

CWSEI Projects in the Department of Statistics

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Projects 2008/09

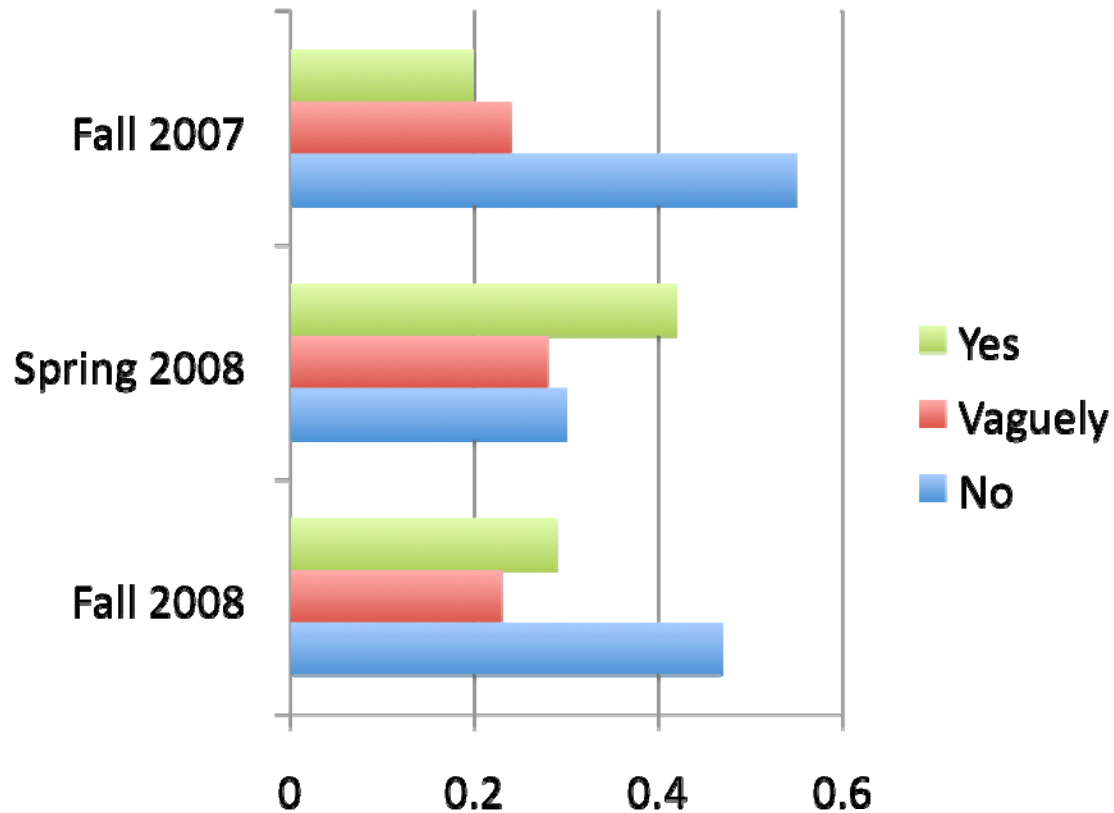
- Post-course student interviews to measure retention of concepts from introductory course.
- Experiments comparing effectiveness of types of computer-based labs.
- Analysis of student attitude surveys.
- Enhancement of STAT 100, 335, 443.

Student Interviews

- Interviewed students who had taken Stat 200 in 2008 and had not taken any Statistics courses since.
- Asked 12 conceptual questions from the course in order to determine how well students are maintaining concepts from introductory Statistics courses.
- Also asked about study habits, such as how often they attended lectures.

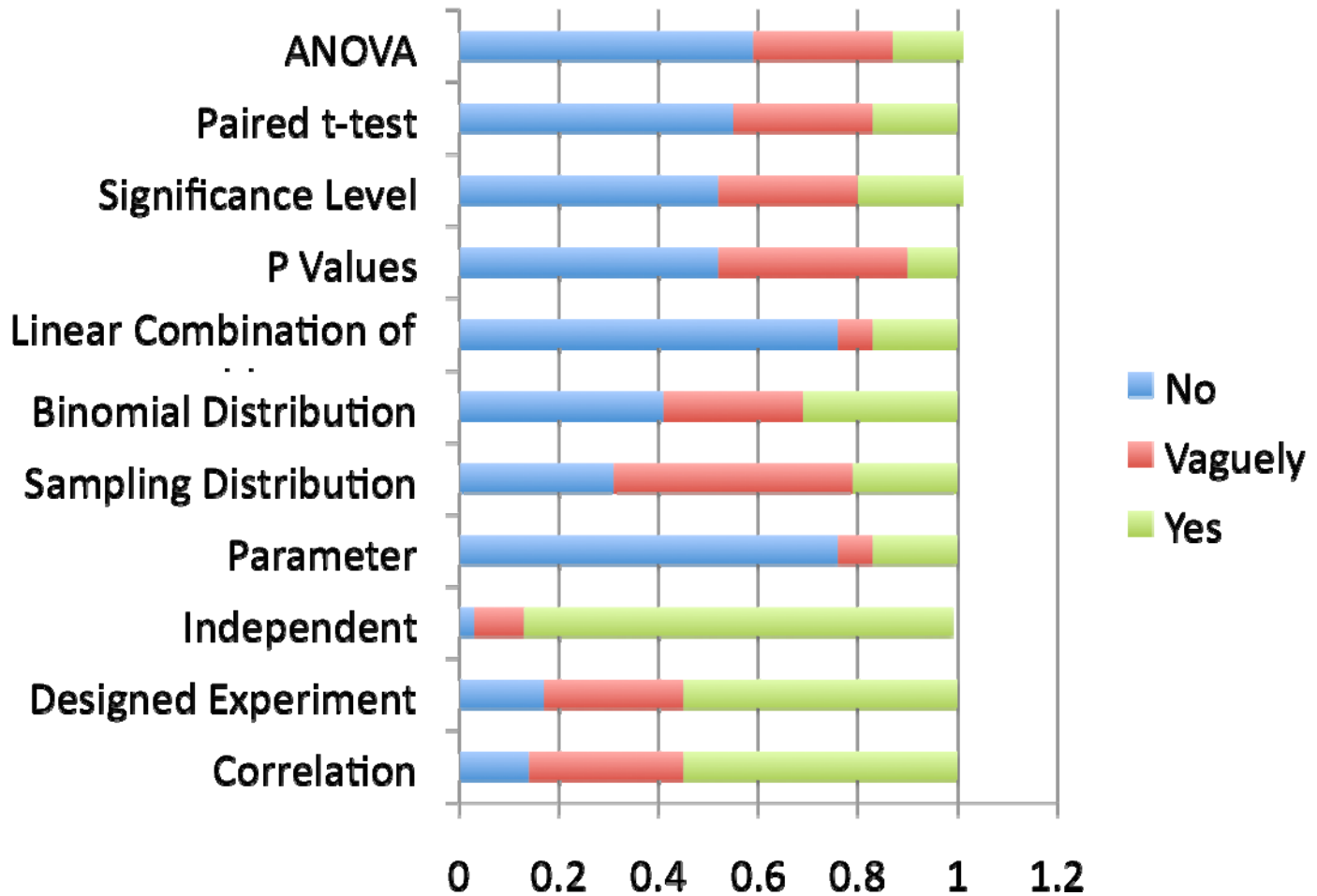
Student Interviews

- Created a classification guide for student responses in order to classify the level of understanding of the concept with one of “no”, “vaguely” or “yes”, defined by suitable descriptors.
- Compared Fall 2008 student responses with previous interviews from Spring 2008 and Fall 2007, 29 students in total.



Student Interviews

Comparing the percentage of students over all three semesters whose understanding was classified as “yes”, “vaguely” or “no” to all items combined from Fall 2007 to Fall 2008



Student Interviews

Comparing the percentage of students over all three semesters whose understanding was classified as “yes”, “vaguely” or “no” to the items listed.

Student Interviews

Overall, questions with the most misunderstandings (over 50% of the 29 students placed in the “no” category) dealt with the following concepts:

- Parameter
- ANOVA
- Paired t-test
- Significance level
- P-value
- Linear combination of variables

Overall, questions that were understood the best (over 50% of the 29 students placed in the “yes” category) dealt with the following concepts:

- Correlation
- Comparison of designed experiment versus observational study
- Independence

Lab Experimentation

- Students were randomly assigned to one of two different labs in order to determine whether learning the Central Limit Theorem was more effective from a lab based on an applet versus a lab based on simulations using Excel.
- The results from the lab worksheet as well as a Central Limit Theorem question on the Midterm test were used to determine whether one lab was more effective than the other.

Lab Experimentation

- After analyzing the data from the lab and the midterm, it was found that the use of the applet did not significantly change the results on either the midterm or on the lab worksheet in comparison to the use of the Excel simulation.
- The applet-based lab could be considered preferable since it was easier to carry out and less time-consuming.

Student Attitude Surveys

- On-line attitude survey for students on Stat 200 in Fall 2007 and Spring 2008.
- Students were asked to respond to the same survey at the beginning of the course and again at the end.
- Items dealt with four types of issues: Relevance, Problem Solving, Conceptual and Personal Interest
- Each item was ranked on a 5- point Likert Scale, with 1 indicating “strongly disagree” and 5 indicating “strongly agree”.

Student Attitude Survey

- Students were removed from the data who did not answer both the pre and the post survey.
- Subsequently, there were 256 students from the Fall semester and 142 students from the Spring semester.
- It was of interest to determine whether students were significantly changing their attitude about Statistics from the beginning of the course to the end, and if so, which items were causing the significant attitude change.

Student Attitude Survey

- An item referred to as being “Positive” is one where an expert in the field would respond with a 4 or a 5 (i.e., agreeing with the statement).
- An item referred to as being “Negative” is one where an expert in the field would respond with a 1 or a 2 (i.e., disagreeing with the statement).
- A student is considered to have disagreed with the expert if they answered with a 1, 2 or 3 on a positive item or 3, 4 or 5 on a negative item.

Student Attitude Survey

- Results were compared using the so-called “kappa” statistic.
- Kappa values are used here to measure agreement with an “expert” on a scale from -1 to 1
- -1 indicates complete disagreement with the expert, +1 indicates complete agreement with the expert.
- Each student was given a kappa value for their pre survey and a second kappa value for their post survey.

Student Attitude Survey

- Kappa values are found using a two-way table
- Agreement with the expert is found in the two diagonal cells- top left and bottom right
- For each student, and for each of their surveys, the number of items where each situation below occurs is recorded

Negative item and student answers 1 or 2	Negative item and student answers 3, 4, or 5
Positive item and student answers 1, 2, or 3	Positive item and student answers 4 or 5

Student Attitude Survey

	Student answers 1,2, (3)	Student answers (3), 4, 5	Total
Expert answers 1, 2 (negative item)	a ($e \cdot g / N = j$)	b	$a + b = e$
Expert answers 4, 5 (positive item)	c	d ($f \cdot h / N = k$)	$c + d = f$
Total	$a + c = g$	$b + d = h$	$a + b + c + d = N$
	$\text{Kappa} = [(a + d) - (j + k)] / [N - (j + k)]$		

Note that the numbers in brackets, j and k, are expected values for those cells

Student Attitude Survey

For example, if the survey consisted of 6 items, where the first 4 were positive and the last 2 were negative, and the student answered in order with 1, 4, 5, 4, 2, 3, then the corresponding two-way table would be:

	Student answers 1,2, (3)	Student answers (3), 4, 5	Total
Negative item	1 (4/6)	1	2
Positive item	1	3 (16/6)	4
Total	2	4	6

The kappa statistic based on this student's answers would be:

$$[(1+3)-(4/6+16/6)]/[6-(4/6+16/6)] = 0.25$$

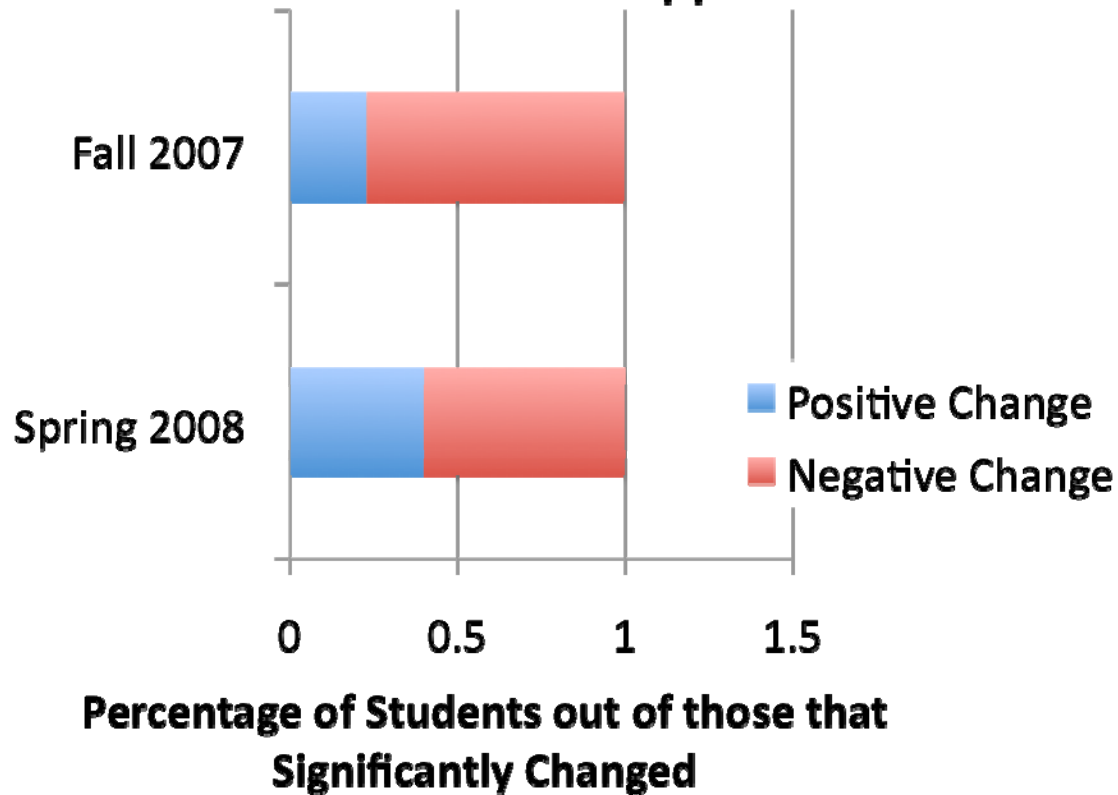
Therefore, the student slightly agrees with the expert.

Student Attitude Survey-

Student Results

- Kappa values from the pre and post survey are dependent since the same students appear in both samples.
- A method known as bootstrapping was used to compare the two kappa values and determine whether each student significantly changed their attitude towards Statistics from the beginning of the course to the end
- Code (in R) and a User's Guide were created to analyze such data.

Pre Versus Post Kappa Value



Comparing the percentage of students (out of those that significantly changed their kappa value) that had a higher kappa value from the pre survey compared to that of the post survey versus those that had a higher kappa value from the post survey.

Student Attitude Survey- Student Results

Fall Semester

- 60 out of 256 students (23%) had significantly changed their attitude from the beginning of the course to the end
- Out of those 60, 46 (77%) agreed with the expert less at the end of the course than they had at the start.

Spring semester

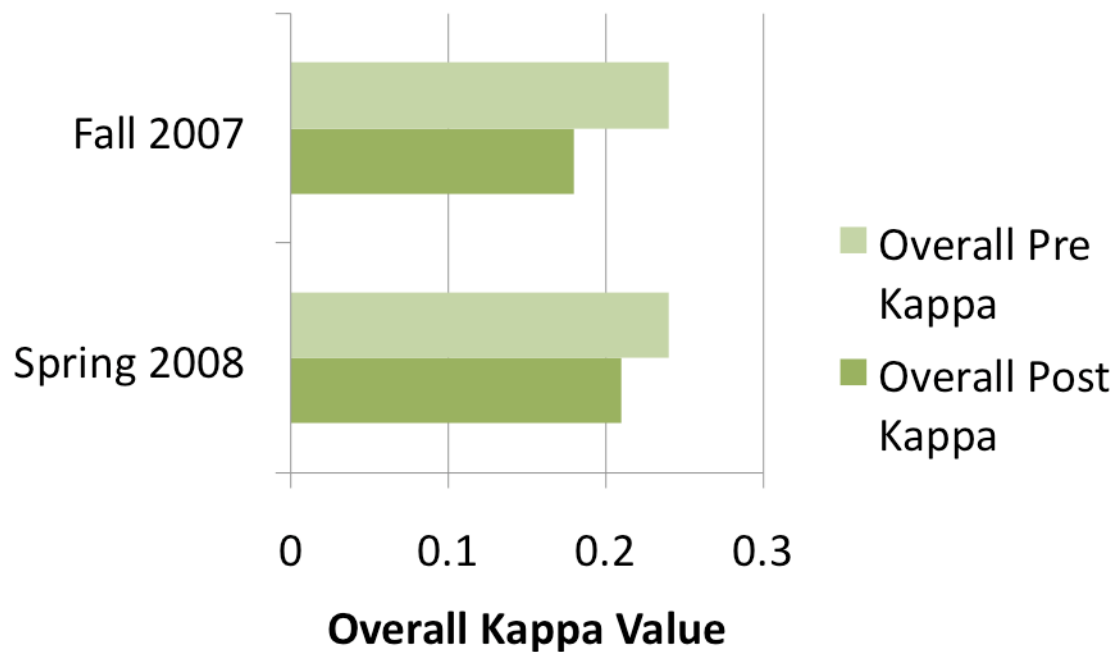
- 30 out of 142 students (21%) had significantly changed their attitude from the beginning of the course to the end
- Out of those 30, 18 (60%) agreed with the expert less at the end of the course than they had at the start.

Student Attitude Survey-

Overall Results

- To determine whether the class overall had significantly changed their attitude from the pre survey to the post survey, an “overall kappa” value was found by pooling data across all items.
- Another form of bootstrapping was implemented to determine whether the overall kappa values were significantly different from the beginning of the course to the end

Comparing Overall Kappa Values from Fall to Spring



Student Attitude Survey- Overall Results

Fall Semester

- Pre Overall Kappa Coefficient: 0.24
- Post Overall Kappa Coefficient: 0.18
- Difference: -0.06
- Difference was not found to be significant

Spring Semester

- Pre Overall Kappa Coefficient: 0.24
- Post Overall Kappa Coefficient: 0.21
- Difference: -0.03
- Difference was not found to be significant

Student Attitude Survey

- Since the Spring and Fall semester are independent, confidence intervals can be used to compare the Spring and Fall overall kappa values.
- Both the Pre and Post overall kappa values were not found to be significantly different between the Fall semester to the Spring semester.

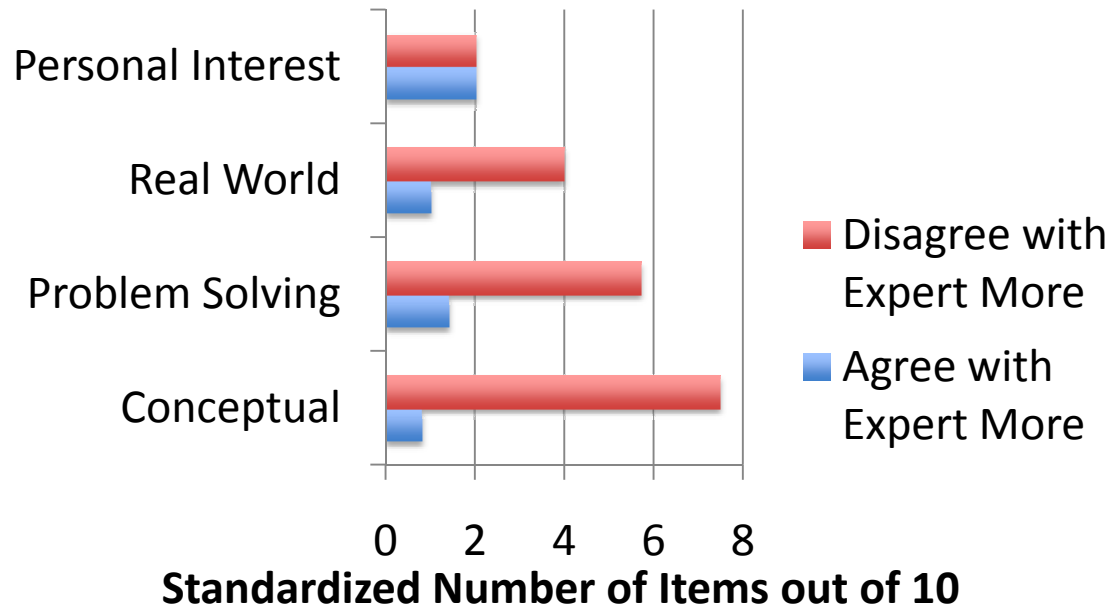
Student Attitude Survey- Item Results

- We considered the percentage of students that agreed with the expert response for each item.
- What type of item did students consistently disagree or agree with the expert from the post to the pre surveys? On which items did students change their level of agreement?

Student Attitude Survey- Item Results

- Students seemed to agree with the expert less at the end of the course than at the beginning most on Conceptual and Problem Solving items. *For example: “In Statistics, it is important for me to make sense out of formulae before I can use them correctly.”*
- Students agreed with the expert more at the end of the course on Personal Interest items. *For example: “I enjoy solving Statistics problems.”*

Types where Agreement with Expert Changes from Pre to Post Survey



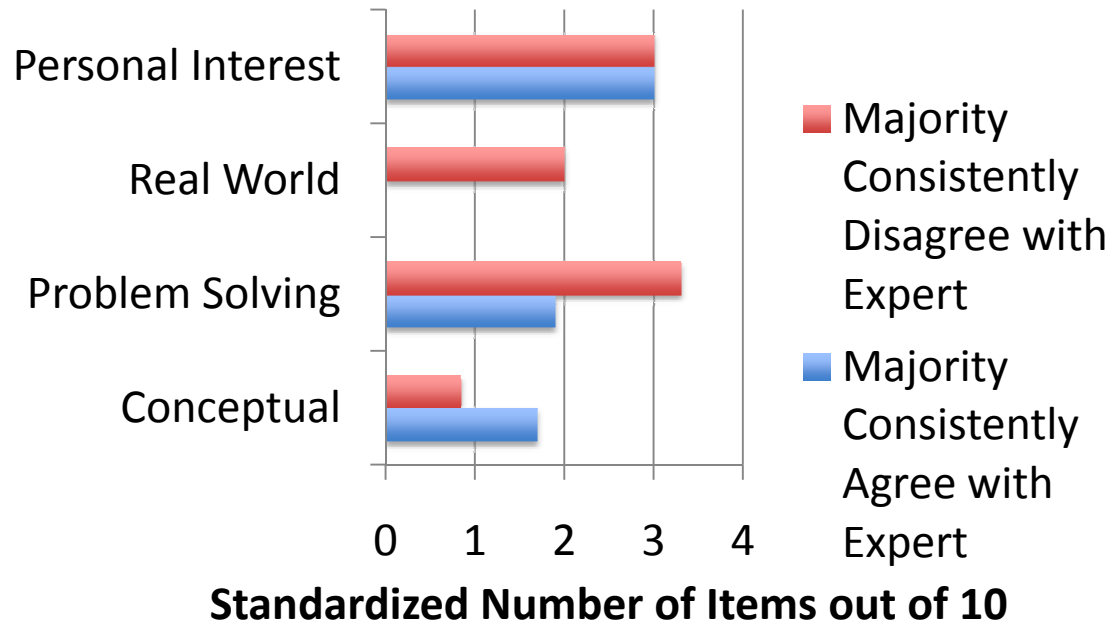
Student Attitude Survey- Item Results

The number of each type of item where agreement with expert changes from the beginning of the course to the end. Numbers are standardized, since there were an uneven amount of each type of item on the survey.

Student Attitude Survey- Item Results

- After combining the Spring and Fall data, the majority of students consistently agreed with the expert from the pre to the post survey on items related to “real world” relevance. *For example:* “Statistics can tell us nothing about variation in the world.”
- Students consistently disagreed with the expert from the pre to the post survey on Problem Solving items. *For example:* “I cannot learn Statistics if the teacher does not explain things well in class.”

Types where Students Consistently Agree or Disagree with Expert



Student Attitude Survey- Item Response

Number of item types where students consistently agree or disagree with the expert from the pre to the post survey. Numbers are standardized since there are an unequal number of items of each type on the survey

STAT 100: Statistical Thinking

- Modular course, with learning outcomes for each of the six modules.
- Five instructors in total.
- Clickers used each class for first time this year.
- Now half of faculty in department has experience of using clickers in lectures, either here or in STAT 200.

STAT 335: Statistics in Quality Assurance & STAT 443: Time Series and Forecasting

- Detailed learning outcomes created.
- In-class activities devised for each lecture: students work in small groups on activity sheet each session. Solutions posted by next day for quick feedback.
- Concept-based labs developed for STAT 335.