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Web-ECoTEC: an optimization tool for the ECoTEC assessment methodology

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Abstract

Knowledge building results from exploration of and experiences with one’s environment. According to Piaget, experiences can be physical, logical-mathematical and social. Of these, experiences that develop logical-mathematical knowledge are the most difficult to detect in computational tools for both distance and classroom education. In constructivist principles, the methodology called Cognitive Structure for Constructivist Educational Technologies – ECoTEC characterizes computational tools for education according to the types logical-mathematical thought structures that can be constructed by the users of the tools. Online availability of assessment tools widens access and can also facilitate user interpretation of results. To this end, the objective of this study was to develop an interactive tool to aid in automated data collection and calculation of metrics proposed by the ECoTEC methodology. The demonstration prototype, called Web-ECoTEC, is in the form of a website hosted on a Server at the Federal University of Uberlândia, Brazil. It consists of a set of pages on the World Wide Web (www) based on the HyperText Markup Language (HTML) with hypertext links. Web-ECoTEC aids response collection and generation of characterization results from the computational tools. Responses are easy to enter and the instrument quickly prepares assessment results in various formats for the user-evaluator. Real-time results calculation facilitates interpretation and assists in the selection of computational tools used for building logical-mathematical thought.

Keywords: optimization tool; assessment methodology

1. Introduction

Most educational software is currently developed by combining computer and telecommunications technologies with an emphasis on the internet. This combination has been applied to various types of classroom and distance education. It is expected that this type of software may contribute to the processes of teaching and learning.
Development of most of these tools has been guided by constructivist epistemology (Elissavet & Economides 2000; Costa et al. 2005). This perspective supports pedagogic practices related to interactivity, collaborative learning, learner autonomy and working with errors (Costa et al. 2005).

According to constructivist theory, knowledge is constructed through exploration of and experience with ones environment. Piaget classifies experiences as physical, logical-mathematical and social (Flavell 1963). Of these experiences, those that develop logical-mathematical skills are the most difficult to detect in educational software. To assist in the decision about which software to use to construct logical-mathematical thought, Santos et al. (2011) developed a model called Cognitive Structure for Constructivist Educational Technology – ECoTEC. This methodology characterizes software based on the types of logical-mathematical thought structures that can be constructed through its use. Online availability of evaluation tools makes them accessible worldwide and facilitates results interpretation by user-evaluators. To this end, Web-ECoTEC was developed to automate data collection from computational tools and to calculate metrics proposed by the ECoTEC methodology.

2. Web-ECoTEC structure

A website needs a theme, objectives and users (Siegel 1996; Silva 2008). The theme is the main idea or topic of the site. Objectives are determined by deciding what role the website will fill and by answering the question: Why? Users can be described by their age, experience and motivations for using the site. This data answers the question: For whom? It should be remembered that those who visit the site do so to get information. Because the Web-ECoTEC website is an evaluation instrument, Depover et al. (1998) affirm that it is also necessary to answer the following questions: “Who evaluates?”, “What to evaluate?” and “When to evaluate?”.

The Web-ECoTEC theme is associated with the efficiency of educational software based on the operative theory of Piaget. Regarding users and the question “Who evaluates”, software evaluation is done by specialists, and Mathematics teachers and educators in particular. Specialists should have at least a superficial understanding of Piaget’s theory and evaluators should have thorough knowledge of the software under evaluation. This knowledge can be gained hands-on and with or without students.

The answer to the question “What to evaluate?”, and the objective of Web-ECoTEC is to evaluate educational software for mathematics. During evaluation, an indirect measure is assigned to the software for how well it contributes to building logical-mathematical structures. This measure indicates how effectively specific skills were developed (Depover et al. 1998). It is an analysis of the end result of the teaching and learning process and whether the student has successfully developed the intended competencies through use of the software.

Necessary subsequent assessment (Silva 2008) answers the question “When to evaluate?” or at what stage to evaluate. Mathematical content specialists and teachers evaluate the final software products but not their development.

2.1. The communication structure

A website’s structure should present information in an organized manner. This encompasses information structure, organization and accessibility (Bonsiepe 1997; Moura 2003). Use of Web-ECoTEC is facilitated by its structure. To achieve this, similar information is grouped together and displayed to allow clear, easy visual access to content and efficient site navigation.

The hierarchical hypertext base of Web-ECoTEC organizes content radially or in the shape of a star. More general information appears at the top of the hierarchy and progressively more detailed information at lower levels. Nodes descend from a common root and each is connected to others at lower levels. The star or radial shape has a head node with other nodes connected to it. Transitioning from one node to another requires returning to the highest node.

The Web-ECoTEC communication structure diagram (Figure 1) represents what was proposed by Moura (2003) – relationships between links, sections and interfaces which create a sense of space and suggest a system of navigation.
2.2. Interface structure

Design of the interface included choosing colors, font type and size, icons and screen organization. In the demonstration version of the optimization instrument, some principles of visual communication were followed such as: unifying colors, using short paragraphs focused on essential information, using lowercase letters (resulting in improved readability) and highlighting information (through tasteful use of bolding and color, etc.). In addition, the screen was not overloaded with heavy objects and images to ensure quick page loading.

The main menu on the home page, www.elianeelias.prof.ufu.br, has the following options: “Introduction”, “Register”, “Evaluate” and “See Evaluations” (Figure 1). By clicking on these links, the user-evaluator can access the other pages of the site. The main menu can also be accessed through the option “Introduction” which is available on each page of the site.

The “Register” link allows the user-evaluator to log in by username and password. The page also has an option for new user registration. If a username or password has been forgotten, the site prompts user-evaluators to enter their registered email address. After identification by username and password, a list of registered software appears.
Here, users have several options including: evaluating registered software, deleting software evaluations, changing passwords, changing account information, recommending the site to another person and registering new software.

The “Evaluate” option in the main menu requires user-evaluators to choose a software category to evaluate. After selecting the category, a report is displayed for software that has already been registered and is ready for evaluation. If the user-evaluator doesn’t want to register, he or she can still evaluate software as a guest which is a sub-option under “Evaluate”. In this case, software can be evaluated but, results will not be saved.

The last option on the main menu, “See Evaluations” allows the user-evaluator to see evaluations given by others. The user selects the category and evaluation by the name of the software and evaluator and corresponding educational background. The user is then presented with the general conclusion of the evaluation.

Software characterization metrics are displayed in checklist form. Each metric offers three possible responses: yes, no or does not apply. A “Read more” button is available for each metric to clarify potential questions about the metric.

The checklist can be accessed in two ways: (1) by clicking “Evaluate”- located in front of the registered software listing, or (2) by clicking “Evaluate” in the main menu. A pop-up displays links to information about the number of questions answered and time spent on each module of the ECoTEC methodology (Santos et al. 2011). Other options, “See result”, “Save result” and “Redo module”, are available after completion of each of the three modules.

Applets are programs that are executed within the pages of the evaluation modules. These programs use data stored in the database and captured from the checklist. The measures, calculation expressions and characterization indicators proposed by the ECoTEC methodology (Santos et al. 2011) have been translated to the command lines. After data compilation, an evaluation results page is produced for each module and another for the general conclusion.

Applets running in the Web-ECoTEC pages also produce pop-ups prompting users about unanswered questions. This feature promotes system consistency.

Navigating the checklist allows the user-evaluator to (1) request help by clicking on “Read more…”, (2) return to the module summary on any page, (3) save the current document, (4) evaluate one module at a time and save the evaluation, (5) print the current document, or (6) see evaluations made by other professionals.

3. Software characterization with Web-ECoTEC

As an overview of the evaluation analysis that integrates all three modules, Web-ECoTEC displays software results as a graphic organizer, a systemic network and a characterization report. These three methods make it possible to visualize results in different ways.

The graphic organizer highlights the logical-mathematical thought structure to be built with the help of the software. This feature is based on the theory of concept maps – diagrams that represent a group of ideas to be taught, learned or evaluated (Novak 1995). These diagrams use color to assist interpretation.

The systemic network provides a quantitative overview of the desired and actual parameters in the software. In the field of educational research, Bliss & Ogborn (1977) used, for the first time, a systemic network to analyze large quantities of qualitative data. In Web-ECoTEC, the systemic network has the following objectives: (1) facilitate a global understanding of each module, (2) provide a structure for system characteristics, (3) show the inter-relationships between characteristics and (4) show the frequency at which these characteristics occur in the process.

Finally, the characterization report gives a brief description of aspects of operational activities such as interaction and cooperation that user-evaluators have identified in the software. This report is a synthesis of what has already been completed separately in each module.

4. Conclusions

The development of a demo version of the interactive Web-ECoTEC tool for automatic data and information collection facilitates the task of validating the ECoTEC evaluation methodology. It is perfectly possible to use Web-ECoTEC to characterize educational software for the construction of logical-mathematical thought structures according to Piaget’s theory.

Web-ECoTEC contributes to the collection of responses and generation of characterization results from educational software for mathematics. Data input is easy and evaluation results are quickly produced in various formats. Real-time results calculation speeds interpretation and selection of software for mathematics education.
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References


