Making Better Data Dashboards
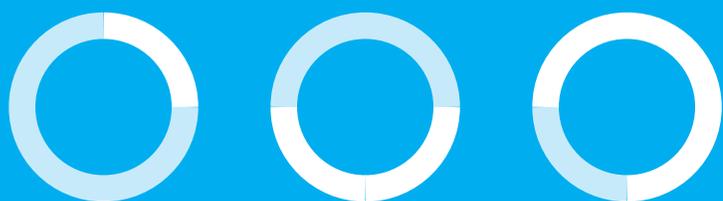
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Executive Summary

Presenting and using data in effective dashboards is a current challenge for both dashboard developers and educators. We believe one of the major roadblocks to designing better dashboards is the lack of suitable language to describe how dashboard design relates to data needs. This whitepaper presents a framework, or common vocabulary, to solve that problem.

The framework breaks dashboards into five dimensions. This framework does not attempt a one-size-fits-all solution, but rather assumes that different educators have different data needs and therefore require different dashboard designs. Each of the five dimensions of the framework can be thought of as a spectrum — one end of the spectrum is best for some educators and EdTech products, and the other end best for others. The five dimensions are:

1. Report vs. Dashboard
2. Level of Analysis
3. Mastery vs. Progress
4. Simple vs. Detailed
5. Type of Benchmarking

We also apply this framework to a list of educational data user profiles, to demonstrate how dashboard design recommendations can be generated for different kinds of data users. We suggest this framework can both *1)* help educators and developers have a more specific and useful dialogue around data needs and *2)* help researchers by providing a framework to characterize and evaluate the effectiveness of different kinds of dashboards.

I. Introduction

A field in need

In a survey of 4,600 teachers nationwide, 78% of educators reported using data regularly, yet 66% of teachers also report not feeling fully satisfied with the data and tools that they use.[1] This may be in part due to a lack of professional development for educators focused on data use, but also in part caused by poor dashboard design by education technology providers.[2] It would seem imperative that something in such high demand would receive immediate attention, focus, and improvement.

Yet the path forward is not exactly clear. Consider this quote from the same report[1]:

> *"Teachers are overwhelmed by the volume of data, [and] worry that the data lack the detail required to address the needs of individual students ..."*

In other words, the issue is that data is simultaneously too overwhelming, yet also doesn't contain enough detail. This seems nonsensical at first, but points to how dashboards fail in both respects — by not providing the right kind of overview and by not digging into the right kind of detail. Meaning, there is something fundamentally wrong with how current dashboards are being designed for the educators currently using them, and we lack the right kind of language to even express the problem clearly.

...there is something *fundamentally wrong* **with how current dashboards are being designed for the educators currently using them, and we lack the right kind of language to even express the problem clearly.**

This problem is most pressing for game-based learning. We are at a point in time where high quality and engaging educational games are available for educators,[3] and more schools are starting to use games in their classrooms.[4]

Furthermore, "data" has become one of the hottest terms in education. These three themes converge into the need for an educator-focused game data dashboard, or a way to show data from games to educators.[5]

Although effective data displays are crucial for many educational tools, they are especially critical for complex learning tools like games. It's not always obvious what learning has occurred in a game by simply watching a student play a game, and games do not always produce easily evaluated student artifacts. We also know that games are most effective when integrated into an educator's lesson plans, rather than being used separately by students and disconnected from the other learning that occurs.[6] But, for an educator to effectively use and integrate games into their teaching, they need insight into what learning occurred in the game.[7] A well-designed dashboard can provide the informative and actionable gameplay data that is most needed.

Considering the importance of this issue for digital games in specific and education technology in general, we wish to present the first steps towards making better dashboards for educators. We conducted a group brainstorming process with current teachers, former teachers, school administrators, and EdTech providers. The result of this process is a community-generated framework to understand issues in dashboard design, and how different design decisions relate to educator needs.

The process

We conducted a multi-step group brainstorming process with a mix of about 60 educators and designers at SxSWedu in March 2016 in a session titled "Making Better Teacher Dashboards". The steps are described below and will be referenced throughout this document.

[1] Teachers Know Best: Making data work for teachers and students. www.teachersknowbest.org/reports/making_data_work. Report by the Gates Foundation (2015).

[2] A survey by Lexia conducted at ISTE 2015. Only 35% of teachers had a high level of comfort in dealing with data, but 52% also felt current screener assessments did not provide clear and actionable data. http://lexialearning.com/success/press-releases/lexia-survey-assessment

[3] See any of the meta-analysis of game-based learning efficacy studies, by Clark et al. 2016, Wouter et al. 2013, or Stitzman 2011.

[4] Takeuchi, L. M., & Vaala, S. (2014). Level up learning: A national survey on teaching with digital games. New York: The Joan Ganz Cooney Center at Sesame Workshop.

[5] The National Education Technology Plan (2015). released by the U.S. Department of Education. http://tech.ed.gov/netp/

[6] See Stitzman, T. (2011). A meta-analytic examination of the instructional effectiveness of computer-based simulation games. Personnel Psychology, 64, 489-528. Also see Rowe, E., Bardar, E., & Asbell-Clarke, J. (2015). Building Bridges: Teachers Leveraging Game-Based Implicit Science Learning in Physics Classrooms. In D. Russell, & Laffey, J. (Ed.), Handbook of Research on Gaming Trends in P-12 Education. Hershey, PA: IGI Global.

[7] Fishman, B., Riconscente, M., Snider, R., Tsai, T., & Plass, J. (2014). Empowering Educators: Supporting Student Progress in the Classroom with Digital Games. Ann Arbor: University of Michigan. gamesandlearning.umich.edu/agames.

1. Ideation
The first step involved generating ideas. Participants were instructed to silently write as many answers as they could think of on sticky notes, in response to the following two writing prompts:

> *What questions do you want to answer with a dashboard?*
>
> *What actions do you want to take with that information?*

The purpose of this process was to capture the diversity of each individual's thoughts on paper. In total, 263 ideas were collected on sticky notes.

2. Sorting
The second step involved putting all sticky notes on a common space (in this case two tables in the room), and having all the participants sort the sticky notes into relevant categories. The categories were generated by participants as they read through the sticky notes, according to whatever themes they saw emerging.

This process had two purposes — first to determine what categories occurred to participants in reading through all the responses, and second, to determine how many sticky notes were created that fit into each category.

3. Voting
Once the sorting was complete, participants were given three stickers, and told to vote with those stickers on the three categories or sticky notes that were most important or relevant to them.

The purpose of this step was to determine how important each category was to the participants. This differs from the purpose of the sorting process, in that there can be an obvious category that generates a lot of sticky notes but receives very little votes, meaning everyone commonly thinks of this category but very few people strongly value the category.

4. Discussion
Once the voting concluded, we had an open discussion as a group about the ideas that were generated, the categories that surfaced, and the voting process.

The purpose of this step was to capture the main ideas of any discussions that occurred during the sorting process, or to capture any issues or tensions that might not be appropriately characterized by the generated categories and sticky notes.

5. Dashboard Critique
Next, the authors from the three organizations leading the session provided participants access to the existing dashboards from their games. Participants played through the three organization's games, and then viewed their game dashboard. Participants were invited to critique the dashboards, referencing the categories generated in the previous step whenever it made sense.

The purpose of this step was to test how the categories generated could be applied to real dashboards, and to surface common issues facing existing dashboards.

6. Final Discussion
The session ended with a final discussion to capture any last thoughts and find general similarities and differences in the critiques of the three dashboards.

7. Post-analysis
After the session, the sticky notes were further analyzed to determine any subcategories that existed within each major category, and to surface interesting trends that would be important to this paper.

Main results

The two biggest categories of sticky notes were **Content Mastery** (72 stickynotes, 26 votes) and **Next Steps** (58 stickynotes, 21 votes). The third most common category was **Interventions** (34 stickynotes, 15 votes) which we considered to be a subcategory of Next Steps. Content Mastery was a pretty straightforward grouping, with the

written notes being different variations of measuring content mastery, like "Assess different skill areas" or "What concepts have my students mastered?" Next Steps actually contained a multitude of different kinds of next steps, including next steps for:

- educators to reteach content
- educators to adjust future lesson plans
- educators to connect game-based learning to other learning
- students based on knowledge or ability
- students who need / don't need interventions

There were three categories that got a moderate amount of sticky notes and votes: **Participation/Engagement** (17 sticky notes, 9 votes), **Progress in Game** (19 sticky notes, 8 votes), and **Content Efficacy** (23 sticky notes, 6 votes).

Finally there were several categories that got a low amount of votes, and a low to medium amount of sticky notes: **Trends** (3 sticky notes, 4 votes). **Grouping** (13 sticky notes, 3 votes), **Reporting Up/Down** (6 sticky notes, 2 votes), **Time** (11 sticky notes, 1 vote), **Differentiation** (3 sticky notes, 0 votes), and **Product Info** (4 sticky notes, 0 votes).

Two high level distinctions were found across the different categories in the discussion and post-analysis of the sticky notes. First, information was requested either for individual students, or for the whole class. Even when both were desired, they were each individually and specifically called out as in this sticky note: "Identify areas of weakness individually and class as a whole."

Second, information was asked to be filtered by student across all content, or filtered by content across all students. For example, "Which students are struggling the most? Which are doing the best?" vs. "Identify activities that are the hardest for students."

The origin of a common vocabulary

We hoped our brainstorming process might produce a clear set of design principles for dashboards to follow, but unfortunately the short summary given above has much more diversity than consensus. This is particularly relevant for the most popular category, Next Steps: this category has a vague name, but a closer look finds a mixture of different specific and concrete subcategories.

It was also clear that some of these needs were incompatible — for example, information couldn't be simultaneously filtered by student across all content and filtered by content across all students. A single view has to choose between one or the other. It also wasn't clear that one option was necessarily better than the other, but that both ends of the spectrum were accomplishing different kinds of educator needs.

What we realized was being developed was a common vocabulary of terms that could describe how dashboard designs differ, and how those differences fit various educator needs. This can provide a language to both game designers and educators to better communicate what a dashboard does.

The common vocabulary

As a result of the previous process, a 5 part common vocabulary was developed. Each item in this vocabulary will be described more fully in the next section.

II. The Framework

1 Report vs. Dashboard

Report	**Dashboard**
Static, printable PDFs	Dynamic, real-time interfaces
One-time use	Used repeatedly, daily to weekly
Shareable with admins / parents	Mostly for educators / students

2 Level of Analysis

Low Level of Analysis	**High Level of Analysis**
Focus on visualizing data and patterns	Focusing on actionable insights
Leaves interpretation of data to educator	Puts interpretation of data on designer
Can require more educator time and effort to understand the data	Can be unclear why actions are being recommended

3 Mastery vs. Progress

Mastery	**Progress**
Student content / skill knowledge	Student engagement
How well they did	Time on task
Performance data	Compliance data

4 Simple vs. Detailed

Simple	**Detailed**
Easy to understand	Takes time to process
Classwide overviews	Examine data by student, class, school-levels
One view / screen	Multiple views / screens
Shows 1 dimension, by students or by content	Shows multiple dimensions simultaneously

5 Type of Benchmarking

Peer-comparisons		**Absolute Performance Standards**	
All students on platform	**Students within your class**	**Game designer defined metrics**	**Standardized testing metrics**
Compare to other students		Compare to externally established performance standards	
Relative comparisons		Absolute comparisons	

II. The Framework

1. Report vs. Dashboard

An enlightening discussion point and dashboard critique surfaced by the participants was that some of the "dashboards" being shown by the presenters were actually reports. This led to an important discussion about what the difference is between a report and a dashboard, and the appropriate use for each. At the beginning of this paper, we used the term "dashboard" to refer to any system used to display the data that results from games, since this is the term commonly used today. In fact, the 2015 National Education Technology Plan[8] also uses the term "dashboard" when discussing the importance of providing educators and other stakeholders with data. However, this term proved to be confusing during the discussion and highlighted the need for a more defined set of vocabulary to discuss data and visualizations. The distinction that was developed through that discussion provides a helpful bedrock design principle for educational data providers.

One of the key differences between reports and dashboards that was highlighted by the participants was that reports are usually static, whereas dashboards are dynamic and interactive. When asking what a dashboard is, the most common response is to refer to a car dashboard. This dashboard changes based on real-time data and gives you access to only the information that you need most often: speed and gas level. This is an example of a well-designed dashboard, since it's always up to date and shows you only the most relevant information. A common reference when discussing reports is a report card, which shows you static data up to that moment in time, and gives detail into every subject, often including additional comments from teachers. In general, a report shows all (or a defined subset) of the detailed data, and can often be printed or sent as a single document. Conversely, a dashboard is a dynamic data experience that usually starts off showing very specific, high-level data (such as car speed), but includes filtering mechanisms to craft different data views based on the user's current needs[a] (such as showing miles per gallon). Though reports can be updated with current or even real-time data, they are often a snapshot of students' current status. Dashboards continually collect data and usually surface longitudinal trends through visualizations. One participant's reaction to a presenter's dashboard was "there's too much going on here, so it's a detailed report, not a dashboard". This highlights a general assumption that dashboards should be pared down and easy to look at, whereas reports can display much more data at once.

> **This highlights a general assumption that dashboards should be pared down and** *easy to look at,* **whereas reports can display much more data at once.**

Participants strongly agreed that mastery data should be provided to educators. A report is the perfect method for showing current mastery levels or scores on a game or assessment because it is conducive to a static snapshot-style visualization. For more complex or long-term data, the developer can create real-time models or analyses within a dashboard to display information such as which students need interventions[b]. Importantly, reports and dashboards are not mutually exclusive, and some developers may find it hard to define their data displays as one category or the other. Especially when serving a diverse set of educators, developers may find that offering both methods of visualization is the best way to meet all their educators' needs. However, understanding the differences between reports and dashboards and the affordances of each will allow developers to make more informed decisions on how to clearly communicate information to educators. An educator looking for a quick, high-level view of how their whole class is doing may prefer a dashboard, whereas an educator looking for scores or grades would find what they need in a report.

> "Adjust my lesson plan based on the % of students progressing to the next level or falling behind"
>
> (a)

> "Which students would benefit from interventions?"
>
> (b)

2. Level of Analysis

The nature of the output of the data dashboard is another important area of consideration. This was made clear by a tension between presenting data and analyzing data that surfaced during the brainstorm and critique. Along with data depicting mastery, participants called out "next steps" as an essential dashboard component that was missing from the presenters' dashboards. Many participants felt that it is not enough to just show the data; the proper interpretation must also be made clear. In other words, data platforms should answer the educators' eventual question: "So what?"

Some participants wanted dashboards to take the analysis even a step further, and not only support interpretation of the data, but also tell the educator what they should do next with their student or class[c] based on that data. This was made evident by the large number of sticky notes and votes for the "Next Steps" category during the brainstorm. Providing suggested interventions and activities would reduce the load on educators and allow them to act on the data faster. This would be a welcome feature, as recent studies have shown that a majority of educators aren't confident in using data to inform their instruction.[9] However, there was some disagreement on how deep into analysis and next steps a data dashboard should go, and what facet of the class should be included in next steps suggestions. Among the 92 sticky notes related to Next Steps and interventions, participants called for next steps for teachers to adjust their instruction[d] as well as next steps for students needing interventions[e]. This suggests a consensus on the importance of using game data to influence future learning and activities, but a lack of clarity around how the data should be applied and what kind of analysis should be done.

When analyzing game data to determine next steps, the developer must make value judgments as to what the data should and should not be used for. In making these decisions, they are narrowing the use case by answering a specific question that they think is most important or the data is most relevant to. The further the developer goes into providing these next steps, the more reliant the educator is on the developer's judgment and the less likely they are to take the time to make their own judgments on what is an appropriate response to the students' data. The closer the developer stays to just presenting the data, the more they're allowing the educator to provide their own interpretation and related intervention. Furthermore, educators have a wide range of familiarity and comfort with handling data — doing too little or too much analysis could alienate educators on either side of that spectrum, while providing both can ignore the constant call for data dashboards to remain "simple".

This is an important area of discussion for developers and their users, and this conversation is likely to change in the future as educators take advantage of increased professional development opportunities around data-informed instruction. Educators who are comfortable with data and have many different questions they want to answer with the dashboard would prefer a lower level of analysis, whereas an educator who lacks the time or skills to dig into the data would look for explicit next steps. Understanding their desires and expectations around analysis and the "so what?" will help decide what the output of your data dashboard should be.

> **The closer the developer stays to** *just presenting the data,* **the more they're allowing the educator to provide their own interpretation and related intervention.**

[9] http://www.ednetinsight.com/news-alerts/from-the-editor/teachers-and-data.html

> "Inform next instructional steps, for the class in aggregate, and for individual students"
>
> (c)

> "I would like to adjust my lesson plan to target areas of need"
>
> (d)

> "Discover which Ss need support"
>
> (e)

3. Mastery vs. Progress

Participants were interested in seeing how well their students mastered the class content in the game, but also wanted the ability to review how much progress students made in completing the game. Those who talked about mastery were interested in both the classwide view of the concepts that the class mastered, but also desired the ability to identify which individual students were demonstrating skill mastery. Generally, when discussing mastery, participants were seeking ways to visualize whether students were attaining success in the game[f]. Educators using game-based tools for teaching particular skills or concepts may be more focused on mastery. When using in a school-day class, the teacher in this scenario wants to determine whether students are mastering concepts and standards that are critical to success in their class and will use these data in conjunction with other information that they regularly review. Interest in mastery data may be less critical for an educator using games in non-core subjects or outside of the school-day.

> **Tracking completion allows educators to** *intervene* **with students who may be struggling with instructions, game play, or another issue.**

In addition to successful mastery of content, participants noted that educators want to be able to track whether their students are engaged and making progress through the game. When participants generated their ideas on sticky notes about what they wanted to see and do with a dashboard, they expressed that they would measure progress in different ways using terms such as "time on task", "engagement" and "completion"[g]. Specific feedback also included an interest in being able to track how many students completed the game's objectives. Having the ability to track whether students are completing in-game tasks would help educators to identify which of their students are disengaged in the classroom and are therefore not progressing. In other words, tracking completion allows educators to intervene with students who may be struggling with instructions, game play, or another issue. Lastly, some participants viewed progress or completion as compliance data[h]. Metrics like time on task, or an indicator of whether a student completed a game episode that was assigned as homework, would give an educator an easy way to view whether students are following instructions and completing assigned activities.

During the dashboard critique, some participants voiced that it would be helpful to see evidence of content mastery within the same dashboard view as students' completion or progress. Having one place to view this interconnected information was appealing as it meant having to navigate less through several pages of information and providing a quick review of both progress and mastery. While there are some games designers that have successfully integrated these components in a seamless fashion, such as Learning Game Network, some of the participants in the session felt that these were distinct constructs and would be better viewed as their own sections of a game's dashboard. Concerns were also raised around having too much information on one screen and not being able to easily identify the important findings to act on quickly. Designers must consider whether there are simple ways to show educators what their students have completed while also providing a level of detail on student mastery that is actionable.

"Which students achieved the learning goals of the game?"

(f)

"About how much time do students spend on various tasks?"

(g)

"Has/has not played? (in the past X hours/days)?"

(h)

4. Simple vs. Detailed

The discussion highlighted the importance of providing data that show enough detail to be useful for educators while also being simple enough to be quickly understood. This clearly requires a careful balance and these desires are sometimes at odds with each other.

Consumers of data often want an overview that provides a simple understanding of what they need to know at a single glance. For instance, providing a simple view in a dashboard shows higher-level data where information is shown in summary, whereas a deeper view would show students' data broken out by some parameter(s). Participants note that educators are looking for a place to review the data from their class as they create whole-class instructional plans, but they also are interested in methods to easily share these data with their school administrators[i]. Having a simple overview of what their class accomplished would allow for easy, periodic "reporting up" to administration. These simple views also help educators to report out to parents and students, thus impacting several stakeholders, all through one simple view of a class's data. Educators using this view may want to do a daily review of students' data before and / or after a class session with limited time available to them. Furthermore, a significant benefit of a simple dashboard view is that it allows an educator to quickly make real-time decisions in a classroom as students complete tasks.

While a simple overview of a class's performance is important, participants also noted that many educators want the opportunity to more deeply explore their students' data in the dashboard. They desire the ability to drill down into given tasks, and to view data from a variety of perspectives. Participants discussed exploring data deeply in different ways

> While *"simple"* is an often used term, educators would likely find that dashboards with very few data points are not actionable.

and by different parameters, including by students[j], by standards, by content[k], and by time[l]. This deeper exploration of data would allow educators to create detailed plans for grouping students or to adjust lesson plans for the next day. While educators would review this more complex view of their data less frequently than a simple overview, a deep dive is critical for those who want to use their students' data to adjust their instructional plans on a regular basis.

It is critical that developers understand what educators are looking for when designing their dashboards. While "simple" is an often used term, educators would likely find that dashboards with very few data points are not actionable. In the session, participants consistently said that the presenters' dashboards should be simplified, yet they also emphasized the importance of various kinds of detailed information that would not be possible while also providing less information on the screen. This dichotomy suggests that participants were expressing a desire for a dashboard that is clear and easy to understand, no matter how much data is displayed or how detailed the information is. Though there is no silver bullet for designing a simple, yet detailed dashboard, extensive user testing help to determine how to present data clearly and effectively.

"Show my principal what students have learned"

(i)

"Which students are struggling the most? Which are doing the best?"

(j)

"Identify content that shows the most deficits"

(k)

"Identify historical skill/growth"

(l)

5. Type of Benchmarking

During the dashboard critique and the discussion it was clear that the data meant very little without some sort of benchmark shown for context[m]. As participants noted, by displaying comparison benchmark data, an educator is more accurately able to assess when and with whom to intervene. There were two suggested methods for benchmarking data: comparing students' scores to other students who completed the same task and comparing students' scores to a goal or ideal score. Given that games are designed to be challenging, and often deeply integrate the learning in ways that are purposefully difficult for players and educators to identify, providing some context around a game's scores helps to surface meaning.

> ...providing some context around a game's scores helps to *surface meaning.*

A peer-comparison, comparative benchmarking method allows educators to see how one student in their class is performing relative to the rest of the class[n], or how their class is performing compared with other classes[o]. This aims to give the educator some sense of where a class should be and show "typical" performance on a given task. This method is most useful when the comparison group is large and when the dashboard allows the educator to select a group that has similar qualities to his / her class[p]. For instance, an educator in a low-performing 4th grade class would not necessarily find it useful to benchmark her class against a group of high-performing 9th grade students.

Another way of benchmarking students' performance is by presenting a value for what success or mastery on a task would look like. Educators and students would be looking at their performance as it compares to a goal value, or a set level that would indicate that the students were successful or proficient on a given task. To ensure that this measure of mastery is meaningful, the tasks assessed in the game could be connected to a performance standard on an external metric, like a standardized assessment, or aligned to skills determined by the game designer. This method of benchmarking is more task-oriented than student-oriented, which may be what teachers are accustomed to when considering the goal-setting tasks that they often undertake in their day-to-day instruction.

Educators teaching in core-subject or general education classes are often focused on standards or content requirements for their students and having a performance standard would be helpful for them to determine whether their students are meeting the goals for the course. On the other hand, educators that are using games with a particular subgroup of students may want to focus on how their students compare with others with the same characteristics. For instance, English Language Learners (ELLs) may demonstrate different patterns of performance than a general population of students, making it helpful to the educator to compare her class to other ELLs rather than comparing their scores with a performance standard.

"What does success look like?" [m]

"Identify areas of weakness individually and class as a whole" [n]

"Compare results across classrooms. Find trend in common." [o]

"Compared to "similar" students, how did this student do?" [p]

III. Using the Framework

This paper started with a quote from the recent *Teachers Know Best*[10] report, which noted that a) current dashboards are insufficient, and b) we lack the language to express exactly how dashboards are insufficient. As such, it seems appropriate to end by asking the question — does the vocabulary described here help illuminate issues described in that report?

The main purpose of this paper is to develop a vocabulary to describe how dashboards differ in design, and how those designs meet different educator needs. An underlying assumption behind this process is that different educators have different needs, and one dashboard design won't work for all educators (or all products). This is consistent with the analysis in the Teachers Know Best report, which breaks educators into 6 categories of data users, each with different usage and needs. The vocabulary presented here maps very nicely onto those educator categories, and provides a useful deeper level of analysis for dashboard developers.

Let's go through the six categories of data users as defined in the *Teachers Know Best* report. Any quotes are taken directly from the report.

Data Mavens

Data Mavens are the most advanced users of data. They "focus on data collected over time, along with information about student growth, student strengths and weaknesses, and student engagement." They also believe that "every student should have a personalized learning plan." These educators are looking for **detailed student level data** about **mastery** that is shown **over time in a dashboard** and provides a **visualization for them and students to interpret** and act on. Their next steps are very student-centered.

Growth Seekers

Growth seekers also use data strongly, but mostly to "tailor what students learn by differentiating instruction in the classroom." They want "feedback on their own performance as a teacher" as well as information about students, including "time spent on task, student strengths and weaknesses, student engagement, student attendance and behavior, and ways to differentiate instruction." These educators are looking for **overviews that show whole class performance**, ideally with **actionable analysis of data** that suggests next steps for them as an educator. These educators are also interested in **detailed student information**, especially when **benchmarking against other students**, and also value **progress as much as mastery**.

Aspirational Users

Aspirational users "believe that data can help them differentiate instruction, but they often find data overwhelming." They primarily want "student strengths and weaknesses and strategies to differentiate students." These educators are looking most for **simple, overview** data that provides an **analysis of data for differentiation**, in other words they want the data to do as much work for them as possible. **Reports** will work just fine, and should focus on individual student **mastery**.

Scorekeepers

Scorekeepers are all about "assessment data that help them prepare for state tests and other high stakes measures." Their focus is on "grades in their gradebook, class averages, and assessment data that focus on the number of misconceptions and the percentage of students who meet or miss the minimum score." The primary concern of these educators is that data is **externally benchmarked**. They are looking for **reports** that create a **visualization of data**, that is **detailed in breaking out standards** but averaged over their whole class.

[10] Teachers Know Best: Making data work for teachers and students. www.teachersknowbest.org/reports/making_data_work Report by the Gates Foundation (2015).

Perceptives

Perceptives tend to rely on their own observations, and "may not identify themselves as 'number people'." Although they rely on non-digital processes more than digital tools, they are interested in information on "observations of students; students self-reflection; and information about student growth, student engagement, and ways to differentiate instruction." This is a group that self-identifies as being against digital tools and especially dashboards, so in one sense it feels wrong to characterize them in a spectrum of digital dashboard needs. On the other hand, many of their needs could be accomplished by an appropriately-designed dashboard, and it feels overly exclusive to not consider this group at all. These teachers may be satisfied with **simple** ways to **visualize and sort** analog data about students, particularly if the dashboard can **show and sort data over time**.

Traditionalists

Traditionalists focus primarily on grades and find digital tools and data "unnecessarily difficult." In additional to grades, they focus on "most frequently missed questions on assessment, and time spent on task." Like Perceptives, Traditionalists also self-identify as being against data and digital tools, and so the application of this framework must be lightly applied. Any dashboard for this group would have to emphasize **simplicity and low barrier to entry** above all else, while also covering both **progress and mastery**, with an emphasis on **external grade-like benchmarks**.

In general, this shows how explicit links can be created from educator needs to dashboard design using the vocabulary presented in this paper. The *Teachers Know Best* report provides one such categorization scheme of educators, but this framework can be applicable to any given set of educator needs or educator personas.

We hope this framework can help foster deeper dialogue between developers, educators, school administrators, and other dashboard users so that together we can understand how best to display and use data to support learning. Though we believe this is a step forward in these efforts, the landscape of educational technology is evolving quickly, and we all must change with it. The tools, pedagogies, and research-based best practices are changing at a rapid pace. Professional development opportunities are increasing and improving, which will affect the ways that those educators understand and use their data. This may change which needs are most salient to those educators, and the dashboard designs that most appeal to them. Through collaboration and conversation — with a common set of vocabulary — we can learn from each other's successes and failures and realize the potential of data dashboards for transforming education.