

Data Driven Learning and Instruction with Naiku



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Naiku is a next generation assessment platform, providing teachers with comprehensive assessment tools to help teachers collect data about their students to make informed instruction to improve learning.

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To Improve Student Learning, We Must Understand How Students Learn

In the wilderness of educational practices, programs, and interventions, ranging from charter schools, to phonics instruction, to peer instruction, one practice has been shown, time and time again, to greatly improve student learning: **feedback**. It is one of the most researched and documented ways of how students learn. In this white paper, we review the educational research literature about how students learn through feedback and how educational assessment technology can be an effective tool for teachers to improve feedback and consequently improve student learning.

What is Feedback?

Feedback is information regarding aspects of one's performance or understanding that reduces the discrepancy between what is understood and what is aimed to be understood.ⁱ According to John Hattie, Professor of Educational Psychology at the University of Auckland, the purpose of feedback is to reduce the discrepancy between current performance and a desired goal. Feedback can provide cues that capture a person's attention, direct attention to the processes to accomplish the task, provide information about erroneous hypotheses, and be motivational so that students invest more effort or skill in the task.ⁱⁱ Similarly, Valerie Shute, Professor of Educational Psychology and Learning Systems at Florida State University, argues that the goal of feedback is to enhance learning, performance, or both, engendering the formation of accurate, targeted conceptualizations and skills.ⁱⁱⁱ

Types of Feedback

Feedback comes in many forms and styles. Shute presents a summary of different types of feedback, loosely organized by complexity. In the simplest case, feedback can be **verification** -- such as giving information about whether the performance was correct or incorrect. Feedback can be **error-flagging** -- locating the mistake for learners, without providing the correct answer. At a more complex level, feedback can be **elaboration** -- providing explanations why a specific response was correct, and allowing the learner to review part of the instruction. It can be **topic-contingent** -- providing learners with

information relating to the target concept or skill being studied. It can be **response-contingent** -- providing feedback that focuses on the learners' specific responses, describing why the answer is incorrect and why the answer is correct.^{iv} Regardless of the complexity level of the feedback, Shute finds that feedback is effective when it is non-evaluative, supportive, timely, and specific. Feedback that lacks specificity may cause students to view it as useless and lead to uncertainty about how to respond to the feedback.

Feedback is effective when it is non-evaluative, supportive, timely, and specific.

Not all feedback is beneficial. Feedback produces negative learning effects when it is constructed as critical or controlling. It also has negative effects when it interrupts a student who is actively engaged in problem solving. It doesn't have positive learning effects when it is just praise on performance or effort (i.e., "you did great" or "you really tried hard").

Why Feedback Works

Hattie posits that feedback is effective because it incorporates three major questions and four major dimensions of learning.

The first question is "**where am I going?**" When students understand their goals and what success at those goals look like, then feedback is more powerful and effective. These goals should be transparent and well communicated.

The second question is related to progress feedback: **How am I going?** It is important for students to know their current status relative to the desired goal or standard. This is information about progress and how to proceed.

The third question, "**Where to Next?**" is more consequential. This helps students choose the next most

appropriate challenges, and different strategies and processes to accomplish those tasks.

Three Feedback Questions:

Where am I going?

How am I going?

Where to Next?

To maximize student learning, feedback should aim to address one or more of these questions specifically and in a timely manner. When providing feedback, teachers should be cognizant of the feedback question that it addresses.

Feedback is also effective because it can work at four levels or dimensions. First, at the **Task** level, feedback can let a student know whether the performance on the task was correct or incorrect or whether more information is needed. At the **Process** level, students are provided feedback on the strategies that are needed to perform the task. Students may be given alternative strategies to consider or use. Feedback at this level helps students learn the relationships among ideas.

Four Dimensions of Feedback:

Task

Process

Self-Regulation

Self

Third, at the **Self-Regulation** level, students monitor, direct, and regulate actions towards the learning goal. This is the capability to create internal feedback and to self-assess.

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This can be where students develop confidence in the correctness of the response. Feedback at the fourth level, **Self**, is ever present and almost useless. This is personal evaluation and affect about the learner. Praise such as "good girl" or "you're doing great" does not have positive learning effects.

Effect of Feedback

How effective is feedback? The effect on student learning and achievement can be measured by a statistic called the effect size. A value of 0 has no effect. Negative values have decreased effects; they actually hinder student learning. Positive values enhance student learning.

Across more than 800 meta-analyses and 50,000 studies, Hattie found that reducing class size has an effect size of .20.^v This translates to a 10% improvement in the rate of learning. Across all the studies, the average effect size was 0.40. The effect of feedback was 0.73, almost 4 times more powerful than reducing class size. This is in the top ten among the hundreds of programs and interventions investigated by Hattie.

Clearly, feedback is effective. It leads to improved student achievement and learning. It is most effective when it is timely, specific, and related to one of the three questions. Feedback that works at the self-regulation level, where it requires students to engage in metacognition (i.e., to think about what they know and don't know) has also been found to be most effective. Feedback should not be praise regarding effort or performance.

The average effect size of feedback is 0.73. That's four times larger than the effect of reducing class size.

Feedback and Assessment

Feedback is a fundamental process in assessment. We have to measure to know where the students are, so that we can

direct or instruct them to where they need to go. Based on assessment results, teachers can give feedback to verify the correctness of the student response. They can give feedback to explain the rationale for the correct answer and for incorrect responses.

Hattie found that feedback is most effective when it is frequent. He found that a typical student receives one piece of feedback every 25 minutes.^{vi} That's a lot of data to collect and to monitor. As Shute found in her research, feedback is most effective when it is efficiently and timely given and received.

Feedback should not be a one-way street.

In today's world of bubble sheets, scanners, and crowded classrooms, teachers find it difficult to provide timely and specific feedback to their students. Students don't find assessment feedback that comes days or weeks later informative or useful. At that time, they probably have already forgotten about the strategies they used to solve the problems on the test. It is no longer timely and relevant. Students lack a mechanism to efficiently self-assess and self-regulate. Teachers lack a mechanism to aggregate and make sense of all the feedback data. This is where assessment technology can play a pivotal role.

Also, feedback does not have to occur in a vacuum. It should not be provided just after the assessment is completed. It can and should be provided during and post assessment. And feedback should not be a one-way street. It should not be just teachers giving feedback to students. What Hattie and Shute and other researchers have found is that student self-assessment (i.e., students giving feedback about and to themselves) can be equally or even more effective than feedback solely from the teacher. In fact, Hattie found that student self-assessment and self-reported grades were shown to have the largest effect size among educational practices and interventions.^{vii}

This is where educational technology and, more specifically, educational assessment technology can greatly help teachers and students engage in effective and efficient

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feedback. A good assessment technology platform allows teachers to give more frequent and specific feedback to their students by efficiently and quickly identifying student performance by learning objective, and correlating that to additional information such as student confidence, reflection, and justification/journaling to provide a more complete picture of student performance. Online assessment platforms can provide teachers with immediate results about how their students performed on the overall assessment or on specific questions. It can provide them with feedback about the entire class, about a group of students, or about each specific student.

The Four Key Principles of Data-Driven Instruction

Data from assessments is not only a critical component of feedback, it is integral to data-driven instruction and student learning. Bambrick-Santoyo^{viii} enumerates the following four key principles of data-driven instruction.

1. **Assessment.** Creating rigorous interim assessments that provide meaningful data.
2. **Analysis.** Examining the results of assessments to correctly identify the causes of both strengths and shortcomings.
3. **Action.** Teaching more effectively what students most need to learn.
4. **Culture.** Creating an environment in which data-driven instruction can survive and thrive.

Educational Assessment Technology and Data-Driven Feedback and Instruction

When teachers use an online educational assessment system, they are able to quickly assess their students, and immediately receive feedback about their learning. They can know more than just whether the students got the answer right or wrong. They can gain knowledge about student learning by standards and gain insight into student thinking (e.g., what strategies they used and how confident they were in their answers).

A critical component of that is the analysis of assessment results. Teachers not only need to know how the entire class performed on the assessment, they need to know how they performed by learning standard by item. And teachers need to know and have ready access to how each

student performed on the test, by learning standard, and by item.

In Naiku, the Class Results report on an assessment quickly provides teachers with these data-driver information about their students. It provides an overview of how the entire class performed. It also provides results by learning standard. Scores for each student are also provided for the overall assessment, by learning standard, and by item.

Results for Math Quiz 1
Math P3-Lin

Students	15
Results	15
Items	5
Mean Score	3.00
Standard Deviation	1.73
Variance	3.00
Minimum Score	0.0
Maximum Score	5.0
Reliability	0.71
SEM	0.93

Class Average	3.0 (60.0%)
Class Lowest	0.0 (0.0%)
Class Highest	5.0 (100.0%)
Possible	5.0

80	Exceeds	7	46.67%
70	Meets	0	0.00%
60	Partially Meets	2	13.33%
0 to 60	Does Not Meet	6	40.00%

Change the cut scores permanently in your profile settings.

Student Scores

To transfer scores to your Gradebook: Open your gradebook and press F8

To export only the proficiency score (which are set to 1, 2, 3, 4) for a standard, select one before pressing the hot key: **Result score**

First Name	Last Name	Score (of 5)	CCSS.MA.6.EE.A.1	CCSS.MA.6.RP.A.1	CCSS.MA.6.RP.A.2	Confidence	Actions
Maya	Angelou	4	80.0%	100%	50%	100%	N/A
Jane	Austen	3	60.0%	50%	100%	0%	N/A
William	Blake	4	80.0%	100%	50%	100%	N/A
Elizabeth	Browning	3	60.0%	50%	50%	100%	N/A
Emily	Dickinson	5	100.0%	100%	100%	100%	N/A
Robert	Frost	4	80.0%	50%	100%	100%	N/A
Langston	Hughes	5	100.0%	100%	100%	100%	N/A
John	Keats	1	20.0%	50%	0%	0%	N/A
Henry	Longfellow	1	20.0%	0%	50%	0%	N/A
Pablo	Neruda	2	40.0%	50%	0%	100%	N/A
Sylvia	Plath	2	40.0%	50%	0%	50%	N/A
Edga	Poe	1	20.0%	0%	50%	0%	N/A
William	Shakespeare	0	0.0%	0%	0%	0%	N/A
John	Steinbeck	5	100.0%	100%	100%	100%	N/A
Walt	Whitman	5	100.0%	100%	100%	100%	N/A

The Proficiency Level scores are 1, 2, 3, 4. You can change them permanently in your Profile Settings

By Standard

Standard	Item(s)	Points Possible	Pct Correct	Proficiency Level	
- CCSS.MA.6.EE.A.1 - Write and evaluate numerical expressions invol...	3, 5	2.0	60%	Partially Meets	<input checked="" type="checkbox"/>
- CCSS.MA.6.RP.A.1 - Understand the concept of a ratio and use ratio...	1, 2	2.0	60%	Partially Meets	<input checked="" type="checkbox"/>
- CCSS.MA.6.RP.A.2 - Understand the concept of a unit rate a/b assoc...	4	1.0	60%	Partially Meets	<input checked="" type="checkbox"/>

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Additionally, Naiku provides proficiency scores (i.e., mastery scores) for each student. These scores, ranging from 1-4, are based on how students performed overall and on each learning standard.

Student Scores

To transfer scores to your Gradebook: Open your gradebook and press F8

To export only the proficiency score (which are set to 1, 2, 3, 4) for a standard, select one before pressing the hot key: **Result score**

First Name	Last Name	Overall Score Level	CCSS.MA.6.EE.A.1	CCSS.MA.6.RP.A.1	CCSS.MA.6.RP.A.2	Confidence	Actions
Maya	Angelou	4	4	1	4	N/A	Actions
Jane	Austen	2	1	4	1	N/A	Actions
William	Blake	4	4	1	4	N/A	Actions
Elizabeth	Browning	2	1	1	4	N/A	Actions
Emily	Dickinson	4	4	4	4	N/A	Actions
Robert	Frost	4	1	4	4	N/A	Actions
Langston	Hughes	4	4	4	4	N/A	Actions
John	Keats	1	1	1	1	N/A	Actions
Henry	Longfellow	1	1	1	1	N/A	Actions
Pablo	Neruda	1	1	1	4	N/A	Actions
Sylvia	Plath	1	1	1	1	N/A	Actions
Edga	Poe	1	1	1	1	N/A	Actions
William	Shakespeare	1	1	1	1	N/A	Actions
John	Steinbeck	4	4	4	4	N/A	Actions
Walt	Whitman	4	4	4	4	N/A	Actions

The Proficiency Level scores are 1, 2, 3, 4. You can change them permanently in your Profile Settings

By Standard

Standard	Item(s)	Number of Students Meets or Higher	Pct of Students	
- CCSS.MA.6.EE.A.1 - Write and evaluate numerical expressions invol...	3, 5	6	40.0%	<input checked="" type="checkbox"/>
- CCSS.MA.6.RP.A.1 - Understand the concept of a ratio and use ratio...	1, 2	6	40.0%	<input checked="" type="checkbox"/>
- CCSS.MA.6.RP.A.2 - Understand the concept of a unit rate a/b assoc...	4	9	60.0%	<input checked="" type="checkbox"/>

Bambrick-Santoyo provides a template analysis an interim assessment in Table 2.1 (page 59)^{ix}. The key components of that analysis shows how students performed overall, by item type (e.g., multiple-choice items, constructed-response items), by learning standard, and by item. It's a quick overall view of student performance. For example, by item, a teacher can quickly see which items a student got right (i.e., null or blank value in the table) and wrong (i.e., the wrong choice the student selected).

Naiku provides all of the key components of this analysis in the Class Results table under the "Show Item Scores" tab. Results for each student as well as the class average are provided for the overall assessment, by item type, and by each item.

These are all critical pieces of the data-driven instruction framework. Without quick and easy access to these types of analysis on an assessment like those provided in Naiku, teachers are typically left with nothing more than an overall score for a test.

Student Scores

To transfer scores to your Gradebook: Open your gradebook and press F8

To export only the proficiency score (which are set to 1, 2, 3, 4) for a standard, select one before pressing the hot key: **Result score**

File Name	Last Name	Total Score: PTS	Total Score: %	H/C: PTS	H/C: %	CR: PTS	CR: %	CCSS.MA.8.P.1.1	CCSS.MA.8.P.1.2	CCSS.MA.8.P.1.3	CCSS.MA.8.P.1.4	CCSS.MA.8.P.1.5
Maya	Angelou	4	80.0	2	66.7	2	100.0		C		1	1
Jane	Austen	3	60.0	2	66.7	1	50.0			C	0	1
William	Blake	4	80.0	2	66.7	2	100.0		A		1	1
Elizabeth	Browning	3	60.0	1	33.3	2	100.0		C	C	1	1
Emily	Dickinson	3	60.0	3	100.0	2	100.0				1	1
Robert	Frost	4	80.0	3	100.0	1	50.0				1	0
Langston	Hughes	3	60.0	3	100.0	2	100.0				1	1
John	Keats	1	20.0	1	33.3	0	0.0	C	A		0	0
Henry	Langfellow	1	20.0	1	33.3	0	0.0	A		D	0	0
Pablo	Neruda	2	40.0	0	0.0	2	100.0	C	C	C	1	1
Sylvia	Plath	2	40.0	1	33.3	1	50.0	A		A	0	1
Edgar	Poe	1	20.0	1	33.3	0	0.0	C		C	0	0
William	Shakespeare	0	0.0	0	0.0	0	0.0	D	D	A	0	0
John	Steinbeck	3	60.0	3	100.0	2	100.0				1	1
Walt	Whitman	3	60.0	3	100.0	2	100.0				1	1
Class Mean		3.0	60.0	1.7	57.8	1.3	65.3	60.0	60.0	53.3	60.0	66.7

Other Types of Feedback Provided by Naiku

Assessment technology platforms not only give immediate feedback, they can greatly facilitate the giving and receiving of feedback by both teachers and students. Here's a look at some of the other unique ways that Naiku incorporates and uses feedback in the assessment process.

In Naiku, students can get immediate feedback at the task level about what they got right or wrong. For example, Deb Meyer, an 8th grade teacher at Meyer Middle School in River Falls, WI, who uses Naiku with her social studies class, finds that she knows what her students understand before they step out of the room and the students know as well. With Naiku, teachers can also give feedback at the process level to their students by giving rationale statements about strategies for obtaining the correct solution or by directing them towards different new activities and challenges based on their results on that assessment.

"I love that before students step out of the room I know if they are understanding what I taught."

Deb Meyer, Social Studies Teacher, Meyer Middle School

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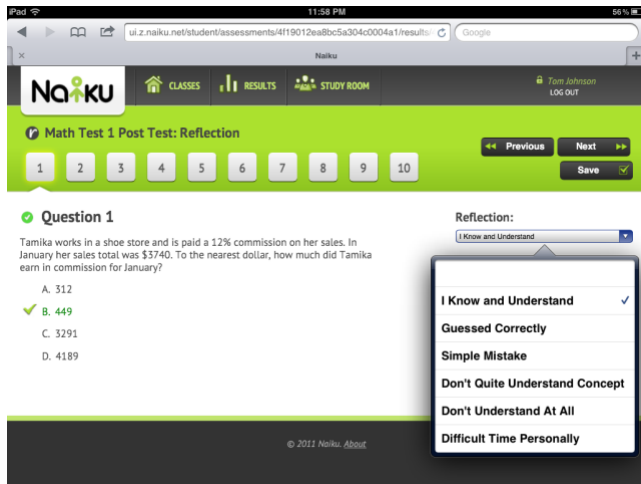
Naiku Quick Question

For daily, one-the-fly formative assessment, Naiku provide teachers with a tool called Quick Question. This is polling software that teachers can use to check for understanding at any time – whether they have an item or assessment prepared in advance or not. Did they understand today's lesson? Let's take a quick check with Quick Question. The teacher verbally asks a question, shows it on the projector, or other means, and students respond on their computer, tablet, or smart phone. Instantly, the teacher is given feedback from the students. For example, the teacher can ask an exit tag question before the class ends to see if the students understood the lesson for the day. Teachers click on Exit Tag to start accepting responses, and students respond by saying that they understood it all, some of it, or none of it. In addition, they also can tell the teacher more about that they know or do not know in a free field text entry to personalize their response.

Quick Question is essentially much like student response systems ("clickers") that are being used in many classrooms, in that teachers can receive instant feedback on student knowledge. With today's web based technology in Quick Question, however, there is no proprietary hardware needed – students can use a Smartphone, tablet, or any other web enabled device. Plus, the range of item types – including Exit Tag and Short Answer/Text, are far more versatile than the simple T/F and Multiple Choice of

the typical clicker. The best part about Quick Question, though, is that it is free formative assessment resource for teachers.

Naiku Journaling, Confidence, and Reflection



In addition to Naiku's formative assessment features, Naiku also uniquely includes a student journaling, confidence, and reflection mechanisms. Journaling is where students can set goals, reflect on those goals, and share them with their teachers. This works at the self-regulation dimension as described by Hattie. Again, this is feedback that students can give daily to themselves and to their teachers.

Another key feedback mechanism in Naiku is our Confidence feature. This is where students engage in self-assessment as they take an assessment. As they answer each test question, they can rate their level of confidence in

ⁱ Hattie, J.A. C., & Timperly, H. (2007). The power of feedback. *Review of Educational Research*, 77(1), 81-112.

ⁱⁱ Hattie, J.A.C., & Gan, M. (2011). The use of feedback to make learning visible to the teacher and learner. In R. Mayer & P. Alexander (Eds.), *Handbook of Research on Learning and Instruction*.

ⁱⁱⁱ Shute, V. J. (2008). Focus on Formative Feedback. *Review of Educational Research*, 78(1), 153 -189.

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the answer. Corresponding to this they can also explain and justify their answer. Again, this is feedback via self-assessment at the self-regulation level. Researchers have shown that when students predicted their performance in mathematics, it provoked the students to connect among mathematical ideas that they learned; which promoted understanding of mathematics. ^x

Lastly, Naiku also encourages students to reflect on their performance after the assessment. Immediately after submitting their test, students are able to review their score and individual answers. When coupled with automatically provided teacher rationale, students can quickly reflect on their answer selections and determine why they got the question right or wrong. For example, upon further reflection, a student may realize that she truly knows and understands the concept when she got the question correct, or she may realize that she guessed correctly. If the student got the question wrong, she perhaps made a simple mistake, or perhaps did not understand the concept at all. Reflection works closely with confidence. When students predict their performance by rating their confidence, and then reconcile their prediction against actual performance through reflection, they are working at the self-regulation level and are developing their meta-cognitive thinking skills.

Conclusion

Feedback is a great mechanism for improving student learning. To maximize the potential for increasing student achievement from feedback, feedback must be frequent, specific, and related to the task. Educational assessment technology platforms like Naiku can be great tools that help teachers improve learning and achievement through effective and efficient feedback.

^{iv} *ibid*

^v Hattie, J.A.C. (2009). *Visible learning: A synthesis of 800+ meta-analyses on achievement*. Oxford, UK: Routledge.

^{vi} *Ibid*.

^{vii} *Ibid*.

^{viii} Bambrick-Santoyo, P. (2019). *Driven by Data 2.0. A Practical Guide to Improve Instruction*. 2nd ed. San Francisco, CA: Jossey-Bass.

^{ix} Ibid

^x Kasmer, L. A. & Kim, O. (2012). The nature of student predictions and learning opportunities in middle school algebra. *Educational Studies in Mathematics*, 79(2), 175-191.