Evaluation of schools activities with digital interactive simulations

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ABSTRACT
The paper explores the usage of digital interactions and usability methods to contribute in collecting information about user experiences and behaviors for educational propose. Based on the outcomes of the research analysis and testing this work provides a detailed view of a proposal for alternative solutions on educational materials. It delineates the positive outcome of learning at young age using digital environments inside the classroom using ergonomics criteria and usability test. The usability tests could identify interface best practices on the development of educational materials and suggest improvements that rise quality to the user. It is presented a system allowing teachers to create simulation activities inside the classroom that make the students practice sustainable values. An interactive activity was developed for student face simulations based on the school’s subjects. When the students face it, they are sought to make decisions considering the consequences. The objective is solving a problem considering the sustainable values. Results documentation show patterns identification could be used as a guideline for interface development able to provide effective learning experiences.

Keywords
Human computer interaction (HCI), Usability testing, Interaction devices, Graphical user interfaces, Interaction design process and methods.

1. INTRODUCTION
In 1992, the UN Conference on Environment and Development held in Rio de Janeiro, Brazil developed the Agenda 21. It is an action plan of United Nations with regard to sustainable development. One of the chapters is dedicated to promote education and training. It focused on the process of orienting education to develop knowledge and values of sustainable development considering the three main topics: economy, society and environment.

The United Nations General Assembly adopted the resolution to establish the decade of education for sustainable development from 2005 to 2014 because it realized education as a key to sustainable development as a part of a system that includes the Kyoto protocol, monitoring and influence further global agreements that can provide different models of social and economic development. The concept of sustainable development encompasses several knowledge areas. For educational propose, it must be defined what it means and which approach must be applied. The United Nation split the sustainable development in three main areas: society, environment and economy.

• Society: an understanding of social institutions and their role in change and development, as well as the democratic and participatory systems which give opportunity for the expression of opinion, the selection of governments, the forging of consensus and the resolution of differences.

• Environment: an awareness of the resources and fragility of the physical environment and the affects on it of human activity and decisions, with a commitment to factoring environmental concerns into social and economic policy development.

• Economy: a sensitivity to the limits and potential of economic growth and their impact on society and on the environment, with a commitment to assess personal and societal levels of consumption out of concern for the environment and for social justice. [1]

There are many reasons, which contribute to the education information in classrooms by making students learn better. A system was designed in order to provide a fully equipped service to empower the student with more transparency and subject information to raise knowledge acquisition. The system offers solutions using computers with mouse input; mobile devices as in Figure 1 with touch input for activities outside the school and group activities with the movement sensor from Microsoft Kinect.

The system involves a whole cycle offering different ways of knowledge acquisition. Different learners can choose their way of informing themselves about the system and could by applied elsewhere online.
The research approaches different experiments on information design, cognitive skills and human-computer interaction in relation to education at young age. The methodology applied and the result of the field research during the research period represented by a text documentation, pictures and testimonials that are necessary to introduce the an activity prototype. The prototype is a game called SuperChef. The goal is getting points by choosing sustainable options during the cooking process as going to the supermarket, choosing products, dispose the trash and consider the sustainable development. On section 2 describes production details and implementation approaches and more accurately how a project could be approached and includes the usability test analysis.

1.1 Relevance
The teachers and instructional designers could think about the implementation of interactive classes for development of courses and training in schools, universities and companies. As well as evaluate the process and the teamwork environment during the design process.

1.2 Aim
The aim is to provide information about the design process during a course development and helps teachers and instructional designers to bethink about the subject with a user point-of-view.

2. EDUCATIONAL APPROACH

2.1 Tilbury report
The values are the most relevant content of the education for sustainable development. They are based on the respect and human responsibly as a world citizen. It means respect for others, diversity tolerance, concern about resources, justice and dialogue. It means the process must maximize capacity and increase engagement in the subject. To achieve this goal the learning process should have more interactive approach and change the position of the teacher as a disseminator of knowledge and change this strategy to engage students in questioning ways of thinking in a critical way aiming to create a opinion and encourage participatory learning. The table below shows the educational shifts proposed by Education for Sustainable Development from the Tilbury report (see Figure 2):

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing on knowledge</td>
<td>Understand and getting to the root of issues</td>
</tr>
<tr>
<td>Teaching attitudes and values</td>
<td>Encouraging values clarification</td>
</tr>
<tr>
<td>Seeing people as the problem</td>
<td>Seeing people as facilitators of change</td>
</tr>
<tr>
<td>Sending messages</td>
<td>Dialogue, negotiation and action</td>
</tr>
<tr>
<td>Behaving as expert - formal and</td>
<td>Acting as a partner - informal and</td>
</tr>
<tr>
<td>authoritative</td>
<td>equilibrium</td>
</tr>
<tr>
<td>Raising awareness</td>
<td>Changing the mental models which</td>
</tr>
<tr>
<td></td>
<td>influence decisions and actions</td>
</tr>
<tr>
<td>Changing behavior</td>
<td>More focus on structural and</td>
</tr>
<tr>
<td></td>
<td>institutional change</td>
</tr>
</tbody>
</table>

Figure 2. Tilbury report [6]

2.2 Field research
The school Pedro II is a traditional public educational institution in Rio de Janeiro. It is one of the oldest schools in Brazil and has named in honor of the Brazilian emperor Pedro II during the 19th century. Located in Tijuca, a neighborhood at the north zone of Rio de Janeiro with middle class residents.

During the visit it was possible to observe the school physical and pedagogic structure. The education is divided into three levels: elementary school, middle school and high school. The field research focuses on elementary and middle school where the students are between 5 and 15 years old. The number of students per class is between 25 and 35 students. Approximately 1000 students are enrolled and each grade has 4 classes.

2.2.1 Teachers and sustainable values
An interview was scheduled with one teacher that holds the sustainable development education projects for 8 years old students. She follows a resolution from the Ministry of Education that presents guidelines of subjects and contents that should be teach. Otherwise, provide a class focus on sustainable development is not mandatory. One of my questions was how to inform abstract values and make the children understand. The pupils are open for information and discussion without a background of opinions.

At the same time, the sustainable values are abstract and to approach the subject the teacher combine the values with daily news. It means the kids were encouraged to read newspapers and discuss topics as technology consumption, health and natural resources.

The teacher explained all the activities during the year and she told me some issues that she had to deal with during the process. One of the issues is the majority of the kids have difficulty to work in groups because they are the only child at home. The majority of the kids had difficulty to share, discuss and act as a group. It is difficult for them to realize how important they can be when work in teams.

Furthermore, the result of the daily news discussion was positive but it did not change the behavior of the children at the first. The teacher realized that she needed to provide actions activities to motivate the kids to move and apply the acquire knowledge. She
said the path to follow must be “challenge – information – action”.

The goal of the project was to create a cost-effective alternative for action activities to help teachers to implement simulation with different scenarios and adaptable for different types of schools. (see Figure 3 and Figure 4)

Figure 3. E-learning activity screen and interaction simulation

Figure 4. Screen describes the shopping options considering sustainable arguments.

3. INFORMATION DESIGN
Information design is a subject of visual communication background that connects different graphic design tools to convert data (numerical content) or text (verbal content) into plastic representation. The main role of information design is to create accessible information to the receiver. The bond of different tools as typography, illustration, ergonomics, psychology, communication studies and informatics make the information design development. The development consider the human matter, it means significance on the information acquirement by the receiver with efficiency. Gui Bonsiepe supplement this thinking:

“The communication process and the knowledge share are related with the knowledge presentation and it could be the main design function. The innovative design go thought proposals to embody technological tools into daily life. It means, create useful artifacts and comprehensive information.” [22]

This comprehensive information quoted by Bonsiepe must to be obtained through a multidisciplinary study where the content, the shape and the user are part of the process of information design development. According to Frank Thissen:

“Information design is about the clear and effective presentation of information. It involves a multi and interdisciplinary approach to communication, combining skills from graphic design, technical and non-technical authoring, psychology, communications theory and cultural studies.” [25]

Considering more industrial approach to information design, the information is used in almost all kinds of products and services that make relations to people. It means computer interfaces, machines interfaces, technical information, city plans, street signage. It important to detach that the relation between people and objects is made by the information the objects give to the people. Projects development consider cultural factors, psychology, ergonomics and communication theory. It is also necessary to test the objects to confirm the effectiveness of the use and adjust eventual problems. As interact with people, information design is a human-centered process. The human-centered project is based by research. It means contact to possible users for tests on medium process stage. In the beginning of the project was important to define the user target, consider their expectations and needs. For that, interview were schedule to collect information about the target group. With the aim to achieve good results after the prototype, an usability test were conducted to create feedback outcomes provides revision of some processes.

4. USABILITY
With propose of produce a usability test inside the school with students; a research about ergonomic criteria was necessary to identify guidelines of quality evaluation. These standards [13, 14, 15] help on providing results of the existing problems and guide for a new prototype development.

The Schaffer Method™ [11] was used as a good practice list of activities that helps on an efficient development of human computer interaction project.

For the test implementation, some aspects of literature review on usability were consider:

1. Universal usability
2. Offer informative feedback
3. Prevent errors
4. Short-term memory load
5. Flexibility and efficiency of use
To evaluate the effectiveness of the usability test, the usability goals [16] were considered:

- Effectiveness (do successfully what is supposed)
- Efficiency (how it helps user to have success)
- Safety (avoid danger or unexpected situation)
- Utility (good functionality avoid unnecessary)
- Learnability (easy to learn to use)
- Memorability (no need to learn again to use)

(see Figure 5)

4.1 Evaluation

Complete a full simulation test based on a UI prototype. Maintain an ongoing process of monitoring site performance. The research question is: How the evaluation of digital interactive technology helps on school content learning?

4.1.1 Space and materials
The testing was holding on a school classroom with 2 cameras. The first camera was focus on the screen; the second camera was focus on user actions. The images were used for evaluation the users behavior by the researcher only. The usability test use a computer and mouse for input.

4.1.2 People
The test supervisor has two functions: explain the activity before the test and ask questions based on a questioner after the activity ends.

4.1.3 Teacher
The teacher invites some students to participate on the usability test. After the trial, the teacher provides feedback about the experience.

4.1.4 Test users
The test has three experiments with three students each. One student interacts with the screen and the other two students help to think and make decisions. It took place three times with different students. The test was hold with 8 years old students enrolled on the 3rd grade.

4.1.5 Time
The test and interview will take around 20 minutes.

4.2 Evaluation overview
The evaluation was divided in three different groups. The first test user group consists on three users doing the activity together. The group will be called G1. The G1 took 08:20 to do the activity.

The introduction text was read in detail by all group components. On the first introduction page the users they have thought the images were links and on this moment G1 had a consistency problem. Along the text reading it was observed that the users could not understand entirely the text.

The group had a good relation and made decisions together after discussion.

The first decision-making inside the market was two options of tomato. The choice was based on a discussion like: “it is more expensive, but better” and “the cheaper option has more salt and does not help the local economy”. In general, the feedback headline was read but the text below it did not have much attention by G1. It was important to identify when the user does not know the subject, it spend more time reading and try to understand it. When the user knows about the subject, it does not read carefully and try to guess the answer.

When G1 got on the cooking activity the concentration was high. “Nice, let’s cook” one user said. Otherwise, during the activity there were feedback problems because the action was to repeat a click four times. “Is it just to click?” was a frustrating question.

The G1 group did the drag and drop activity as expected and when it finishes read the results.
others participants tried to advice but it did not work. After three wrong choices that give no points on score, one user give up on the activity and start to walk though the room.

4.2.1 Universal usability
The activity could have better range of diverse users as from novice to expert, different ages and educational level to avoid the phase from one user tester that said: "I didn’t read the text because the activity is too easy". When the user was asked if the activity was too hard, it said: "Than I would read it." At the same time, there were some problems with texts and images. One group could not understand the meaning of “CO\textsubscript{2}”. It means the text was not compatible with the users vocabulary. Another example regarding pictures is the olive oil bottle. One picture had olive oil inside a glass bottle that could be used for drinking. One user said: "What is it? Wine?". One other user had a negative face expression when saw the image of raw cow meet. It could be related to some cultural relation and it is a good opportunity to think about the type of images to use according to the range of users.

4.2.2 Standards
The consistency follows the interface design with similar buttons, boxes, colors, and fonts. During the usability test there was not any episode of misunderstanding regarding the layout.

4.2.3 Informative feedback
The feedback box that appears after an action is a positive usability result that provides the user a response about the action. Nevertheless the feedback had two levels of information and all the test users did not read it. Less than half of the test users read the whole feedback information. The majority only read the primary information. It is not sure if the information was useless or not relevant for the user testers.

4.2.4 Dialogs
During the activity, the user test group 2 did something unexpected. The group chose some links to click but they were not sure about the further development of the activity, so they decided to click with the right button on the mouse and press back to start the activity again and maybe undo some mistakes. It is a signal of lack of closure information. The users were insecure about the further information because the interface does not provide an informative feedback at the completion of a group of actions. This kind of feedback gives the user a sense of accomplishment and gives the user the control of the situation.

4.2.5 Error prevention
The error prevention is well done. The activity was carefully developed to avoid problems to occurring. There were no cases of unsolved situation. In one situation, the test user decided to start the activity without the renew setup from the instructor. During the activity the money was gone and the user could not continue the activity. The link was redirect to explanation page showing the problem and providing a link to restart the activity from the beginning.

4.2.6 Visibility
The time response of the activity was good and there were no incidents of lose users’ attention because of delay.

4.2.7 Flexibility and efficiency of use
The drag and drop action had different behavior among the group users. The action was place the trash inside the correct color bin. The test group 1 executed the action as expected as click and hold the image and move the image until the trash can and left the mouse button. The test group 2 clicked on the image once without feedback and after the three tries the group could drag and drop and on the next exercise the activity was natural without any problem. The third group did not use the drag and drop function. The action was to click direct on the trash bin. This is a case of flexibility that the user can do what is more comfortable for them and it keeps working.

4.2.8 Aesthetics
Regarding the aesthetics, an image misleads the user test on the kitchen page. To start cooking the user was suppose to press on a button on page bottom but the user tried to take some elements from the shelf or move the oven. It is a case where the illustrations did not help to user inside the environment. It competes with the relevant information and affects the efficiency. On the other hand, the food pictures on the pages stimulate the users to choose between different dishes and discuss about it. The video test shows more interest on the screen when there are photographs on it. One test user when choosing the dish said: "I am getting hungry."

4.2.9 Workload
The workload according to Bastien and Scapin [15] must to be reviewed. There were many texts that most of the user testers did not read and also did not affect the result of the activity.

4.2.10 Codes
In general, the significance of codes has succeeded. The icons for score, environment, economy, society, and coins are well
represented. Meanwhile, the argument icons (environment, economy and society) could be bigger and receive more detaches. The coins and score area could be bigger. During the user testing, was not observed any user checking the amount of money left.

5. DISCUSSION
The interface as a communication platform must offer a smoothly use. In case of trouble, it is needed to identify the problem and fix. The project result and conclusion were important to identify guidelines of quality evaluation on digital educational material. The usability test was relevant considering the feedback from the users by test and interview.

The user objective on the usability evaluations was reached the end of the activity with success. Based on the evaluation results was possible to propose improvements and identify behavior patterns.

The activity aims to be a testing material to evaluate the human-computer interaction. Further developments must to be done for possible implementation. It is possible to summarize the conclusion with some sentences based on the study:

5.1 Target and hardness
It is important to identify minutely the target user and it knowledge about the activity subject. When the user does not know about the subject, it spends more time reading and tries to understand it. When the user knows about the subject, it does not read carefully and try to guess the answer. There are two solutions for this issue. The first is developing an activity with small amount of content for a small target user. The second is the development of a broad activity with all levels of contents suitable for a large target.

5.2 Gamification
The concept of progression and achievement makes the users more committed to the activity and introduce a pleasant educational experience.

5.3 Layout consistency
It is evident the layout and interactions must be consistent but it is important to avoid repetitive actions. It means invest time on a range of actions possibilities. When the activity is predictable, the user loose interest.

5.4 Action
The users spent more time on screens where have task to be accomplished. Text screens with “next” button are nearly invisible to the user.

5.5 Images
Users give more attention on screens with visual information as photograph, illustration or diagram.

5.6 Innovation
It is positive to test new interactions mostly with young people who easily learn new commands.

5.7 Development control
The interface must have a development control to make the user focus on the educational activity and avoid it to do other tasks. Some users reported no believe on connection between use of digital devices and education.

5.8 Vocabulary and pictures
Consider the possibility the text is not compatible with the users vocabulary. Avoid pictures without clean meaning, cultural offensive or inappropriate for age.

5.9 Text amount
Less than half of the test users read the entire feedback information. The majority only read the headline information. Make sure that all the text is useful and relevant to the activity.

6. CONCLUSION
Finally, the propose improvements, positive aspects and patterns identification could be used as a guideline for interface development able to provide users pleasant learning experiences.

The project result and conclusion were important to identify guidelines of quality evaluation on digital educational material. The usability test was relevant considering the feedback from the users by test and interview.

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8. REFERENCES
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