



Research Memorandum

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Question-Based Reports for Policymakers

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Abstract

Score reports for administrators are often presented in ways that are not easily interpretable by these stakeholders. In order to design score reports for this audience, it is important to understand how policy is implemented at the local level and how administrators make use of achievement data to inform their decisions. We have reviewed existing literature on how policymakers use assessment data for decision making and designed initial score-report prototypes taking into account the questions these stakeholders want answered according to their responsibilities. The score reports were developed for the Cognitively Based Assessment of, for, and as Learning (CBAL) project. This paper describes a question-based reporting system designed for administrators, reports on the results of a usability study conducted with seven administrators, summarizes recommendations provided by a group of experts, and describes future work.

Key words: score reports for administrators, achievement data, decision making, question-based reporting system, usability study

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Table of Contents

Related Research.....	6
A Question-Based Reporting System	8
Method	15
Participants.....	16
Results.....	17
Expert Review.....	17
Summary and Future Work.....	18
References.....	19
Appendix.....	21

List of Figures

Figure 1. What are the results for my district for the 8th grade tests in all subjects? (Part 1).....	10
Figure 2. What are the results for my district for the 8th grade tests in all subjects? (Part 2).....	12
Figure 3. What are the results for my district for the 8th grade tests in all subjects? (Part 3).....	13
Figure 4. How did all subgroups in my district perform on the reading tests? (Partial score report image).	14
Figure 5. List of available report links for administrators	15

Related Research

Several researchers have studied how administrators make use of achievement data to inform their decisions. According to Honig and Coburn (2008), administrators increasingly face demands to use “evidence” in their decision making. However, due to the complexity of their responsibilities, they do not always make decisions based on sound evidence. Mac Iver and Farley (2003) report that administrators experience demands from various sources, forcing them to ignore certain demands, accommodate others, and reinterpret others.

A review of the literature identified seven types of responsibilities for administrators (Underwood, Zapata-Rivera, & VanWinkle, 2010): school improvement plans (Honig, 2003; Honig & Coburn, 2008; Miller, 2003; Wayman, Midgley, & Stringfield, 2005), professional development (Brunner et al., 2005; Coburn, Toure, & Yamashita, 2009; Honig & Coburn, 2008; Mac Iver & Farley, 2003), program selection and evaluation (Brunner et al., 2005; Coburn & Talbert, 2005; Guerard, 2001; Honig, 2003; Honig & Coburn, 2008), curriculum selection (Coburn et al., 2009; Honig & Coburn, 2008; Mac Iver & Farley, 2003), improvement of student achievement (Coburn & Talbert, 2005), communication (Chen, Heritage, & Lee, 2005) and staff allocation (Honig & Coburn, 2008). Based on these responsibilities, an evidence-based reporting framework aimed at producing score reports that facilitate administrators’ decision making was proposed (Underwood et al., 2010).

Administrators have difficulty making sense of information presented on score reports. Hambleton and Slater (1997) found that misunderstanding and misinterpretations in reading NAEP reports were common among stakeholders. Participants in this study included state department of education attorneys, directors of companies, state politicians, superintendents, education reporters, and directors of public relations. Factors contributing to these misunderstandings for these stakeholders are hypothesized to be: limited prior experience with NAEP, unfamiliarity with reporting scale(s), limited knowledge of statistics (and statistical terms), and limited time. Recommendations included: (a) simplify the score reports, (b) field test score reports with the intended audience(s), and (c) tailor the score report content and displays for the intended audiences.

Data-driven decision-making (D3M) systems are being used by many teachers, principals and district administrators to produce different types of score reports (e.g., Guerard, 2001). D3M systems store data and allow the user to analyze the data in order to make different decisions.

These systems require users to understand the structure of the data and make appropriate selections to generate score reports. Wayman (2005) states that although computer-based tools are important, additional support should be provided to teachers in the form of professional development, leadership for a supportive data climate, and collaboration among educators to learn about effective ways of using data.

Previous research showed that although some of these D3M systems provide tools for advanced and beginning users, they usually do not offer support for the interpretation and appropriate use of the data (Snipes, Doolittle, & Herlihy, 2002; Underwood, Zapata-Rivera, & VanWinkle, 2010; Wayman et al., 2005). We have proposed a question-based approach to interacting with score report information. In this approach, questions that administrators may ask about student performance data are used to guide their interaction with the score report prototypes (Underwood et al., 2010).

Related research also includes work on principles and heuristics for developing score reports (e.g. Goodman & Hambleton, 2004; Hattie, 2009). Work by Mayer (2001) on principles for developing effective multimedia applications is also relevant. We have implemented many of these recommendations in our score reports for administrators.

Several score report design principles were used to create the score report prototypes presented in this paper. Some instances include:

Present relevant information (Hattie, 2009; Mayer, 2001). Each page (section) of the score report responds to a particular question that is of interest to the teacher. Only the information needed to respond to the question is presented on the screen. Additional information is available through links (e.g., explanations and sample tasks).

- Minimize scrolling (Hattie, 2009). Instead of scrolling to each section of the report, teachers use the navigation pane on the left, or the next and back buttons at the top of each screen.
- Use color in a purposeful way (Hattie, 2009). This can be seen in the choice of colors for the interface components and the colors used to show performance levels (i.e., red indicates there is a problem, yellow represents a warning, and green shows no problem; go).

- The order of presentation from general to detailed information with the most important information presented first (Goodman & Hambleton, 2004; Hattie, 2009).
- Use various representations (Mayer, 2001). Information such as the performance levels and percent of students performing at each level is presented both textually and graphically.
- Place related words and pictures near each other on the page or screen (Mayer, 2001). This principle of spatial contiguity is used by placing rollovers and legends in close proximity to the graphic or label.
- Provide information that helps users understand and make appropriate uses of score reports (Goodman & Hambleton, 2004; Hattie, 2009). The reports use less statistical jargon, provide Key Findings directly below each graphical representation, do not report too much information to overwhelm the user, and provide clear interpretations and a results section.
- Account for individual differences by providing information that can be used by both low and high ability users. This principle (individual differences) can be seen in the use of text and graphics as well as the various levels of explanations the user has access to in the report (Mayer, 2001).

This work has been done in the context of ETS's Cognitively Based Assessment of, for, and as Learning (CBAL) research project (Bennett & Gitomer, 2009). The next section describes the process we undertook to develop a question-based reporting system as well as the types of questions stakeholders (e.g., administrators) ask and how this score reporting framework can be used by administrators.

A Question-Based Reporting System

Based on existing literature and interviews, Underwood et al. (2010) identified two overarching types of questions policymakers typically ask: those related to knowing about student achievement (i.e., usually questions about student performance data) and those more directly related to policymakers' responsibilities such as professional development, staff allocation, program selection and evaluation, and curriculum selection. Those questions related to policymakers' responsibilities can include the use of student achievement data in order to

make objective decisions. A question-based interface to access student achievement data was thought to be appropriate for this audience. The question-based interface keeps track of the questions that the stakeholders recently selected. Once a user has selected a question, a report addressing that particular question is produced and is geared toward the user. These results can directly inform decisions to be made in the future or can spark new questions.

For example, reports that appear in response to a user selecting a student achievement question (e.g., How are my district's students performing in reading?) will show a graphical depiction of the data that can answer the selected question as well as result descriptions, highlights of the results, limits of what can be interpreted, and statistical information. We used the questions related to student achievement data as the basis for our administrator question-based score reporting system.

The next section shows two types of reports for administrators and describes some of the design principles applied in their creation.

Report Designs

This section presents the main features of the prototype administrator score-reporting system. Each score report includes the following sections: left-hand and top navigation menus, graphical representation, key findings, results, purpose and use, definitions, interpretations, and links to other reports.

We tried to make our score reports more readable by using headings and including Key Findings and Results sections to help users locate the results more easily. To add more meaning for the users, we included comparisons among the different groups (e.g., schools or subgroups) on each score report. Each of our score reports has a graphical display and is accompanied by text that highlights interesting results. We used color in a meaningful way (red, yellow, and green to highlight relevant issues, e.g., red to indicate there is a problem, yellow a warning, and two shades of green to indicate no problem and go); provided only the necessary information, with the most important information first to help users follow a path; kept a theme for each score report (i.e., each report has a different focus—on the tests, over time, by grades, or subgroups); and presented clear Purpose, Use, Key Findings, and Results sections, in order to provide clear interpretations for the user.

Following Goodman and Hambleton’s (2004) promising features of score reports, we designed our score reports specifically for our audience (i.e., administrators). We also kept a theme for each score report (Hattie, 2009) and designed the score reports with Mayer’s 2001 principle of individual differences in mind.

Figure 1 shows the score report generated after a user decides to view overall results for the tests. First, the user makes a selection between overall results or subgroups from the left-hand navigation menu. Next, the user chooses among results for tests, over time, or by grades and then makes selections from the drop-down menu options presented at the top of the screen. In this example, “my district,” “8th grade,” and “all subjects” were selected. Finally, the user clicks on the GO button to generate the score report.

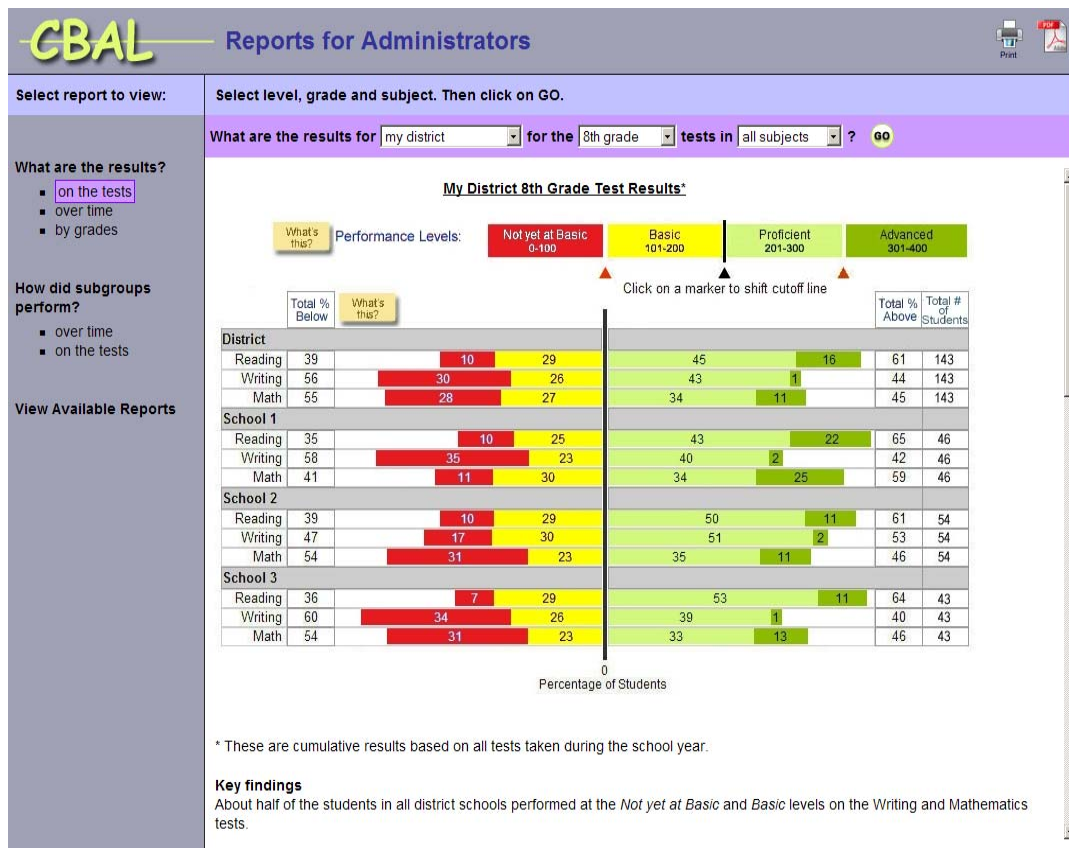


Figure 1. What are the results for my district for the 8th grade tests in all subjects? (Part 1).

The icons in the top right-hand corner allow the user to print the report or save the score report (as a PDF). The performance-level legend at the top is interactive and allows the user to

click on the marker to shift the cutoff line. Users can shift the cutoff line by clicking on the triangular indicator that separates the performance levels. This moves the cutoff line to the region selected and updates the totals for percent below and above, accordingly.

The use of headings for each section is consistent with Goodman and Hambleton 's (2004) recommendations for improving readability. We also employed Goodman and Hambleton's recommendation to add meaning for users and Mayer's (2001) principle for spatial contiguity by including "What's this?" rollovers next to the performance levels legend and next to the "Total % Below" column. The rollovers provide additional information and are placed near the area on the score report.

Each row in the graphical representation displays the percentage of students falling within each of the performance levels as well as the total number of students tested. The information in the graphical representation is organized by district, school, and subject. We followed Goodman and Hambleton's (2004) recommendation to use a graph that displays the major findings without overwhelming the user with too much statistical jargon or information. In addition, the graphical representation takes into account Mayer's (2001) principle for using both words and pictures. Directly below each graphical representation, Key Findings are provided for the user followed by results with a comparison section in which we limited the amount of text and information presented. The Key Findings section is consistent with Goodman and Hambleton's recommendation for using a highlight section; Goodman and Hambleton's recommendation and Mayer's coherence principle for not reporting too much information or extra information, and Hattie's (2009) principle of presenting the most important information.

Figures 2 and 3 show additional text that follows the Key Findings on each score report. Figure 2 provides a written summary of the main results based on the graphical representation (see Figure 1). The results are organized by district, school, and an overall comparison section. The user can scroll up to refer to the graphical representation when reviewing the results. This is consistent with Hattie's (2009) principle of presenting clear interpretations for the user by providing the user with a results section; Goodman and Hambleton's (2004) recommendation to add meaning for the user by reporting comparisons, strengths and weaknesses, and reporting in relation to performance levels; and Mayer's (2001) principle for using various representations (i.e., graphs as well as text).

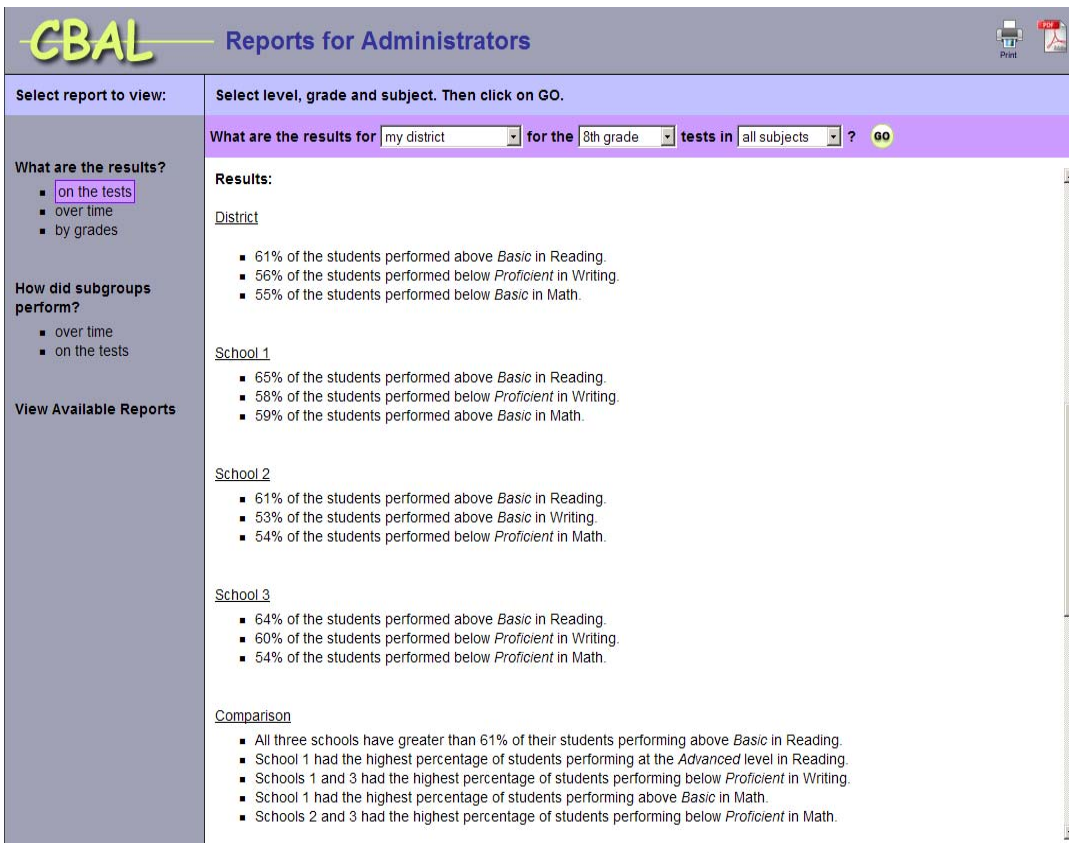


Figure 2. What are the results for my district for the 8th grade tests in all subjects? (Part 2).

Figure 3 displays the Purpose, Use, Definitions, Interpretations, and Links sections found on the score report. The Purpose and Use sections are provided to help the user understand the overall purpose of the score report as well as appropriate uses. Goodman and Hambleton (2004) note that the lack of information regarding purpose and use is a potentially problematic feature of some score reports. We have also followed Hattie's (2009) principle of providing clear interpretations by presenting a clear purpose and use on the score report. In addition, by providing a purpose and use on the score report we are attending to Mayer's (2001) principle of individual differences by making sure all users (those with low and high levels of knowledge) have this information.

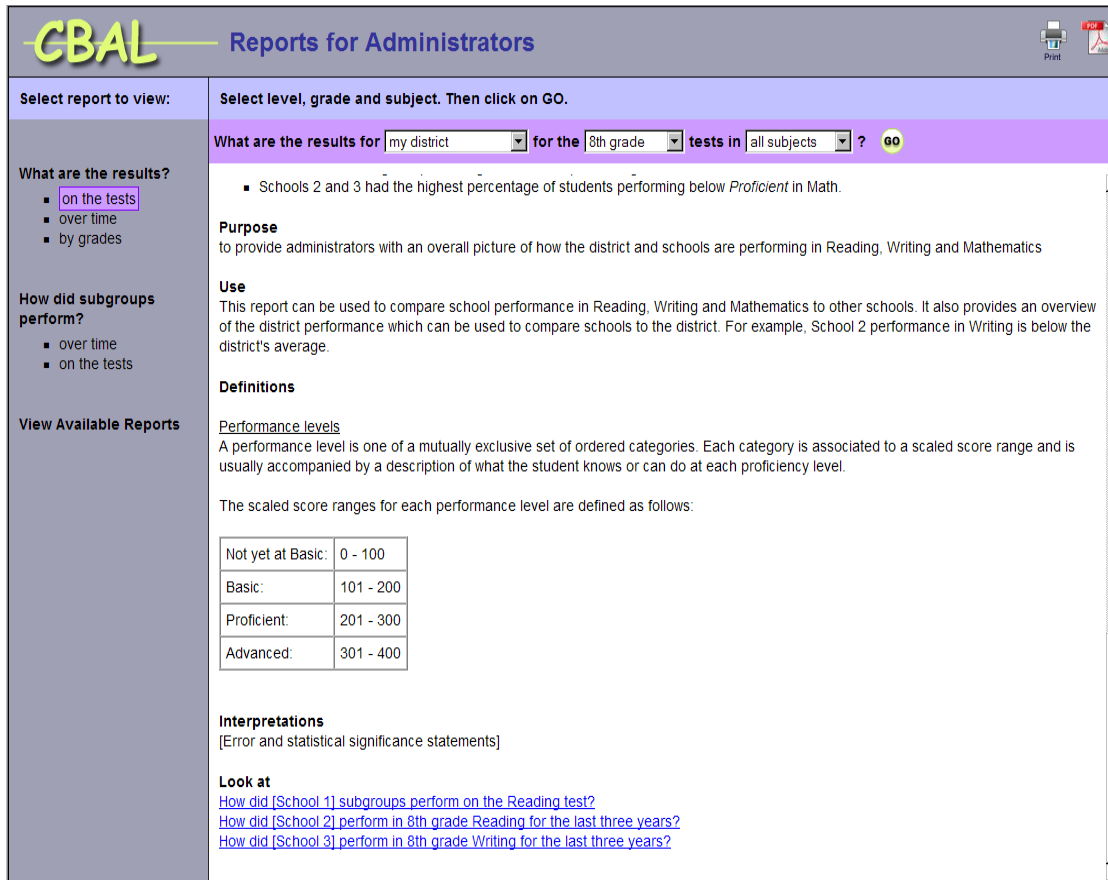


Figure 3. What are the results for my district for the 8th grade tests in all subjects? (Part 3).

In order to avoid Goodman and Hambleton’s (2004) potentially problematic feature of a lack of information on the precision of scores and the use of statistical jargon as well as Mayer’s (2001) principle of individual differences, we provide definitions as supplementary information and an interpretations section that will provide information about error associated with the tests and additional statistical terms to help aid in understanding the score report for all users. Definitions for error and statistical significance were not available at this point.

Each of our score reports responds to a particular question. Hattie (2009) recommends keeping a theme for each score report. We have implemented additional score reports, each with its own focus (See Figure 5 for a list of score reports).

Figure 4 shows an additional score report example of how all subgroups in the district are performing in reading over time with the following drop-down options selected: all subgroups, my district, and reading. Using Mayer’s (2001) individual differences principle, we included a

legend at the top of the score report to help all users (especially those with a low level of knowledge in this area) interpret the boxplots. By including the scale at the top and bottom of the graph, we avoided Goodman and Hambleton’s (2004) potentially problematic feature of not including a scale. The low, mean, and high scores are displayed for each subgroup as well as described in the results section. We have implemented an additional subgroup report, which provides information about how different ethnicities in the district are performing in reading over the past two years.

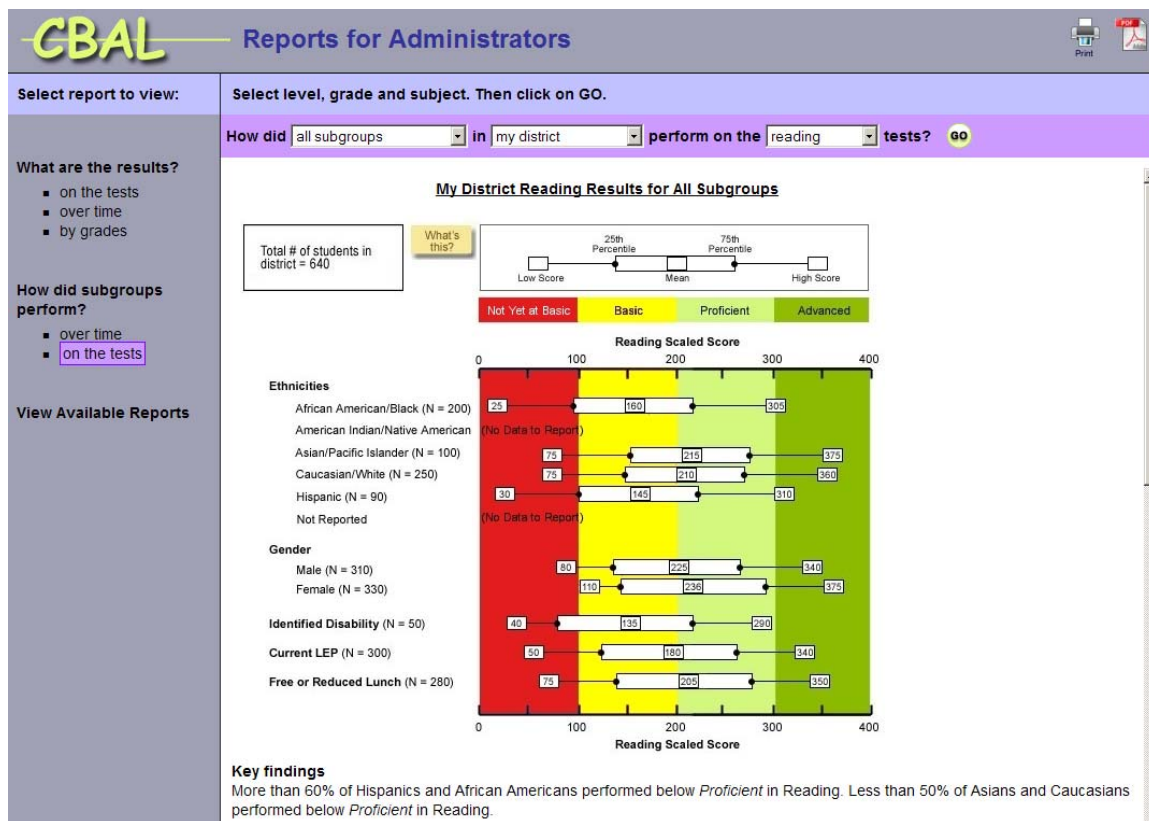


Figure 4. How did all subgroups in my district perform on the reading tests? (Partial score report image).

An additional feature of our interface allows the user to display all of the available score report links by clicking on the “View Available Reports” link located in the left-hand navigation menu (see Figure 5). A user can navigate to a score report by clicking on a link on this page or by using the left-hand navigation menu and drop-down menus. In addition to the score reports discussed previously, we have implemented all of the score reports listed in Figure 5.

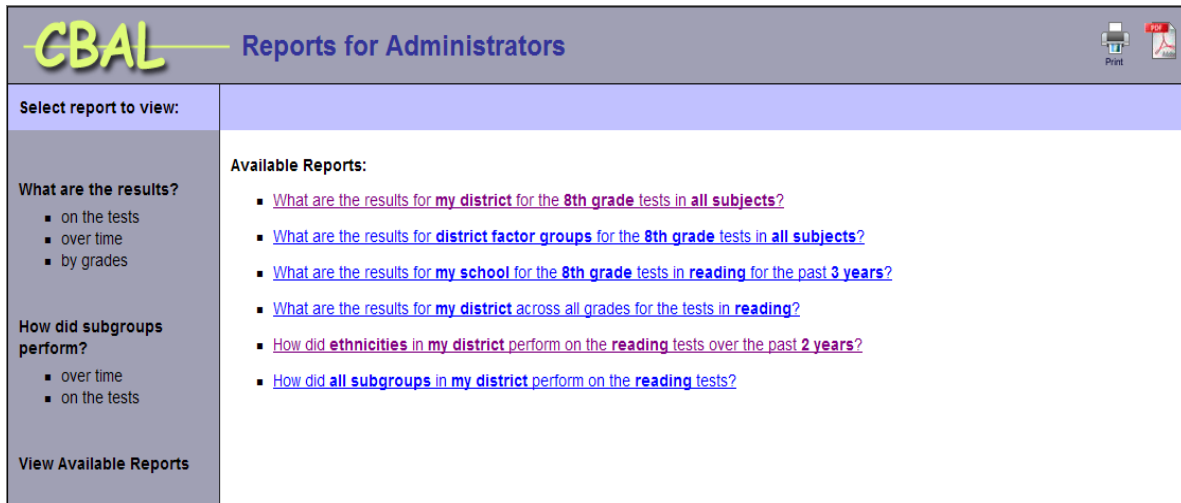


Figure 5. List of available report links for administrators.

The next section of the paper describes a usability study conducted with local administrators.

Usability Study

The main goal of the usability study was to identify major accessibility, readability, interpretation, and navigation problems of the administrator score reports and use this information to improve their design.

Method

A written protocol was designed and used to guide participants' interactions with the score reports (in total, six score reports were reviewed). This protocol included questions about different components of the score reports (see Appendix A). The questions were administered by a researcher to the administrators on a one-to-one basis. The figures presented in the paper are from the most recent version of the score reports, with some of the recommendations incorporated. Participants interacted with an earlier version of the score reports. At the end of the interview, participants answered a short background questionnaire as well as questions about their experiences with score reports and measurement terms. The results are presented in Tables 1 and 2.

Table 1***Participants' Background***

ID	Gender	Race	Highest level of education	Years of experience (Administrator)	Position
A1	Male	Caucasian	Master's	2	Assistant principal
A2	Female	Caucasian	Doctorate	7	Special education administrator
A3	Male	Caucasian	Doctorate	16	Principal
A4	Male	Caucasian	Master's plus credits	13	Principal
A5	Female	Caucasian	Master's	30	Principal
A6	Female	Caucasian	Master's plus credits	5	District supervisor (guidance and careers)
A7	Male	Caucasian	Doctorate	40	Executive county superintendent

Table 2***Participants' Familiarity With Educational Measurement and Score Reports (N = 7)***

Question	Number of administrators (selecting each category)
What types of reports do you receive each academic year?	4 - individual student reports (your classroom only) 2 - classroom reports (your classroom only) 3 - school reports 3 - district reports 1 - none
How many graduate courses have you taken in educational measurement (e.g., statistics, measurement theory)?	3 - 1 course 3 - 2 to 3 courses 2 - more than 3 courses
How comfortable are you with statistical terms such as standard deviation, variance, and measurement error?	0 - not at all comfortable 3 - somewhat comfortable 4 - comfortable 0 - very comfortable

Participants

Seven local administrators, whose positions ranged from school-level to county-level, received a gift certificate for their participation. Table 1 displays the participants' background information.

Results

Overall, we found that participants liked the “What's this?” rollovers (3 out of 3) and the performance level legend (7 out of 7), agreed the “Key Findings” were reasonable (7 out of 7), and agreed that the question-based menus and purpose and use sections were clear (6 out of 6). Not all of the participants responded to each of the interview questions due to time limitations. One of the participants stated that the results section had redundant information (due to the graphical representation displaying the same information), but affirmed this section was useful. Two participants were not able to correctly explain a boxplot. As a result, the “What's this?” rollover text for the boxplot has been updated. The following suggestions were provided by participants:

- Change the order of the items in the drop-down menus (i.e., from smallest to largest),
- Change the wording from *similar districts* to *DFG* (district factor groups; see definition below),
- Grey out options in the drop-down menu that are unavailable (e.g., math, writing, 7th, etc.),
- Move purpose and use to their own section, so they are not under definitions, and
- Add the functionality of clicking on a bar and receiving the number of students in that bar or a list of the students in that category.

(Note: District Factor Groups (DFGs) are an approximate measure of SES. In the state of NJ, DFGs allow for a comparison of demographically similar schools on statewide assessments.)

Expert Review

Four experts, Ronald K. Hambleton (University of Massachusetts, Amherst), Priti Shah (University of Michigan), Howard Wainer (National Board of Medical Examiners), and Rebecca Zwick (ETS), also reviewed the six score reports. In general, the experts found the score reports accessible and easy to understand. We have incorporated their color use recommendation and plan on addressing some of the other recommendations in the future. The recommendations provided by the experts included:

- **Vertical bars.** One expert thought it would be easier for administrators to interpret the representations if the bars were vertical. Experts suggested carrying out a study to explore whether using vertical bars improves administrator understanding of the score reports.
- **Color use.** The experts wanted color to be used in a more meaningful manner. Specifically, they suggested using different shades of the same color that would become darker as the performance level increased. An additional suggestion was to use red, yellow, and green to highlight relevant issues (e.g., red could be used to indicate there is a problem, yellow a warning, and green to indicate no problem; go). We have addressed this issue.
- **Attendance information.** It was suggested that we include information about attendance for administrators who may want to see how many days of school students who were performing at a certain level missed on average.
- **Standard error of difference.** An expert recommended including the standard error of difference when comparing subgroups.
- **Regrouping rows.** Another recommendation was to regroup the rows, so the rows show information grouped by subject followed by district and school.
- **Moving *Number of Students* column.** Experts suggested moving the column to the left of the representation in order to reduce the chances of overlooking this information. Currently, a user must read through the row to find this information.

Summary and Future Work

This paper describes related research in the area of score reporting, describes a question-based reporting system designed for administrators, reports on a usability study, and summarizes recommendations from experts.

Future work includes revising the score reports based upon the feedback gathered, linking the score reports to teachers' classroom reports as well as individual student reports, and carrying out additional studies comparing how alternate representations may influence administrators' understanding of score reports, the types of decisions they make using these types of score reports, and their access to score report information.

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Appendix
Administrator Score Report Interview Questions

[Question-based Menu]

1. Are the questions used to access the reports clear?
2. How does this question-based menu compare with the way you currently access reports?
3. What does cumulative mean in this context?

[Interaction Questions]

4. Are the questions with drop-down menus clear?
5. Are the options in the drop-down menus comprehensive? (When answering, please think about all of the options that are available to you.)
6. Do you find the page with direct links to the reports useful?
7. Do you prefer the page with direct links or the drop-down menus to access the reports?

[Cumulative results]

8. How would you use the performance levels legend?
9. If you haven't done so already, please move the marker on one of the reports. Is the interactive cutoff line (marker) useful? Explain.
10. What do the terms Total % Below and Total % Above refer to?
11. Please describe Figure 3. My District 8th Grade Test Results?
12. Are the Key Findings located under each graph reasonable?
13. Are the Results located under each graph useful?
14. What other kinds of information would you like to see?
15. Are the Purposes and Uses of each report clear?
16. How would you use this report?

[Subgroup Questions]

17. Is the Boxplot legend clear? If not, why?
18. Are there any other subgroups that you would like to see displayed?
19. Please describe Figure 4. My District Reading Results for All Subgroups
20. Are the Key Findings under each subgroup graph reasonable?
21. Are the Results located under each subgroup graph useful?

22. What other kinds of information would you like to see on the subgroup reports?
23. Are the Purposes and Uses of each subgroup report clear?
24. How would you use this report?

[General]

1. In addition to error and statistical significance statements, what other kinds of Interpretations do you think should be included on the reports?
2. What other types of reports do you usually receive?
3. What kinds of graphical representations do the reports you receive include?
4. Please provide additional comments/suggestions that you feel could help improve your interaction with this reporting system (interface).
5. Please provide us with additional comments/suggestions for how to improve the reports.