12 | Diving lessons: Taking the data literacy plunge through action research

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Helping students to become data literate is a challenge on many levels, but none is so compelling as this: how do we make data interesting and meaningful to them? One answer may lie in contextualizing data skills in the world and interests of our students by having them do research themselves following the action research model.

Knowing that modeling is an impactful teaching strategy (Coffey n.d.) and recognizing the role of affect in the information seeking process (Kuhlthau 1993), we can better address this dilemma by employing action research (AR) to both improve our own practice and skills set and provide an authentic example to students of how we use data to solve real-world problems. The visible and intentional use of action research will also help to increase our credibility with students who struggle with the inquiry process. When we show them that we have taken the plunge, too, we can state with confidence that we understand what they are going through!

In this chapter, you'll learn the stages of action research and how to apply them to pursue your own areas of interest. Once you've become comfortable with the format, you can teach it to your students. By making data collection and use personal, the data is relevant and relatable to our own contexts. Data we don't know about and things we are unfamiliar with raises two barriers for students; studying data they know closes that gap.

In thinking about how to wade into action research, it's first im-

portant to understand what it is and how it can be leveraged to our advantage. This chapter's goal is to show that action research is truly practitioner-friendly and not at all that sort of "swallowing sawdust" experience that most of us think about when we hear terms like data or research.

What is action research and evidence-based practice?

Action research is a systematic, intentional, problem-focused, and solution-oriented investigation. It is context-specific and therefore meaningful and relevant to the researcher (us!). It is also future-oriented: when we engage in action research, we are testing whether or not some action or cycle of actions or interventions will result in improvements in professional practice (Hart and Bond 1995). We may also research to find out, with greater confidence, whether what we are doing is having the desired effect. Action research helps the practitioner bridge the gap between theory and practice, and for educators and school librarians, it is not only an ideal way to better understand and improve our work, it is also a tool for evidence-based practice (Gordon 2006).

Evidence-based practice has its roots in health care, where it is defined as "the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients" (Sackett, Rosenberg, Gray, Haynes, & Richardson 1996, p. 71). In considering its usefulness in education, researcher Ross Todd was an early proponent of evidence-based school librarianship, which he defined as "an approach that systematically engages research-derived evidence, school librarian-observed evidence, and user-reported evidence in the ongoing processes of decision making, development, and continuous improvement to achieve the school's mission and goals. These goals typically center on student achievement and quality teaching and learning." (Todd 2008). As the recent

passage of the federal Every Student Succeeds Act (ESSA) reminds us, being able to use evidence as a rationale for decision-making is gaining prominence in how K-12 schools move forward. Teachers and school librarians can gather evidence via action research to help improve instruction, or, in the instance of the examination of program and services, to address the ongoing needs of students and the learning community.

Educators are already using a variety of data and evidence to get a snapshot or sense of instructional and program needs, utilization, and effectiveness. The data sources may include traditional quantitative measures such as test scores, demographics (student, community, and school profiles), comparative costs, availability of resources and user records, and more. However, the most powerful use of these data is in combination with the kind of data that may be culled from student interviews, examination of student work, questionnaires, focus groups, pre/post-tests, observation and field notes, case studies, and several other standard qualitative research methods. Although some numerical data may be collected and analyzed in qualitative studies, they remain distinct from the quantitative style of research. Yes, you read that right. Not all data is quantitative – a point we often tend to forget!

We also neglect to realize that while quantitative studies are the norm for the pure sciences, the social sciences do not lend themselves to the same sort of methodology. Qualitative research probes *why* something happens, rather than documenting the frequency of occurrence. Qualitative work may focus on smaller samples or fewer participants, exchanging scale for depth of insight and understanding. Rather than reporting results statistically, qualitative research is somewhat anecdotal, and therefore well-suited to studying the relationships among student achievement and teaching practice. Action research is an ideal tool for looking at many of those elusive elements of need in education.

In the complex environment of the school, action research provides a structure for teaching in order to:

- » **identify problematic areas in the design, implementation, and evaluation of the instruction;**
- » **develop teaching strategies that generate data about student performance;**
- » **collect evidence using qualitative and quantitative methods in naturalistic settings;**
- » **analyze evidence at the point of need and apply it to the revision of instruction; and**
- » **apply evidence to determine how to improve instruction in the future.**

Action research is flexible, individualized, and usable at any developmental level. It assumes that teachers and school librarians are knowledgeable about their areas of endeavor and gives them power to make decisions (Gordon 2006). It can be carried out by a single educator or by a collaborative group.

One of the more significant qualities of action research is that it puts the teacher and school librarian in the position of accepting more responsibility for her (his) own professional growth (Wood 1988) and, by doing so, to empower the practitioner with the ability to advocate – with evidence – for the practices she (he) values most. Most significantly, action research is a self-reflective process that helps to elevate the academic climate of a school as students see their educators join them in doing research. Students see us as learners who are willing to model the research process.

The bottom line is that YOU can be a researcher with action research, and once you can do it, you can help students become action researchers, too.

Why action research?

The advantage of action research is its immediate impact. Action researchers don't have to wait for a test company to score and return results. The results stay in-house and are immediately put to use to support, communicate, and facilitate change. Consider the use of action research as a platform from which we can take a deep dive into finding out answers or possible strategies to address some fundamental questions about how effective our instruction or delivery of service is in relation to what we are aiming to provide at the local level.

In the action research model, teachers and school librarians pose questions that address the problems related to curriculum or program development and implementation. Consider these potential questions:

- » **Are we teaching the appropriate skills for each level?**
- » **Where are the gaps in instruction?**
- » **Do all students have equal access to resources?**
- » **Is this instructional strategy leading to the results we want?**
- » **What is the impact of our work?**

These types of questions are rooted in a primary question for the teacher and school librarian: *How can I do it better next time?*

Action research follows a series of phases and is an iterative process (Gordon 2006). While presented here in a linear format, good researchers know that all research is iterative. We may reach a point in the process where we realize we need to backtrack. Perhaps we realize our question needs refining or editing because the data we collected is insufficient. Perhaps we realize, when synthesizing, that having more or different data would give

us more insight. So as you read through the following stages, keep this iterative – or "go back a few stages" – approach in mind. Especially with novice researchers who are less skilled at predicting how the research might unfold, going back and revisiting stages is to be expected, not a sign of poor planning.

The action research proposal

Whether you are a teacher, administrator, school librarian or a student, the first step in getting started with action research is to develop a proposal (Figure 1). The proposal is a template that provides novice and expert researchers alike with a flexible structure and sequence that prompts the researcher to:

» **identify the purpose and scope of the research;**

» **develop and pose researchable questions;**

» **select appropriate data collection tools;**

» **develop a plan for data collection and analysis;**

» **anticipate how and to whom you will present your findings;**

» **reflect on the process and outcome of the project.**

Planning the overall framework of your action research up front can help you visualize the entire process before you begin. This can help you (and student researchers) anticipate stumbling blocks, plan for possible challenges, and mentally "rehearse" the research activities before beginning them.

Asking a researchable question

The process begins by gathering basic information about the individual or team submitting the proposal. The first significant

Proposal for action research

Submitted by

Date

Research Question or Hypothesis

Project

Data Collection. Please include at least two methods (e.g., interviews, questionnaires, grades, observation journal entries, photographs, student products/projects, formative assessments, focus groups, case studies, content analysis)

Figure 1: The action research proposal guides the researcher into envisioning the action research as a whole.

section is focused on the *Research Question* (or *Hypothesis*). This is often framed as a problem in the form of a researchable question and is derived from an area of your practice where you would like to see improvement. Choose a problem and question that is important to you. Later, if you implement action research for students, try to find opportunities to link their classroom curriculum with research questions for which they have genuine interest or that are meaningful and resonant for them. In both instances, take care as well to create a question which can be effectively measured and evaluated (Table 1).

Strong research questions	Weak research questions
How might setting up a self-checkout station impact our library's circulation? (This question can be measured by comparing previous circulation to future circulation.)	Does self-checkout work? (Weak because we aren't clearly defining what "works" looks like – is it mechanical functioning? successful use by students? increasing circulation?, etc.
How might ten minutes of sustained silent reading impact reading scores? (Strong because we can measure the scores from before tand after the intervention and compare them.)	Do school library hours impact learning? (Hard to measure because there could be many factors impacting learning – how would we know that changing the library hours was the necessary factor?)

Table 1: Strong vs. weak research questions

For instructional problems, it can be helpful to ground the problem in educational theory. This not only aligns your area of concern with an established body of knowledge, but allows educators to engage in meaningful discussions and exchanges about how students learn and what interventions are most appropriate (and when) in order to ensure their success (Ballard, March, & Sand 2009). In general, the work of the constructivists offer us a place to begin to tie action research to theory. Bloom's Taxonomy, Dewey's notion of learning by doing, Gardner's work on multiple intelligence, Piaget's idea of knowledge construction by assimilation and accommodation, Vygotsky's metacognition and the Zone of Proximal Development and Kuhlthau's Information Seeking Process are access points to anchor questions to theory. As an example, a proposal that considers the question, "Are third

grade students able to gather information and then demonstrate higher levels of thinking beyond the competency of knowledge"? aligns well with Bloom's Taxonomy because it allows the researcher to gather evidence to assess if students are progressing from the lowest end of Bloom's cognitive domain which includes knowledge toward comprehension, application and ultimately the "higher order" areas of analysis, synthesis, and evaluation. It also lends itself to the development of a secondary question that addresses a performance task, "Will the task of creating a diary and comparison charts promote higher level of thinking?"

Project

The *Project* section of the proposal (you can rename this "area of research" for students) helps to deal with the pragmatic aspects by helping to identify the "Who, What, When" of the process. Some questions to consider at this stage:

- » **What will be studied?**
- » **Who will lead the research?**
- » **Will this be an individually-led investigation or a collaboration with another teacher or groups of teachers (or students/groups of students), or even a school-wide investigation?** The size of the group of researchers does not change the researchable question: each follows the same process and considers the use of similar data collection resources – the difference is that individual action research focuses on a single educator's particular teaching assignment, role or interest, whereas collaborative action research involves at least two participants seeking to address a mutual concern and school-wide action research involves a group: perhaps a discipline-specific team, grade level, or the entire learning community. Support from outside agencies or organizations may be

used or needed in all three approaches – such as working with a college or university, other schools or district personnel or community and state agencies. Support may also involve the need for financial resources to fund staff release time for planning and/or training purposes.

» **When will the research be conducted?** When will data be synthesized? When will results be available? This helps to establish a timeline to fuel progress and build in accountability. In your proposal you will have identified a start and end date for this purpose. It can be as short as one instructional period, or extend to a year-long or multi-year investigation. As you get started, it's wise to keep it manageable. In choosing and administering your data collection tools, you have to consider schedules, personnel availability, etc. since action research is designed for you to learn from your results and apply what you have learned as soon as possible.

» **Who will receive the results of the research (and, if appropriate, recommendations based on that research)?** This may inform the types of questions that are investigated, the types of research instruments used, and the format, or style of the report of findings (Calhoun 1993).

This section of the proposal also includes an opportunity to give a **brief description, or abstract,** of the overall project to ensure it is helpful to those to whom you are making the proposal and/or to someone who may have a similar problem to investigate so that they have an idea of how they might replicate it. By taking the time to consider the abstract in advance, you gain a valuable tool for communicating with stakeholders throughout the process, a kind of elevator pitch – a short overview of your project that you can share with interested stakeholders. Depending on the scope of your project, the abstract may also have value when shared in a school newsletter, distributed at a parent-teacher organizational meeting, or placed in your annual teaching portfolio.

Data collection

The *data collection* component of the proposal provides the description of the measurement tools and collection methods you will use to gather data. At least two types of evidence should be collected because having multiple measures allows the researcher to compare and contrast using a wider variety of lenses and increases the reliability and validity of the research.

You might consider some of the following data collection tools:

» **Interviews** – While time-intensive, interviews can give you in-depth insight into how a particular student approaches, thinks about, or processes work responding to specific pre-determined, questions. While in general they are conducted one-to-one and face-to-face, they can also occur via email or via video conferencing.

» **Focus groups** – These allow the researcher to meet with a small sample group of participants (about six to eight people) and record their individual responses to questions as well as how they respond to and interact with other focus group participants. Focus groups help to explore participant needs and how they feel about ways to address those needs. It's important to provide structure and ground rules in conducting focus groups so the session will flow smoothly.

» **Grades and test scores** – Evidence of students' performance using grades, tests, quizzes, homework, and standardized assessment continue to be valuable as these are the traditional data sources that most stakeholders understand and value and their use can help us to communicate results. Nonetheless, they should never be used as the sole source of data. For example, students with test-taking anxiety may underperform on tests but have higher performance levels in small-group projects. By

limiting oneself to just test scores, an educator might see an amplified set of weaknesses and miss some strengths.

» **Observation/field notes** – These are the written observations of what the researcher "sees" occurring in the field (the classroom or other learning environment). They reflect only what is going on and are not subject to interpretation as they occur. Over time the researcher will see patterns emerging from this data. As with interviews and focus groups, analyzing the notes takes significant time, though the revealed insights may also be significant.

» **Questionnaires/surveys** – A questionnaire is comprised of questions that respondents answer in a given format – either as open-ended (respondents articulate their own response) or closed-ended (respondents pick an answer from a options provide to them). It is part of an overall survey process which also includes identifying the population to administer the survey to, deciding on the delivery method, striving to ensure questions are valid by considering responder variabilities and then analyzing results. Questionnaires/surveys are useful because data can be gathered from larger populations, and they are relatively easy to tabulate. However, care must be taken to construct questions carefully so that they are understood by respondents, and it helps to develop a script for whomever will administer the survey so that participants hear the same message at the same time and to eliminate any potential bias in the way the survey is presented

» **Checklists/charts** – These can take various forms but are generally pre-designed by the instructor for a student to fill in before, during, and after projects. Examples include a K-W-L chart (what a student knows [K], wants to know [W], and has learned [L] about a topic); teacher checklists which address what content was covered or when new skills or concepts were introduced; and rating/reflection checklists used with students or teachers to assess how

they see themselves at a given point in time. Not only are checklists helpful in documenting completion of tasks or attainment of skills but also in tracking time spent on an activity/task.

» **Photographs** – Photo elicitation is a data collection tool defined as showing photographic images during research interviews for participants or subjects to comment on (Lorenz & Kolb 2009). Collier (1957) wrote that more information was elicited from interviews with study subjects when photographs were used to elicit responses during interviews. In addition, the subjects were less easily fatigued by the interview process when the act of looking at photographs was included in the interview process.

» **Journal entries** – Journals are helpful to document the research process from beginning to end. They are usually most helpful when maintained on a daily or at least weekly basis for a longer project period.

» **Rubrics** – While rubrics are also time-intensive to construct and use, they are excellent sources of data since they describe specific indicators and attributes of what student work should include and provide a consistent and accurate scoring mechanism for the work.

» **Students products/projects** – Samples of student performance (assignments, quizzes, tests, as well as projects and presentations) provide rich sources of data by providing evidence of patterns or gaps and are expressions of the level of student learning and the effectiveness and impact of instructional intervention.

» **Portfolios** – These are excellent examples of data collection and evidence over time. Decide in advance what you are measuring. For example, are you looking at each portfolio and giving it a global aggregate score of quality? Selecting the same essay from each portfolio for comparison? Measuring each student's growth and comparing it?

See Appendix A for a complete comparison of the above data instruments.

After you have identified your data collection tools, try to complete your proposal in enough time to ensure that you can set it aside for a few days and review it with fresh eyes so that it is reflective of your best thinking and is achievable. Consider any challenges or barriers to implementation and refine the proposal to address them. If you are doing research that extends beyond your classroom, involves other educators, or collects data that is out of the norm for your school or district culture, now is a good time to run your plan past designated administration.

With the proposal completed, you are now ready to move from planning and into action — collecting data. But before we go there, don't hesitate to consider your proposal as a living document. If, in the course of conducting research, you discover that what you are researching yields little result, is unanswerable with the data collection instruments you have chosen, or runs into other barriers, don't hesitate to return to the proposal to update and retool it. Next stop, data collection!

Sorting and analyzing data

After you have your information in hand, **data analysis** is in order. Again, refer to Appendix A for strategies. The key here is to discover patterns regarding students or their work. What themes and ideas came up repeatedly? Are they consistent? Do they change over time? Sometimes, sorting the information you find into various configurations can yield different insights with each sort. Consider such patterns as:

» **Chronological order/stages** – categorizing the data chronologically, by importance and by frequency (e.g.,

how often an occurrence repeats) can yield interesting results.

» **Procedures/steps** – Note anything of significance that stands out as you review the procedures used or the steps taken in the study.

» **Causes/effects** – Does the research question still fit the data that is emerging?

» **Problems/solutions** – Does the data collected to address the problems identified in the research questions lead to actionable solutions?

» **Similarities/differences** – Look for what matches your assumptions/educational theory as well as what doesn't fit your expectations or theories of other researchers.

» **Relationships (human/spatial)** – Does the physical environment have any impact on participants or the data collection process and therefore findings?

» **Main ideas and themes** – Watch for ways that the data develops into categories that surface through supporting evidence.

» **Perspectives and attitudes** – Preconceived notions and bias may be variables that emerge and should be noted – context matters.

» **Best-worst/Most-least connections** – These patterns emerge when using questionnaire/survey data collection tools that ask for participants to "scale" or "rank" their preferences or responses and can provide valuable insight.

» **Defining characteristics of the population** – Information related to age (or grade), gender and learning variabilities are important factors.

» **Other variables** – Are there other factors that have been identified as influencing results – especially in an unexpected way?

Apply the action or intervention

After spending so much time engaged in researcher mode, it's easy to think that your work is done, but remember that you engaged in action research in order to figure out how effectively something is working (or not working) and where interventions or changes may be needed. The action research cycle doesn't end with a report! Take what you have learned and implement your recommendations. Notice how much more confident you are with data on your side – data that matters to you!

Presenting the findings

Finally it's important to determine what will be the best methods of reporting your findings and why. First, return to your proposal and confirm the audience that will receive your findings. It may just be data that informs your instructional practice, but it may be that this data has value beyond your classroom or school. Should the superintendent or school board see this? What about a professional organization at a conference? Would sharing it with the parent-teacher organization be a consideration? Hopefully, you can see that it's important to share the results of local action research in numerous ways and with numerous audiences to help build awareness and create understanding of the important work that educators do on a daily basis and/or highlight the achievement of students who undertake the process. For educators there are a number of communities to connect with and places/venues to do so such as:

- » **School teams, departments**
- » **Faculty meetings**
- » **School board**
- » **Professional development meetings**

- » **Social networks**
- » **Regional conferences**
- » **Professional journals**
- » **Digital portfolio**

For students the list might include opportunities to share results with or via:

- » **Other students**
- » **Faculty**
- » **School board**
- » **Parents**
- » **Community groups**
- » **Social networks**
- » **College or job applications**
- » **Digital portfolio**

Be sure to consider the limited time of your audience. Whether your audience is the curriculum director or parents via a newsletter, think about how to take your findings and present them in ways that are visually impactful. Elsewhere in this book, you will find a wide range of strategies for displaying and presenting data in charts, graphs, infographics, and other visualizations. Remember your goal is to communicate your findings in such a way as to spur others to action: to embrace your pedagogical techniques, fund interventions to close instructional gaps, volunteer in your classroom or library, and more. Think impact!

Consider these possibilities:

- » **Classify or categorize findings,** combining several smaller themes into larger patterns.

- » **Similarly, make generalizations about student work,** supporting the assertions with quotes, photos, or other evidence from student work.

- » **Alternatively,** point out notable exceptions to the pattern and why the exception merits attention.

- » **Share annotated student work or artifacts** to help your audience notice the same details, strengths, or weaknesses that you do. For example, you could share three anonymized student paragraphs, noting what makes one weak, one average, and one strong. By adding annotations, you guide your audience to see the work as you see it and to use the same vocabulary and criteria you do to describe it.

- » **Address variables or unexpected issues encountered** – Share what you learned related to unexpected results or surprises and how you handled them.

- » **Discuss supports needed such as funding, release time, or PD** – Make sure you are clear as to what is needed to take action and make progress in addressing the research problem.

- » **Predict what is next** – Often times results of one action research project leads to the identification of additional areas for investigation.

- » **Imagine what if...?**

If this is a high-profile project, you may also wish to create a single graphic that can be posted in Facebook feeds, Instagram accounts, or Twitter accounts. Easy graphic design templates from sites like Canva.com or Creative Commons-licensed icons from TheNounProject.com can give your findings a polished, professional look, even if you're not a professional artist.

As you work on sharing findings, stop occasionally to reflect. Consider these strategies to focus you and keep you energized in the final lap of your research:

- » **Return to your proposal and check that you are still on track.** Does your message convey what was learned relative to the original hypothesis?

- » **Have you incorporated any unexpected "aha" moments or surprises?**

- » **Do you need to not only share findings but also make recommendations based on those findings?**

- » **Have your findings pointed you to areas for future research or investigation?** As an iterative and reflective process, action research often leads to yet another question or problem to investigate.

While it's easy for me to make suggestions and provide pointers, the best way I can convey the action research process in action is to share a personal experience in its use and effectiveness.

Action research in action

When I worked as a Director of Library, Media and Instructional Technology in a New England school district, an Assistant Principal colleague and I, functioning as Lead Researchers, were able to use the action research model to deal with questions regarding the use of interactive whiteboards (IWBs). There were varying opinions among decision-makers in our district as to their overall effectiveness – before investing districtwide in a capital expense, we needed to gather data so our decisions were not based solely on hunches and individual perceptions.

Our district decided to solicit proposals from interested teachers in order to test-drive the technology. Proposals were vetted and grant funds used to place IWBs in selected settings across the district. The use of action research took the personal opinions, preferences, and biases of decision-makers out of the equation when we were able to boil down the Primary Research question/hypothesis to:

> "Does the use of Interactive Whiteboard Technology improve the delivery of instruction (efficiency and efficacy) and result in better student performance?"

Using what we knew about our community and its needs, we also designed our study to consider some underlying questions such as:

» **Will the technology provide increased opportunities** for differentiation related to modalities and the learning needs of Special Education students?

» **Is there a difference** in the level of engagement in learning exhibited by students during similar lessons with and without the Interactive White Board?

» **What is the total cost of ownership** for Interactive Whiteboard Technology (including deltas for support, energy, software, hardware, and training)?

» **What is the impact** (to a greater or lesser degree) on the utilization of other classroom technologies?

Next, we undertook our action research Study Design. First, teachers received training in the use of the technology. This consisted of contracting with a certified IWB trainer and providing a full-day of release time in which the teachers not only gained technical skills but determined in which of the core content areas to concentrate (and) collectively created a protocol to use the technology to deliver instruction and address selected items found in the unit assessment. Monthly after-school follow up ses-

sions were scheduled to provide support and an opportunity for teachers to share their experiences and talk about the merits and weaknesses of the technology. These discussions were recorded and the Lead Researchers noted trends and patterns.

Additional data was collected using pre- and post-intervention student questionnaires and a teacher self-assessment survey was developed and administered. We also asked teachers to keep weekly journals, in which they entered important observations made throughout the duration of the study.

Administrators and Lead Researchers engaged in regular three-minute walk-throughs to log the number of instances in which they observed IWB use and *how* it was being used. The Lead Researchers convened a series of focus groups and conducted individual interviews with both students and teachers in the Fall of the school year in which they were asked questions regarding their experiences with the IWBs. This exercise was repeated in the Spring in order to be able to compare/contrast data and determine if the IWB intervention had impact.

Finally, The research team analyzed Automated Help Desk Records to determine if there were any trends in servicing the whiteboard technology.

The Plan of Action included the following sequence:

1. **Information Technology and Library Media and Instructional Technology Directors** issued request for quotes/request for bids, for identified products and ordered equipment.
2. **Trainer Integrationist** (our job title for the person who designs and delivers professional development for instructional technology integration) developed a training plan/timeline.
3. **Information Technology Director** facilitated installation.

4. **Lead Teachers** met for a training presentation and designed a plan for using/sharing whiteboards. The group discussed elements of research important to the district in different subject areas.

5. **Lead Teachers** trained other partners/team members in small group training facilitated by District Trainer/Integrationist. Each team presented content area plans to the Assistant Superintendent/Director of Library Media and Technology.

6. **Student** samples were collected.

7. **Pre-Questionnaires/Self-Assessment Surveys/Observation** activities conducted.

8. **Teacher Journal Protocol** developed and administered.

9. **Teachers** implemented the project and conducted unit assessments.

10. **Administrators and Lead Researchers** conducted three-minute walk-throughs.

11. **Post-Questionnaires/Self-Assessment Surveys/Observation Journal Protocol** developed and administered.

12. **Student** samples for compare/contrast collected and analyzed.

13. **Data analyzed.**

14. **Recommendations made.**

The findings were reported to the local school board and shared in a publication of the district's web site. Included were a summary as well as charts, graphs, and a review of trends and excerpts from teachers' journals. Our major findings were that although teacher preparation time was significantly increased, the teacher participants all felt the time invested was worthwhile because of the results and because the ability to save and archive their lessons would pay dividends in the future and ultimately ensure more time to focus on direct instruction. Additionally it was

noted that the technology paid the best learning dividends in the areas of math and science.

In addition, surprises and lessons learned were noted such as the use of the technology for classroom managements tasks (attendance, lunch counts, etc.) and the fact that this provided additional opportunities for students to hone their skills and make use of the technology transparent. Another surprise encountered was the shift from teacher-directed learning to student-directed learning and the creation of a collaborative culture for learning. The students worked better not only as individuals, but as a group in solving problems and using higher order thinking skills to do so.

We were also careful to note variables that came into play that might have impacted the study, such as the fact that the teacher participants were highly motivated and had high-end technology skills to begin with. These educators were also willing to put in a great deal of time and received considerable training and support throughout the process. Finally, we were gratified to learn that as we were conducting our research a similar, though large-scale study was being conducted by well-known education researcher Robert Marzano, who wrote:

> ...results indicated that, in general, using interactive whiteboards was associated with a 16 percentile point gain in student achievement ..." and" Interactive whiteboards have great potential as a tool to enhance pedagogical practices in the classroom and ultimately improve student achievement. However, simply assuming that using this or any other technological tool can automatically enhance student achievement would be a mistake. As in the case with all powerful tools, teachers must use interactive whiteboards thoughtfully, in accordance with what we know about good classroom practice (Marzano 2009, 81).

Marzano's findings aligned with our own local study and mapped well to our additional conclusion that an important variable in the effective utilization of the technology is the willingness of the teacher to implement and use it to transform practice and that appropriate professional development and other support must be provided throughout in order to sustain the effort and produce positive and sustainable results.

Engaging in action research throughout the pilot project yielded several benefits to our school district. Teachers benefited through renewed understanding of the importance of development of new skills for new pedagogies and instructional design in order to successfully implement the project. Student learning was improved and their time used more effectively because they were engaged and on task as the focus was more on student-directed learning. School board members were able to see how the technology could be used, but were also cognizant of the fact that funding and support for teacher training to ramp up technology skills and especially shifting practice from teacher-driven to student-driven in the implementation would be crucial in any wide-spread adoption.

Action research and the connection to data literacy

It's easy to see how relevant action research was for our district. Imagine how powerful it could be to ask students to consider problems and questions that are relevant for them or the community. Experienced teachers and school librarians understand how action research affords a unique opportunity to provide an authentic learning experience in which students can also learn to engage personally with data and to sort, interpret, and analyze information from data. Additionally action research allows them the chance to develop and evaluate implications as well as to use data themselves to solve problems and communicate solutions. Action research can be harnessed to gather data and construct

meaning, giving important context to why and how data matters to students. This starts with discussion among teachers and school librarians to identify collaborative curriculum access points or to address problems that impact student learning in the respective content areas.

Teachers and school librarians can design instructional units in which they serve as coaches, guides, and mentors to students who undertake action research projects. This begins with assisting them to identify problems or areas of interest, pose researchable questions, and write proposals. It extends to encouraging them to anchor questions in a theoretical base whenever possible, and involves working with them to identify the best data collection tools and ways in which to approach data analysis and reporting. Finally, teachers and school librarians work to empower students to share their findings with appropriate audiences and move toward taking action that address the area of investigation.

Conclusion: Time to get your feet wet

Action research presents a unique opportunity for us to renew and refresh our professional practice as well as model and demonstrate to our students that we are engaged in using data and evidence to inform and improve that practice. As you try action research for yourself, I hope you will keep in mind that it is a process, and it is in the data analysis component that the "aha" moment occurs. Findings lead us to the development and application of interventions (the *action* in action research) and often leads to further research.

On a professional level, action research helps us to improve through continual learning and progressive problem solving. It also leads to a deeper understanding of practice and how we can relate it to the greater body of educational theory as well as

provides us with an opportunity to contribute to the community in which our work is embedded. We can share the results of local action research in numerous ways and with numerous audiences to help build awareness and create understanding of the important work we do on a daily basis.

Through the use of action research we have the opportunity to influence decision-makers and the community by validating how students learn and achieve in an information environment and because it is grounded in local actions, local processes, it can lead to local, immediate outcomes.

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Appendix A: Data instrument comparison

Interview	
Good for	In-depth exploration of an individual's thinking, work flow, work processes, problem-solving strategies, beliefs, or other ideas or feelings that may be difficult to capture in student work or artifacts; Interviewer can provide clarification if needed.
Less effective for	Quickly determining patterns across a group. Data does not provide opportunity for quantification.
How time intensive is it to collect data?	Extremely – depending on the age of the student or interviewee, interviews can last as little as five minutes for preschoolers or up to an hour for adults.
How might you record the data you find?	Use an audio recorder to capture all audio (most smartphones come with a preloaded app for this). Make notes throughout the process, noting the time stamp so you can easily go back to the recording and recapture anything you miss.
How time intensive is it to analyze this data?	Extremely. Consider working with a partner to retell the interview based on your notes.
What strategies could you use to analyze it?	Transcribe each idea on to a separate sticky note, then sort all the sticky notes into categories to identify themes, patterns or conflicts. (For more information, search online for "affinity wall" or "affinity diagram").
Other notes	Requires intense analysis.
Focus group	
Good for	Allows for "focus" type interview with a representative sample of respondents.
Less effective for	Proving structure for respondents.
How time intensive is it to collect data?	Requires determining subject availability and scheduling which can be challenging in a school setting.
How might you record the data you find?	Use an audio recorder to capture all audio (most smartphones come with a preloaded app for this). Make notes throughout the process, noting the time stamp so you can easily go back to the recording and recapture anything you miss.
How time intensive is it to analyze this data?	Extremely. Consider working with a partner to retell the interview based on your notes.
What strategies could you use to analyze it?	Transcribe each idea on to a separate sticky note, then sort all the sticky notes into categories to identify themes, patterns or conflicts. (For more information, search online for "affinity wall" or "affinity diagram").
Other notes	Requires intense analysis.

Photographs

Good for	Used in interview and focus group situations to elicit more detailed response from participants than other tools; are especially useful with visual learners.
Less effective for	Proving structure for respondents.
How time intensive is it to collect data?	Requires determining subject availability and scheduling which can be challenging in a school setting.
How might you record the data you find?	Use an audio recorder to capture all audio (most smartphones come with a preloaded app for this). Make notes throughout the process, noting the time stamp so you can easily go back to the recording and recapture anything you miss.
How time intensive is it to analyze this data?	Extremely. Consider working with a partner to retell the interview based on your notes.
What strategies could you use to analyze it?	Transcribe each idea on to a separate sticky note, then sort all the sticky notes into categories to identify themes, patterns or conflicts. (For more information, search online for "affinity wall" or "affinity diagram").
Other notes	Consider the need for photo permissions if you plan to use any photographs of students in reports or publications.

Grades/test scores

Good for	Use as evidence of student performance and instructional effectiveness and in determination of patterns/gaps.
Less effective for	Tendency to over rely on scores as the sole indicator of student understanding or teacher effectiveness.
How time intensive is it to collect data?	Depending on the instrument, can be quick/efficient or can be quick/efficient if retrieving a single data point. Evaluation over time can be time-intensive.
How might you record the data you find?	Electronic grade book and/or database.
How time intensive is it to analyze this data?	Relatively efficient.
What strategies could you use to analyze it?	Sort course or individual assignment grades from highest to lowest; compare individual scores over time; compare scores from this year to those of past years.
Other notes	Single scores do not reflect the nuances of student strengths and weaknesses the way artifacts of student work do.

Observation/field notes

Good for	Gathering first-hand comprehensive (oral and visual) data in authentic context.
Less effective for	Use when there is a need to be unobtrusive so as not to influence the subjects.

How time intensive is it to collect data?	Depending on circumstances, observation can be short and a one-time occurrence, or it can be of greater length and take place over time.
How might you record the data you find?	Audio and/or video recorder.
How time intensive is it to analyze this data?	Transcription is often required and can be time consuming.
What strategies could you use to analyze it?	Pulling out keywords and themes using qualitative data software or index cards.
Other notes	Consider using audio or video recorders (with permission) alongside notes. Record the elapsed time on the recorder next to your notes so you can quickly navigate the recording.

Checklists/charts

Good for	Quick/efficient if retrieving a single data point. Evaluation over time can be time-intensive.
Less effective for	Use when there is a need to be unobtrusive so as not to influence the subjects.
How time intensive is it to collect data?	Depending on circumstances, observation can be short and a one-time occurrence, or it can be of greater length and take place over time.
How might you record the data you find?	Tally methods to record frequencies and percentages.
How time intensive is it to analyze this data?	Easily quantifiable and can be displayed in chart format.
What strategies could you use to analyze it?	Observation of patterns; counting of items; identification of missing items.
Other notes	If checklist is paper-based, consider using a clipboard held at an angle so those being observed cannot see the questions.

Questionnaires/surveys

Good for	Rapid gathering of information to find broad patterns and source of user information (demographics). Provide means for pre/post data collection.
Less effective for	Surfacing nuance or ideas you did not think of when designing multiple choice.
How time intensive is it to collect data?	Closed-end responses can be quickly "counted" through the use of numeric value systems like Likert or rating scales; open-ended responses requiring narrative responses will take more time to sort .
How might you record the data you find?	Data collection instruments serve as the record and rating scales yield data that can be displayed in tables and charts.

How time intensive is it to analyze this data?	The formats of different questions will yield different types of data and questions may be open to interpretations; open-ended questions require more time for analysis.
What strategies could you use to analyze it?	Survey software like Google Forms, SurveyMonkey, or Qualtrics can help visualize closed responses; use coding techniques similar to those for observation/field notes for open-ended responses.
Other notes	Check with school district about where student data can be stored online so you are consistent with district policies.

Journal entries

Good for	Identifying daily habits and patterns; reflections on what is really happening; can be maintained by teacher or students.
Less effective for	More difficult to collect in a timely manner.
How time intensive is it to collect data?	Must be vigilant and intentional in recording dates and times.
How might you record the data you find?	Head notes or scratch notes LeCompte and Schensul (1999, p.31) describe head notes as, "...memories or mental notes kept ... until such time as it is possible to actually write things down." Scratch notes are jottings written right after an event when it is inappropriate to write during the event itself.
How time intensive is it to analyze this data?	Daily and/or weekly transcription into digital form to assist with trend analysis.
What strategies could you use to analyze it?	Qualitative analysis, such as assigning each concept in thee entry a separate sticky note, which are then arranged to find patterns in data.
Other notes	Prompts may be helpful for student journals.

Rubrics

Good for	Identifies criteria to measure impact; Provides authentic assessment of student learning and data regarding how students view their own progress;
Less effective for	When data must be collected in a timely manner.
How time intensive is it to collect data?	Need to be well-designed and communicated to and depending on what is being assessed can take significant time.
How might you record the data you find?	Lend themselves to numeric format and can be displayed/represented in a variety of ways.
How time intensive is it to analyze this data?	Somewhat.
What strategies could you use to analyze it?	Consider plugging the points students receive in each category into a spreadsheet so it can calculate various statistical information and reveal patterns.

Other notes	Be careful in how various categories are weighted. Check for balance in your rubric by asking yourself, "How many points are going to demonstration of understanding? How much to following directions? How many to aesthetics?"

Student products/projects

Good for	Samples of student work provide authentic evidence.
Less effective for	Occasions in which data must be pulled together rapidly.
How time intensive is it to collect data?	Need to develop a plan or schedule to collect/harvest data in an intentional manner.
How might you record the data you find?	Collect representative samples at different periods of time to provide evidence of performances and changes over time.
How time intensive is it to analyze this data?	Very.
What strategies could you use to analyze it?	See earlier sections on interviews and focus groups.
Other notes	Some families may be uncomfortable if minimal student work comes home with the student. Consider photocopies or photographs so you have a duplicate from which to work.

Portfolios

Good for	Showing growth and changes over time — artifacts maintained for continuous review.
Less effective for	When data must be collected in a timely manner.
How time intensive is it to collect data?	Need to establish criteria for determining what work will be included.
How might you record the data you find?	Collect representative samples at different periods of time to provide evidence of performances and changes over time.
How time intensive is it to analyze this data?	Very.
What strategies could you use to analyze it?	Similar to Projects.
Other notes	See notes in Projects section above.

If you have five minutes,

Share these rules of thumb in the action research cycle with students:

- Action research is problem-focused and solution-oriented.
- You must frame a problem into a researchable question.
- The question needs to be one which can be measured and evaluated.
- Data collection tools need to be carefully selected.
- Data must be sorted and analyzed in order to discover patterns and outliers.
- Analysis leads to identifying the action/s to address the problem.
- Findings should be shared and reflected upon by an authentic audience.

If you have thirty minutes,

What would action research look like in a high school classroom? Walk through these examples and ask students to begin to think about what data collection tools would be appropriate.

- **Math:** Would the introduction of a peer tutoring program be of benefit to those struggling with advanced math concepts?
- **Social Studies**: Does the difference in levels of Internet access in the home environment impact equal access to the curriculum by students?
- **Science:** Does water quality vary according to zip code?
- **English:** Do cultural and language differences impact the viewpoint of a student related to engagement with books on the required reading list.

If you have one class period,

Extend upon the examples above and engage students in conversations that lead them to how they would follow the rules of thumb as cited.

If you have multiple class periods,

Have students develop an action research proposal for each of the examples as well as extend learning to the creation of either a collaborative or school-wide action research proposal.