Practical Foundations for a Science of Education

Paul Zachos paz@acase.org

Monica De Tuya monica@acase.org

Association for the Cooperative Advancement of Science and Education

What we have been enjoying so far at this conference over the past few days have been inspiring presentations concerning science and science education.

This morning we will be considering something quite different. We will be considering the possibility of a science of education.

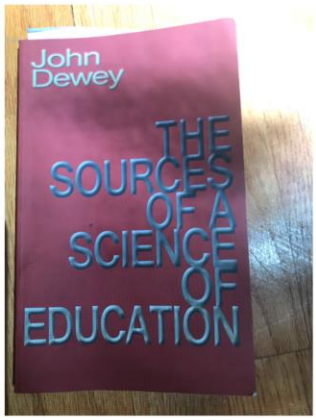
ACASE – The Association for the Cooperative Advancement of Science and Education

Our mission at ACASE is nothing less than the humanization of education in the 21st Century.
What may come as a surprise is the way we do it — through a renewal of educational assessment and evaluation.

One source of inspiration for us is the work of John Dewey, one of the foremost philosophers of the 20th Century. Here you see him on one of his visits to China where he joined Chinese educators in the development of an educational system for the new republic.

It was almost 100 years ago that Dewey posed a question: Can there be a science of education? That is, can the content and processes of education be approached scientifically?

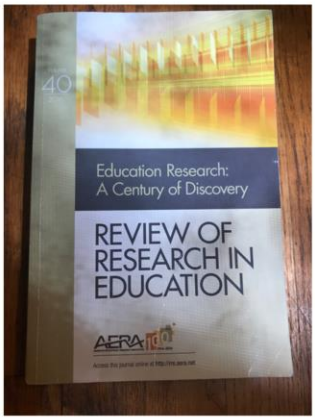
His answer was an emphatic YES.



Dewey began by pointing out that science is not restricted by subject matter. Scientific investigation can be applied to any object, any process, any event. What makes an investigation scientific is whether it is systematic and empirical.

Dewey had great hopes for the application of science to the educational enterprise.
He imagined it would lead to:

- A deepening understanding of existing facts.
- a path towards discovery of new facts.
- Confirmation of theories and practices. In fact, Dewey anticipated Karl Popper's insight that disconfirmation of theories and findings is a primary characteristic of science.
- Dewey expected that a scientific approach would increase understanding and control in education and provide liberation from dull routine and tradition.



One might think that in the ensuing century Dewey's dream was realized.

After all we have a century of educational research, so many private and public institutions and initiatives devoted to educational research. *Evidence based decision making* has become a battle cry in the field of education.

Sadly, I must inform you that John Dewey's dream has not been realized. There is a profound and simple reason for this.

The educational community has not been working with the right information and it has been misusing the information that it has.

This wrong information, this information that we are misusing is derived from High-Stakes Norm-Referenced tests.

HSNR tests

High-Stakes

Norm-referenced

What does this mean?

In *Norm Referenced* tests the meaning of the score is found in the comparison of the levels of performance of students. The scores have no other meaning.

This is the wrong information because comparative performance information on student attainment has no useful application for planning and improving teaching. It is only useful for social management in educational settings.

High Stakes means that the resulting scores are used to make decisions that affect students' lives. The entire world wide controversy surrounding testing relates to this fact. Educationally useless information is collected and applied to inappropriately make decisions that effect peoples' lives.

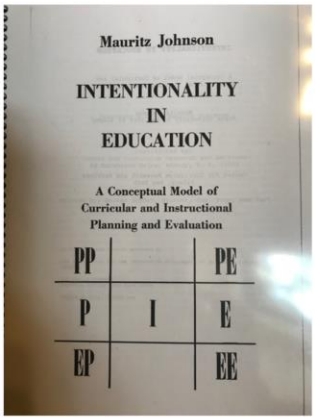
Consider conventional test scores and the results of most educational research. Can this information be used to help teachers with their everyday decisions?

By contrast Dewey saw that a science of education must provide information to teachers that will improve their decision making.

Educationally Useful Information

What makes information educationally useful is very simple — It must tell us *what was learned* and *what was not learned*. With this information, and only with this information can a teacher plan, carry out, and improve instruction.

The key to educationally useful information can be found in the work of Mauritz Johnson.



Johnson was the preeminent educational thinker of the 2nd half of the 20th Century.

Johnson made a discovery, perhaps the most critical founding contribution to educational science.

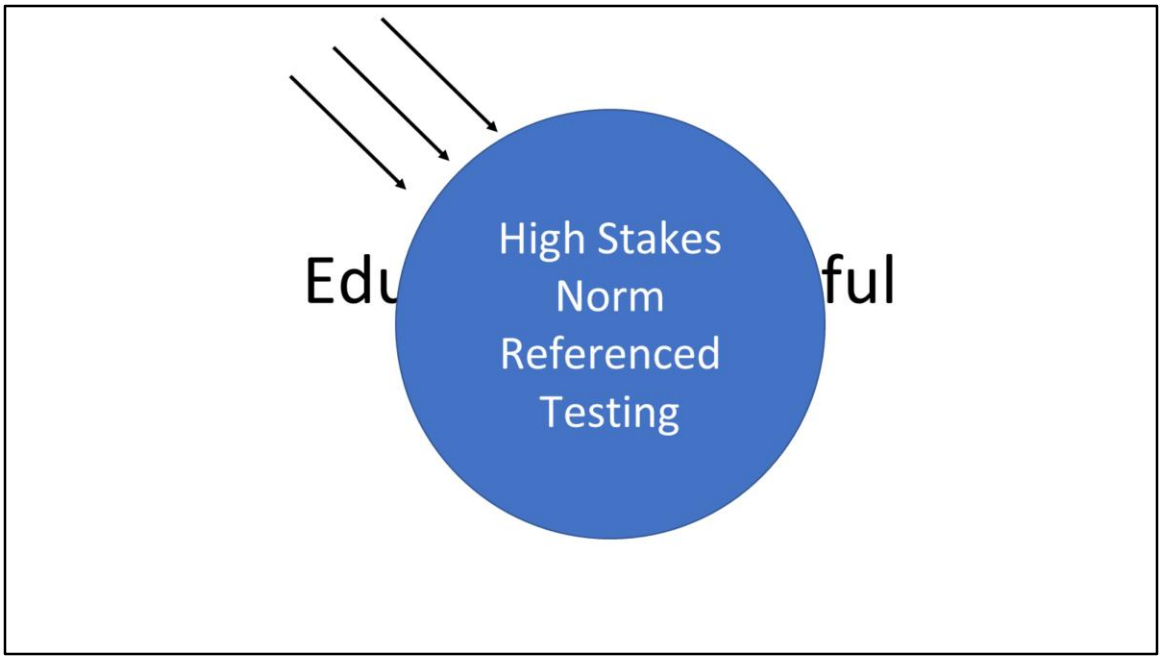
Johnson discovered that the key to systematic thinking and action in education is the *intended learning outcome* — what we expect the student to learn.

Information about what students have learned, how well they have attained the intended learning outcome, *is exactly* the information needed for educational decision making.

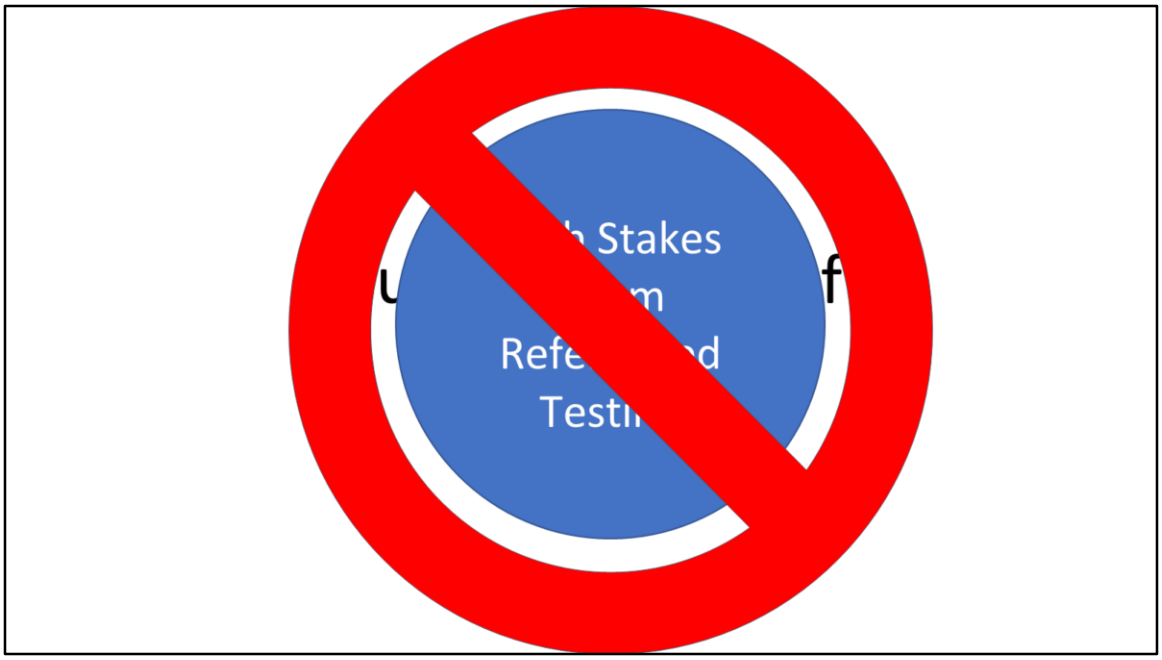
When we build norm-referenced tests we obscure that information.

Educationally Useful Information

Information on what was learned. What was not learned. That is the true basis for educational decision making, the information foundation for educational science.



HSNR summary test scores obscure the critical information the rests in the individual test items that compose them. The information that could have been used to support educational decision making is lost and misused.



Let us begin by not using that wrong information.

Let's look at what truly useful educational information is.

Practical learning goal

If we express the intended learning outcome at a level of specificity appropriate to the everyday job of teaching and learning, we have what we can call a *practical learning goal.*

Let's look at a practical learning goal.

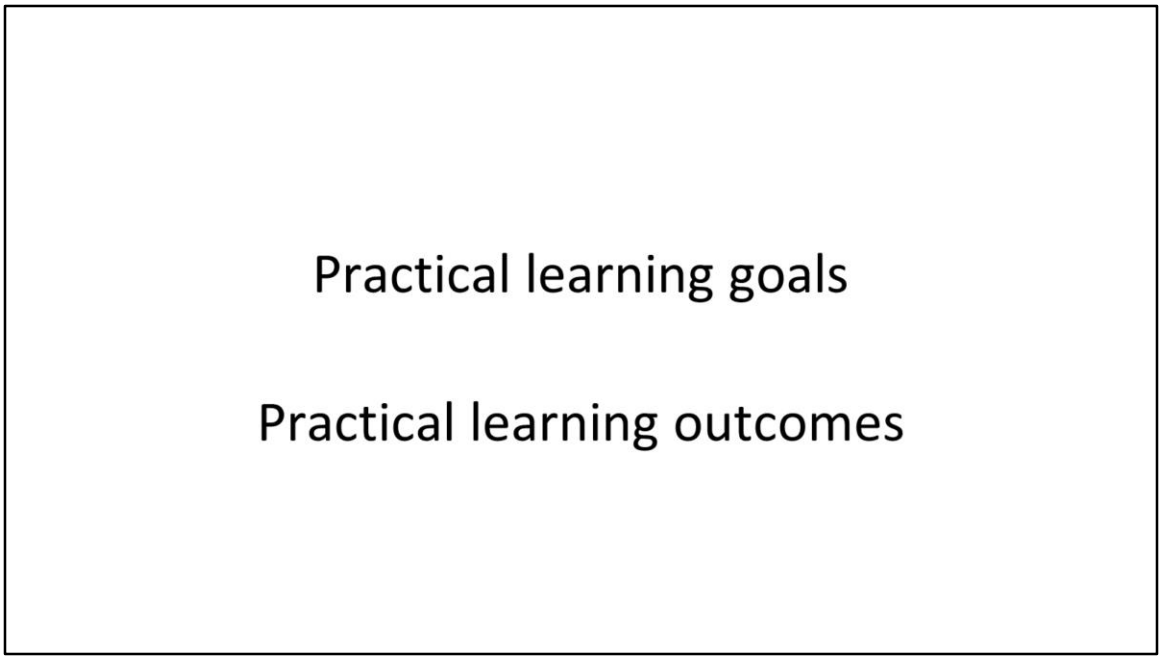
Practical Learning Goal

Density of Solid Objects

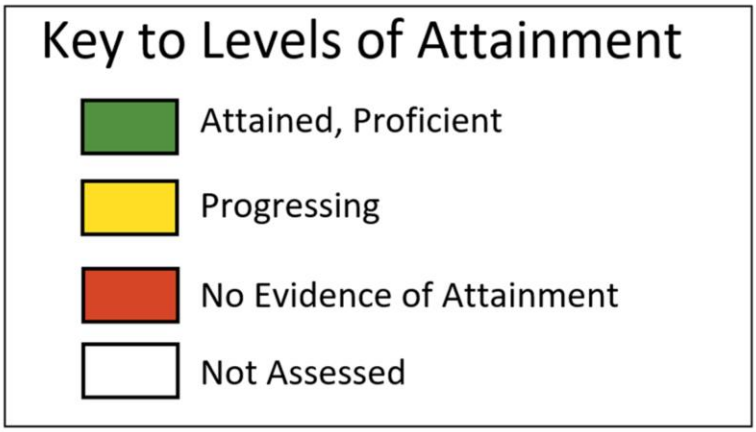
The ability to conceptualize the density of a solid object in terms of the relationship between its mass and its volume

This is the level of information needed for educational decision making. A teacher who knows how well a student has attained this learning goal has the information needed to plan, carry out, and evaluate instruction.

Let's look at the construction of that information.



When we have information on how well that learning goal has been attained we have the *practical learning outcome*. With the practical learning outcome, finally we have the unit of information telling us what was learned and what was not learned — the true information base for teacher decision making and for a science of education.



An assessment can be carried out on a practical learning goal to tell us how well it has been attained.

Let's look at this practical learning outcome. We can color code the results for the most simple display.

Red tells us we have no evidence concerning whether the student has attained the learning goal.

Yellow tells us the student is progressing regarding this learning goal.

Green tells the student has attained this learning goal at the level of proficiency that we are interested in.

This is it! The basic information concerning what was learned and what was not learned. Without that information there is no firm ground on which to evaluate what is happening in an educational program.

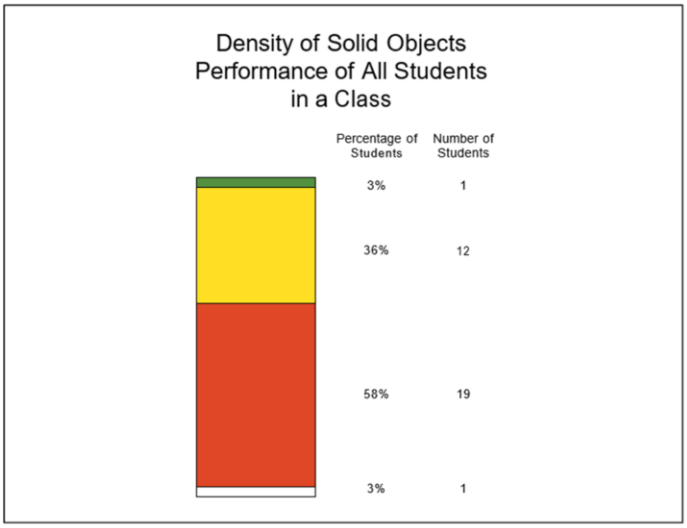
Let's look at how a classroom teacher can use such information.

But first let's give some attention to one of the inspirations for what you are about to see.

Let’s pause for a minute and pay tribute to two of the pioneer educational scientists of the 20th Century.

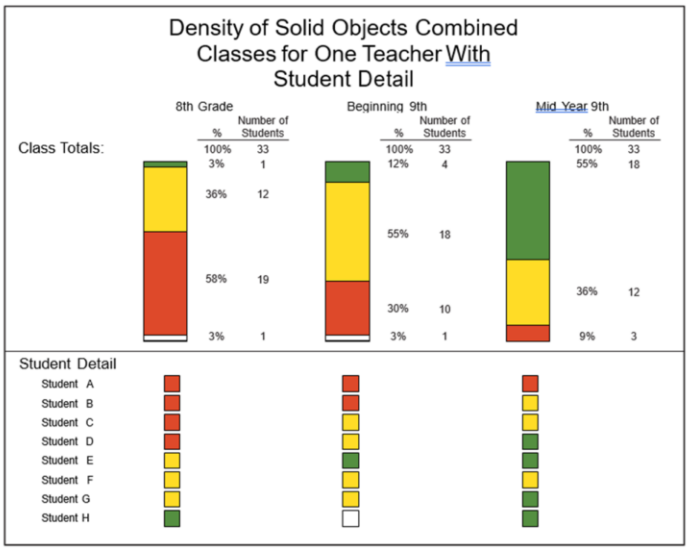
Barbel Inhelder and Jean Piaget carried out painstaking research on the growth of scientific capabilities of children from the ages of roughly 7 to 17. They observed children building and testing concepts in the presence of natural phenomena. They collected and analyzed this information at the level of practical learning outcomes, that is,

precisely the kind of information that a teacher can use for every day decision making.



Here we can look at a entire class in terms of how well they have attained the learning goal.

We can make that information even more useful.



We can see how individual students are doing as well as the class as a whole.

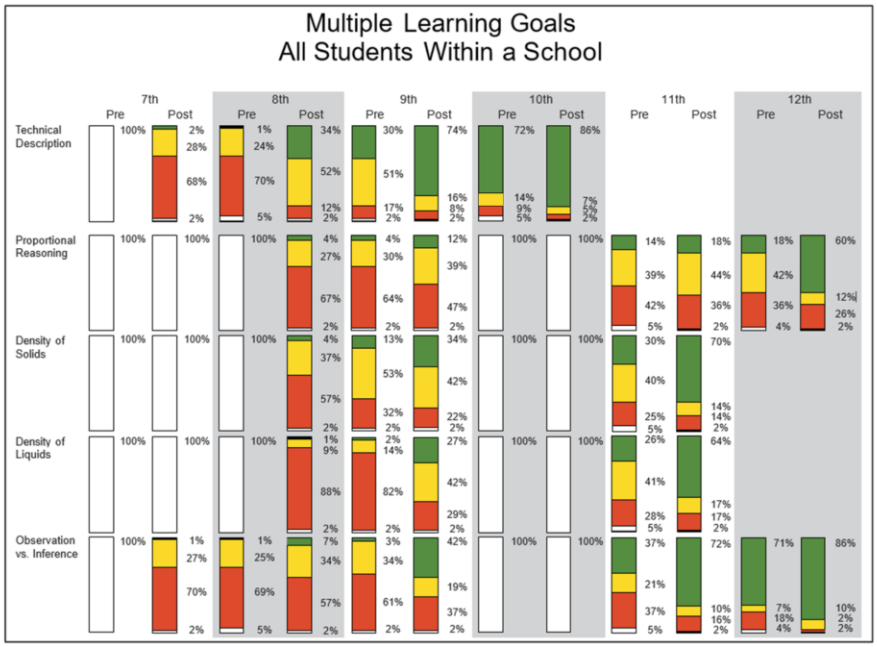
We now know **who** to teach as well as **what** to teach.

We can enhance this further by looking at student performance over time.

Here we have 3 occasions of an assessment of Density of Solid Objects.

So far we have not lost any information.

We can go further we can look at information of this kind for an entire school.



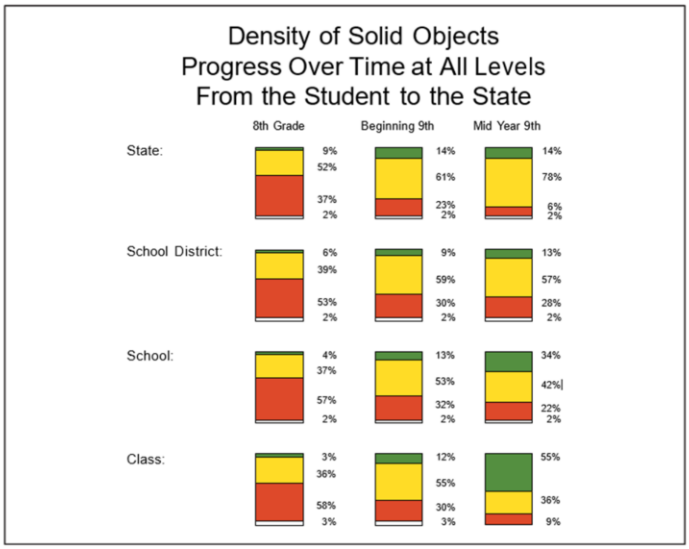
Here we have information on how well 5 different practical learning goals have been attained**, Observation** and **Technical Writing** skills as well as **Density**.

We might be tempted to take the results of our assessments of these capabilities and add them up to get a total test score.

Here is where we must be very careful. The educational value of information is lodged in the discrete practical learning goal. When we add up these discrete different learning goals we end up with a norm referenced test score, a number that has no sound educational application. We call this *mis-aggregation.* It destroys the educational usefulness of assessment information.

Here you see that we can observe each learning goal separately over time. Remarkably, the very same information that is of most

use to teachers and learners is the information most needed by supervisors and parents.



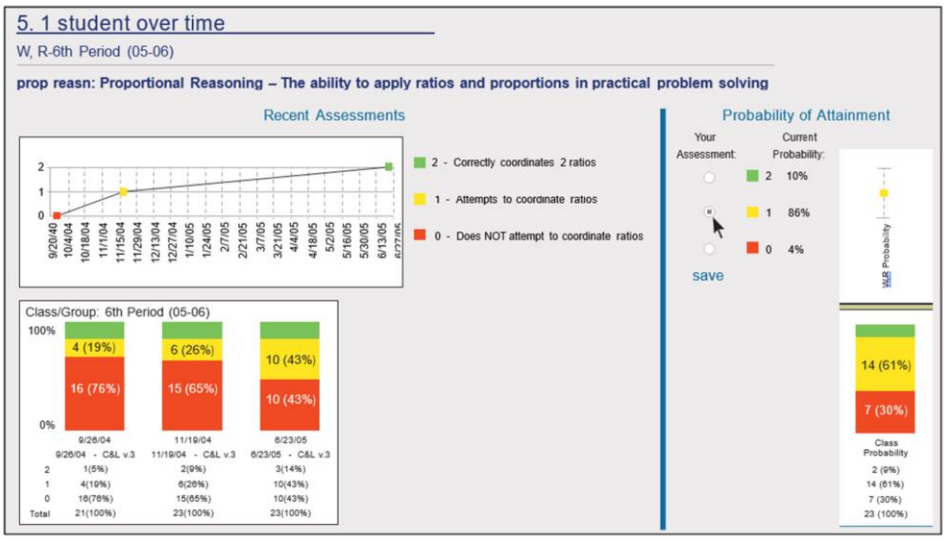
The amazing thing is that there is no limit to our ability to aggregate information in a useful way, and to do so without losing its meaning. We can move from classroom to all of a teacher's classes, to the school — even to the level of a state.

The same information collected and used by the teacher can be used to improve programs, plan professional development and make policy, for budgetary purposes and for scientific study of the effects of various conditions on attainment at any or all levels.

This speaks of a tremendous efficiency in educational information collection and use. The information that the teacher needs for everyday decisions is the same information that the supervisor, evaluator, scientist, policy maker, needs for their decisions.

We can discuss this in greater detail if you like, but first I want us to

more more deeply into the possibilities for a science of education.



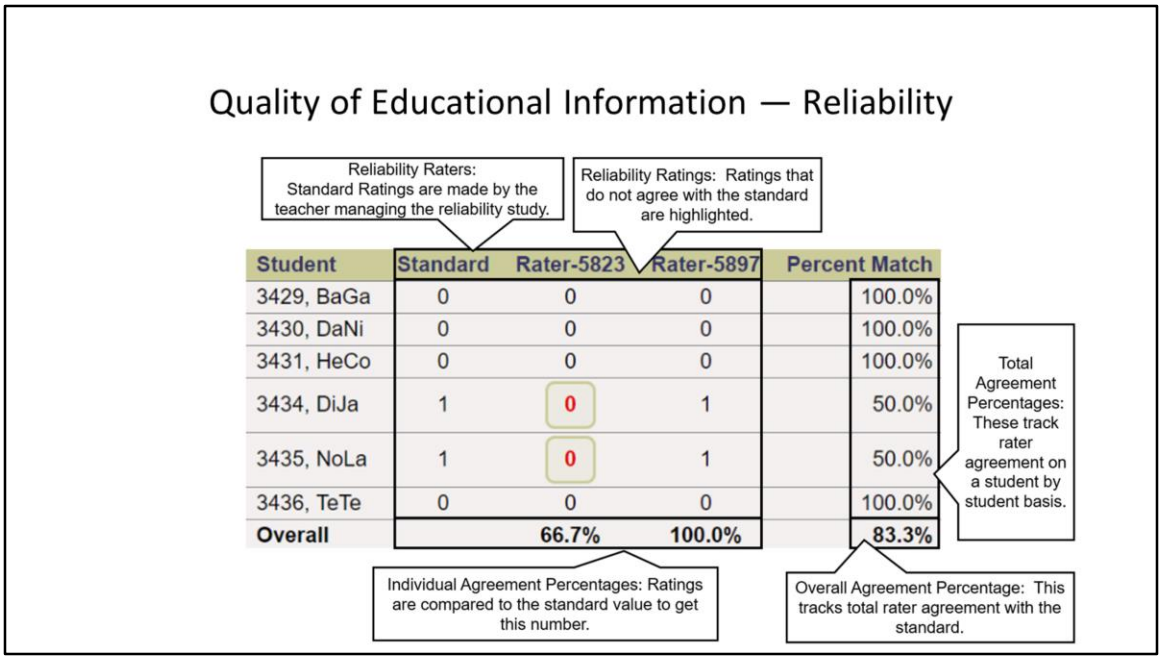
Since the beginning of this century the educational research community has been trying to bridge the abyss between their research and every day decision making by teachers.

They have failed. Why? Because they have been working almost exclusively with scores from high-stakes norm referenced tests.

Two examples are the failure of the educational research community to take the critical scientific criteria of validity and reliability and apply them to classroom assessment.

And yet these are very solvable problems if we work at

the level of practical learning outcomes, that is information from the assessment of discrete learning goals specified at a level that is meaningful and useful to teachers.



Our organization is beginning to develop ways to evaluate the validity of PLOs. But we have actually made substantial progress in building ways to establish and improve the reliability of practical learning outcomes. Our most recent work has been in this area and we believe that the problem of reliability of classroom assessments has been solved. I will be happy to discuss this further with anyone who is interested.

Let's look here at the ratings of attainment for 6 students on a learning goal such as Density of Solid objects. Let's imagine that 0 corresponds to no evidence of attainment, 1 to progressing and 2 to attained.

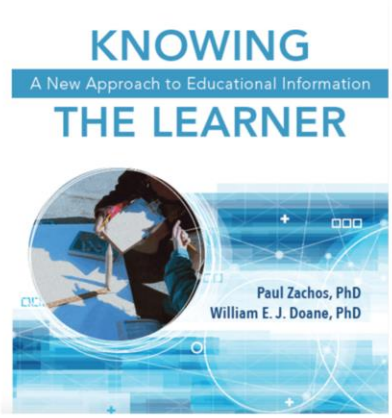
Note that there are 3 sets of ratings of student attainment, imagine that the ratings have been made by 3 different teachers.

Reliability is not very high here. Agreement is low.

But disagreement can be a wonderful thing. Why are these teachers disagreeing? Has one of them not followed the rating instructions? Are the rating instructions inadequate? Is there something deficient in the assessment or the conceptualization of the learning goal?

A study of reliability of educational information provides many opportunities for improving

an educational program or an educational research instrument.



You can find out more about this approach to educational information and a truly scientific approach to educational decision making in our book, *Knowing the Learner.*

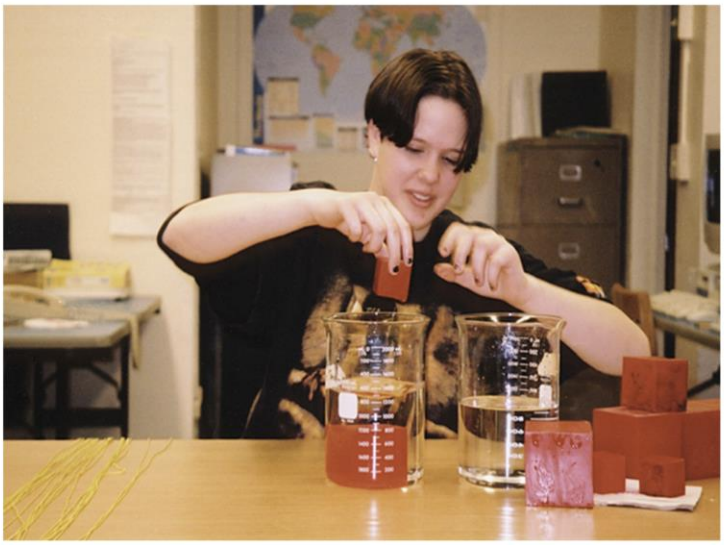
I’d like to turn now to your questions

But first let's visit our friends again.

I like to think of Jean Piaget and Barbel Inhelder, watching today's presentation and then turning to look at each other and saying,

“Yes, maybe we have made a contribution to the improvement of education.”

Thank you.



Thank you!

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