Combined Use of Software that Supports Research and Qualitative Data Analysis: Potential Applications for Researches in Education

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Abstract This article analyzes the potential applications of the articulation between software programs designed to investigate and analyze qualitative data similarities on researches in the education field. The first part of this article discusses the context and the meta-ethnographic process. Next, it explores the use and articulation of software programs designed to support qualitative research, namely webQDA and CHIC. The third part presents the weaving of the meta-ethnographic analysis. The final remarks focus on the integration of this study's findings, synthesis and conceptualization, combined with the acknowledgment of the contributions derived from the articulated use of both programs to develop this research.

Keywords webQDA software · CHIC software · Qualitative analysis · Research in education · Meta-ethnographic approach

1 Introduction

This study analyzes the potential applications of the articulation between software programs designed to investigate and analyze qualitative data similarities in research work in the education field.

We focus on two specific software programs: the web Qualitative Data Analysis (webQDA)—a qualitative data analytic tool in a collaborative online environment—and the Correspondence and Hierarchical Cluster (CHIC).

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The relevance of the present study lies in the potential incorporation of these two programs combined in a research where the treatment of data using the first software (webQDA) allows for organizing them in categories and/or themes, hence preparing them to be used by the second one (CHIC). Such strategy enabled the researchers to retrieve the processing performed with both software programs at different moments of their work as a means to search for new significant elements in the ongoing study and, also, to deepen the analyses.

In order to explain how we developed the articulation between these two software programs, we synthesized the results of a study conducted within a research (Almeida 2013; Godoi 2013), using the meta-ethnographic methodology. For this, we present the context and the meta-ethnographic process next. After that, we discuss the improvements in the use of software tools in qualitative research. Finally, we offer the analysis of the findings resulting from this study.

2 The Context and the Meta-Ethnographic Process

This work chose, as its investigative object, the issue of synthesizing results from a study conducted within a project (Almeida 2013), funded by the grant of "One Computer per Student Program" (PROUCA 2010) of the Brazilian Agency for Scientific and Technological Development (CNPq), the Coordination for the Enhancement of Higher Education Levels (Capes) and the Ministry of Education (MEC). This study is delimited by a teacher development course held in an elementary school that participates of the PROUCA program, located in a municipality in the state of São Paulo, Brazil.

Project and Program UCA were inspired by the Project One Laptop per Child (OLPC) designed by Nicolas Negroponte, whose ideas were launched in Brazil in 2006 when the one laptop per student option was adopted by the public schools. The recipient schools were in charge of managing the equipment distribution to students, and this feature sometimes restrained the use of laptops solely to activities developed inside the school. In order to provide the professional development for teachers so that they could build their basic technological skills as well as help them with the integration of technology and curriculum as proposed by Shapley et al. (2010), and Suhr et al. (2010), the development course uses the b-learning[1] modality. In the selected school, the development program was a direct responsibility of the Pontifical Catholic University of São Paulo, a private university in the state of São Paulo, Brazil.

[1]B-Learning, or Blended Learning, is considered a hybrid learning modality, that is, the teaching-learning processes involve both on-site and online contexts, and they can resort to different methodologies and resources.

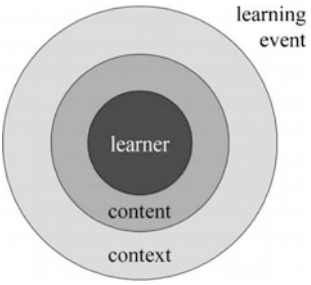

Fig. 1 A simple model relating learner, content, and context in a learning event (Quoted from Figueiredo and Afonso 2006, p. 5)

This type of development using b-learning modality involved theory-practice workshops and online activities in the learning environment e-Proinfo,[2] on the choice and evaluation of digital learning material (DLM) (Godoi and Padovani 2009; Godoi 2013; Nokelainen 2006; Squires and Preece 1996, 1999), having as a basis the Contextual Evaluation Plan (Ramos et al. 2004), which allowed educators to reflect upon their choices before, during and after the use of DLM.

The concept of context is based on Figueiredo and Afonso (2006), who bring relevant contributions for the understanding of what the term "context" means. The authors adopted a simplified model that relates the learner (e.g., the in-service teacher) to the content and the context in a learning event (e.g., the selection of digital teaching material). This model proposes three definitions: (1) A learning event is a situation where an individual learns; (2) The content is the information that has been structured and coded as a text (e.g., the Contextual Evaluation Plan; the developer's spoken words or any other media used in on-site or online development); (3) Context is the set of relevant circumstances for the learner (in this case, the teacher) to build his knowledge (Fig. 1).

In this model, presented in Fig. 1, we can see that the lines between the layers—content and context—become blurred, that is, from the content layer you can cross into the context layer and vice versa. In this view, "one generates the other" and "one cannot exist without the other", which is a feature that is shared by the development course under analysis in this article.

This cross section is restricted to two teachers who contributed with their reflections, interacted in the e-Proinfo forums and produced written reports using the Contextual Development Plan. The individuals are identified according to the code consisting of a number followed by letters and one numeral referring to the mnemonic indicating their teaching level and/or position they hold, such as: EST1 = Elementary School Teacher I,[3] EST2 = Elementary School Teacher II.[4]

[2]e-Proinfo. Retrieved April 30, 2016, from e-proinfo.mec.gov.br.

[3]The Brazilian elementary school I (1st through 5th grade) is equivalent to the United States elementary school level (1st through 5th grade).

[4]The Brazilian elementary school II (6th through 9th grade) is equivalent to the United States middle school level (6th through 8th grade).

We chose meta-ethnography for the methodological approach, according to Noblit and Hare (1988) and Alarcão (2015), as a process of meticulous analysis founded on an interpretive approach that involves data re-interpretation besides favoring a contextualized analysis. The meta-ethnographic researcher's role is to interpret, re-configure, re-construct and synthesize in the sense that he reinterprets and evaluates the scope of findings in qualitative research. In meta-ethnography—besides data synthesis—we often perform analysis, integration, transformation and conceptualization of qualitative results.

We used the meta-ethnographic approach for the analysis and synthesis of findings from a research previously conducted by Godoi (2013). The authors of this study used such findings to obtain the themes. The process was conducted following the steps below, as proposed by Noblit and Hare (1988), and re-signified by the authors based on the characteristics of the research data:

- Re-read the study, take notes, reformulate and create themes and key sub-themes;
- Determine how the themes are related;
- Synthesize the findings, work on integrating them and identify the changes;
- Write out the synthesis and conceptualize the results.

For this process to be rigorous and clear, the researcher needs to recover the context of the original study and reinterpret the results without ignoring the original author's viewpoint (Alarcão 2015).

It is worth underscoring that the meta-ethnographic approach does not imply undervaluing the methodology used originally, namely the Design-based Research (PBD) (Reeves 2000), since meta-ethnography is characterized by its flexibility to incorporate aspects that emerged from the situation under study.

3 Software Used to Support Qualitative Research: The Combined Use of webQDA and CHIC

In the last 30 years, there has been a growing development and interest for qualitative research approaches that are able to incorporate the specific and complex features of contexts under study and, at the same time, improve scientific rigor. Groups of researchers started to focus on software creation, many of which became accessible products available for the academic community, some with specific licenses and some license-free. Since then, the use of software tools in scientific investigations of qualitative or qualitative-quantitative bases has gained important recognition in the scientific scene, both in the development of strategies for literature review and in data collection, analysis and triangulation (Souza et al. 2011a, b, 2015).

Souza et al. (2010) underscore that, although researchers use software tools for the analysis of qualitative data, it is essential to take into account that these tools

should not "[…] ignore the theoretical, technical and methodological developments that took place in human and social sciences in the last decades." (p. 294).

Based on the epistemological, methodological, technical and technological breakthroughs, we present the combination of two software tools, which can make a difference depending on whether the research is qualitative or qualitative-quantitative. In this study, the first software used is webQDA, which is an online system that supports the analysis of non-numerical and non-structured data. It promoted the identification of categories and/or themes treated by the second software—CHIC—used to support the analysis of similarity across data.

For this study, we sought software that would allow for the systematization and viewing of connections across the different moments in the research. Hence, we chose to use webQDA and CHIC for the treatment of multidimensional statistic data.

3.1 webQDA Software

The webQDA is an online software tool designed to support qualitative investigations mainly for the organization and treatment of collected data (Sousa et al. Souza et al. 2010, 2011a).

These authors consider that, although webQDA is presented as an "empty" form—in the sense that it can be configured to suit the researcher's needs without pointing to a specific design for the investigation—its organizational structure is based on the foundations of content analysis, more specifically in the content structure presented by Bardin (2004): Analysis organization; Coding; Categorization; Inference.

Based on Bardin's (2004) structure, it is important to understand the elements that organize the rationale behind the webQDA work to guide data organization in this study considering three parts: Source, Coding and Questioning.

The insertion of data sources is the first action performed by webQDA, when the researcher inserts the available data (e.g. text, image, video and/or audio). This area can be organized according to the researcher's needs, document type or their function (Souza et al. 2011a, b, 2015). In this study, the sources used and organized to produce the material to be analyzed were: field logs, discussion forum, and written reports created by the teachers attending the development course.

From the textual records in the collected material in the pedagogical interventions (field data collection), it was possible to start the organization of this material on the webQDA.

After this initial organization, we went on to work with the Coding. This step requires a more careful reading of data excerpts aiming to create the themes, the dimensions, the indexes or categories—both the descriptive (a priori) and the interpretive (emerging) ones (Souza et al. 2011a, b, 2015). For this study, we chose to create themes and sub-themes (a priori and emerging from the textual excerpts), which had been organized and coded. These codes consist of numbers (corresponding to the set of themes, dimensions, categories or indexes identified in each phase of the research) and letters, which refer to the mnemonic of the corresponding theme.

Table 1 Themes and sub-themes of the contextual evaluation plan

Code	**PCEP—Preparation of CEP by the teacher**
	A priori and emerging sub-themes
01PCEP	Students characterization
02PCEP	Curriculum contextualization
03PCEP	Identification of curricular convergence zones
04PCEP	Definition of learning objectives
05PCEP	Identification of competencies and/or skills
06PCEP	Proceedings and criteria for choosing the DLM (emerging)
07PCEP	Activity proposed using the DLM
08PCEP	Support resources
09PCEP	Physical context organization
10PCEP	Digital Learning Material used (emerging)
11PCEP	Evaluation devices
12PCEP	Familiarization with the DLM (emerging)
Code	**DCEP—Development in action over CEP by the teacher**
	Emerging sub-themes
13DCEP	Conceptualization and introduction of the issue in the pedagogical activity
14DCEP	Distribution of pedagogical activities using DLM and support resources
15DCEP	Time and space management
16DCEP	Pedagogical activities applied
17DCEP	Evaluation of results in context after DLM use
18DCEP	Students' attitude (inside and outside classroom)

The treated themes are related to the Contextual Evaluation Plan (Ramos et al. 2004): Preparation of the Contextual Evaluation Plan by the teacher (PCEP) (emerging sub-themes from the textual excerpts and a priori identified from the theory); Development of action based on the Contextual Evaluation Plan by the teacher (DCEP) (emerging sub-themes), as shown in Table 1.

In Table 1, we have 2 themes and 18 sub-themes, which includes a total of 9 sub-themes a priori and 9 emerging sub-themes.

After the establishment of the codes and the creation of themes and sub-themes from the textual excerpts, we started to use the webQDA section entitled Questioning, which provides a set of tools to help the researcher challenge the data and form relation matrices based on the configuration assigned in the previous stages.

In this study, we entered one questioning that corresponds to the combinations/relations of the themes related to the Development of the Contextual Evaluation Plan by the teachers (Table 2).

Once this cross is made, the webQDA automatically launches 0 or 1 values in the matrix cells, thus showing the presence or not (true or false; yes or no) of a priori and emerging dimensions corresponding to the textual records (provided by the research subjects.) In the end, it is possible to export this matrix to a spreadsheet

Table 2 Matrix construction

CEP development		
Questioning: What are the relations established by the teachers in the CEP Preparation and Development?		
Matrix	Theme	Similarity tree
1	PCEP (a priori sub-themes) + DCEP (emerging sub-themes)	1st graph

in .CSV format which is the kind of format of text files used to import/export data from spreadsheets between different programs.

This organization performed by the webQDA software corroborates the methodology proposed by Almeida (2008) and adopted by other researchers (Gras and Almouloud 2002; Souza et al. 2011a, b, 2015; Valente and Almeida 2015) to represent this relation using Excel spreadsheets, which bring the codes for data from the textual records in the first column and, in the first row, the codes for the a priori and emerging sub-themes (e.g. 01PCEP, 02PCEP—see Table 1) and the values zero (0) and one (1) in the cells. After exporting the spreadsheet it is possible to open it in Excel, download it and process it using CHIC.

All this process helps and supports the researcher to identify the analyzed elements as well as the triangulation relations established with the various parts of the investigative project.

However, Souza et al. (2011a, b, 2015) remind us that the webQDA and other qualitative analysis tools alone are unable to make the artificial intelligence processes "find," "interpret" or "discover" result patterns. A critical, creative and analytical researcher will always be needed to interpret data.

Finally, having this structural and organizational overview of the software, and hence corroborating Souza et al. (2011a, b, 2015) ideas, the webQDA allowed us to: work on, organize, distribute and systematize data; establish themes and sub-themes that were treated by CHIC; underscore important aspects stemming from the data and, lastly, help interpret the results.

3.2 CHIC

The software tool named Correspondence and Hierarchical Cluster (CHIC) is based on the foundations of a multidimensional statistic method and implicative statistical analysis (ASI). It is used in qualitative and qualitative-quantitative studies to extract association rules of a set of data (subjects and variables), by providing an association index and a representation of its structuring. Régis Gras started to build it in 1985, as an improvement of the theses developed by Almouloud (1992) and Ratsimba-Rajohn (1992) (Gras and Régnier 2015, p. 23).

The multidimensional analysis can be considered an important tool for research in human sciences, whose qualitative expressions risk being limited to vague

phrases, such as: "teachers said that …, teachers believe that…, we think that …" (Almeida 2008, p. 330).

To avoid this limitation, CHIC enables the construction of graphs and the viewing of meanings in the interrelated data by using approximations, similarities and contradictions. Thus, it reveals the conceptions of subjects and provides information, which is not always available in classic symmetric models (Gras 1996; Almeida 2008).

CHIC provides four types of data representation. We chose the hierarchic analysis of similarities because this resource enables the viewing of similarities and/or dissimilarities between themes and sub-themes of variables organized in levels through a hierarchic similarity tree (Almouloud 1992).

Aiming to find new possibilities of interpretation for the reflections recorded by the teachers participating in the PROUCA development course and more specifically in the Development of the Contextual Evaluation Plan, as shown in Table 2, we adopted the articulation of the matrix organized through the webQDA to generate the similarity tree constructed through CHIC.

Hence, regarding the development of the Contextual Evaluation Plan, we made one questioning (Table 2)—information presented by the teachers in the CEP Preparation and Development—which generated the similarity tree graph (Fig. 2).

For the development and analysis of the graph shown in Fig. 2, U-shaped clusters were identified in the similarity trees, namely classes and sub-classes, and their interconnections. According to Borges (2009), usually the analysis of similarities starts at the strongest class, that is, with the cluster showing the highest grade of similarity and represented by the shortest distance in the U-shape width.

Gras and Almouloud (2002) and Borges (2009) explain that it is up to the researcher to interpret the relations and interconnections viewed in the trees using the contextual knowledge about the research scope and also by the theoretical basis of the study, while remaining open to identify unexpected relations leading to surprising results and new findings about the case in study.

Next, we present the weaving of the result analysis of a section from one research conducted by Almeida (2013) and Godoi (2013), using the meta-ethnographic approach.

4 The Weaving of the Meta-Ethnographic Analysis

From the section selected for this study and for the result analysis using the meta-ethnographic approach, we sought to synthesize the findings of the similarity tree (CEP Preparation and Development) and integrate them into the analysis.

We consider as findings the strongest U-shaped clusters referred to as classes and sub-classes, that is, the cluster with the higher grade of similarity identified by the shortest distance in the U width as shown by the similarity tree in Fig. 1. From these clusters in the similarity tree, we defined one theme to discuss in this meta-ethnography: Digital Literacy.

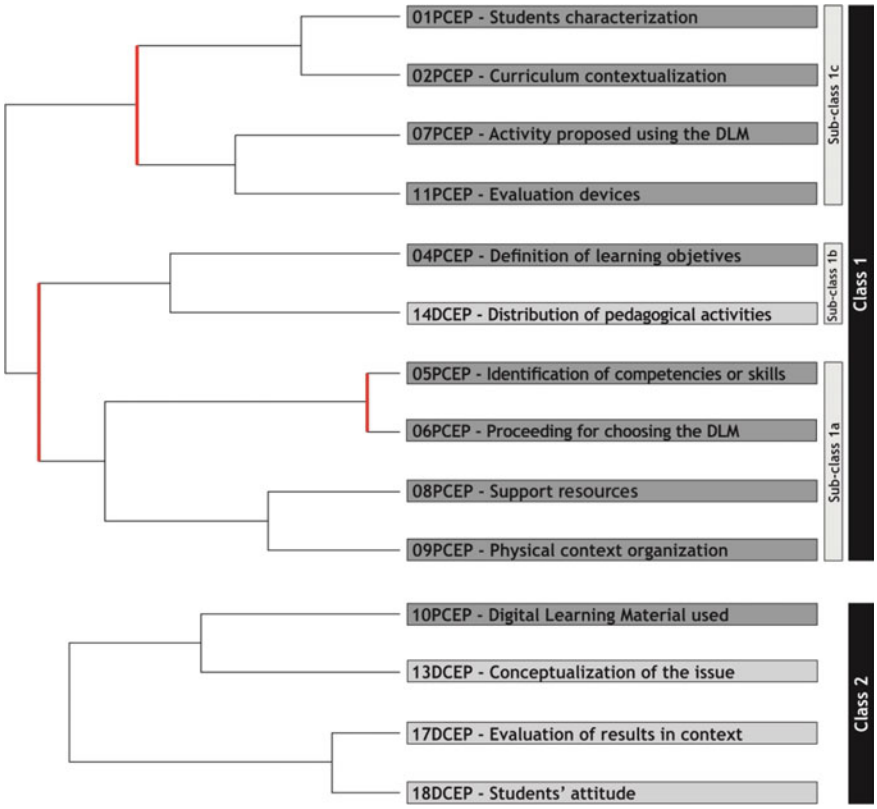

Fig. 2 CEP preparation and development—similarity tree—1st graph

The theme—Digital Literacy—is formed by four sub-themes: Identification of competencies and/or skills [05PCEP], Proceedings and criteria for the choice of the digital learning material [06PCEP], Resources and support material [08PCEP] and Physical context organization [09PCEP], as shown in Fig. 3, which then divides into two sets.

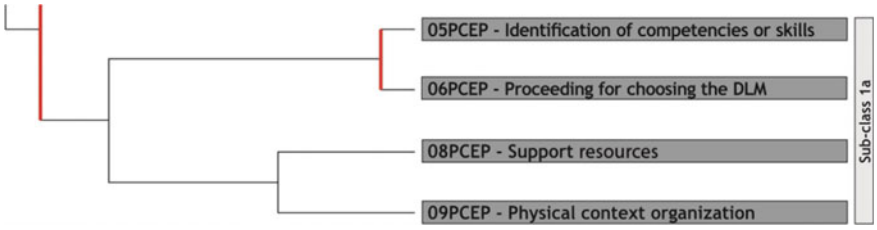

Fig. 3 Digital literacy

The first set of this sub-class indicated the most significant level in the graph (level 1—similarity 0.915095) showing that when the teachers performed the proceedings (actions) and/or when they established pedagogical criteria to choose the digital teaching material, they also tried to identify the competencies that students need to develop. The following excerpt shows this concern:

> At the time, I chose to work with the Blog tool and create together with the students this feature to take ownership of this tool, and thus contribute to their digital literacy and enhancing reading and writing skills. I also tried to help students develop the ability of reasoning and communicating, critical thinking and creativity. [01 EST1]

This excerpt also shows that the teacher is concerned about the students' digital literacy and more specifically about the skills that the students need to develop such as reading and writing critically and consciously so that these skills make sense when working with them in the Blog.

Rojo (2009) explains that with the emergence and continuous expansion of the access to Information and Communication Digital technologies (ICDT), there is a demand for new literacy. The author also explains that the term "literacy" seeks to encompass the social uses and practices of language that involve writing in different contexts. Digital literacy, therefore, encompasses reading and writing using ICDT (Soares 2002; Warschauer 2008; Valentini et al. 2013) to develop the skills of rational and critical thinking, creativity, communication, protagonism, cooperation and meaning making.

This first set (sub-class 1a) unfolds and creates the second, in which we can identify the choice of support resources and the physical context organization that the teacher brings to class. The following textual excerpt shows this organization:

> The class will be divided into groups of 4 and 5 persons totaling 6 groups. Each group will be responsible for further development of a type of geometric figure. They will be doing this activity in *Impress* and presenting the slides on the digital board. [02EST2]

In both excerpts, the proposal to use the technology in the pedagogical practice is present in distinct situations. In the first excerpt, the teacher—working at elementary school I—expresses his concerns, chiefly, about his students' digital literacy. The second excerpt suggests that the teacher working at elementary school II, besides having concerns about digital literacy, is also preoccupied about other situations, such as context organization, expansion of a specific issue in the curriculum and the organization of this issue to be presented in the classroom.

Therefore, this set of four sub-themes shows that by performing the proceedings (actions) and/or by establishing/adopting criteria for the choice of the digital teaching material, the teacher also seeks to create conditions/strategies for the development of competencies that the students need to develop, such as reading and writing, together with digital literacy. After this step, the teacher starts to organize the physical context for his class and to choose the support resources that will be used in the presentations of students' assignments.

5 Final Remarks

This article analyzed the potential applications of the articulation between software programs for research in education designed to investigate and analyze qualitative data similarities, namely webQDA and CHIC.

For that, we used the meta-ethnographic approach which allowed for the following: retrieve and define a section in a study conducted within a broader investigation (Almeida 2013; Godoi 2013); reformulate and recreate themes from the strongest clusters of one similarity tree; synthesize and integrate the findings of this study aiming to combine them and identify changes; and, finally, to conceptualize results.

As for the synthesis and findings of this research, what was mostly noticeable in the development of the Contextual Evaluation Plan in the similarity tree was the identification of the teachers' need to establish pedagogical criteria as guidelines for the digital teaching material, as well as the need for them to intervene and organize the context and create the conditions for the development of multiple literacy forms by the students.

As for the conceptualization of the combined use of both software tools, it is important to remember that they are not static and each research requires a suitable way to be conducted depending on the object characteristics, context, data to be analyzed, and the researcher's style.

In this study, the combined use of webQDA and CHIC brought significant contributions for the research development, as described throughout the text. It is possible to infer that the greater gain we obtained in the use of webQDA was to organize the research data, edit the themes and sub-themes and make the questioning flexible, besides enabling us to prepare the data to be used by CHIC to answer the research questions. Having all these possibilities, the use of the two software tools added quality to the study and also saved time as webQDA automates the (re)constructions performed. If we had not used it, we would have had to manually construct all the spreadsheets in Excel and then import them to CHIC. The CHIC software, in turn, allowed for the hierarchical structuring of the set of themes and sub-themes and created a rule-based system, identified the recurrences, exceptions, approximations and distancing, which made it more significant for the study, as opposed to simply compiling the information conveyed by each of these classes represented in the hierarchical tree. Hence, it was possible to make conjectures based on stable representations regarding the meaning of relations depending on the level of hierarchy of the classes.

Finally, as a result, we believe we have contributed to the construction of a referential as to how to use both software tools in combination. Therefore, this use does not imply that these tools should be used separately, but rather, that one software is used to (re)feed the work with the other. Hence, we are certain that other articulations with different software require a movement towards new investigations.

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