Article

Oficina Desafio – Challenging creativity

Marcelo Firer[*]

Oficina Desafio, Challenge Workshop, is a project of UNICAMP Exploratory Science Museum – the Science Center of the State University of Campinas (Brazil). It is an outreach project, consisting of a fully - equipped mobile workshop constructed on a truck, which visits schools and gives the students open solution real problems challenging them to "design, construct and operate a device" capable of solving the challenge. Analysis of the evaluation forms answered by school students reveals that participants of the challenges perceive it as a "learning opportunity", in the sense they identify school related capabilities as conditions that increase the chance of facing the challenges successfully.

Oficina Desafio, The Challenge Workshop, which was developed in 2006 as part of the UNICAMP Exploratory Science Museum, is designed to stimulate creativity in solving problems, team-working and the satisfaction of creating/building concrete objects.

The main target audience is students from 5th grade on, including adult students that go to night-school. In its first five months of activity, Oficina Desafio posed more then fifty challenges, in ten different cities in four states of Brazil, working with more then 2500 people.[1]

The project has a large spectrum of activities, including workshops and other kinds of support for teachers, but we will focus on the work done directly by students' teams, which has two major variations we will briefly describe.

The "*Big Challenge*" (Grande Desafio) is an annual competition whose first edition was launched in 2007. A real open ended problem is presented and people are challenged to "design, build and operate" a device that helps to solve the problem.[2] Students have up to three months to work in small teams to develop their solution. This program ends with a closing event where all the teams present their projects, operating the device in an official competition arena. They also present the development process as a whole and are evaluated based on both items. Teams with outstanding performance in many criteria are given prizes. This program is strongly inspired and adapted from The Tech's Challenge that is now undergoing its 21st edition and has firmly supported our team.[3]

The second major variation is the "*Small Challenges*" (Pequenos Desafios), so called because those are similar activities that have been designed to take place at school and to directly enroll students for one single day. It started to operate in August 2006 and made more than 150 events. The mobile workshop, which supports activities of the Big Challenge, has a central role in the Small Challenges. The truck itself has a central workshop equipped with electrical machinery and a small office. Besides that, it carries equipment for ten small working stations, equipped with a working bench and a tool chart.

It arrives at school with a team of six monitors and the truck driver. The monitors are undergraduate and graduate students that participate in a 40-hour training program that focuses on the use of the workshop (use of tools and machinery, security rules, basic carpentry, packing and unpacking of the truck) and the pedagogical aspects directly related to their role as monitors (dynamic of personal relationship within groups, subtleness of counseling). After this initial training they also participate in seminars and short courses (approximately 4 times per year).

One of the monitors acts as the coordinator of the activity and each of the remaining five is designated to advise two teams (the students are divided into up to ten teams, 5 to 8 members per team). After unpacking all the equipment carried in the truck (between 30 - 45 minutes), the coordinator-monitor announces the challenge and teams start working in their projects. The monitors encourage a short brainstorming sessions and drawings of sketches of the device to be built. After this initial period, they have from two to three hours to build the designed equipment, and the monitors help them in the use of electrical tools and advise on the solution of technical problems. The activity ends with the teams presenting and explaining their devices.

Figure 1. Sample solutions to the mine elevator challenge.

As an example, we quote the challenge to "*design, build and operate a device to ensure safe operation of a coal mine elevator during an electricity blackout*". The devices run on a large variety of principles, including, for example, (the) filling/emptying with water a counterweight (weight), pulley or gear hand operated engines and spring operated devices.

Despite the evident difference in the development of both activities, mainly in the rhythm and consequent depth of engagement, both kinds of challenges (Big and Small) share the same overall goals that are reflected in the judging criteria used to grant the awards: *Creativity* in the search of solutions to the presented problem, *Design Process* that includes planning and documentation, testing and improving process, and a *Team Work* that makes of every team member an actual partner of the project.

Besides these common goals and the propaedeutic goal of stimulating the participation of students in the Big Challenge, the Small Challenges program has an important characteristic that opens opportunities and imposes some proper objectives.

The arrival of the mobile workshop at school is generally an event per itself, since it is big, has a bold and unique design and there are very few complementary projects that reach schools within its buildings and walls. Also, the Small Challenge engages entire school classes (two classes per event) and not single individuals. The fact that the whole school is aware of the event and that a teacher has classes that took part in it as a collective, opens opportunities for teachers to develop other activities that refers to this experience, exploring science/math contents that emerge from the solutions and other curricular contents arising from the problem situation. Moreover, it proposes a methodological approach which is very consonant with the general (constructivist) directives of Brazil's Ministry of Education, elaborated in the 1990's, and originates much anguish among school teachers. This kind of anguish is predictable when moving from content- centered teaching attitudes to problem-solving context as described in theoretical literature, for example, in Perrenoud's[4] discussion about changes in learning assessment imposed by changes in school programs and approach and somehow also recognized by educational authorities[5]. Aware of this situation, the Science Museum team makes efforts to support the teachers' activities that explore the problems and questions arising from small challenges, organizing workshops and clinics and providing discussion groups. However, the basic premise underlying the Workshop Challenge program is that *the challenges developed at school provide the students with a significant experience that is recognized as a learning opportunity*. In this statement we implicitly distinguish between the skills and practical knowledge developed and used during the Small Challenges and the structural learning of knowledge that is undertaken in schools. So, when speaking of a *learning opportunity* we are considering the possibility, to be carried out at school, to transpose practical knowledge into the universe of structured knowledge and vice-versa.

This is the question we will try to answer in this work.

Questionnaires evaluation

The primary source of information is the questionnaires answered by each of the students' team at the end of every "Small Challenge". This is only part of the information gathered for evaluation and

documentation of the work, but we will not take into consideration for this analysis the data that emerge from teachers' questionnaires and monitors' reports but, since it is not yet inserted into our data-base. The collected data refer to 252 team's answers, representing about 1688 individuals who took part in the challenges between July and November 2006.[6]

The forms have more then 20 questions, most of them open questions, and they play an important role in the formative and corrective evaluation of the project, leading already to some substantial changes and improvements. Moreover, it gives some substantial support for summative evaluation, not only concerning the good execution of the work, but facing the crucial question of indeed having the cultural/educational/scientific expected "performance". This last aspect is our concern here, so most of the questions, which have only a technical interest, are ignored, and we look for the answer to the following questions:

1. What did you like most in the Challenge Workshop[7]?
2. What didn't you like in the Challenge Workshop?
3. Does your team think that the challenge presented to you was a tight challenge, neither too difficult nor easy?
4. If you could elect someone (adult or youth) to join your team, who would you choose? What is his/her occupation (profession)? Why would you have chosen this person?

All of these are open-ended questions, and the answers to each one were separated into few different categories. This is not a taxonomy, there is no hierarchical relation between those categories, and they were determined to identify the perception participant students have from the "Small Challenges" and to support formative evaluation of the program.[8]

Going further we describe and analyze the answers to each question separately and end with an overview. For each question we first present the classifications and summarize each with a few sample answers.

1. What did you like most in the Challenge Workshop?

The answers to this question were classified into four categories:
- Contents and creativity: This category is actually a positive answer to our leading question and so, classification in this category must be careful. Only answers that expressed the contentment explicitly using words as creativity, experience, learning, imagination and ideas were considered to be relevant. Typical answers to this category are: *"The Challenge itself, to build an equipment to solve the problem using creativity and intelligence";"The use of practical knowledge we already had and acquiring new one"; "The opportunity of thinking".*
- Material facilities: Answers that refer to the tools and machinery provided, the workshop itself, the material and parts they could use. Typical answers to this category are: *"Availability of equipment"; "working with carpentry"; "Opportunity of building things with our own hands".*
- Team working: Many times presented in contrast to the usual class activities organization. Typical answers to this category are: *"Team working"; "The interaction between the individual and the collective"; "The union of our team".*
- Monitors: The guidance and orientation of the monitors, including help in the use of tools and machinery. Typical answers to this category are: *"The hospitality of the monitors"; "The monitors, specially the girls from Social Science and Biology", "The attention and the care of the monitors".*

2. What did you not like in the Challenge Workshop?

The answers to this question were classified into four categories.
- Material conditions: It includes mainly the absence of a shadowed area, distance from drinking water and non- available tools and parts.
- Time lack: Not enough time to construct the project as it was designed. Typical answers to this category are: *"Lack of time"; "Not enough time to accomplish the challenge"; "Time was short and we couldn't finish the task".*
- Organization problems: It includes interpersonal problems within the group or team working organization, space organization, the monitors' work, device presentation, line for using

machinery. Typical answers to this category are: *"To share the monitor with another team"; "We didn't have enough information"; "Sometimes the disorganization of the team….."; "From certain people in the group".*

- <u>Failure situations:</u> Complaint about the failure of the device to accomplish the task and discontentment with essential (and hence unavoidable) aspects of the project, such as operating tools, team working, planning. Typical answers to this category are: *"It didn't work!"; "We had good ideas but had no time to conclude them, so it wasn't productive."; "Of what we had to do"; "Working".*

3. *Does your team think that the challenge presented to you was a tight challenge, neither too difficult nor easy?*

This is actually a question with only two possible answers (yes or no), but necessary to find out the adequacy of the challenge, what turns to be essential when considering the intent to turn it into a learning opportunity.[9]

4. *If you could elect someone (adult or youth) to join your team, who would you choose? What is his/her occupation (profession)? Why would you have chosen this person?*

This last question in the form aims to understand what kind of knowledge, skills or competencies the students identify with the activity they had just done. There are three categories, the first one identified with the *challenge* itself, the second with the *workshop* and the third with *teamwork*, the three main components of the Challenge Project.

- <u>Content-related contribution:</u> Into this category were classified all answers that pointed out intellectual knowledge and or skills, inferred either from the profession indicated (engineer, scientist), some general ability (has good ideas, knows how to solve problems), or some specific knowledge (knows how to teach robotics). Typical answers to this category are: *"He is an architect and has skills in making projects"; "He is a teacher ... since he is very intelligent and solves stuff quickly"; "Isaac Newton, because he has a large knowledge of mechanics."*
- <u>Manual skills:</u> Identified either by explicit statements (know how to use tools), or inferred from the person occupation (carpenter). Typical answers to this category are: *"He is an electric engineer and he is very good at carpentry."; "He is a teacher and has ability in using tools."*
- <u>Social contribution:</u> Personal qualities that the group enjoy or can contribute to team-work.
- Typical answers to the categories are: *"Because he is nice"; "Because she has a positive attitude and would like the activity"; "She is a student, she helps us, she is cool and creates a nice feeling to all."*

The distribution of answers to each of the questions

The distribution of the answers to this question is summarized in the tables below.

	Contents and Creativity	Material Facilities	Team-work	Monitors	Other	No answer	More than one answer
Total	125	86	48	26	26	11	60
Percentage	50%	34%	19%	10%	10%	4%	24%
Percentage of answered questionnaires	52%	36%	20%	11%	11%		25%

Table 1. Distribution of answers for question 1.

	Material Conditions	Time Lack	Organization Problems	Failure Situations	Other	More than one answer	No answer
Absolute Num.	68	72	10	15	23	24	71
Percentage	26%	29%	8%	11%	9%	10%	28%
Percentage of answered questionnaires	38%	40%	12%	15%	13%	13%	

Table 2. Distribution of answers for question 2.

There are answers classified into more then one category.

	Adequate	Not adequate	No answer
Absolute Num.	211	29	12
Percentage	84%	12%	5%
Percentage of answered questionnaires	88%	12%	

Table 3. Distribution of answers for question 3.

	Content-related contribution	Manual skills	Social contribution	Others	No answer
Absolute Num.	80	15	31	17	121
Percentage	32%	6%	12%	7%	48%
Percentage of answered questionnaires	61%	11%	24%	13%	

Table 4. Distribution of answers for question 4.

There are answers classified into more then one category.

Some conclusions

Comparison between the answers to the first two questions shows a general contentment of the participants: When asked about what they *did* like, only 4% gave no answer and about 24% answered with more then one item, comparing to 28% that gave no answer and 10% that gave more then two answers when asked about what they *did not* like. Moreover, great part of the discontentment is due to the lack of time, a faithful testimony of the engagement of students in work. This conclusion concerning the engagement of students is strengthened by the clear adequacy of the challenge proposed to teams (88% of the answers).

Figure 2. Teams working at projects.

Figure 3. Team presenting their device.

Satisfaction and moreover engagement are also supported by simple observation during the events at school. The picture above, showing students concentrated on their work stations, with the mobile workshop in the background, is a typical situation of the Small Challenges. In this context, the questionnaires are used only as evidence that supports what is already known.

However, the main question asked in this work, whether *the challenges developed at school provide the students with an experience that is recognized as a learning opportunity* is more subtle and observational data can be misleading, since we are trying to understand a perception that does not involve any physical action. At this point the answers to questions 1 and 4 are elucidative.

The classification of the answers to both of these questions took into consideration the three major components of this program, namely: 1) The challenge to solve a problem; 2) Building a device in the workshop; and 3) Doing that as a team.

The answers to the first question show that about half of the students (52% of the answers) enjoyed the event mainly because of the challenge itself. Moreover, most students (61% of the answers) recognized that the knowledge of contents and general capability for problem solving are the main characteristics needed to succeed in the challenge. Identifying knowledge as an important ingredient to success in the challenge may be viewed as a need of help to face difficulties in designing and constructing a device to solve the proposed problem. However, this interpretation may be discharged by noticing that only 9 teams (4% of the answers) felt the challenge difficulty was not adequate because it was too difficult or they did not have enough time to accomplish it.

All those answers allow us to conclude by giving a positive answer: *Yes, students do have a significant experience that is recognized as a learning opportunity*. This perception by itself only suggests that teachers may use the *Challenge* as an opportunity to discuss contents involved in the problems (that suggest situations related do social, historical, biological contents) or those that emerge from the devices (mainly mechanical and mathematical contents). To encourage and support changes in teacher's attitude and more frequent use of this kind of methodology, the Museum offers regular clinics to teachers and encourages them to propose their challenge, which may be related and supportive to their teaching subjects. That can be done by using the visit of the Mobile Workshop as either a starting point or an apex to their teaching programs. Actual changes in attitude and the use of wider and unusual range of methodologies involve long term work that may be trigged by repeated visits of the Challenge team.

Finally, we remark that students' perception of this activity opens the possibility for teachers to engage students in other significant problem solving situations, to explore the contents that appear in the students' devices, and use them. On the other hand, it broadens the responsibility of the Science Museum staff to encourage and support teachers' engagement and development of class plans using such a methodology.[10]

Notes and references

[1] From July 2006 up to November 2007 more than 7.500 school children were attended by the program, but only those attended in 2006 are taken into consideration in this work.

[2] In 2007 the Big Challenge was related to fighting fire in the woods and in 2007 to picking oranges.

[3] *The Tech Museum of Innovation* is a science center at San Jose, California, that generously presented all details of their *Challenge* program.

[4] P. Perenoud, *Avaliação: da Excelência à Regulação das Aprendizagens: Entre Duas Lógicas*, Porto Alegre, Artes Médicas (1999).

[5] See for example program for in-service course sponsored by Goias State Education Authority, available at <http://educacao.go.gov.br/portal/supem/documentos/telesala03.pdf>.

[6] We have an amount of 640 questionnaires including data from July 2007 to December 2007, but only (the) those answered in 2006 are completely inserted in the data-base, and hence used in this study.

[7] *Challenge Workshop,* Oficina Desafio in Portuguese, is the name of the project, stamped in the truck and with a linguistic nuance that refers equally to the "work" as to the "shop", i.e., it focuses both on the material structure and the activity.

[8] A set of 30 answers was subjected to intercoder reliability test, being classified independently by two different persons, the values agreeing significantly (average correlation of 0.85) and this was considered as the basic validation for the classification of the given answers.

[9] Many teams explained their answers to this question in the appropriate space. We looked more closely on those that found the challenge inadequate. Among 17 answers, 4 complained of difficulty to face the challenge and 5 claimed the time was too short to accomplish the task. The other 8 answers vary from finding it too easy, not compatible with the tools and materials supplied and other reasons.

[10] The experience of *The Tech Museum of Innovation* shows that up to 90% of the teachers that take part in their teachers' clinics adopt the "Challenge Methodology" at school. Details can be found in: *Design Challenge: Learning Through Problem Solving, in ASTC Dimension*, September/October 2002.

Author

Marcelo Firer has a PhD in Mathematics from the Hebrew University of Jerusalem. Beside his work as a mathematician at UNICAMP, State University of Campinas in Brazil, he is director of the Exploratory Science Museum - UNICAMP. E-mail: mfirer@ime.unicamp.br.