Rigor and flexibility in computer-based qualitative research: Introducing the Coding Analysis Toolkit

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ABSTRACT

Software to support qualitative research is both revered and reviled. Over the last few decades, users and skeptics have made competing claims about the utility, usability and ultimate impact of commercial-off-the-shelf (COTS) software packages. This paper provides an overview of the debate and introduces a new web-based Coding Analysis Toolkit (CAT). It argues that knowledgeable, well-designed research using qualitative software is a pathway to increasing rigor and flexibility in research.

Keywords: qualitative research; data analysis software; content analysis; multiple coders; annotation; adjudication; inter-rater reliability; tools

INTRODUCTION

Effective qualitative data analysis plays a critical role in research across a wide range of disciplines. From biomedical, public health, and educational research, to the behavioral, computational, and social sciences, text data analysis requires a set of roughly similar mechanical operations. Many of the mundane tasks, traditionally annotations performed by hand, are tedious and time-consuming, especially with large datasets. Researchers across disciplines with qualitative data analysis problems increasingly turn to commercial-off-the-shelf (COTS) software for solutions. As a result, there is a growing literature on computer-assisted qualitative data analysis software (CAQDAS), with Fielding and Lee's study (1998) serving as an enduring landmark in the canon.

These various COTS packages (eg NVivo, ATLAS.ti, or MAXQDA, to name just a few) evolved from pioneering software development during the 1980s, with the first programs available for widespread public use early 1990s (Bassett 2004). Software tools provide a measure of convenience and efficiency, increasing the overall level of organisation of a qualitative project. Researchers enhance their ability to sort, sift, search, and think through the identifiable patterns as well as idiosyncrasies in large datasets (Richards & Richards 1987; Tallerico 1992; Tesch 1989). Similarities, differences and relationships between passages can be identified, coded and effectively retrieved (Kelle 1997a; Wolfe, Gephart & Johnson 1993). The research routine is substantially altered. In the best cases, more intellectual energy is directed towards the analysis rather than the mechanical tasks of the research process (Conrad & Reinharz 1984; St John & Johnson 2000; Tesch 1989).

The first part of this article summarises the claims associated with using software for qualitative data analysis. Next, we acknowledge the oft-mentioned concerns about the role of software in the qualitative research process. We then introduce a new web-based suite of tools, the Coding Analysis Toolkit (CAT), designed to make mastery of core mechanical functions (eg managing and coding data) as well as advanced projects task (eg measuring inter-rater reliability and adjudication) easier.[1] Finally, we assert that CAQDAS tools are useful for increasing rigor and flexibility in qualitative research. Assuming a user (or team) running a project has a basic level of technical fluency, the requisite research design skills, and domain expertise, coding software opens up important possibilities for implementing and transparently reporting large-scale, systematic studies of qualitative data.

Claims for beneficial effects of software

The ease and efficiency of the computerised 'code-and-retrieve' technique undoubtedly enables researchers to tackle much larger quantities of data (Dolan & Ayland 2001; St John & Johnson 2000). In many projects, a code-and-retrieve technique provides a straightforward data reduction method to cope with data overload (Kelle 2004). For some researchers, simply handling smaller amounts of paper makes the analytical process significantly less cumbersome and tedious (Lee & Fielding 1991; Richards & Richards 1991a). No longer constrained by the capacity of the researcher to retain or find information and ideas, CAQDAS creates possibilities for previously unimaginable analytic scope (Richard & Richards 1991). Furthermore, large sample size in qualitative research allows for better testing of observable implications of researcher hypotheses, paving the way for more rigorous methods and valid inferences (King, Keohane & Verba 2004; Kelle & Laurie 1995).

CAQDAS preserves and arguably enhances avenues for flexibility in the coding process. Code schemes can be easily and quickly altered. New ideas and concepts can be inserted as codes or memos when and where they occur. The raw data remains close by, immediately available for deeper, contextualised investigation (Bassett 2004; Drass 1980; Lee & Fielding 1991; Richards & Richards 1991; St John & Johnson 2000; Tallerico 1992; Tesch 1991a). Exploratory coding schemes can evolve as soon as the first data is collected, providing an opportunity for a more thorough reflection during the data collection process, with consequent redirection if necessary. Coding using CAQDAS, therefore, is a continuous process throughout a project, rather than one stage in a linear research method. It becomes much easier to multi-task, entering new data, coding, and testing assumptions (Bassett 2004; Richards & Richards 1991; Tesch 1989).

Interactivity between different tools and functions within the various software packages provides another key aspect of its flexibility (Lewins & Silver 2007: 10). These features open up new ways of analysing data. Qualitative researchers can apply more sophisticated analytical techniques than previously possible (Pfaffenberger 1988), routinely revealing patterns or counterfactual observations not noticed in earlier analyses. Many software packages enable examination of relationships or links in the data in ways that would not be possible using hypertext links, Boolean searches, automatic coding, cross-match-

1 The second author is the sole inventor of the Coding Analysis Toolkit and has a financial interest in it should it ever be commercialised.

ing coding with demographic data, or frequency counting. Some products go beyond textual data, allowing users to link to pictures, include sounds, and develop graphical representations of models and ideas (St. John & Johnson 2000). Brown (2002, Paragraph 1) sees these benefits as the result of 'digital convergence' that is widely noted in research, media and pop culture domains. Researchers also find CAQDAS uniquely suited to facilitate collaborative projects and other forms of team-based research (Bourdon 2002; Ford, Oberski & Higgins 2000; Lewins & Silver 2007; MacQueen, McLellan, Kay & Milstein 1998; Manderson, Kelaher & Woelz-Stirling 2001; Sin 2007a; St John & Johnson 2000).

Perhaps the most important contribution of CAQDAS is to the quality and transparency of qualitative research. First, CAQDAS helps clarify analytic strategies that formerly represented an implicit folklore of research (Kelle 2004). This in turn increases the 'confirmability' of the results. The analysis is structured and its progress can be recorded as it develops. In making analysis processes more explicit and easier to report, CAQDAS provides a basis for establishing credibility and validity by making available an audit trail that can be scrutinized by external reviewers and consumers of the final product (John & Johnson 2000). Welsh (2002: Paragraph 12) argues that using software can be an important part of increasing the rigor of the analysis process by 'validating (or not) some of the researcher's own impressions of the data.'

In addition to the benefits of transparency via the audit trail just mentioned, the computerised code-and-retrieve model can make the examination of qualitative data more complete and rigorous, enabling researchers and their critics to examine their own assumptions and biases. Segments of data are less likely to be lost or overlooked, and all material coded in a particular way can be retrieved. 'The small but insignificant pieces of information buried within the larger mass of material are more effortlessly located – the deviant case more easily found' (Bassett 2004: 34). Since the data is methodically coded, CAQDAS helps with the systematic use of all the available evidence. Researchers are better able to locate evidence and counter-evidence, in contrast to the level difficulty performing similar tasks when using a paper-based system of data organisation. This can, in turn, reduce the temptation to propose far-reaching theoretical assumptions based on quickly and arbitrarily collected quotations from the materials (Kelle 2004).

CAQDAS can also be utilised to produce quantitative data and to leverage statistical analysis programs such as SPSS. For many researchers new to qualitative work or for those seeking to publish in journals typically averse to qualitative studies, there is significant value in the ability to add quantitative parameters to generalisations made in analysis (Gibbs, Friese & Mangabeira 2002). For other researchers – especially those working in applied, mixed method, scientific and evaluation settings – the ability to link qualitative analysis with quantitative and statistical results is important (Gibbs et al 2002). In these instances, CAQDAS enables the use of multiple coders and periodic checks of inter-coder reliability, validity, conformability and typicality of text (Berends & Johnston 2005; Bourdon 2000; Kelle & Laurie 1995; Northey 1997).

Another important contribution of CAQDAS results from the capability of improving rigorous analysis. Computerised qualitative data analysis, when grounded in the data itself, good theory, and appropriate research design, is often more readily accepted as 'legitimate' research (Richards & Richards 1991: 39). Qualitative research is routinely defined negatively in relation to quantitative research as the 'non-quantitative' handling of 'unstructured' data (Bassett 2004). This negative definition conveys a sense of lower or inferior status, with a specific reputation for untrustworthy results supported by cherry-picked anecdotes. Computerised qualitative data analysis provides a clear pathway to rigorous, defensible, scientific and externally legitimised qualitative research via transparency that the qualitative method traditionally lacks (Kelle 1997a; Richards & Richards 1991; Tesch 1989; Webb 1999; Weitzman 1999; Welsh 2002).

Some cautionary notes

The impact of CAQDAS on research is extensive and diverse. For some, however, such effects are not always desirable. The enhanced capability of dealing with a large sample may mislead researchers to focus on raw quantity (a kind of frequency bias) instead of meaning, whether frequent or not (Mangabeira 1995; Seidel 1991; St John & Johnson 2000). There exist very legitimate fears of being distant or de-contextualised from the data (Barry 1998; Fielding & Lee 1998; Sandelowski 1995; Seidel 1991).

Mastering CAQDAS itself can be a distraction. Many researchers complain they have to invest too much time (and often money) learning to use and conform to the design choices of a particular software package. It has been noted that new users encounter usability frustration, even despair and hopelessness, along the way to CAQDAS fluency or completed project, if they ever get there (St John & Johnson 2000). Closing the quantitative–qualitative gap via computer use threatens the sense shared by many about the distinctive nature of qualitative research (Gibbs et al 2002; Richards & Richards 1991a; Bassett 2004).

Of particular concern is a widespread notion that grounded theory is literally embedded in the architecture of qualitative data analysis software (Bong 2002; Coffey, Holbrook & Atkinson 1996; Hinchliffe et al 1997; Lonkila 1995; MacMillan & Koenig 2004; Ragin & Becker 1989). This is linked conceptually to an overemphasis on the code-and-retrieve approach (Richards & Richards 1991a; Tallerico 1992). At issue is the homogenising of qualitative methodology. In this sense, CAQDAS may come to define and structure the methodologies it should merely support, presupposing a particular way of doing research (Agar 1991; Hinchliffe et al 1997; MacMillan & Koenig 2004; Ragin & Becker 1989; Richards 1996; St John & Johnson 2000; Webb 1999).

The debates are ongoing. Previous studies suggest that the structure of individual software programs can influence research results (Mangabeira 1995; Pfaffenberger 1988; Richards & Richards 1991c; Seidel 1991). We join others who acknowledge the paramount role held by the free will of the human as computer-user and active, indeed dominant, agent in the analytic process (Roberts & Wilson 2002; Thompson 2002; Welsh 2002). Researchers can and should be vigilant, recognising that they have control over their particular use of the software (Bassett 2004).

The remainder of this paper introduces a new system, the Coding Analysis Toolkit, which is part of an effort at the University of Pittsburgh to enhance both the rigor and flexibility of qualitative research. The CAT system aims to make simple, usable, online coding tools easily accessible to students, researchers and others with large text datasets.

The Coding Analysis Toolkit

The origin of the Coding Analysis Toolkit

Accurate and reliable coding using computers is central to the content analysis process. For new and experienced researchers, learning advanced project management skills adds hours of struggle during trial-and-error sessions. Our approach is premised on the idea that experienced coders and project managers can deliver coded data in a timely and expert manner. For this reason, the Qualitative Data Analysis Program (QDAP) was created as a program initiative at the University of Pittsburgh's University Center for Social and Urban Research (UCSUR). QDAP offers a rigorous, university-based approach to analysing text and managing coding projects.

QDAP adopted the analytic tool ATLAS.ti (http://www.atlasti.com), one of the leading commercial CAQDAS for analysing textual, graphical, audio and video data. It is a powerful and widely-used program that supports project management, enables multiple coders to collaborate on a single project, and generates output that facilitates effective analysis. However, as a frequent and high volume user of ATLAS.ti (eg more than 5,000 billable hours of coding took place in the QDAP lab this year), certain limitations stand out.

First, ATLAS.ti users perform many repetitive tasks using a mouse. The click-drag-release sequence can be physically numbing and is prone to error. It decreases the efficiency of our large dataset annotation projects and represents a distraction from the core code-and-retrieve method. Most COTS packages in fact share this awkward design principle. Coders must first manually retrieve a span of text (click-drag-release) and then code it (another click-drag-release) for later retrieval; hence a more accurate description of much of the COTS software is as *retrieve*-code-retrieve and not code-and-retrieve.

Second, ATLAS.ti lacks an easy mechanism to measure and report inter-coder reliability and validity. Clients of QDAP point to their need to make these measures operational in their grant proposals and peer-reviewed studies. ATLAS.ti provides limited technical support for the adjudication procedures that often follow a multi-coder pre-test. There are other software applications for calculating inter-coder reliability based on merged and exported ATLAS-coded data; however, each of these programs rather inconveniently has its own requirements regarding data formatting (Lombard, Snyder-Duch & Bracken 2005), raising concern that researchers may be forced to choose some fixed procedure that can easily accommodate further to use the particular tool.

Key functionality of the Coding Analysis Toolkit

In order to address these problems, QDAP developed the Coding Analysis Toolkit (CAT) (http://cat.ucsur.pitt.edu) as a complement to ATLAS.ti. This web-based system consists of a suite of tools custom built from the ground up to facilitate efficient and effective analysis of raw text data or text datasets that have been coded using the ATLAS.ti. The website and database are hosted on a Windows 2003 UCSUR server; the programming for the interface is done using HTML, ASP.net 2.0 and JavaScript. The aims of the CAT are to serve as a functional complement and extension to the existing functionality in ATLAS.ti, to open new avenues for researchers interested in measuring and accurately reporting coder validity and reliability, to streamline the consensus-based adjudication procedures, and to encourage new strategies for data analysis in ways that prove difficult when performed during the traditional mechanical method of doing qualitative research. The following sub-sections summarize the primary functionality and the breakthroughs made within the CAT system.

Data format requirement

The CAT system provides two types of work modes. The first mode uploads exported coded results from ATLAS.ti into the system for using *Comparison Tools* and *Validation and Adjudication Module*. In this case, the CAT system functions as a complement or extension to ATLAS.ti. The second mode allows users to upload a raw, uncoded data file and an optional code file with a .zip file, an xml-based file or a plain-text file. Then, the assigned sub-account holder(s) can directly utilise the *Coding Module* to perform annotation tasks. In this situation, CAT replaces the coding function in ATLAS.ti. With CAT, users have more flexible options when adopting analytic strategies than they do when using ATLAS.ti alone.

Dynamic coder management

Users need to register accounts first and then log on to access CAT. The system also allows users to assign additional sub-accounts to their coders for practicing coding and adjudication procedures. Due to its web-based nature, project managers can quickly and readily trace the coding progress and monitor its quality. It thus offers a collaborative workbench and facilitates efficient multiple-coder management.

Coding module

In CAT's internal *Coding Module*, a project manager, who registers as the primary account holder, has the ability to upload raw text datasets with an optional code file and has coders with sub-accounts to code these datasets directly through the CAT interface. This *Coding Module* features automated loading of discrete quotations (ie one quotation at a time in a view) and requires only keystrokes on the number pad to apply the codes to the text. It eliminates the role of the computer mouse, thereby streamlining the physical and mental tasks in the coding analysis process. We estimate coding tasks using CAT are completed two to three times faster than identical coding tasks conducted using ATLAS.ti. It also allows coders to add memos during coding. While this high-speed 'mouse-less' coding module would poorly serve many traditional qualitative research approaches (where the features of ATLAS.ti are very well-suited), it is ideally suited to annotation tasks routinely generated by computer scientists and a range of other health and social science researchers using large-scale content analysis as part of a mixed methods approach. Figure 1 shows the *Coding Module* interface.

Comparison tools

The *Comparison Tools* comprise two components: *Standard Comparison* and *Code-by-Code Comparison*. For the *Standard Comparison,* the CAT system has taken the 'Kappa Tool' developed by Namhee Kwon at the University of Southern California – Information Sciences Institute (USC/ISI) and significantly expanded its functionality. Users can run comparisons of inter-coder reliability measures using Fleiss' Kappa or Krippendorff's Alpha (shown as Figure 2). A user can also choose to perform a code-by-code comparison of the data, revealing tables of quotations where coders agree, disagree, or (in the case of ATLAS.ti users) overlap their text span selections. Users can choose to view the data reports on the screen or, alternatively, can download the data file as a rich-text file (.rtf).

Validation and adjudication module

CAT's other core functionality allows for the adjudication of coded items by an 'expert' user who is a primary account holder or by a sub-

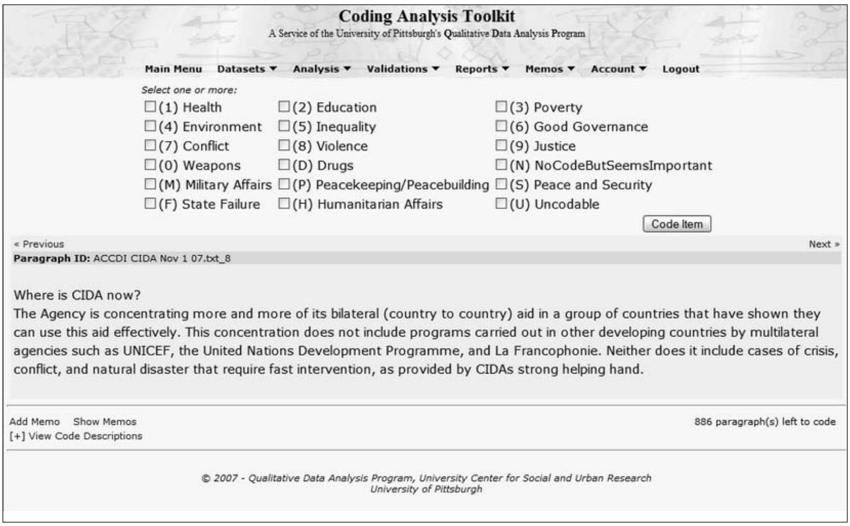
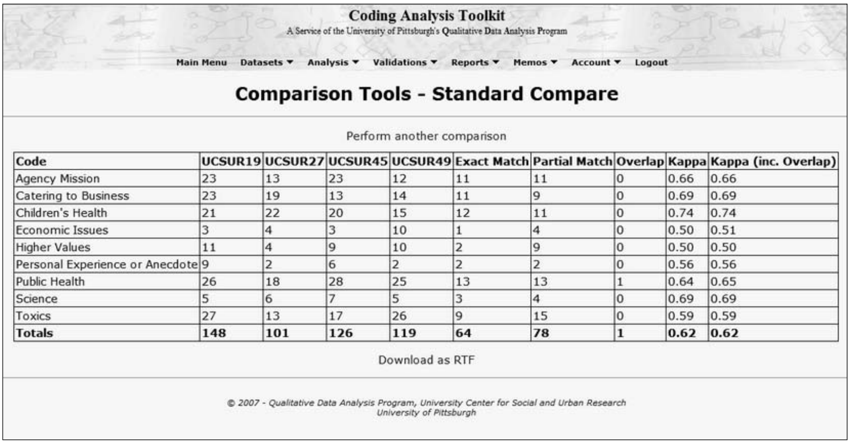


FIGURE 1: THE CODING MODULE INTERFACE



Code	UCSUR19	UCSUR27	UCSUR45	UCSUR49	Exact Match	Partial Match	Overlap	Kappa	Kappa (inc. Overlap)
Agency Mission	23	13	23	12	11	11	0	0.66	0.66
Catering to Business	23	19	13	14	11	9	0	0.69	0.69
Children's Health	21	22	20	15	12	11	0	0.74	0.74
Economic Issues	3	4	3	10	1	4	0	0.50	0.51
Higher Values	11	4	9	10	2	9	0	0.50	0.50
Personal Experience or Anecdote	9	2	6	2	2	2	0	0.56	0.56
Public Health	26	18	28	25	13	13	1	0.64	0.65
Science	5	6	7	5	3	4	0	0.69	0.69
Toxics	27	13	17	26	9	15	0	0.59	0.59
Totals	**148**	**101**	**126**	**119**	**64**	**78**	**1**	**0.62**	**0.62**

FIGURE 2: STANDARD COMPARISON ON A SAMPLE DATASET

account holder attached to the primary account holder. An expert user (or a consensus adjudication team) can log onto the system to validate the codes assigned to items in a dataset. Figure 3 shows the interface of the validation function, which, just like the *Coding Module*, was also designed to use keystrokes and automation to clarify and speed-up the validation or consensus adjudication process. Using the keystrokes 1 or 3 (or Y or N), the adjudicator or consensus team reviews, one at a time, every quotation in a coded dataset. While the expert user validates codes, the system keeps track of valid instances of a particular code and notes which coders assigned those codes. This information provides a track record of coders, assessing coder validity over time. If two or more coders applied the same code to the same quotation, the database records the valid/invalid decision for all the coders. It also allows the account holder(s) to see a rank order list of the coders most likely to produce valid observations and a report the overall validity scores by code, coder, or entire project (shown as Figure 4), resulting in a 'clean' dataset consisting of only valid observations (shown as Figure 5).

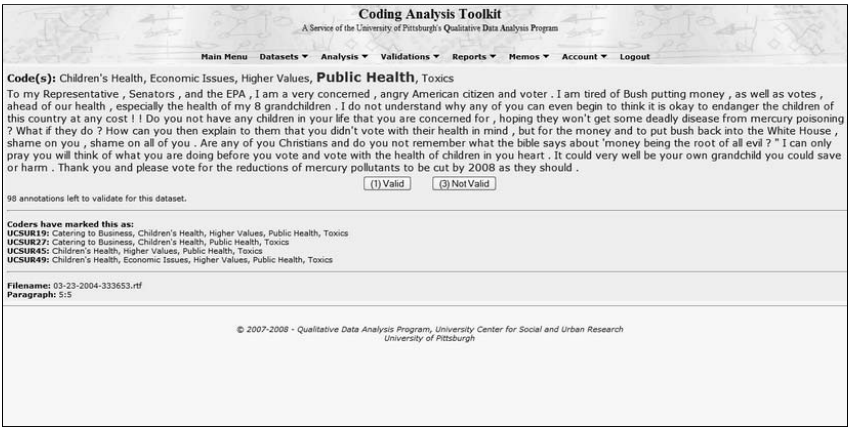
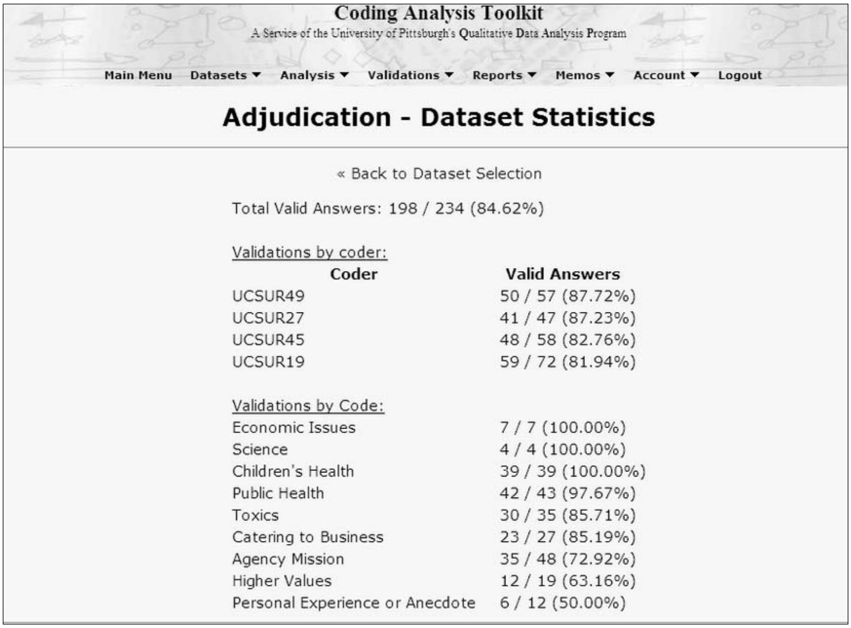


FIGURE 3: THE VALIDATION AND ADJUDICATION MODULE INTERFACE



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Main Menu | Datasets ▼ | Analysis ▼ | Validations ▼ | Reports ▼ | Memos ▼ | Account ▼ | Logout

Adjudication - Dataset Statistics

« Back to Dataset Selection

Total Valid Answers: 198 / 234 (84.62%)

Validations by coder:

Coder	Valid Answers
UCSUR49	50 / 57 (87.72%)
UCSUR27	41 / 47 (87.23%)
UCSUR45	48 / 58 (82.76%)
UCSUR19	59 / 72 (81.94%)

Validations by Code:

Economic Issues	7 / 7 (100.00%)
Science	4 / 4 (100.00%)
Children's Health	39 / 39 (100.00%)
Public Health	42 / 43 (97.67%)
Toxics	30 / 35 (85.71%)
Catering to Business	23 / 27 (85.19%)
Agency Mission	35 / 48 (72.92%)
Higher Values	12 / 19 (63.16%)
Personal Experience or Anecdote	6 / 12 (50.00%)

FIGURE 4: ADJUDICATION STATISTICS REPORT

DISCUSSION

This section further discusses how users can apply inter-coder agreement outputs and adjudication procedures to reinforce the rigor of research and utilise the multiple approaches offered by CAT to enhance the flexibility of coding and analysing procedures.

Inter-coder agreement measures support rather than define rigor

Criticism about the rigor of qualitative research has a long history. Ryan (1999) points out those skeptics tend to ask qualitative inquiries two questions:

> 'To what degree do the examples represent the data the investigator collected?' and
>
> 'To what degree do they represent the construct(s) that the investigator is trying to describe?'

Both questions focus specially on investigators' synthesis and presentation of qualitative data and are related to issues of reliability and validity of research.

For many years, some investigators have advocated 'the use of multiple coders to better link abstract concepts with empirical data' (Ryan 1999: 313) and to thus be able to effectively address such suspicion (Carmines and Zeller 1982; Miles and Huberman 1994). Multi-coder agreement is also beneficial for text retrieval tasks, especially when the dataset is large. An investigator who uses a single coder to mark themes relies on the coder's ability to accurately and consistently identify examples. 'Having multiple coders mark a text increases the likelihood of finding all the examples in a text that pertain to a given theme' (Ryan 1999: 319). It helps build up reliability of the analysis process. Recognising the benefits multiple coders use as a means to increase rigor and to enhance the quality of qualitative research, QDAP currently adopts this approach.

Ryan (1999) summarises that multi-coder agreement serves three basic functions in the analysis of text. First, it helps researchers verify reliability. Agreement between coders tells investigators the degree to which coders can be treated as 'reliable' measurement instruments. High degrees of multi-coder reliability mean that multiple coders apply the codes in the same manner, thus acting as reliable measurement instruments. Multi-coder reliability proves particularly important if the coded data will be analyzed statistically. If coders disagree on the coding decision with each other, then the coded data are inaccurate. Discrepancies between coders are considered error and affect analysis calculations (Ryan 1999: 319).

Second, multi-coder agreement can also function as the validity measure for the coded data, demonstrating that multiple coders can pick the same text as pertaining to a theme. This provides evidence that 'a theme has external validity and is not just a figment of the primary investigator's imagination' (Ryan 1999: 320). CAT users can obtain reliability measures to serve the two previously discussed functions through the *Comparison Tools* (shown as Figure 2).

The last function of multi-coder agreement provides evidence of typicality. It can help researchers identify the themes within data. Ryan (1999) notes 'with only two coders the typicality of responses pertaining to any theme is difficult to assess'. A better way to check typicality of responses is to use more than two coders; in this case, we assume that the more coders who identify words and phrases as pertaining to a given theme, the more representative the text. Therefore, agreement among coders demonstrates the core features of a theme. Some may argue that these core features represent the central tendency or typical examples of abstract constructs.

On the contrary, the disagreement highlights the theme's peripheral features, representing the 'edges' of the theme (Ryan 1999). They are seen as marginal examples of the construct. They may be less typical, but are not necessarily unimportant. Within CAT, users can acquire both central tendency and marginal information on the coded data through *Dataset Reports*, which list the quotations by each code and are tagged with the coder ID. Figure 5 shows the report of a sample dataset. In this case, the four coders all annotated the second quotation as the code name of 'economic issues,' which indicates this quotation is commonly identified as the same theme or key concept, while the first and the fifth quotations are coded by only one coder; the investigator may need to consider how to handle these peripheral features in his or her analyses.

There are at least three moments in which Lombard, Snyder-Duch & Bracken (2005) suggest doing an assessment of inter-coder reliability:

1. During coder training: Following instrument design and preliminary coder training, project managers can initially assess reliability informally with a small number of units, which ideally are not part of the full sample

Annotations for Code: Economic Issues

(1 coder: UCSUR49)
a public health standpoint , the EPA's new policy is a disaster . But for Bush's energy industry allies , who are responsible for most mercury pollution , it's yet another bonanza . Increased pollution levels will allow these companies to save millions , while their top managers keep writing big campaign checks to support George W . Bush--it's a pretty sick cycle

(4 coders: UCSUR19, UCSUR27, UCSUR45, UCSUR49)
Businesses CAN afford to implement stronger controls and still make a profit (AND not pass on huge costs to the consumer) ! I know it , Bush knows it , and the affected companies know it . It's the nature of business to look for ways to cut costs . It's the role of all of us to inform them that the greater benefits of improving the environment outweigh than the cost of implementing these control measure , and represent a tremendously greater benefit than preserving the billion dollar CEO salaries of a few ! (I say oust them - they are tainted by greed and they are sacrificing our children's future for a paycheck

(2 coders: UCSUR19, UCSUR27)
From a public health standpoint , the EPA's new policy is a disaster . But for Bush's energy industry allies , who are responsible for most mercury pollution , it's yet another bonanza . Increased pollution levels will allow these companies to save millions , while their top managers keep writing big campaign checks to support George W . Bush--it's a pretty sick cycle

(2 coders: UCSUR27, UCSUR45)
In the 1980s Florida authorities , finding intolerable levels of mercury already present in the flesh of fresh water fish , had to issue a ban on eating such fish . This caused great hardship for the many Floridians for whom the fish they caught provided their major subsistance

(1 coder: UCSUR49)
It is a disgrace that in such enlightened times , there should be any question at all about mercury emissions . . . . this country belongs to all of its citizens ; it is not a toy for profit , to gorge the gullets of the special-interest groups . As an agency for the American people , as you used to be , it is imperative for all of us , that you do not allow this disgraceful situation to continue . . . . . . Mercury emissions and effluviums have caused hideous deformities , mental retardation and other deficiencies , and mutations , within a quantity of the Japanese public , and it has been clear for a long while , here in the US , that birth defects , attention deficit disorder , socially serious misbehaviors due to brain changes , and seizures , and other such horrible physical conditions can be directly attributable to mercury . There are many area of the country now , where these conditions are horrific , ----though they are often silent , and unrecognized for what they are , thanks to the interest of a select few , who have the ability to keep these situations from being aired to the general public . . We urge you to do what you were intended to do , and protect this county from the greedy , and prolific ! , profiteers

FIGURE 5: CODED DATASET REPORT

of units to be coded, refining the coding scheme or coding instruction until the informal assessment reveals an adequate level of agreement.
2. During a pilot test: Investigators can use a random or other justifiable procedure to select a representative sample of units for a pilot test of inter/multi-coder reliability. If reliability levels in the pilot test are adequate, proceed to the full sample; if they are not adequate, conduct additional training, refine the code book, and, only in extreme cases, replace one or more coders.
3. During coding of the full sample: When confident that reliability levels will be adequate (based on the results of the pilot test of reliability); investigators can assess the reliability by using another representative sample to assess reliability for the full sample to be coded. The reliability levels obtained in this test can be the ones to be presented in all reports of the project.

In a traditional way, these assessments might be carried out once for each moment through the linear time, or only one time for the whole coding process, most likely during coder training or in pilot study before starting to code the full sample. With CAT, the reliability assessment can be easily and quickly obtained at any time. The coding tasks become a dynamic and circular process, allowing the investigators intimate control over the analytic courses.

Adjudication procedures for supporting rigor

The CAT system provides a flexible framework to practice adjudication of coded data. The flexibility of assigning sub-accounts holders in CAT allows a user to choose the way of arranging the adjudication strategy depending on his/her own human resources. The following three conditions can all be served:

1. an investigator can assign the coding tasks to coders and he/she does the coded data adjudication when he/she is the only investigator in the project;
2. when the condition is a collaborated project involving one primary investigator and other co-investigators, parts of the research team can do the coding tasks while the other parts take responsibility of adjudication;
3. investigator(s) participate in coding and have an external party serve as the expert adjudicator(s). This third condition can also be seen as part of the auditing process, which can add to the 'confirmability' (or 'objectivity' in conventional criteria) of qualitative research.

Multiple approaches for supporting flexibility

Rather than imposing a fixed working procedure on users, we expect researchers using CAT to maintain their free will. The decision of using all or certain aspects of the available functionality depends on the researchers' judgment according to the nature of their studies. We encourage qualitative researchers to keep a critical perspective on CAQDAS use and, more importantly, to use it in a flexible and creative way. CAT, as a flexible and dynamic workbench, supports multiple approaches in qualitative research:

- It can be used as a complementary tool to ATLAS.ti or as a tool supporting the whole coding and adjudicating and output analysing process.
- It supports a solo-coder work mode or a multiple-coder teamwork mode.
- It allows adjudication procedures carried out by one expert adjudicator or a consensus team.
- It helps to blend quantitative contributions into quantitative analysis – researchers can choose to report texts with qualitative interpretation alone, or researchers can report high or low frequency statistics of coded data as an evidence of central tendency and/or a theme's peripheral features.

Based on this section's discussion of CAT as a tool to enhance qualitative research rigor and flexibility, we may argue that the CAT system, in fact, increases 'closeness to data.' Countering the concerns that researchers will become distance from the data due to computer use, CAT's convenience and flexibility encourages users to 'play' with their data, and to examine data from different angles.

Next steps

Drawing on the rich experiences of qualitative projects implementation and collaborating with clients across disciplines, QDAP has developed rich resource bases to determine the real needs of analysts. The features within CAT are based on a user-centered design. During CAT's development, special attention has been paid to the effectiveness of functionality and to the needs for an easy-to-use and instinctive interface that directly influences the efficiency of the workflow and the user experience. We expect that the CAT system will not only extend but effectively alter the existing practice. In order to verify the potential positive impacts of CAT and to detect problems in its functionality and interface, evaluations are included in our research plan. Therefore, the next step will be to conduct a usability and impact study. Systematic user feedback will be gathered via a beta tester web survey in April 2008 and will shape the future development of CAT. At the same time, QDAP continues to extend the capabilities of CAT. Its reliability as software may prove sufficiently robust enough to merit commercial licensing before the close of 2008.

References

Agar M (1991). The right brain strikes back. In NG Fielding and RM Lee (Eds.), *Using Computers in Qualitative Research* (pp. 181–193). London: Sage.

Barry CA (1998). Choosing qualitative data analysis software: Atlas.ti and Nudist compared. *Sociological Research Online, 3.* Retrieved 30 January 2008, from http://www.socresonline.org.uk/socresonline/3/3/4.html.

Bassett, R. (2004). Qualitative data analysis software: Addressing the debates. *Journal of Management Systems,* XVI: 33–39.

Berends L and Johnston J (2005). Using multiple coders to enhance qualitative analysis: The case of interviews with consumers of drug treatment. *Addiction Research & Theory,* 13: 373–382.

Bong SA (2002). Debunking myths in qualitative data analysis. *Forum of Qualitative Social Research,* 3. Retrieved 30 January 2008, from http://www.qualitative-research.net/fqs-texte/2-02/2-02bong-e.htm.

Bourdon S (2002) The integration of qualitative data analysis software in research strategies: Resistances and possibilities. *Forum Qualitative Sozialforschung*, 3(2). Retrieved 30 January 2008 from www.qualitative-research.net/fqs-texte/2-02/2-02bourdon-e.htm

Brown D (2002) Going digital and staying qualitative: Some alternative strategies for digitizing the qualitative research process. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research* [On-line Journal], 3(2). Retrieved 30 January 2008, from http://www.qualitative-research.net/fqs-texte/2-02/2-02brown-e.htm.

Coffey A, Holbrook B and Atkinson P (1996) Qualitative data analysis: technologies and representations. *Sociological Research Online*, 1(1). Retrieved 30 January 2008, from http://www.soc.surrey.ac.uk/socresonline/1/1/4.html.

Conrad P and Reinharz S (1984) Computers and qualitative data: Editor's introductory essay. *Qualitative Sociology,* 7: 3–13.

Dolan A and Ayland C (2001). Analysis on trial. *International Journal of Market Research,* 43*:* 377–389.

Drass KA (1980) The Analysis of Qualitative Data: A Computer Program. *Urban Life,* 9: 332–353.

Fielding NG and Lee RM (1998) *Computer Analysis and Qualitative Research: New technology for social research*. London: Sage.

Ford K, Oberski I and Higgins S (2000) Computer-aided qualitative analysis of interview data: Some recommendations for collaborative working. *The Qualitative Report,* 4 (3, 4).

Gibbs GR, Friese S and Mangabeira WC (2002) The use of new technology in qualitative research. Introduction to Issue 3(2) of FQS. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 3(2).* Retrieved 30 January 2008, from http://www.qualitative-research.net/fqs-texte/2-02/2-02hrfsg-e.htm.

Hinchliffe SJ, Crang MA, Reimer SM and Hudson AC (1997) Software for qualitative research: 2. Some thoughts on 'aiding' analysis. *Environment and Planning A,* 29, 1109–1124.

Kelle U and Laurie H (1995) Computer use in qualitative research and issues of validity. In U. Kelle (Ed.) *Computer-aided Qualitative Data Analysis: Theory, methods and practice* (pp.19–28). London/Thousand Oaks/New Delhi: Sage.

Kelle U (1997a) Theory building in qualitative research and computer programs for the management of textual data. *Sociological Research Online*, 2(2).

Kelle U (2004) Computer-assisted qualitative data analysis. In C. Seale, G. Gobo, J. F. Gubrium, and D. Silverman (Eds.), *Qualitative Research Practice* (pp. 473–489). London: Sage.

King G, Keohane R and Verba S (1994) *Designing Social Inquiry: Scientific Inference in Qualitative Research* Princeton, NJ: Princeton University Press.

Lee RM and Fielding NG (1991) Computing for qualitative research: Options, problems and potential. In N. G. Fielding & R. M. Lee (Eds.), *Using Computers in Qualitative Research* (pp. 1–13). London: Sage.

Lewins A and Silver C (2007) *Using Software in Qualitative Research: A step-by-step guide.* London: Sage.

Lombard M, Snyder-Duch J and Bracken CC (2005) Practical resources for assessing and reporting intercoder reliability in content analysis research projects. Retrieved 17 March 2008, from http://www.temple.edu/sct/mmc/reliability/.

Lonkila M (1995) Grounded theory as an emerging paradigm for computer-assisted qualitative data analysis. In U. Kelle (Ed.), *Computer-Aided Qualitative Data Analysis. Theory, Methods and Practice* (pp.41–51). London: Sage.

MacMillan K and Koenig T (2004) The wow factor: Preconceptions and expectations for data analysis software in qualitative research. *Social Science Computer Review,* 22: 179–186.

MacQueen KM, McLellan E, Kay K and Milstein B (1998) Codebook development for team-based qualitative analysis. *Cultural Anthropology Methods,* 10: 31–36.

Manderson L, Kelaher M and Woelz-Stirling N (2001). Developing qualitative databases for multiple users. *Qualitative Health Research,* 11: 149–160.

Mangabeira W (1995) Computer assistance, qualitative analysis and model building. In R. M. Lee (Ed.), *Information Technology for the Social Scientist* (pp 129–146). London: UCL Press.

Northey Jr, W F. (1997) Using QSR NUD*IST to demonstrate confirmability in qualitative research. *Family Science Review,* 10: 170–179.

Pfaffenberger B (1988) *Microcomputer Applications in Qualitative Research*. Newbury Park, CA: Sage.

Ragin CC and Becker HS (1989) How the microcomputer is changing our analytical habits. In G Blank, JL McCartney and E Brent (Eds.), *New Technology in Sociology* (pp. 47–55). New Brunswick NJ: Transaction Publishers.

Richards L and Richards T (1991a) The transformation of qualitative method: Computational paradigms and research processes. In NG Fielding and RM Lee (Eds.), *Using Computers in Qualitative Research* (pp.38–53). London: Sage.

Richards L and Richards TJ (1987) Qualitative data analysis: Can computers do it? *Australia and New Zealand Journal of Sociology,* 23*:* 23–35.

Roberts KA and Wilson RW (2002) ICT and the research process: Issues around the compatibility of technology with qualitative data analysis. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, *3*(2). Retrieved 30 January 2008, from http://www.qualitative-research.net/fqs-texte/2-02/2-02robertswilson-e.htm.

Ryan G (1999) Measuring the typicality of text: Using multiple coders for more than just reliability and validity checks. *Human Organization,* 58: 313–322.

Sandelowski, M. (1995). On the aesthetics of qualitative research. *Image: Journal of Nursing Scholarship*, 27: 205–209.

Seidel J (1991) Method and madness in the application of computer technology to qualitative data analysis. In NG Fielding and RM Lee (Eds.), *Using Computers in Qualitative Research.* (pp. 107–116). London: Sage.

Sin CH (2007a) Teamwork involving qualitative data analysis software: Striking a balance between research ideals and pragmatics. *Social Science Computer Review* accessed 13 May 2008 from http://ssc.sagepub.com/cgi/rapidpdf/0894439306289033v1.pdf.

St John W and Johnson P (2000). The pros and cons of data analysis software for qualitative research. *Journal of Nursing Scholarship,* 32: 393–397.

Tallerico M (1992) Computer technology for qualitative research: Hope and humbug. *Journal of Educational Administration,* 30: 32–40.

Tesch R (1989) Computer software and qualitative analysis: A reassessment. In G Blank, JL McCartney and E Brent (Eds.), *New Technology in Sociology* (pp. 141–154). New Brunswick NJ: Transaction Publishers.

Tesch R (1991a) Introduction. *Qualitative Sociology, 14:* 225–243.

Thompson R (2002) Reporting the results of computer-assisted analysis of qualitative research data. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, *3*(2). Retrieved 30 January 2008, from http://www.qualitative-research.net/fqs-texte/2-02/2-02thompson-e.htm

Webb C (1999) Analyzing qualitative data: Computerised and other approaches. *Journal of Advanced Nursing,* 29: 323–330.

Weitzman EA (1999) Analyzing qualitative data with computer software. *Health Services Research: Part 2,* 34: 1241–1263.

Welsh E (2002) Dealing with data: Using NVivo in the qualitative data analysis process. *Forum: Qualitative Social Research, 3(2).* Retrieved 30 January 2008, from http://www.qualitative-research.net/fqs-texte/2-02/2-02welsh-e.htm

Wolfe RA, Gephart RP and Johnson TE (1993) Computer-facilitated qualitative data analysis: Potential contributions to management research. *Journal of Management* 19: 637–660.

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