technological product*, in the previously defined way.

In the fourth step we have represented the titles of the articles concerning EPEF - 2014 and SNEF - 2015. Thus, the titles of published works were:

A.04 *Using a solar heater as a didactic tool for teaching concepts of heat;* ***B.04*** *Practical activity associated to the computer simulation for teaching concepts of hydrodynamics;* ***C.04*** *A methodology for teaching physics of birds flying and airplanes in high school;* ***D.04***

Thinking technological objects associated with electromagnetic radiation in high school physics; ***E.04*** *The refrigerator: a teaching proposal for thermodynamics;* ***F.04*** *Digital compasses of mobile devices: scientific knowledge in the location and positioning technologies;* ***G.04*** *Teaching Physics with water rockets and using computer* *technology through a multidisciplinary proposal; H.04 Physics at little waterslide: report of a motivational experience for meaningful learning;* ***I.04*** *Mobile technologies in the teaching of physics: obtaining data on school noise pollution through noise tube institutional project; J.04 The use of rocket prototypes as a way to teach energy conservation: a study based on Vygotsky's theory; L.04 The principle of inertia and the use of seat belts: a teaching strategy; M.04 Teaching sound waves / noise pollution using the mobile device as a supporting tool.*

For the events described above, some methodological aspects related to the published works were described as follows:

A.05 *Report on the construction of conceptual map in order to strengthen links between previously existing physical concepts and other areas of knowledge. The solar heater served as demonstration equipment;* ***B.05*** *Proposes a practical activity that combines concrete and virtual aspects associated with "water rocket". Subjects of research use the material. Receive the previously prepared material to perform the experimentation. Discuss to what extent the simulation results became near or away from the results of actual projectile launch (not completed research);* ***C.05*** *Present a strategy composed of eight stages to help conducting a class in high school. Report that a wind tunnel was used in a practical way "with" the students. The authors themselves constructed a wind tunnel from their reading of other work; ;* ***D.05*** *The work aims, among others, identify content that can be inserted into the physics teaching. It is a bibliographic research. The products: X-ray machines, magnetic resonance and tomograph;* ***E.05*** *Production of textual didactic materials on the refrigerator for teachers based on three pedagogical moments. The research subjects are teachers;* ***F.05*** *Propose the use of resources located on smartphones and tablets. Propose an activity for high school students in three moments;* ***G.05*** *Teaching by investigation (the goal is the set of physical content). It is about a work that has several suggestions for implementation of water rocket. Basically, a work job that has several suggestions to readers;* ***H.05*** *Teaching by investigation. The teaching takes place in a park, in order to insert the student in a motivating environment. The concerned product is the little waterslide, where students performed measures for further analysis;* ***I.05*** *Teaching by investigation. Students measure the loudness at school and answer a questionnaire. There was not considered teaching by projects due to the absence a final product previously planned. The sound level was measured using cell phones with Noise Tube design program in all classes.* ***J.05*** *Teaching by projects; Experimental classes interspersed with lecture classes were applied. The material used: rocket prototypes;* ***L.05*** *They conclude that the dialogical approach promoted in class enables the understanding of Newton's second law. Part of the investigation is constituted by a demonstrative experimentation. The object of teaching: seat belt;* ***M.05*** *They proposed a didactic sequence (nine steps) employing the mobile device as a support tool. Seek to establish the relationship between music heard by students and the sound waves.*

It can be seen, in steps 03 and 05, which *products* have been identified, each of which is accompanied by a brief description. Still, some articles were disregarded, despite its approaches to this proposal. Thus, when we consider the rule of *completeness*, we explain the absence of some published articles, but not considered in this work.

Thus, some published works, however, not included in the sample were:

A.06 Stop and compare: going to the supermarket to learn physics. **A.06** *Presented a methodology for development of an investigative activity with script support to the students and teaching materials to help the teacher. The activity called "Challenging the units of measurement" allowed students to compare prices of a fictional supermarket with those of some large supermarket chains;***B.06** It is about a study of the perception of a video on the electric motor operation produced by high school students. **B.06** *Propose the production of a video on the electric motor as an activity of the didactic laboratory of Physics; several students are characterized as presenters and as a reporter interviewing a scientist (another student) who had invented the motor. It was not identified whether it was produced from cell phone, camera, tablet or other*. Paper presented at the SNEF - 2013; **C.06** Teaching videos: teaching tool with a view to inclusion of deaf students in physics classes in high school. **C.06** *There is concern in familiarizing undergraduates in physics with the education of deaf in the context of regular school. It was not identified whether it was produced from cell phone, camera, tablet or other. Paper pre-*

sented at SNEF-2013. They have produced teaching videos with subtitles in Brazilian Sign Language (Libras) in collaboration with deaf students; ***D.06*** Using of bilingual teaching videos in physics classes. **D.06** They *consider that the employment of bilingual video may become the class more inclusive. It has not been identified if it was produced from the cell phone, camcorder, tablet or other*. Paper presented at SNEF 2013.

4 DESCRIPTION AND ANALYSIS

On the subject of research and resources

Considering the two events, twenty two articles were selected for the sample. The percentages expressing the results for all items were: 54% for item 1.1 (subject of research), 75% for Item 1.2 (Interaction with the *products*), 59% for the item 1.3 (material resources), 62 % to item 1.4 (Cost and access) and 18% to item 1.5 (literature search).

These results have brought some considerations. For example, the item 1.3. A normally acceptable expectation would be that the universe of works centered on *technological products* would result in identifying a very significant amount of material resources available/suggested for the classroom.

However, a more careful attention during the reading of these works allowed us to observe that the focused universe is not enough to reserve a wealth of material resources, and there is a limited amount to a percentage of about 60%. That is to say that it is not higher the amount of works that describe how to design materials or contributes more specifically and directly with resources to the teaching reader. In part, this could be justified by the fact that, despite referenced in technological *products*, some studies take a different direction with respect to the contribution with materials. Taking as an example the work D.02 (*Weapons: security or insecurity?*) in which high school students attended a course at the Federal University of Itajubá studying *Instrumentation for Physics Teaching* as discipline. During the course, the concern was focused on the thematic approach, being explored the controversy surrounding the subject, the arguments and the student's participation in a dialogic activity. Therefore, the thematic nature of the activity makes a contribution to the teaching that can constitutes itself in a pedagogical resource of dialogical value. However, is in opposition to the exploitation of the *product* as **material resource** with potential to be rebuilt, redesigned or used for demonstration in the classroom.

In the work E.02 (*An experience of using pedagogic robotics* ..), students were challenged to mount a catapult that could throw a ball. The activities were developed from a *kit* over which we have found no information with some level of detail. In this sense, we understand that the superficiality of information involving a particular *product* can help make remote concrete applications from the proposed strategies. This does not imply the impossibility of acceptance and involvement of the reader (teachers and students) with the resources and strategies identified in works such as exemplified. The diverse course we are referring to, among others, occurs when the author uses the *product* to achieve their pedagogic strategies, but does not talks sufficiently and directly about the material used, making it difficult to reuse the *product* by the reader-teacher.

With regard to the literature researches, we found that many of them are characterized by identify and justify the inclusion of content in education, contributing to the development of curriculum proposals. We can identify this situation in the work D.04 (*Thinking technological objects* ..) in which the authors aimed, from the knowledge of X-ray machines, magnetic resonance imaging and proton emission tomography finding relevant issues to work in high school teaching. Note that in most part of bibliographic items found, proposed activities using the *products* are presented. In many of these proposals, however, the authors do not mention the biggest concerns in testing such proposals, which, of course, ultimately reduce the quality of the application proposal of the product.

On the strategies

Most strategies and didactic sequences found are focused on experimental activities.

The distribution of research axes produced the following results (approximate): 35% for experimentation, 20% for computer simulation; 20% for education by research; 10% for education through projects and 15% corresponding to other axes. Four papers focus on the simulation, and of these, 3 proposes the use of simulation in combination with experimentation. When considering only work that contributes with material resources (in the sense of item 1.3), the results were redistributed as follows: 50% for experimentation, 33% for computer simulation or teaching by inquiry; 8% for education through projects and 25% corresponding to other axes.

Some strategies identified are close to the teaching proposal by inquiry. The work H.04 is situated close to 20%. This carries in its title (*Physics at little waterslide: report of a motivational experience ...*) the identification of a *technological product*, i.e., the little waterslide. Being applied to teaching concepts of energy and its conservation, the *product* composed part of a methodological process leading students out of school, that is, the motivating aspect developed into a park where students could appropriate of concepts of conservation of energy. This is a teaching strategy that consists of working with theoretical classes and then glimpse in practice before the theory studied in class, allowing several questions from the students. The differentiating element in this type of strategy is to provide students with the building of their own questions, thus becoming protagonists of an educational process.

Still, 69% (9 of 13) of the studies that describe how to prepare materials or contribute to enriching education have the potential to realize initiatives between high school teachers. Among the 69% are inserted: A.02; B.02; C.02; F.02; C.04; G.04; H.04; J.04; M.04.

And the following were excluded: H.02; I.02; J.02; B.04. However, it is noteworthy that the fact of contributing to teaching and research does not necessarily imply that one teacher can reproduce the proposed activities. It is possible that 33% of articles associated with the simulation, for example, are associated with extra-curricular education of its own authors.

Thus, among the main factors that can make difficult the practice of such teaching strategies were mainly: the difficulty in dealing with software and commands, often requiring the formation of teams in different specialties, and technical knowledge, such as electronics and specialized computer.

About the arguments

We observed that, after discuss the applied methodology, the authors have their arguments distributed as follows: 23% argue about the motivation of the students, 18% argue about learning physical skills and 9% argue about the occurrence of reflections associated with the political, cultural or social development of students.

Thus, in a general sense, we realize that *technological products* have appeared in the articles associated with the interest of awakening motivational aspects. These occur predominantly through experimentation, as we can *infer* from the 35% obtained prior to experimentation.

The various claims by an education turn, among others, to awaken the interest and motivation of students occurred in recent decades gained momentum in various sectors of education. Thus, today, motivation and interest terms are already well established in the lexical structure of many works and of many high school teachers. Evidence of this is that not a few authors consider the *technological products* a source of student motivation.

During the reading of the work, we found that such *products* have justified their presence, often for motivating students, but the mediation regarding the construction of physical knowledge still remains remote. For

ISSN online: 2176-9230 | ISSN impresso: 1984-4239

example, the work M.04 (*Teaching of sound waves / pollution using the mobile phone*) that focuses on the mobile devices carried by high school students. Their authors proposed an instructional sequence that uses the phone as a tool to support the teaching of sound waves. The instructional sequence referred to comprises nine activities aimed to educate students about the possible harms of loudness. The motivational aspect is referred to by the authors by highlighting that the mobile device may turn out to be "*a source of student motivation*", "assisting" in the learning of physics concepts.

In discussing both sound waves as noise pollution, it is possible for students to stay expressing themselves in the field of socio-technological concepts, leaving the physical concepts in other plans. As we have put in quotes (above), the role of auxiliary which would take the learning of physics concepts might seem insignificant for the student, compared to less abstract concepts dealt with socio-technological, ethical and cultural concepts.

5 FINAL CONSIDERATIONS

Recently, several articles have proposed the inclusion of *technological products* in education considering they are capable of providing differentiated teaching.

As we see currently in physics education research, we can find a different category of *technological products*, not necessarily sophisticated, which have been the subject of attention of the authors in order to awakening motivation and student´s interest by physical sciences. The motivational processes associated with these *products* have been proposed as elements that catalyze their pedagogical actions, mainly, through experimentation, and there is a tendency to associate it with computer simulation.

The educational moment in which we live still considers the assumptions of the Law of Guidelines and Bases of Education (LDB / 96), according to which deepen the knowledge acquired in elementary school would be one of the basic educational goals. But for now, we seem to go deeper only on motivational strategies.

When it comes to high school, it is necessary, among others, overcome the motivational stage to also reach the stage of learning science, which still seems a very hard way.

REFERENCES

ALENCAR, E. S.; FLEITH, D. de S. ***Criatividade*: Múltiplas perspectivas.** Editora UnB, 3 ed.2009.

BARBOSA, R. C. G.; GARCIA, T. M. F. *Softwares gratuitos para o ensino de Física no Ensino Médio: estudo sobre condições de acesso*. In: **XXI Simpósio Nacional de Ensino de Física (SNEF)**, 2015, Uberlândia. *Resumos..*.Uberlândia: 2015.

BARDIN, L. ***Análise de conteúdo*.** Luís A. Reto e Augusto Pinheiro (Trads.). São Paulo: Edições 70, 2011.

BUNGE, M. ***Treatise on basic philosophy*.** Part II. Boston: D. Reidel, v. 7, 1958.

CUPANI, A. La peculiaridad del conocimiento tecnológico. ***Scientle studia***, São Paulo, v. 4, n. 3, pp. 353 – 371 2006.

FRANCO, M. L. P. B. ***Análise de conteúdo*.** Brasília: Liber Livro, 2012.

MITCHAM, C. ***Thinking through technology: The path between engineering and philosophy*.** London: The University of Chicago Press, 1994.

PACEY, A. ***La cultura de la tecnología.*** Ciudad de México: Fondo de cultura económico, 1990.