ANALYSIS OF AN EDUCATIONAL SOFTWARE FOR LANGUAGE LEARNING: insights from the Theory of Structural Cognitive Modifiability and Human-Computer Interaction

RESUMO: O estudo analisa um software para o ensino de inglês como língua estrangeira reportando (i) a interação entre o software e o aprendiz, (ii) as operações cognitivas/mentais requeridas para execução das tarefas propostas pelo software, e (iii) as estratégias pedagógicas implementadas pelo software. Aspectos de ergonomia de software também são analisados para avaliar o grau de interatividade e usabilidade do software (Ergolist, 2011). Os resultados mostraram que o software tende a aplicar uma visão conteudista de ensino e a análise ergonômica revelou que os recursos didáticos utilizados pelo software atendem a maior parte dos critérios de usabilidade, requerendo poucas modificações.

PALAVRAS-CHAVE: software educacional; teoria da modificabilidade cognitiva estrutural; interação humano-computador

ABSTRACT: The aim of the study is to analyze a software for teaching English as a foreign language reporting (i) the interaction between the software and the learner; (ii) the cognitive/mental operations required to perform the tasks in software and (iii) the pedagogical strategies implemented by the software. Human-Computer Interaction (HCI) aspects of the software were also analyzed so as to evaluate its degree of interactiveness and usability (Ergolist, 2011). Results of the study suggest that the software is content-oriented and the ergonomic analysis revealed that the didactic resources applied by the software meet most usability criteria, requiring few modifications.

KEYWORDS: educational software; theory of structural cognitive modifiability; human-computer interaction

1. Introduction

Several ideas have been advocated in favor of the use of technological devices in class based on the fact that computers permeate learners' daily activities and may serve as tools to motivate those students who do not usually feel motivated by a traditional class design (Burns; Griffin; Snow, 1999 cited in Meskill, 2005).

According to Valente (1993), information technology should be seen as a way to open new opportunities for learners and teachers, in a move from more traditional to more modern pedagogical practices centered on the learning, rather than on the teaching process. Though, as pointed out by Reis (2008), a change in the pedagogical paradigm does not relate only to implementing new ways to use computers in class but also needs to be meaningful for all involved in the learning process: teachers, learners and schools.

What seems to be more relevant regarding the use of new technology in education, apparently, is not the decision of using it or not, but whether these pieces of technology are indeed promoting learning. This concern is also present in the field of English language teaching (hereafter ELT). As argued by Chapelle (1996; 2007), the great amount of computer-mediated tasks to which English as a foreign language (hereafter EFL) learners are exposed to and their innovative and interacting nature may impact the acquisition of the foreign language once access to new forms of input is constant in computer mediated (hereafter CM) interaction, thus providing extended time, frequency and possibly depth of exposure to the target language.

Another important aspect to be taken into consideration regarding the use of computer-mediated activities in education is related to the mediating characteristics of such activities. From a socio-cultural perspective (Feuerstein, 1994; 1997), learning develops thorough mediated experiences as they enable learners to transcend their actual knowledge stage so as to perform tasks which lead to the development of autonomous reasoning and behavior. In this sense, the mediator plays a major role in selecting and modifying the stimulus learners will receive. When addressing the learner-computer interaction, educational softwares may mediate between stimuli and learners as they are designed to offer users a way to apply the knowledge they have acquired to solve problems and perform different activities. To do that (in the case of educational softwares designed to teach English), the software designer needs to take into account the knowledge learners already have about the language, their learning necessities, and most importantly, their reasoning patterns in order to enable mediation and therefore cognitive modifiability, as proposed by Feuerstein (1994; 1997).

Whether the software is perceived as a relevant tool for learners seems to depend on its degree of interactiveness with the user and the level of complexity. Put

differently, aspects of human-computer interactions appear to impact learners' perception of the educational software as well as their performance on the tasks proposed.

With that in mind, the main objective of the present study was to analyze the validity of an educational software designed to teach English as a foreign language to beginners. Taking into account the theory that sees learning as the modification of cognitive structures through mediated learning experiences (Feuerstein, 1994; 1997), four secondary objectives were pursued in the present study, namely: (i) to assess aspects of the interaction between the software and the learner; (ii) to investigate the cognitive/mental operations learners need to undergo in order to perform the tasks required by the software; (iii) to investigate the pedagogical strategies implemented by the software and (iv) to evaluate Human-Computer Interaction (HCI) aspects of the software so as to determine its degree of interactiveness and usability. In what follows, a brief review of the main theories underlying this investigation is presented.

2. Review of Literature

2.1 Theory of Structural Cognitive Modifiability

The Theory of Structural Cognitive Modifiability (hereafter SCM), as proposed by Feuerstein, sees the human mind as being capable of modifying itself. This capability is related to the generation of mental schemes and operations that can be applied to different learning contexts when necessary. According to Feuerstein (cited in Noguez, 2002), the SCM results from a combination of biological and sociocultural factors and refers to a mutable rather than a static state. Therefore, it develops through changes in the cognitive structures of the learner by means of mediation.

To Feuerstein, mediated learning experiences (hereafter MLE) are essential to human cognitive development since they foster the modification of mental structures. In this sense, the mediator is seen as the potentializer of the learning process, interfering between the stimulus and the learner, leading him, according to his learning needs, to the restructuring of his reasoning patterns.

2.1.1 Mediated Learning Experiences Functions

As proposed by Feuerstein, mediated learning experiences have two main objectives:

1.To transmit socio-cultural values to learners, these values are intrinsically related to the context and require another individual to be shared. In this case, the mediation generates new necessities for learners, who become more willing to transcend their limits in search for new knowledge.

2.To interfere in the stimulus, adapting it to learners' needs. In this case, the mediator selects the stimulus, manipulates its intensity and frequency in order to emphasize what he/she believes is more appropriate to foster learners' modifiability cognitive potential.

Feuerstein argues that not all kinds of mediation can be considered an MLE. The three mediating criteria that characterize an MLE are: intentionality/reciprocity, transcendence and meaning.

➔Intentionality/Reciprocity: to Feuerstein, every teaching act is intentional, since a specific result is expected through a pedagogical intervention. Thus, the mediator (teacher) needs to clarify his intentions regarding the instructional contents and learners' expected behavior. With that, it is expected that learners assume a pro-active attitude, collaborating and engaging themselves into the learning process.

➔Transcendence: the objective of mediation is not only the solution of immediate problems. It is also its function to allow the mediated learner to establish connections between what he is learning and what was already internalized, projecting new ways of facing and understanding future demands. The transcendence also permits the mediated leaner to build a net of interconnect knowledge and abstract connections that will, eventually, lead to the creation of generalizations to be applied in new learning situations.

➔Meaning: the mediation of meaning is important to foster the propensity of the cognitive modifiability of the mediated learner, as it makes clear the relevance of instructional contents and the activities proposed by the mediator. In order for learning to occur, in this case, mediator and mediated must interact so as to change values and life experiences, constructing meaning from each other and getting emotionally engaged in the learning process.

2.3 Ergonomic aspects of educational softwares: human-computer interaction

Human-Computer Interaction (hereafter HCI) is seen as part of a broader field of knowledge known as Software Ergonomics. Its objective is to facilitate the understanding of the system, taking into account users' adaptability to it (Barbosa; Silva, 2010)

The HCI also aims at understanding how users interpret softwares, assuming that every system can be modified and be constantly improved through feedbacks, making it possible for the software designer to make adjustments according to the mental model of a particular kind of user, creating high-quality interfaces.

HCI aspects are of great relevance due to the fact that human natural language is very different from the complex codes that constitute machine language. In this

context, the interface plays a major role once it allows interaction between humans and the machine. Users are responsible for approving and accepting the system as a valid working/learning tool (Moran, 1981).

To Cybis, Betiol and Faust (2007), there are several techniques to evaluate the ergonomic aspects of a software. One of them is the heuristic assessment, which applies usability patterns to evaluate the software interface at any time of the project, either during its execution (designing of the software) or when it is already in the market.

To assess the quality of the interface of the software selected for this study, a set of usability criteria proposed by Ergolist (2011) was analyzed from a heuristic perspective.

3. Method

The present study was conducted to analyze the validity of an educational software – *Interchange Arcade* by Cambridge University Press -, designed to teach English as a foreign language to beginners.

The choice of the educational software was based on the fact that it is part of a well-known English series, used by several English as a foreign Language (hereafter EFL) learners around the world. This software provides an on-line companion of grammar, vocabulary and listening exercises to aid learners in the review and practice of content already studied in class. The software is in fact a complement for the Student Book, since it presents the same contents in the same order of the printed material usually used by the teacher.

In order to investigate the validity of the educational software as a tool to promote EFL learning based on the tenets of the Theory of Structural Cognitive

Modifiability, a set of criteria adapted from Gomes (2001) was analyzed. This set was chosen so as to reflect the main principles of the theory and its implications to learning in general and EFL learning in particular, as can be seen in Table 1.

Table 1: List of criteria used to analyze the validity of the educational software as a pedagogical tool

	Criterion	Description
Interaction between the software and the learner	Mediation of Intentionality/reciprocity	This criterion takes into account whether the software clearly presents its educational intentions to the student by establishing a communication channel with them and expects reciprocity through participation in the proposed tasks.
	Mediation of Meaning	It analyses whether the software approximates students and activities, by proposing meaningful and relevant tasks.
	Mediation of Transcendence	It analyses whether the software helps students understand the learning process by making them generalize to new contexts.
The cognitive operations exploited by the software	Knowledge and content	This criterion analyses whether the knowledge is structured in a logical and coherent way. It also takes into consideration whether the software organizes the content according to its particularities, allowing the student to develop specific kinds of reasoning.
	Form of presentation	It analyses the kinds of languages used by the software such as: numbers, symbols, schemes, visual, audio and audio-visual language. It also analyzes whether the software uses different kinds of languages to reach the greatest number of students.
	Cognitive functions/ Mental operations	It analyses whether the software requires students to undergo specific mental operations such as analysis and synthesis. It verifies whether the software tackles only the final product of the tasks or the underlying cognitive processes.

	Level of abstraction	It analyses whether the software utilizes concrete and abstract information interchangeably, according to the students' needs.
	Level of complexity	This criterion analyzes the complexity level of the tasks regarding the number of stimuli or elements involved. For example, a task that requires the student to solve 2+2 is relatively less complex than a task in which he needs to solve X= (2+2+2+2).3/4.
	Level of efficiency	It analyses whether the software allows students to achieve a reasonable level of efficiency, trying to establish a balance between difficult and easy tasks.
Pedagogical strategies implemented by the software	Observation	This criterion analyzes whether the software interacts with the students leading to a meta-cognition of the observed data, through a series of specific and general interventions.
	Analysis	It verifies whether the software motivates the student to analyze the elements of the tasks, leading them to find relevant information through the mental operation of analysis.
	Conceptualization	It analyzes whether the software helps the student build concepts and name the elements of the tasks.
	Solution planning	It analyzes whether the software helps the student to identify specific and general strategies to solve the tasks as well as provides information that helps students build planning strategies.
	Comparison	It analyzes whether the software provides information about the importance of the mental operation of comparison.
	Argumentation and logical reasoning	This criterion analyzes whether the software provides terms of the process of argumentation. It also verifies if the software helps students understand their own steps, motivating them to verbalize their reasoning (meta-cognitive process).
	Generalization	It analyzes whether the software provides

		concepts that help students transcend the task and assess the mental process involved in learning.

Because of the subjectivity of this type of analysis, three raters were asked to rate the set of criteria based on a scale designed to evaluate how well each criterion is implemented by the software. Table 2 displays an excerpt of the data collection instrument and the scale used.

Table 2: Excerpt of the data collection instrument - rating scale (in Portuguese)

Critério	**O software educacional atende a este critério de forma:**
Interação do software com o educando	
Mediação de Intencionalidade/reciprocidade	( ) Regular ( ) Boa ( ) Muito boa ( ) Excelente Ou ( ) Não atende Comentário:.....

Raters received instructions and a list with the description of each criterion to be analyzed in their L1 – Brazilian Portuguese. So as to assess the ergonomic features of the educational software, its degree of interactiveness and usability, a set of criteria proposed by Ergolist (2011) was evaluated by a rater who is a teacher and also a professional in the Computing area (see the set of criteria in Appendix 1).

4. Results and Discussion

4.1 The software as a pedagogical tool

The analysis carried out in order to investigate the pedagogical validity of the educational software *Interchange Arcade* aimed at assessing (i) the interaction between the software and the learner; (ii) the cognitive/mental operations learners need to undergo in order to perform the tasks required by the software and (iii) the pedagogical strategies implemented by the software. Table 3 displays the results taking into account each rater and their assessment of each criterion related to the aforementioned objectives.

Table 3: Raters' assessment of the educational software regarding its pedagogical validity

Criterion	**Interaction between the software and the learner**		
	Rater1	**Rater2**	**Rater3**
Mediation of Intentionality/reciprocity	**VG**	**G**	**G**
Mediation of Meaning	**VG**	**G**	**VG**
Mediation of Transcendence	**G**	**VG**	**G**
	The cognitive operations exploited by the software		
Knowledge and content	**EX**	**G**	**VG**
Form of presentation	**EX**	**G**	**VG**
Cognitive functions/ Mental operations	**G**	**G**	**G**
Level of abstraction	**G**	**G**	**G**
Level of complexity	**EX**	**G**	**VG**
Level of efficiency	**EX**	**VG**	**VG**
	Pedagogical strategies implemented by the software		
Observation	**VG**	**G**	**EX**
Analysis	**VG**	**G**	**VG**
Conceptualization	**EX**	**R**	**EX**
Solution planning	**G**	**R**	**VG**
Comparison	**EX**	**G**	**No answer**
Argumentation and logical reasoning	**G**	**R**	**EX**
Generalization	**VG**	**R**	**VG**

R = criterion rated as Reasonable /G = criterion rated as Good /VG = criterion rated as Very Good /EX = criterion rated as Excellent

As can be seen in Table 3, raters have different opinions about the criteria evaluated. In what follows, a discussion of their evaluation is presented.

=> Mediation of intentionality/reciprocity: the software displays the objective of each task at the bottom of the screen and makes it clear what kind of answer is expected from learners. However, the objective is not about learning, in general, it is related to the

content being studied. Therefore, the software intention seems more content- than process-oriented.

=> Mediation of meaning: all tasks are meaningful if we consider that they provide an opportunity for students to practice and reinforce grammar aspects of the language learned in class. On the other hand, because most of the tasks are concerned with grammar only, they might not be meaningful for those students interested in developing a more communicative (lexical) competence.

=> Mediation of transcendence: because the tasks are presented from the less to the more complex ones, students can generalize about how they were able to solve the previous task when they are to perform the next.

=> Knowledge and content: the software organizes and displays the content in a logical sequence, from micro to macro structures. In the case of the Simple Past, the first task asks learners to use some verbs in the past to fill in the blanks, whereas the next tasks require them not only to use knowledge regarding the correct form of the verb, but also a greater understanding of the content, since statements and paragraphs with simple past verbs are introduced.

=> Form of presentation: the software makes use of different types of languages, such as verbal, visual and audio-visual. A reason for the discrepancy among raters' evaluation must be related to the lack of schemes. The software does not usually present schemes to summarize key points of the instructional content. Maybe the use of schemes from which learners could abstract grammar aspects required by the task could serve to reinforce the rules, show learners why their response was not correct and enable them to create generalizations to be applied in future contexts. Schemes could be displayed after the feedback given in the end of each task.

=> Cognitive functions/mental operations: raters' assessment of this criterion may be due to the fact that the software seems more concerned with the final product of the tasks than with the underlying cognitive processes of learning. The lack of more detailed feedbacks after the completion of tasks, for instance, might be an indication that the tasks were designed more specifically as a way to operationalize the content studied in class, without deeper concern about developing reasoning/learning strategies.

=> Level of abstraction: the level of abstraction of the software was rated as good because it makes use of abstract and concrete information. Although grammar exercises

usually focus on the abstraction of rules, there are tasks that display information through visual and audiovisual resources.

=> Level of complexity: raters evaluated this criterion very differently. Taking into account the content is presented from micro to macro structures, it is possible to say that the level of complexity seems to increase from task to task. On the other hand, analyzing the instructions given to learners one could argue that it may be somehow difficult for beginners to understand as they are complete statements in English.

=> Level of efficiency: raters tended to have a more positive view towards this criterion. This might be due to the fact that there seems to be a good balance between easy and difficult (less/more complex) tasks, providing learners with the opportunity to reach a good efficiency level.

=> Observation: it seems that raters had a different understanding of what this criterion means. The software does interact with learners in some tasks through feedback messages such as 'you can do better next time', good work'. However, more general instructions about learning how to learn or about the importance of observing certain aspects of the task and their elements seem not to be the focus of the software, since it appears to be more content- than process-oriented.

=> Analysis: raters seem to demonstrate some agreement concerning this criterion. Although tasks do not explicitly require learners to analyze elements to come up with an answer, learners do need to apply this mental operation so as to solve the tasks adequately.

=> Conceptualization: there seems to be a greater disagreement among raters regarding this criterion. Because the software is more content-oriented and focused on performance, there seems to be little concern for the building of concepts that allow the transfer of knowledge to different learning situations.

=> Solution planning: this criterion is somehow related to the building of general learning concepts. The lack of such concepts might undermine learners' opportunities to improve planning strategies that can be used in other language-use contexts.

=> Comparison: this criterion seems to have caused considerable doubt to raters, since two out of three rated it Excellent and Good, and the third replied not having understood it at all. Indeed, the instructions to the activities presented by the software do not make clear whether learners should compare different elements to perform the tasks.

However, if learners are strategic enough to generalize on what they have previously learned, it is probable that they will eventually make use of this mental operation (comparison) each time a new tasks with a higher level of complexity is proposed.

=> Argumentation and logical reasoning: raters' assessments diverge on this criterion. All the tasks proposed by the software do require learners to make use of logical reasoning if they are to be performed correctly. However, there is no explicit instruction to learners aiming at motivating them to think about the steps they took to solve the tasks. Little concern seems to be given to the development of meta-cognition in the way tasks are proposed by the software.

=> Generalization: raters' evaluation of this criterion represents very different points of view. This might be related to the auto-didactic characteristic of the software. That is, due to a more content-oriented approach, it seems that the software was designed to be self explanatory. To some tasks, when learners perform incorrectly, the software provides the correct response as a feedback, but does not give emphasis on the grammar rule itself. If learners are not able to deduce why they were wrong, it is likely that they will have difficulty to create generalizations to these rules. Even if they are able to do that, it does not guarantee generalizations will be correctly applied in new tasks. However, generalizing leads learners to form and test hypotheses about language in use, which seems to make it a very important strategy.

4.2 Ergonomic assessment

Interchange Arcade is entirely available on the Internet (Interchange, 2012).The ergonomic criteria proposed by Ergolist (2011) and analyzed in the present study were: promptness, grouping by location, grouping by format, feedback, legibility, concision, minimal actions, informational density, explicit actions, user control, flexibility, user experience, protection against errors, error message, error correction, consistency, meaning and compatibility. In what follows, a qualitative analysis of each individual criterion is presented:

=> Promptness: all the necessary information for the user to interact with the software is available, facilitating the use of the software and directing students' attention to learning.

=> Grouping by location: the software follows a logical sequence regarding the distribution of the objects on screen, which are easily identified by students,

contributing to keep learners attention on the tasks.

=> Grouping by format: there is a visible difference among commands, options, data and instructions presented by the software, either regarding the kind of letter or the colors and audio signals.

=> Feedback: the software provides learners with information regarding its actions. That is, it displays a specific symbol on the screen each time a piece of information is being loaded. This kind of resource helps to direct students' focus of attention to the learning object.

=> Legibility: the icons used by the software are readable, allowing for a fast interpretation of their meanings, mainly because they are followed by written statements.

=> Concision: the software makes a good distribution of icons, pictures, drawings and other pieces of information in relation to the space on the screen.

=> Minimal actions: there are actions required by the software that would not be necessary if this criterion were accomplished. As for instance, when the learner needs to fill in the blank gaps in a sentence, the cursor does not appear on the gap that should be filled out. In this case, to decrease the number of learners' actions, the cursor should appear where the text is to be placed, speeding the execution of the tasks and freeing students' focus of attention from irrelevant aspects. Besides, learners should be able to move through the software by using not only the mouse, but also specific shortcuts in the keyboard. For an advanced computer user, this might facilitate navigation and save performance time.

=> Informational density: the amount of information (data density) displayed by the software is in accordance with the windows' size or spaces reserved to this end, helping learners to make sense of the content presented.

=> Explicit actions: the software waits until learners give specific commands to perform corrections. That is, an explicit action is necessary from the learner to prompt a particular software response, which is a way of providing learners with the control over the completion of the tasks.

=> User control: The software does not require any pre-requisite in order to perform the

tasks. This means that students are allowed to repeat the exercises/tasks as many times as necessary, in any sequence they prefer, giving them control over their own performance regarding the tasks separately. However, learners seem not have a good control over the great scenario, that is, the software does not provide any kind of record containing scores and other relevant information for students to access in order to have a view of the whole learning process, becoming aware of which contents they are not mastering or what aspects of the tasks they need to improve.

=> Flexibility: this criterion is not accomplished by the software, since it does not allow learners to choose specific kinds of screen configuration, such as particular features for beginners and advanced users, different menu layouts, different background colors, among others.

=> Users experience: in order to fully meet this criterion, the software should allow learners to use the keyboard to replace some functions which are only made by using the mouse, such as the selection and execution of some actions needed to perform the tasks. The software does not take into account the fact that students may be either experienced or novel computer users.

=> Error protection: the way the software was designed contributes to avoid usability errors, since learners are advised when the data input is not correct and must be done again. There is also no danger concerning data loss as they are not recorded for further actions.

=> Error message: in general, messages to users are clear, impartial and polite, meeting this criterion well.

=> Error correction: the software offers students the possibility of error correction by giving them the chance to repeat the exercise as many times as needed.

=> Consistency: there is a good consistency among the different windows displayed by the software. That is, the icons and symbols used in one window always express the same meanings when presented in other windows. The same happens with their color, format, and size of letter used.

=> Meaning: in most cases, the statements that precede tasks are objective and self-explanatory, which, for some learners, may facilitate the understanding of what needs to

be done.

=> Compatibility: there is a certain level of compatibility between learners' expectations and needs regarding the software, once it provides tasks to different levels of knowledge, allowing students to choose what exercises they want to perform. If expectations are not met in the first time, they can decide to go over the same exercise so as to solve their doubts.

In general, data analysis revealed that the software *Interchange Arcade* meets most of the criteria evaluated, being a relevant tool to be used by learners of English as a foreign language.

5. Conclusions: limitations and further research

In general, data analysis revealed the educational software presents a content-oriented approach to EFL learning. Apparently, there is little concern with the underlying mental processes involved in the performance of the tasks, once there is lack of more detailed feedbacks that could lead to the development of learners' meta-cognitive and strategic behavior and thus to cognitive modifiability.

It might be that, if the software provided more detailed feedbacks, including the reasons for errors and details about the grammar rule learners should master to solve the task, they would have more chances to repeat the task and get a positive result, instead of going through tentative and error trials. Though learners could search for the rules in the class book, it would still be interesting to have the chance to choose whether to do it or not.

Regarding the ergonomics analysis, the resources used by *Interchange Arcade* meet most usability criteria, requiring few modifications. The most important interface design features that need re-elaboration, as revealed by data analysis, concerned the following criteria: minimal actions, flexibility, users' experience and user control.

Data analysis also showed it might be important for learners to have the possibility to check their progress through the performance of the tasks in order to have a picture of what they need to improve. A report presenting some statistics regarding learner's performance at the end of each unit would allow for a more accurate analysis, by the learner, of which aspects of the instructional content might not have been

internalized, or might need more practice or even a better understanding of the language rules. This kind of analysis may lead learners to develop a more pro-active behavior towards language learning as well as help them to build a set of meta-cognitive strategies to be applied in different learning situations, thus fostering cognitive modifiability.

The present study, though a relevant step towards a better understanding of the impact of educational software in EFL, suffered from some limitations. First, regarding the relevance of the educational software as a pedagogical tool to promote EFL learning, data analysis revealed a reasonable disagreement among raters for most criteria evaluated. It is believed that certain level of difficulty to evaluate some criteria may be due to the fact that raters were nor teachers nor students of English. As a result, in order to overcome the aforementioned drawback, further research should try to implement the following actions:

- ✓ Re-elaborate the assessment criteria so as to make them clearer and more specific in order to avoid doubts from raters;
- ✓ Have English teachers as raters;
- ✓ Check the internal consistency of the data collection instrument by applying appropriate statistical tests;
- ✓ Check for inter-rater reliability;

Second, the ergonomic analysis was conducted by one rater only. Future research should have other raters assessing the ergonomic aspects of the software in order to gather different points of view about the same pedagogical tool. Moreover, it would be interesting to have learners assess some features of the educational software so as to obtain a different perspective of its degree of usability and interactiveness.

In sum, although the educational software *Interchange Arcade* seems to be an interesting tool to be used in EFL classes, more research is needed to fully evaluate its contribution to foster structural cognitive modifiability and thus, learning.

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Appendix 1 List of criteria and aspects (in Portuguese) used to analyze the ergonomic features of the educational software

Criterion	List of aspects to be observed
Presteza	Verifica se o sistema informa e conduz o usuário durante a interação.
Agrupamento por localização	Verifica se a distribuição espacial dos itens traduz as relações entre as informações
Agrupamento por formato	Verifica os formatos dos itens como meio de transmitir associações e diferenças
Feedback	Avalia a qualidade do feedback imediato às ações do usuário
Legibilidade	Verifica a legibilidade das informações apresentadas nas telas do sistema
Concisão	Verifica o tamanho dos códigos e termos apresentados e introduzidos no sistema
Ações Mínimas	Verifica a extensão dos diálogos estabelecidos para a realização dos objetivos do usuário
Densidade Informacional	Avalia a densidade informacional das telas apresentadas pelo sistema
Ações Explícitas	Verifica se é o usuário quem comanda explicitamente as ações do sistema
Controle do Usuário	Avalia as possibilidades do usuário controlar o encadeamento e a realização das ações
Flexibilidade	Verifica se o sistema permite personalizar as apresentações e os diálogos
Experiência do Usuário	Avalia se usuários com diferentes níveis de experiência têm iguais possibilidades de obter sucesso em seus objetivos
Proteção contra erros	Verifica se o sistema oferece as oportunidades para o usuário prevenir eventuais erros
Mensagens de erro	Avalia a qualidade das mensagens de erro enviadas aos usuários em dificuldades
Correção de erros	Verifica as facilidades oferecidas para que o usuário possa corrigir os erros cometidos
Consistência	Avalia se é mantida uma coerência no projeto de códigos, telas e diálogos com o usuário
Significados	Avalie se os códigos e denominações são claros e significativos para os usuários do sistema
Compatibilidade	Verifica a compatibilidade do sistema com as expectativas e necessidades do usuário em sua tarefa.