



REL Southwest Ask-A-REL Response

June 2017

Question:

What does the research say about using data visualization to support large-scale improvement efforts?

Background:

“Data visualization (or data viz) is a broad term referring to both the visual representation of data and the study of the presentation of data in a visual way (Turban, Volonino, & Wood, 2013). Data viz can also be defined as “the presentation of information in graphical or pictorial form, such as dashboards, interactive reports, and interactive presentations” (Brands, 2014, p. 56). Data visualization is becoming more popular as companies and organizations have access to more data and better software tools to handle the data.”¹ Within K-12 public education, state departments of education recognize the need to support local school districts “learn the basics of data visualization (types of visualizations, characteristics of effective visualizations, and the value of using effective visualizations), when and how to use dashboards and scorecards, identifying and using the right visualization tools, and how best to collaborate with school and district data experts to develop and implement successful tools.”² Education leaders desire to use data visualization tools to improve student achievement, including efforts to inform college and career readiness initiatives.

Response:

Following an established REL Southwest research protocol, we conducted a search for research reports as well as descriptive study articles on data visualization. We focused on using data visualization to support large-scale improvement efforts. The sources included ERIC and other federally funded databases and organizations, research institutions, academic research databases, and general Internet search engines (For details, please see the methods section at the end of this memo.)

¹ Adkins, J. K. (2016). Progression of a Data Visualization Assignment. *Information Systems Education Journal*, v14 n6 p20-26. <https://eric.ed.gov/?id=EJ1135684>.

² Churney, A., & Handville, N. L. (2015). *Using Data Visualization and Reporting to Improve Compensatory Education Programs*. Georgia Compensatory Educational Leaders, Inc. 2015 Conference. <http://www.gcel.org/files/102290212.pdf>.

We have not evaluated the quality of references and the resources provided in this response. and We offer them only for your reference. Also, we searched the references in the response from the most commonly used resources of research, but they are not comprehensive and other relevant references and resources may exist.

Research References

Ali, L., Hatala, M., Gasevic, D., & Jovanovic, J. (2012). A Qualitative Evaluation of Evolution of a Learning Analytics Tool. *Computers & Education*, 58(1), 470-489. <http://eric.ed.gov/?id=EJ947422>

From the ERIC abstract: “LOCO-Analyst is a learning analytics tool we developed to provide educators with feedback on students learning activities and performance. Evaluation of the first version of the tool led to the enhancement of the tool's data visualization, user interface, and supported feedback types. The second evaluation of the improved tool allowed us to see how the improvements affected the users' perceived value of the tool. Here, we present the qualitative results of our two evaluations and discuss important lessons learned stemming from the comparison of the two studies. The results show that educators find the kinds of feedback implemented in the tool informative and they value the mix of textual and graphical representations of different kinds of feedback provided by the tool. (Contains 5 figures and 8 tables.)”

Beaver, J. K., & Weinbaum, E. H. (2015). State test data and school improvement efforts. *Educational Policy*, 29(3), 478–503. <http://eric.ed.gov/?id=EJ1058662>

From the ERIC abstract: “Although much has been written about the potential benefits of effective data use in schools, considerably less attention has been paid to how schools make sense of the data generated from performance-based accountability measures. This article explores schools' usage of state test data, the intensity of data use, and the perceived utility of state test data. Our findings uncover nuanced differences in school data use and reveal a key disconnect in the assumptions of performance-based accountability systems, wherein schools may faithfully use state data to inform improvement efforts while fundamentally questioning the validity of the data itself.”

Breiter, A., & Light, D. (2006). Data for School Improvement: Factors for Designing Effective Information Systems to Support Decision-Making in Schools. *Educational Technology & Society*, 9(3), 206-217. <http://eric.ed.gov/?id=EJ836853>

From the ERIC abstract: “National legislation that increased the role of accountability testing has created pressure to use testing data, along with other data, for instructional decision-making. Connected to this push for data-driven decision-making, is the increased interest in data delivery systems or Management Information Systems (MIS) in education. But, before administrators rush to build data and information systems, we argue for a careful review of existing knowledge about information systems in the education sector in light of what business and organizational research already knows about information systems. We draw on the considerable body of business and organizational research on MIS and a recent educational case study in New York City to

introduce a theoretical framework to describe the process from data to decision-making in schools. Our exploration of how schools use information focuses on the potential of new technologies and new ways of analysis to meet the information needs of educators across different levels of the system. We conclude with a discussion about critical factors for the development and implementation of effective information systems for schools: 1) Build from the real needs of classroom and building educators; 2) Recognize teachers' wealth of tacit knowledge as a starting point; 3) Select appropriate data to include in the information system; 4) Effective testing requires close alignment between standards, teaching and testing; 5) Educators need professional development on instructional decision-making that considers the role of data; 6) Educators need expanded repertoires of instructional strategies; and 7) Further research on effective instructional decision-making and IS support is needed. (Contains 2 figures and 2 tables.)”

Cho, V., Jimerson, J. B., & Wayman, J. C. (2015) Data system implementation: A leader navigates people problems around technology and data use. *Journal of Cases in Educational Leadership*, 18(2), 134–143. <http://eric.ed.gov/?id=EJ1061646>

From the ERIC abstract: “Computer data systems have become a lynchpin to supporting school data use. However, successfully implementing such systems is no easy task. In this case, readers explore the ways in which "technology problems" and "people problems" can be intertwined. The case follows Dr. Molly Winters as she encounters social and organizational challenges relating to district vision, tensions around data use, and tensions involving technology implementation. Her exploration of these issues spans both the school and district levels. Her goal is to analyze and provide recommendations regarding how to support data system use and school improvement throughout her district.”

Halverson, R. R., Grigg, J., Pritchett, R., & Thomas, C. (2007). The new instructional leadership: Creating data-driven instructional systems in school. *Journal of School Leadership*, 17(2), 159-194. <http://eric.ed.gov/?id=EJ807376>

From the ERIC abstract: “The recent press for high-stakes accountability has challenged school leaders to use data to guide the practices of teaching and learning. This article considers how local school leaders build data-driven instructional systems to systematically improve student learning. Such systems are presented as a framework involving data acquisition, data reflection, program alignment and integration, program design, formative feedback, and test preparation. The article reviews data collected in a yearlong study of four schools to describe how leaders structure opportunities to engage in data-driven decision making. (Contains 1 table, 1 figure, and 1 note.)”

Hartong, S. (2016). Between Assessments, Digital Technologies and Big Data: The Growing Influence of "Hidden" Data Mediators in Education. *European Educational Research Journal*, 15(5), 523-536. <http://eric.ed.gov/?id=EJ1114713>

From the ERIC abstract: “The past few decades have witnessed a global enforcement of "governance by data" in education policy, including a significant increase of assessments and quantified evaluation. Within this context, this article focuses particularly on the intensifying evolution of new (digital) information technologies and "mediated"

infrastructures of data flows. The premise is that such technologies and actors of mediation reveal a crucial potential for implementing a new mode of digitalized governmentality in education, which, as "governance by big data", reaches far beyond policy, into educational administration, school practice and individual learning activities. The strategic mediation of (big) data in education (such as that generated through assessments) involves actors, structures and technologies that operate "between" policy, politics, administration, schools and individuals as well as "between" data production, consumption and the data itself, for example by applying practices of data visualization or technical data services around software and databases. However, as this article seeks to demonstrate, such mediators comprise various types of actors who operate very differently within the diverse sectors of education policy, indicating a highly ambiguous yet powerful composition of digitalized governmentality.”

Luppigini, R. (2005). A Systems Definition of Educational Technology in Society *Educational Technology & Society*, 8(3), 103-109. <http://eric.ed.gov/?id=EJ846440>

From the ERIC abstract: “Conceptual development in the field of Educational Technology provides crucial theoretical grounding for ongoing research and practice. This essay draws from theoretical developments both within and external to the field of Educational Technology to articulate a systems definition of Educational Technology in Society. A systems definition of Educational Technology in Society is characterized as a goal oriented problem-solving approach utilizing tools, techniques, theories, and methods from multiple knowledge domains to: (1) design, develop, and evaluate, human and mechanical resources efficiently and effectively in order to facilitate and leverage all aspects of learning, and (2) guide change agency and transformation of educational systems and practices in order to contribute to influencing change in society. This paper offers valuable theoretical grounding to help guide researchers and leaders in the field. (Contains 1 figure.)”

McDonald, S. K., Anddal, J., Brown, K., & Schneider, B. (2007). *Getting the evidence for evidence-based initiatives: How the Midwest states use data systems to improve education processes and outcomes (Issues & Answers Report, REL 2007–016)*. Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Midwest. <http://eric.ed.gov/?id=ED497511>

From the ERIC abstract: “Educational improvement through data-based decision-making using high-quality data is a longstanding goal of policymakers and practitioners, and ensuring the quality of the evidence available to inform such decisions is a key part of the No Child Left Behind Act of 2001. The evidence-based education that such initiatives promote involves the "integration of professional wisdom with the best available empirical evidence in making decisions about how to deliver instruction." A wealth of data at the school, district, state, and federal levels should in principle provide an empirical basis for developing educational policies, practices, and research proposals and designs. The states in the Midwest Region are developing innovative practices for identifying and addressing information priorities within their states and for meeting federal requirements. These practices involve establishing longitudinal student-level and

teacher-level data collections and linking data across the educational information system. Other practices include incorporating key data elements that can leverage other data resources to identify problems that could constrain student achievement and using accountability systems to target educational resources more efficiently and effectively. Midwest states also face challenges in meeting these goals. Data collection staff and resources for training at the local level are limited, and many states do not have enough staff with the skills and experience necessary to analyze the data. Keeping the duplication of data collection to a minimum is also a constant challenge. Finally, federal and state regulations often constrain states' ability to collect key data elements. Given these challenges and constraints, responding to states' information needs and aspirations may best be achieved through a two-pronged approach. First is to establish regional benchmarks and provide guidelines for states wishing to use local data to develop indicators for purposes of comparison. Second is to respond to specific state requests for analytic resources and develop associated training materials. Both tasks have the explicit goals of providing immediate utility and building capacity for the future. Each may usefully be addressed by the regional educational laboratories--singly, in combination, and with external partners. The following are appended: (1) Methods; (2) Illinois; (3) Indiana; (4) Iowa; (5) Michigan; (6) Minnesota; (7) Ohio; (8) Wisconsin; and (9) Instructions for Accessing the State Data Inventories. (Contains 4 notes, 1 box, and 9 tables.) [This report was prepared for the National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education by Regional Educational Laboratory Midwest administered by Learning Point Associates, Inc.]”

McNaughton, S., Lai, M. K., & Hsiao, S. (2012). Testing the effectiveness of an intervention model based on data use: A replication series across clusters of schools. *School Effectiveness and School Improvement*, 23(2), 203-228. <http://eric.ed.gov/?id=EJ963102>

From the ERIC abstract: “Intervention models based on data use can be effective in raising student achievement. This article presents 3 studies of one such model which had reported improved reading comprehension levels in 7 poor urban multicultural schools serving indigenous and ethnic minority communities. The intervention (the Learning Schools Model) used a process comprising critical discussions of achievement and teacher observation data to develop specific and contextualized content for fine-tune instruction. The reliability and generality of the effects of the model were tested in a cluster of "like" schools and a cluster of "unlike" schools. The growth models showed similar effects to the original schools, with gains of between 3 to 4 months additional progress per year over 3 years. The replications show that models that use data to design local program content can be reliably and generally effective, but also there is a need to examine differential effects. (Contains 8 figures, 6 tables, and 1 note.)”

Slater, S., Joksimovic, S., Kovanovic, V., Baker, Ryan S., & Gasevic, D. (2017). Tools for Educational Data Mining: A Review *Journal of Educational and Behavioral Statistics*, 42(1), 85-106. <http://eric.ed.gov/?id=EJ1129382>

From the ERIC abstract: “In recent years, a wide array of tools have emerged for the purposes of conducting educational data mining (EDM) and/or learning analytics (LA)

research. In this article, we hope to highlight some of the most widely used, most accessible, and most powerful tools available for the researcher interested in conducting EDM/LA research. We will highlight the utility that these tools have with respect to common data preprocessing and analysis steps in a typical research project as well as more descriptive information such as price point and user-friendliness. We will also highlight niche tools in the field, such as those used for Bayesian knowledge tracing (BKT), data visualization, text analysis, and social network analysis. Finally, we will discuss the importance of familiarizing oneself with multiple tools--a data analysis toolbox--for the practice of EDM/LA research.”

Solar, M., Sabattin, J., & Parada, V. (2013). A Maturity Model for Assessing the Use of ICT in School Education. *Educational Technology & Society*, 16(1), 206-218.
<http://eric.ed.gov/?id=EJ1016311>

From the ERIC abstract: “This article describes an ICT-based and capability-driven model for assessing ICT in education capabilities and maturity of schools. The proposed model, called ICTE-MM (ICT in School Education Maturity Model), has three elements supporting educational processes: information criteria, ICT resources, and leverage domains. Changing the traditional and exclusive focus on ICT, five Leverage Domains are defined: Educational Management, Infrastructure, Administrators, Teachers and Students. The Leverage Domains generate a hierarchical structure with a second level named Key Domain Areas. These areas should be measurable and controllable, so they are related to a third hierarchical level, called Critical Variables, allowing the model's elements to be assessed qualitatively and quantitatively. The capability and maturity of these variables associated with the intersection with the other two elements establish five levels of capability. The proposed model is strongly supported by the international standards and best practices for ICT management. It has been validated through data collection instruments and its associated web-support tool was also refined with a small pilot study. In summary, the proposed ICTE-MM model provides a basis for self-assessment and improvement planning. It is not just a diagnostic tool but has also been found to be useful for guiding the principals in ICT investment.”

Williamson, B. (2016). Digital Education Governance: Data Visualization, Predictive Analytics, and "Real-Time" Policy Instruments. *Journal of Education Policy*, 31(2). 123-141.
<http://eric.ed.gov/?id=EJ1088103>

From the ERIC abstract: “Educational institutions and governing practices are increasingly augmented with digital database technologies that function as new kinds of policy instruments. This article surveys and maps the landscape of digital policy instrumentation in education and provides two detailed case studies of new digital data systems. The Learning Curve is a massive online data bank, produced by Pearson Education, which deploys highly sophisticated digital interactive data visualizations to construct knowledge about education systems. The second case considers "learning analytics" platforms that enable the tracking and predicting of students' performances through their digital data traces. These digital policy instruments are evidence of how digital database instruments and infrastructures are now at the centre of efforts to know, govern and manage education both nationally and globally. The governing of education,

augmented by techniques of "digital education governance", is being distributed and displaced to new digitized "centres of calculation", such as Pearson and Knewton, with the technical expertise to calculate and visualize the data, plus the predictive analytics capacities to anticipate and pre-empt educational futures. As part of a data-driven style of governing, these emerging digital policy instruments prefigure the emergence of "real-time" and "future-tense" techniques of digital education governance."

Additional Organizations to Consult

Center on Great Teachers and Leaders—<http://www.gtlcenter.org/>

From the website: The Center on Great Teachers and Leaders is based at American Institutes for Research and funded through a cooperative agreement by the Office of Elementary and Secondary Education at the U.S. Department of Education.

The contents of this website were developed under a cooperative agreement (S283B120021) from the U.S. Department of Education. Information presented in this site does not necessarily represent the policies of the Department of Education and does not imply endorsement by the federal government.

Data for Decisions Initiative—<https://datafordecisions.wested.org/research/>

From the website: The Data for Decisions Initiative (DDI) seeks to help education stakeholders—including educators, policymakers, and researchers—access solution-driven tools, resources, and research to inform their practice and develop a better understanding of how high-quality data use can successfully inform teaching and learning.

This page offers foundational research in the field—that is, research that focuses on the critical components of data for decision making, such as data systems, data teams, data coaches, creating a data culture, vision, and the need for leadership. It seeks to understand data for decision making and data use in education.

Center for Education Policy Research at Harvard University's Strategic Data Project—<https://cepr.harvard.edu/event/sdp-institute-leadership-analytics-4>

From the website: The SDP Fellowship is a premier professional development experience led by an accomplished team at the Center for Education Policy Research at Harvard University. The two-year program develops talented data strategists in school systems, state education departments, and nonprofit organizations. By participating in the fellowship, both fellows and their host agencies will grow advanced analytic capacity, develop clear priorities and plans for data and data systems, build organizational willingness to use data for decision-making, and uncover valuable insight about performance. Together with SDP, these leaders are building a growing, national network focused on improving student outcomes in America's public schools.

Methods

Keywords and Search Strings

The following keywords and search strings were used to search the reference databases and other sources:

- Data visualization
- Data school improvement
- Data educational improvement
- Data interpretation

Databases and Resources

We searched ERIC for relevant resources. ERIC is a free online library of over 1.6 million citations of education research sponsored by the Institute of Education Sciences. Additionally, we searched Google Scholar.

Reference Search and Selection Criteria

When we were searching and reviewing resources, we considered the following criteria:

Date of the publication: References and resources published for last 15 years, from 2001 to present, were include in the search and review.

Search Priorities of Reference Sources: Search priority is given to study reports, briefs, and other documents that are published and/or reviewed by IES and other federal or federally funded organizations, academic databases, including ERIC, EBSCO databases, JSTOR database, PsychInfo, PsychArticle, and Google Scholar.

Methodology: Following methodological priorities/considerations were given in the review and selection of the references: (a) study types – randomized control trials,, quasi experiments, surveys, descriptive data analyses, literature reviews, policy briefs, etc., generally in this order (b) target population, samples (representativeness of the target population, sample size, volunteered or randomly selected, etc.), study duration, etc. (c) limitations, generalizability of the findings and conclusions, etc.

This memorandum is one in a series of quick-turnaround responses to specific questions posed by stakeholders in the Southwest Region (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas), which is served by the Regional Educational Laboratory (REL) Southwest at SEDL. This memorandum was prepared by REL Southwest under a contract with the U.S. Department of Education’s Institute of Education Sciences (IES), Contract ED-IES-12-C-0012, administered by SEDL. Its content does not necessarily reflect the views or policies of IES or the U.S. Department of Education nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.