

# Science Education in Rural America:

## Adaptations for the Ivory Tower

Greg Van Doren



## Introduction

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- “The *Ivory Tower* symbolizes detachment...to protect faculty and students from *the real world*... but there are other kinds of knowledge in the world and there are other ways of conveying knowledge than that embodied in the *Ivory Tower*.”
- Ray Barnhardt (1985) *Domestication of the Ivory Tower: Institutional Adaptation to Cultural Distance*

Ideological chasms created within the ivory towers... do not have to exist everywhere.” “Perspectives can be altered, when horizons change from the edge of one’s desk to those that meet the sea or sky.” Van Doren (2010)

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Why choose an Interdisciplinary Studies Program, combining Cross-Cultural Studies with Rural Science Education?

## ● International Rice Research Institute: Rice Production Training Program



# An Extension Agronomist



## *Winter wheat woes*

GREG VAN DOREN, Bonneville County extension agent, examines shoots of winter wheat in a field that had to be irrigated earlier than usual because of hot weather and low moisture. Saturday's thundershowers were welcomed, too, but it is uncertain how long the storm system will persist through this week. (Post-Register/Monte LaOrange)

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# Conflict with the Ivory Tower

## Extension agents now specialists

By JIM HOWARD

Post-Register staff writer

Extension has moved into the com- age and joined the ranks of pro- ns requiring specialists. m management and crop pro- n have become so complex that lists are necessary to provide rs with up-to-date information rrent research, and help them management and production ms.

75 years, the University of Cooperative Extension Service ren in partnership with the U.S. tment of Agriculture to educate rs, ranchers and homemakers h county extension agents. e basic mission of the service ues to be to educate adults and outside the classroom through- aho. But today the county exten- gent is given more responsibility ntify and assign priority to pro- s," said Ray Prigge, District 4 or at Idaho Falls.

farmers are not only producers, lso business managers today," ale Harding, Madison County tural extension agent. "Conse- ly, they are faced with more chal- and depend more on extension s for technical assistance." unty agents and specialists pro- the only access to university ch and information, said Robert a farmer in the Taylor area south ho Falls.

e spend a lot of money on edu- and using the extension service only way we can benefit," Hoff. "We rely quite a bit on university ch and information, otherwise ould depend entirely on fieldmen private industry for informa-

ere are two major role changes med by today's extension agents, pared to the practices of past Prigge said. Taking the leader- ole to solve individual's or group ms is most important. Agents so held accountable by the dis- sioner—the university—and their



(Post-Register/Monte LaOrange)

Bonneville County extension agent Greg Van Doren, right, talks with Boyd Schwieder, a farmer and cattle feeder.

## County agents still make house calls

By JIM HOWARD

Post-Register staff writer

Typical of many county extension agents, Greg Van Doren still makes house calls.

While the University of Idaho Cooperative Extension Service is encouraging its county agents to solve people's problems through group ther-

ers might not be able to handle on their own. Some of those are running a financial analysis of a farm operation through a computer, checking grain testing plots, testing fields for insects or crop diseases. He also routinely sends out special mailers to keep farmers informed on new regulations or developments found through research, and conducts seminars or workshops. At

in Idaho last year, and Van Doren has been one of those constantly doing surveys to keep grain growers advised of the situation.

"I've found only one live aphid this spring while making repeated checks of winter wheat fields in the county," said Van Doren. That has led him to advise growers not to apply pesticides while they are planting spring grain.

before 1992.

This is the second ment concerning th gram here in recent scientists who tour earlier this week although they plan two robot missions decade, other facet ence program are because of a lack of

Volk, 52, is the l seven Soviet shutt some as "the wolf n wolf in Russian.) T bureaucratic dis monaut corps.

They are part c called the Flight and their training t of Zhukovsky, near Volk is technical because he flew at aboard a Soyuz spa- In his first interv reporter, given dur facilities here, th bomber pilot said to fly the shuttle in 16 of the 24 shut Soviets have perfor

The tests are ca plane modeled a resemble the real s in two other less planes that simula atmospheric flight o Volk said he pl

test soon after ret "This is a very se we're only in the be

This may come some western obs because there has t in the flights, that atmosphere had according to Soviet James Oberg.

It seems the fligh while the pilots w orbital flight of t called Buran (Sno took place on Nov hours.

Volk said the qu more Soviet shut "depends on how go."

Prominent Sov Roald Z. Sagdeyev tist, have criticize as having "absol value" and some



Twelve years, trying to find a balance between the needs of rural constituents and demands of changing university goals. Extension professors assimilated or left system...

## Aphids sault wheat

Heaven Hills  
crop stands  
suffer heavily

BY D LESTER  
Herald-Republic

Heaven Hills wheat farmers are battling yet against the Russian aphid populations have spiraled to their first appearance about three

to rapidly attack the aphid, with one hand tied behind their backs against the use of aerial spraying the northern boundary of limited control to ground application-consuming process when

covered in three days by air can with ground rigs.

is so high, each minute lost destroyed, according to one Pro for aphids this spring.

Hewick, president of Concern-unity, a group formed to parry the allegations of drift injury the inability to use aerial aphid the upper hand.

to be treated in a timely manner," said Hamilton. "The aphid, this time is quite valuable."

Greg Van Doren said aphid damage multiplied the way they

rs, people have been telling farmers they could have, but they said Van Doren, who assumed by Cooperative Extension last year haven't exploded like they have



*'The numbers haven't exploded like they have this year.'*

—Extension agent  
Greg Van Doren

TOP PHOTO: Extension agent Greg VanDoren looks for signs of the Russian wheat aphid.

BOTTOM PHOTO: These are the signs: a peeled-back leaf reveals scores of aphids on one plant.

(Staff photos  
by Roy Mustelle)

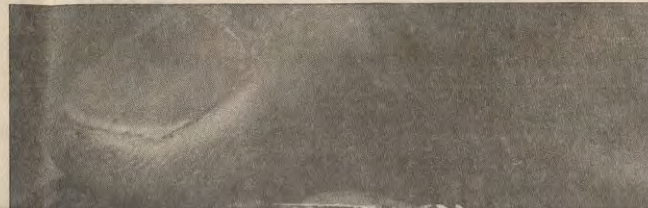
one can tell what the full impact will be."

Damage is estimated to be at least 15 percent in treated fields. Growers are suffering additional losses where the tires of spray rigs trample another 5 percent of the grain.

Aphid damage is in addition to severe drought stress that caused some growers to plow out entire fields of spring grain.

Growers planted more spring grain because of poor moisture, Hamilton estimates there may be as much as 40,000 spring grain acres in the Horse Heavens this year. Rain in late May and early June came too late for many stands and half the total planting is already or about to be plowed under.

Pike said the aphid appears to prefer sparser stands



## Jim Hightower: “Hard Tomatoes, Hard Times: Failure of the Land Grant College Complex” 1972

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- Rural people, including the vast majority of farmers, farm workers, small town businessmen and residents, and the rural poor, either are ignored or directly abused by the land grant effort. Each year about a million of these people pour out of rural America into the cities. They are the waste products of an agricultural revolution designed within the land grant complex. Today's urban crisis is a consequence of failure in rural America. The land grant complex cannot shoulder all the blame for that failure, but no single institution—private or public—has played a more crucial role.



Hightower's lament repeated in rural Mozambique. A warning message...

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# How Much Formal Education is Needed to Teach Science?





# Teach or Sit in an Office?

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For the past ten years, I have been back inside the ivory towers, a certified secondary science teacher and professor who has taught nearly 30 different university science courses, the PI of a major NSF-STEP grant. I learned to assimilate\* youth into Western Science, and am very good at it...but to what end? Where are the university faculty willing to adapt to the cultures around them? Is it detachment or fear? Out there, control is...





...not always in the hands of faculty; as a learner, the one who is usually the teacher often becomes uncomfortable, won't risk embarrassment, is unwilling to adapt. Many become nervous observers, but observance is not the same as experience, and most return to the towers never having tasted the water.



Because too few Westerners adapted to the indigenous cultures around them, they tried to force the people to assimilate into theirs. Those people have not forgotten. Today, political parties and ideologues are struggling for power to influence the minds of youth in the largest compulsory education system ever.

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“the responsibilities of field-based faculty members have had to extend beyond the usual generation and conveyance of literate knowledge, to include the institutional legitimation of indigenous knowledge and skills.”

Ray Barnhardt, 1985.



Witherspoon and Peterson (1995) documented how Navajo language is deeply connected to the physical landscape of their homeland, their art, customs, worldview and cosmology. Angayuqaq Oscar Kawagley, an Alaskan Native, provided numerous details about the Yupiaq worldview (Kawagley, 1995), which have emphasized the importance of place, language and experiences upon worldview.

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“Because Native science is thoroughly wrapped in a blanket of metaphor, expressed in story, art, community, dance, song, ritual, astronomical knowledge, and technologies such as hunting, fishing, farming, or healing, rationalistic scientists, its “younger brothers,” have difficulty understanding its essence of creative participation with nature.” (Cajete, 2000)

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Witherspoon and Peterson (1995) wrote that in a Western worldview “the ontological focus has been on the fundamental and smallest building blocks of the universe that can be isolated.” Cajete (2000) claimed that a dysfunctional cosmology, in which humans perceived of the world as material property, without life or spirit, not only resulted in the domination of Indigenous peoples, but has caused “ambiguity, conflict and tension . . . at all levels of modern life”

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# Ebony within Ivory Towers

Yakima Valley schools have terrible science , mathematics and reading competencies in WA state, yet have received \$ millions to “remedy the\* problem.”

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- Taking on NSTA's 2007 statement:
- For science to be taught properly and effectively, labs must be an integral part of the science curriculum.
- The National Science Teachers Association (NSTA) recommends that all preK–16 teachers of science provide instruction with a priority on making observations and gathering evidence, much of which students experience in the lab or the field, to help students develop a deep understanding of the science content, as well as an understanding of the nature of science, the attitudes of science, and the skills of scientific reasoning. (para. 2)



# Ebony within the Ivory Tower

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## ● NSTA position statement continued:

- NSTA strongly believes that developmentally appropriate laboratory investigations are essential for students of all ages and ability levels. They should not be a rote exercise in which students are merely following directions, as though they were reading a cookbook, nor should they be a superfluous afterthought that is only tangentially related to the instructional sequence of content. Properly designed laboratory investigations should:
  - have a definite purpose that is communicated clearly to students;
  - focus on the processes of science as a way to convey content;
  - incorporate ongoing student reflection and discussion; and
  - enable students to develop safe and conscientious lab habits and procedures. (para. 3)

Ten years, as a professor in a small university on the Yakama Reservation. The ivory towers have not changed that much – even though our mission is to “the under-represented, under-served”

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- “.....Our Native graduate students were supposed to cite refereed articles, written by people who knew nothing about us.”
- Interview with a Yakama Elder, 2010
- (context: oral histories not accepted as scholarly resources)



# Personal PhD Research Project Requirements

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- Must support and validate field-based programs (for faculty who believe in them)
- Must provide evidence to ivory towers of learning
- Must not force beliefs and values of one culture upon another

## The research:

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- NSF-SENCER-SALG surveys compared student assessments of learning gains in introductory chemistry courses for non majors at two universities (UAF and HU) with responses of participants in community chemistry workshops.
- Designed to evaluate *attitudes* towards chemistry, not quantify actual knowledge.



# Evaluation

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- Goal was to examine participant responses for indications that the SENCER-SALG could substitute for quantitative assessments and inform field-based faculty of relative educational successes or failures, as they endeavored to adapt university science to local communities. This study focused on level 4 evidence, *reactions*, of Bennett's model for program evaluation (Bennett, 1976). These *reactions* are critical to evaluation, yet commonly overlooked in education and extension programs.

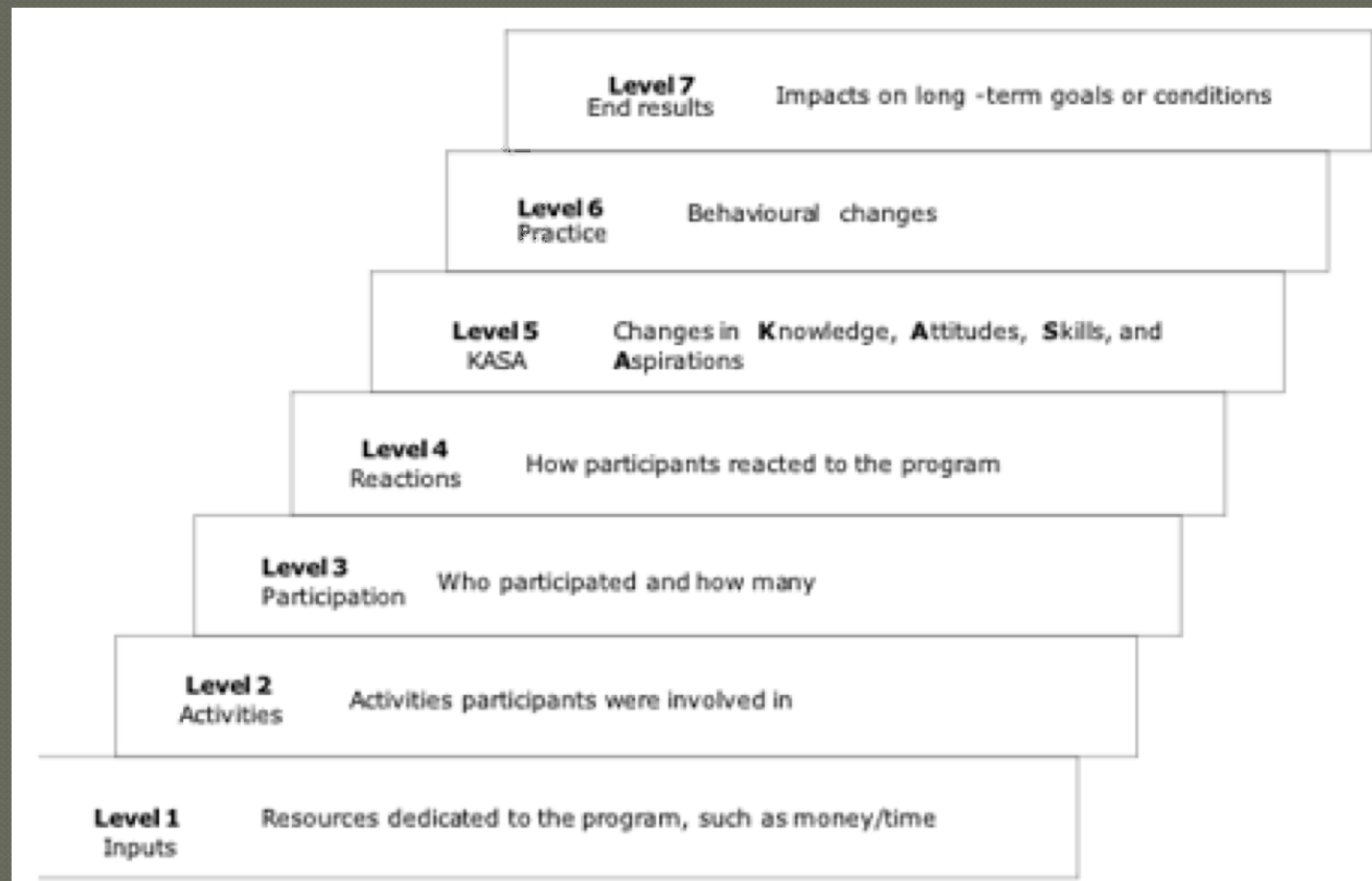
# Evidence (Boyle, 1981)

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- Evidence is an indication, or an outward sign. In evaluation, evidence is composed of:
  - 1 Acts, words, numbers, or things that provide a sign or indication
  - 2 That which provides proof of the extent to which the quality we are examining is present in a program
  - 3 That which, when accumulated into a pattern, provides a picture adequate for judging the extent to which criteria have been met...
- Evidence can be what people say. . . . It can be what actually occurs or what people think occurs. . . . Records of behavior are the usually accepted evidence about the accomplishments of a program. . . . Ratings on attitude scales when the program deals with the affective domain. (pp. 226-7)



# Bennett's Hierarchy of Evidence. Source: Bennett, 1976



# Correlation with Direct Assessments

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- Falchikov and Boud (1989) conducted a meta-analysis study, which compared faculty and student ratings of student performance to direct assessments of student performance. They found that students rated themselves higher than faculty rated them, in absolute terms, but that the average correlation ( $r=.39$ ) was significant. Similarly, SALG researchers (Weston & Seymour, 2006) achieved an average correlation between direct assessments and student self-assessments of  $r=.41$ . While the correlations were moderate, both studies correlated higher self-assessments to higher levels of achievement, as measured by direct assessments. The SENCER-SALG was not intended to substitute for direct assessments used in formal classrooms, but in the absence of direct assessments, the correlation research suggested that SALG responses would provide evidence of learning within informal settings.



# A tool for outside the ivory towers

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- The SENCER-SALG was examined, within informal science education settings, to see if it could inform field-based faculty, who could then modify science education activities and content, “as collaborators in the search for new understandings and new ways of doing things that will build upon, expand, and give recognition to all forms of knowledge” (Barnhardt, 1986, p. 8).
- Because the SENCER-SALG measures attitudes towards learning science, confidence about gains in science literacy, civic engagement interests, future interests in studying science; because it can associate gains in science literacy and general science skills with projects and field work; and because SENCER staff, already familiar with institutional barriers to course implementation, can assist faculty with new courses, it was believed that these instrument and organizational attributes could assist field-based faculty.

# Example of the SENCER-SALG Results

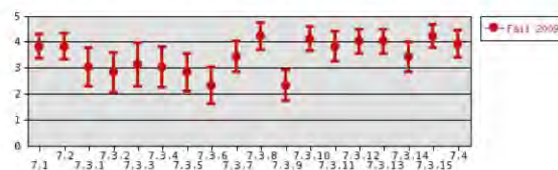
SALG - Student Assessment of their Learning Gains

<http://salgsite.org/analysis/11891>

7.3.5 Scientific names for dyes and pigments	6%	2%	9%	4%	2%	11%
7.3.6 Local or ethnic names for dyes and pigments	9%	0%	9%	4%	0%	11%
7.3.7 How ideas in this class relate to science in other cultures	4%	2%	6%	15%	4%	4%
7.3.8 The chemistry term "pH"	0%	4%	6%	4%	20%	0%
7.3.9 The chemistry term "mordant"	9%	7%	9%	2%	2%	4%
7.3.10 The periodic table of the elements	0%	4%	4%	11%	15%	0%
7.3.11 Charges and how they determine formulas and compounds	2%	4%	6%	9%	13%	0%
7.3.12 Names of elements and compounds	0%	4%	6%	11%	13%	0%
7.3.13 Balancing equations	0%	2%	11%	6%	15%	0%
7.3.14 Phase changes	4%	2%	11%	9%	6%	2%
7.3.15 How this course relates people to world issues	0%	2%	7%	7%	17%	0%
7.4 How ideas from this class relate to ideas encountered in classes outside of this subject area	2%	2%	6%	13%	11%	0%
7.5 Please comment on HOW YOUR UNDERSTANDING OF THE SUBJECT HAS CHANGED as a result of this class.	<a href="#">Enter codes for text answers</a>					
7.6 Please comment on how THE WAY THIS CLASS WAS TAUGHT helps you REMEMBER key ideas.	<a href="#">Enter codes for text answers</a>					

## Summary of scale results

The graphic below lists the mean and confidence interval ( $\pm 3$  times the standard error) for each item.



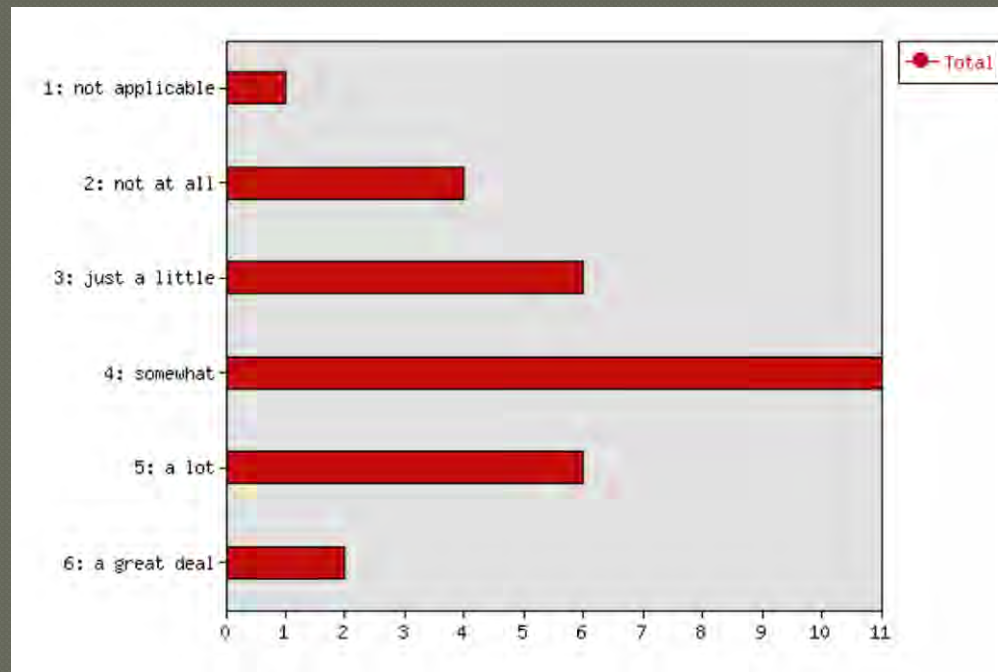
## Increases in your skills

8. As a result of your work in this class, what GAINS DID YOU MAKE in the following SKILLS?	1: no gains	2: a little gain	3: moderate gain	4: good gain	5: great gain	9: not applicable
8.1 Finding articles relevant to a particular problem in professional journals or elsewhere	7%	7%	6%	11%	2%	0%
8.2 Critically reading articles about issues raised in class	7%	2%	9%	11%	4%	0%
8.3 Identifying patterns in data	7%	0%	9%	9%	7%	0%
8.4 Recognizing a sound argument and appropriate use of evidence	7%	0%	9%	7%	9%	0%
8.5 Writing documents in discipline-appropriate style and format	7%	2%	13%	2%	6%	4%
8.6 Working effectively with others	4%	4%	4%	17%	6%	0%
8.7 Working with laboratory supplies	2%	2%	4%	15%	11%	0%
8.8 Observing and learning from results	4%	2%	2%	15%	11%	0%



# UAF Pre-Course Survey Responses

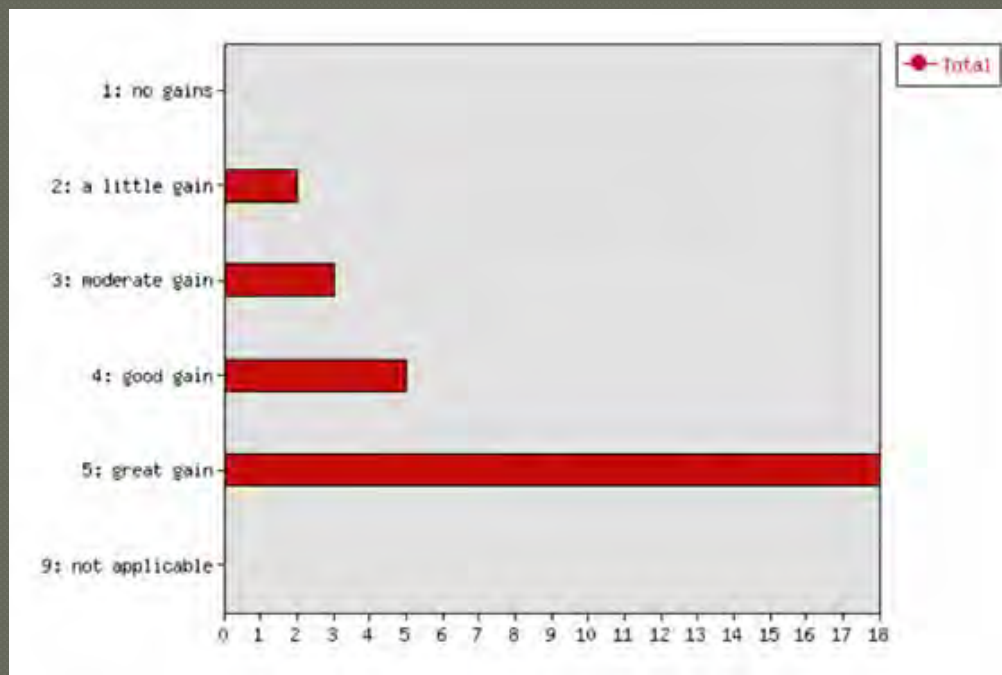
- “Presently I understand pH”:



# UAF Post-Course Survey Responses

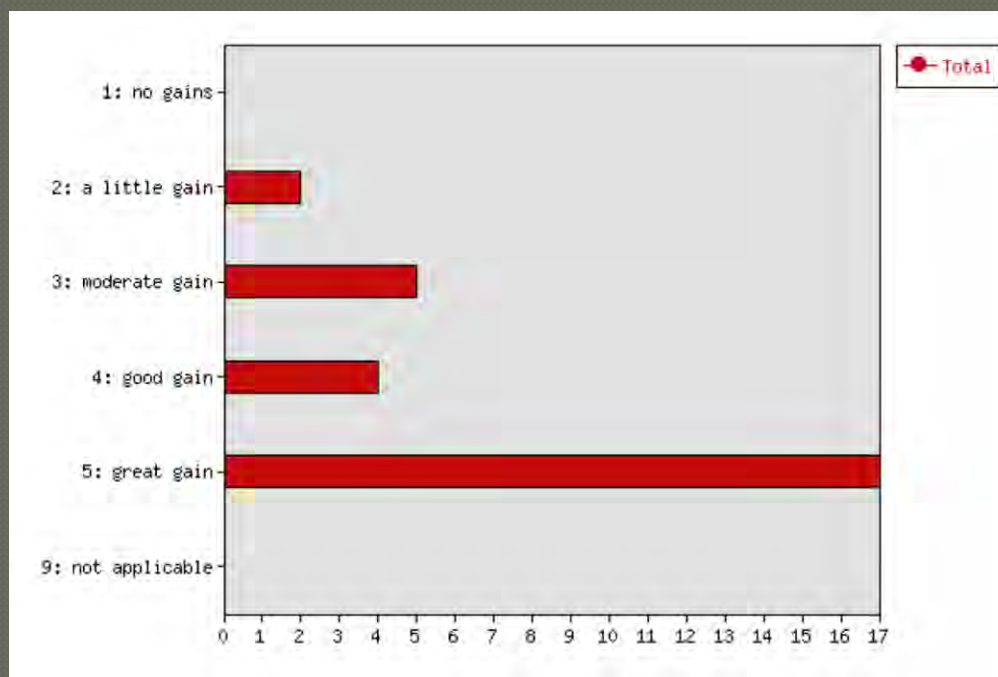
Note: correlation of gains to prior understanding

- “As a result of your work in this class, what GAINS DID YOU MAKE in your UNDERSTANDING of each of the following?” (the chemistry term pH)



# The UAF CHEM 100 course is an issues-based course, utilizing text “Chemistry in Context”

- Response to: “how course relates people to world issues”





Why is understanding pH such a big deal?

It matters in agriculture, in solution chemistry, and biology.

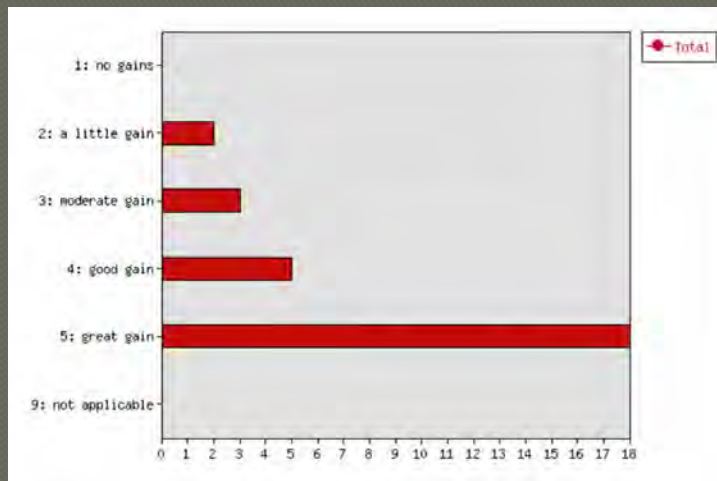
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- Students, who had successfully passed examinations in prior semesters, indicated they neither remembered the science concepts as generalizations (acidity, defined as  $\text{pH} = -\log [\text{H}^+]$ ), nor grasped the synthetic processes chemists use to answer questions. Group numbers describe the number of an element's valence electrons; stable electron configurations and the Octet Rule are used to predict and describe changes in the number of valence electrons and resultant charges for ionizing elements. In soils, cation exchange capacity (CEC) is affected by the number of charges each cation carries and by soil pH. CEC increases as pH increases, etc.

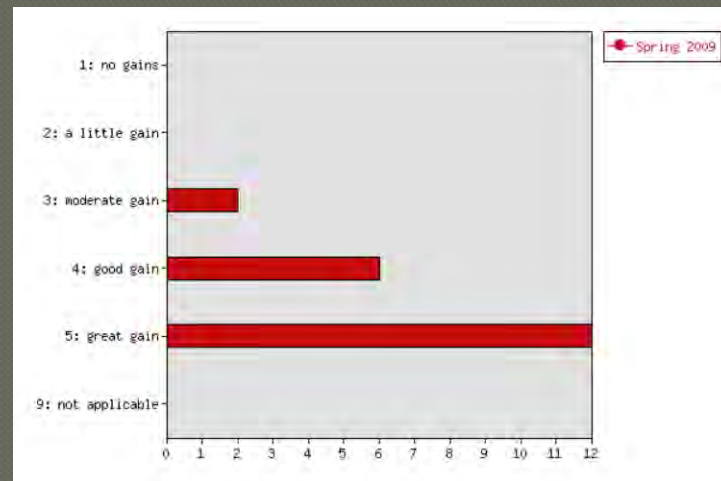
# UAF and HU Learning Gains Reported for “pH”

- The HU course substituted natural dye labs for standard pH labs

## ● UAF



## HU



# University course comparisons

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- The surveys indicated generally that students did not claim learning gains for content not included in the course; many UAF students either reported “no gain” or “not applicable,” for questions related to dyes and pigments, which were not part of the UAF CHEM 100 course. While there were variations among responses, with some students reporting learning gains for content not taught; the survey results were similar to those obtained by other SALG researchers, the data support moderate correlations between direct assessment and the SALG, as reported by Weston and Seymour (2006).



The confounding of prior knowledge with interest has been a major methodological flaw in educational research (Baldwin, et al., 1985)

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- If the reading research can be extrapolated, then introductory chemistry students should comprehend the subject better, if they either have some prior knowledge or an interest in the subject. If both prior knowledge and subject interest occur, there should be additive effects upon their comprehension. The UAF course associated current issues with chemistry principles and student knowledge, to stimulate student interest in chemistry. The HU course associated traditional knowledge and customs with chemistry principles, to build upon prior knowledge. The SENCER-SALG survey results, in learning gains, were comparable for either approach.

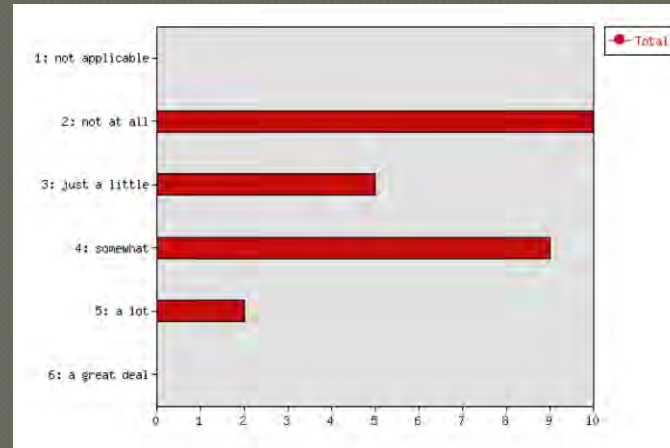
## How did the SALG perform outside the university?

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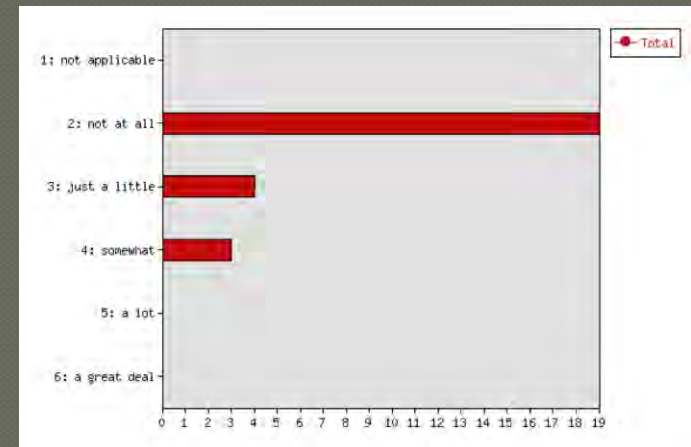
- A two-day, 6-hour workshop was held for weavers at the Tamastlikt Cultural Center, in Pendleton, Oregon. Over 20 weavers and artists attended, from three states, with several Native American Elders among them.
- Principles of pH were presented with natural dyes, as in the HU laboratory sessions.

# Tamastlikt Pre-Workshop Responses

● Understand pH



● How pH changes colors





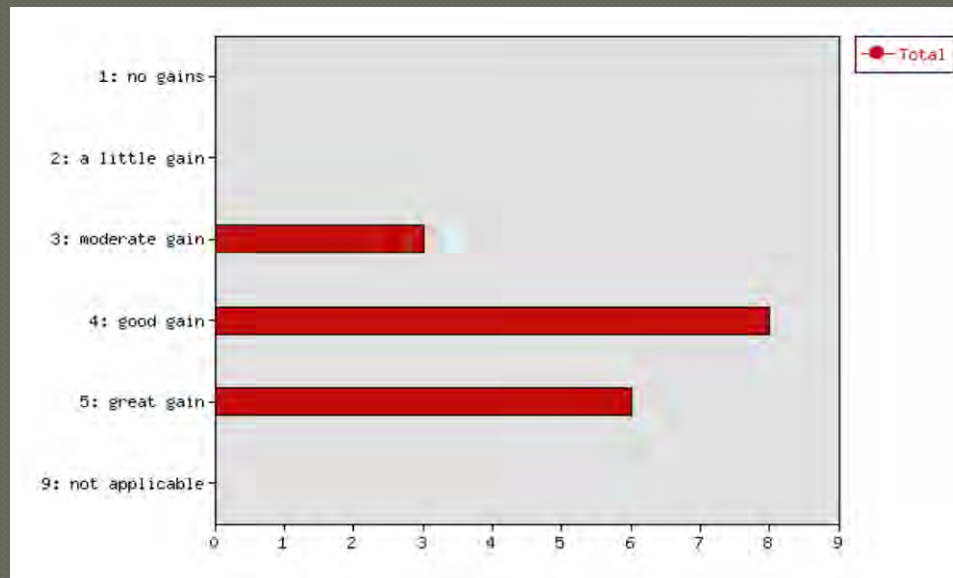
# Tamastlikt Post-Workshop Responses

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- In the Tamastlikt post-workshop survey, the highest gains were reported for “the importance of dyes and pigments to my culture” and “how to obtain and extract dyes and pigments.” As in every other pre/post survey, the highest pre-workshop understandings directly correlated to the highest gains reported in the post-workshop survey, with the exception of “the chemistry term pH.” Although pH was the main concept taught in the workshop, it was the application of the concept (using pH to change colors) that resulted in “how to obtain and extract dyes and pigments” being the highest gains reported in the post-workshop survey.

# Tamastlikt Post-Workshop Response

- “how to obtain/extract dyes and pigments



The SENCER-SALG not only provided quantitative data, but also a wealth of qualitative information. While this study focused on the “understanding” question-stems, educational researchers, experienced in qualitative research methods, might find that SENCER-SALG written responses, in all of the other question-stems combined, could supplement qualitative research methods.

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- “ I really haven’t learned very much about the main concepts of basic chemistry, I am still crumby at balancing equations, I still don’t know anything about reactions or elements...I could not stay afloat in any other chem classes” (UAF CHEM 100)
- “I have learned a lot in this class, however my understanding of it all is still somewhat vague.” (HU CHEM 101)
- “I started seeing the difference between science and public value issues. Many times we try to mix those two. It also encouraged me to learn more about the protection of our enviornemnt. My firend works in European Comission in Brusell and I asked her to send me some information about what they are doing. She did. So it was very relevant and interesting to read in those brouchers concepts that we actually learned in class.” (UAF CHEM 100)



Sometimes, an isolated response can be discouraging:

“I already knew most of the stuff he talked about.” (High school workshop)  
The combined SENCER-SALG responses from an unidentifiable individual can be evaluated.

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- 1: “It helped me learning by showing me that I can say my opinion and not being shy about not being right.”
- 2: “I did say a few things on topics that I remembered or know the answers to.”
- 3: “I learned something new.”
- 4: “I already feel comfortable with my peers.”
- 5: “I already knew most of the stuff he talked about.”
- 6: “He taught it with a lot of interaction.”
- 7: “I like chemistry, since the beginning of the school year.”
- 8: “I know how to make dyes.”

So, how does this all fit together?





## Honor cultural traditions, place, languages

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Utilize university resources...

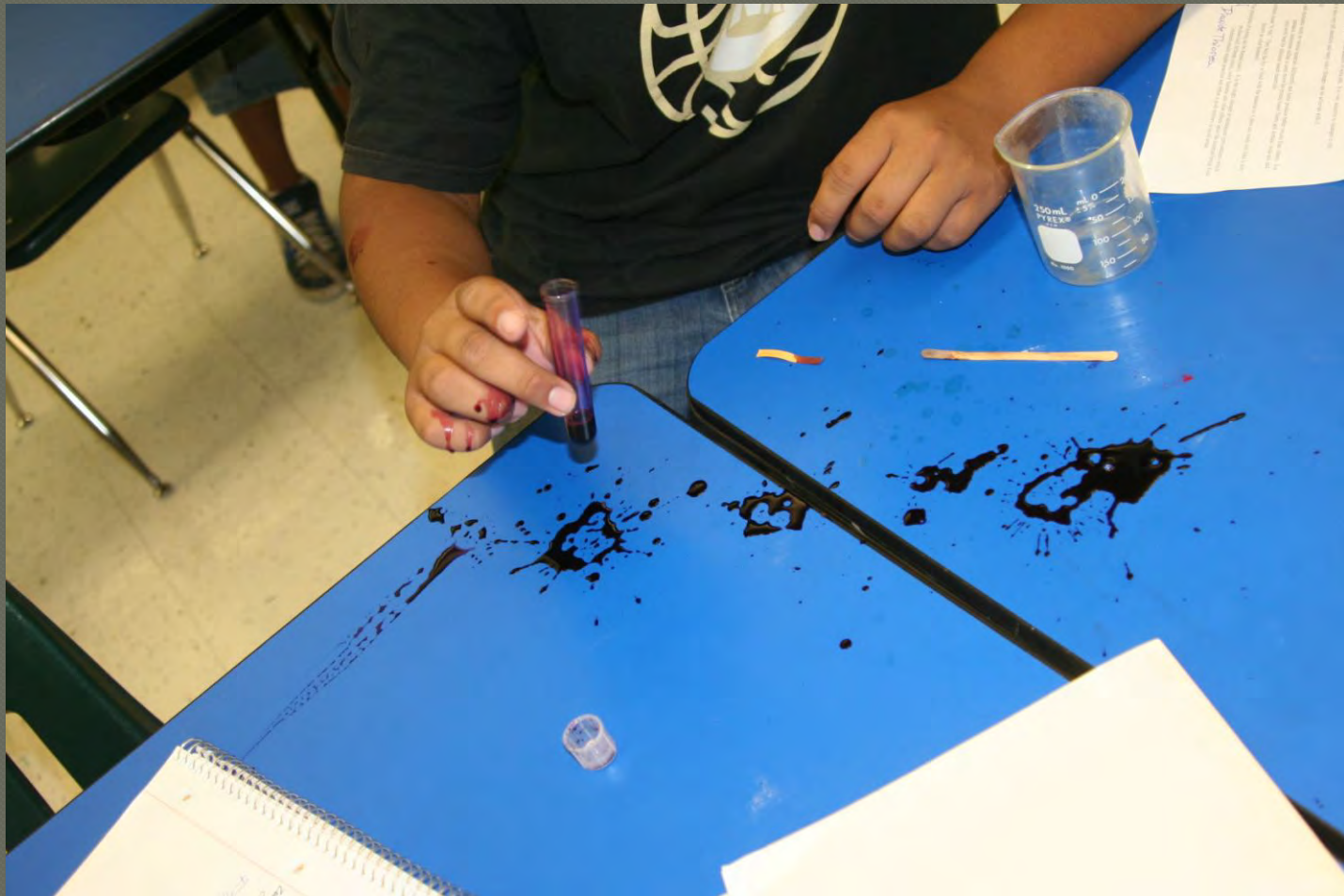


Take the university to the people, with relevant programs...





Get used to failures and keep experimenting...





Science and science education may be prominent aspects of the lives of those working in university laboratories and classrooms, but it is important to acknowledge Western Science is not as prominent to indigenous ways, or seen in the same context.

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These students picked the berries, extracted the dye, changed the colors by altering the pH, dyed traditional weaving materials, and collaborated in *inter-generational learning* (Wynn, 2010) communities, with master weavers to make gifts for their Elders. Context is everything.

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It will take both research scientists and science educators, working together, to adapt to rural communities, to collaborate with the people there. Both scientists and science educators will be a long way from the familiarity of the ivory tower, but if they study the world around them, they will survive. Research scientists and educational researchers collaborating with Native American communities can help one other become a little bit smarter, in both the woods and in their books.

