



Simulated Work Environment in Introductory Statistics



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Goal

We propose a new approach to teaching Statistics which incorporates principles from Experiential Learning and Social Constructivism. Students are placed in a simulated work environment and given one realistic task to complete as opposed to a set of smaller problems used in most statistics courses. The aim of this paper is to compare our new theory of learning with existing theories and looking for improvement in attitude, interest and performance.

Experimental Design

Year 1	
Groups	# Participants
Group 1	34
	46
Group 2	28
Group 3	30
Total	138

Year 2	
Groups	# Participants
Group 1	27
	33
Group 2	35
Group 3	27
Total	122

Description of groups:

Group 1: Tutor-led tutorial (Passive not using Real data – this is the traditional tutorial in the school of Mathematics and Statistics, UCD). This approach is motivated by the Behaviourist and Instructivist approach to learning. Two replications of this group were delivered.

Group 2: Group Problem Solving tutorial (Active but using Real data – this is what is currently thought of as the best models). This is based on standard Constructivism and Social Constructivism.

Group 3: Simulated Work Environment tutorial (Active Learning and using Real data – this is our new innovation). This utilises concepts from Social Constructivism and Experiential Learning.

Method/Assessment tools

Attitude

- SATS (Students attitude towards Statistics) : This is a standard tool, developed by Schau et. al. that is used in Statistical Education to measure students' attitudes to Statistics.
- We monitored attitudes at three times during the semester:
 - Week 1: Pre Course SATS, Week 7: Post MCQ SATS and Week 12: Post SATS.

Interest

- Attendance records

Performance

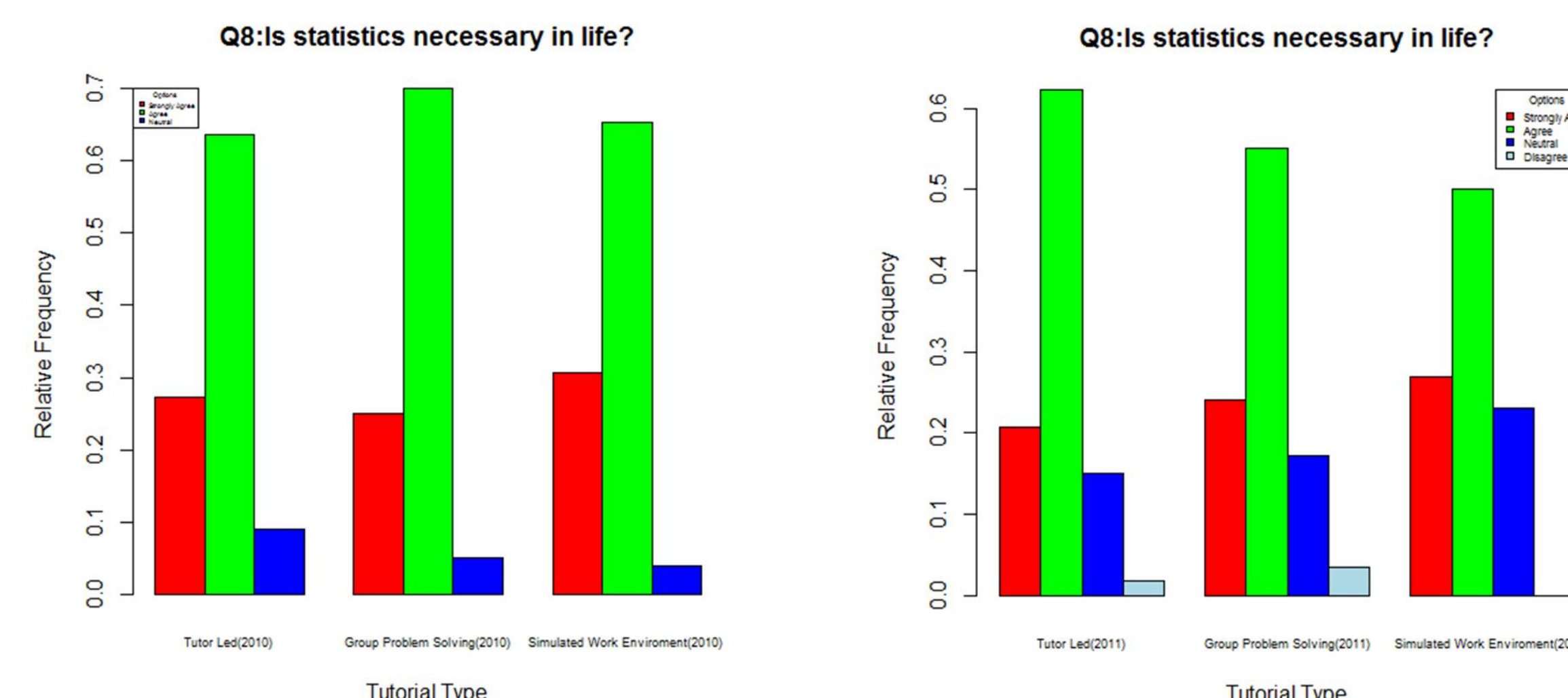
- CAOS (Comprehensive assessment of outcome in Statistics) developed by Garfield and Del Mas as a standard assessment of statistical literacy. Administered in Week 1 and Week 12.
- MCQ Based on course content, delivered in week 7.
- Exam grade: Final Exam delivered after course completion.

Analysis/Results

Analysis Techniques Used Included:

- Descriptive Statistics – Tables, Bar plots, Box plots.
- Inferential Statistical techniques – Linear Models, Generalized Linear Models, Cumulative Link Models, ANOVA.

RESULT 1: Students in each group had similar attitudes at the start of term for both years.



Cumulative Link Model : Analysis of Ordinal Response Variables

```
as.factor(prs_statsnecessaryinlife[122:259]) ~ as.factor(prs_TutDay1to3[122:259])
```

```
link threshold nobS logLik AIC niter max.grad cond.H
logit flexible 108 -111.98 233.96 6(0) 4.64e-10 1.6e+01
```

```
Coefficients: Estimate Std. Error z value Pr(>|z|)
as.factor(prs_TutDay1to3[122:259])2 0.0141 0.4505 0.031 0.975
as.factor(prs_TutDay1to3[122:259])3 -0.0297 0.4690 -0.063 0.950
```

RESULT 2: Students interest as measured by attendance was significantly higher for group 3.

Poisson Regression using GLM: Analysis of Count Data as Response Variables

```
glm(formula = ca_NewAtt2011 ~ as.factor(ca_NewTutDay2to3_2011), family = poisson)
```

```
Coefficients: Estimate Std. Error z value Pr(>|z|)
(Intercept) 1.92112 0.06468 29.700 < 2e-16 ***
as.factor(ca_NewTutDay2to3_2011)3 0.33988 0.08969 3.789 0.000151 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

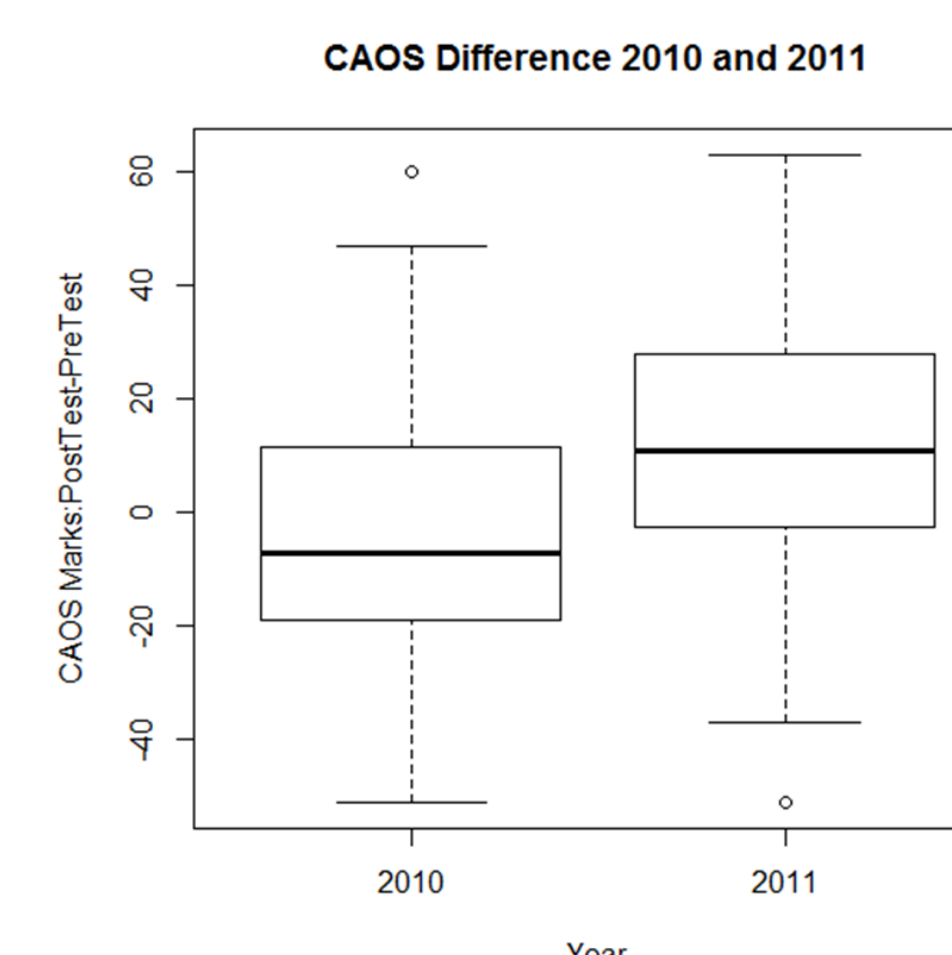
RESULT 3: Students performed better in 2011 vs 2010.

Linear Model: Analysis of continuous numerical response with factors dependent

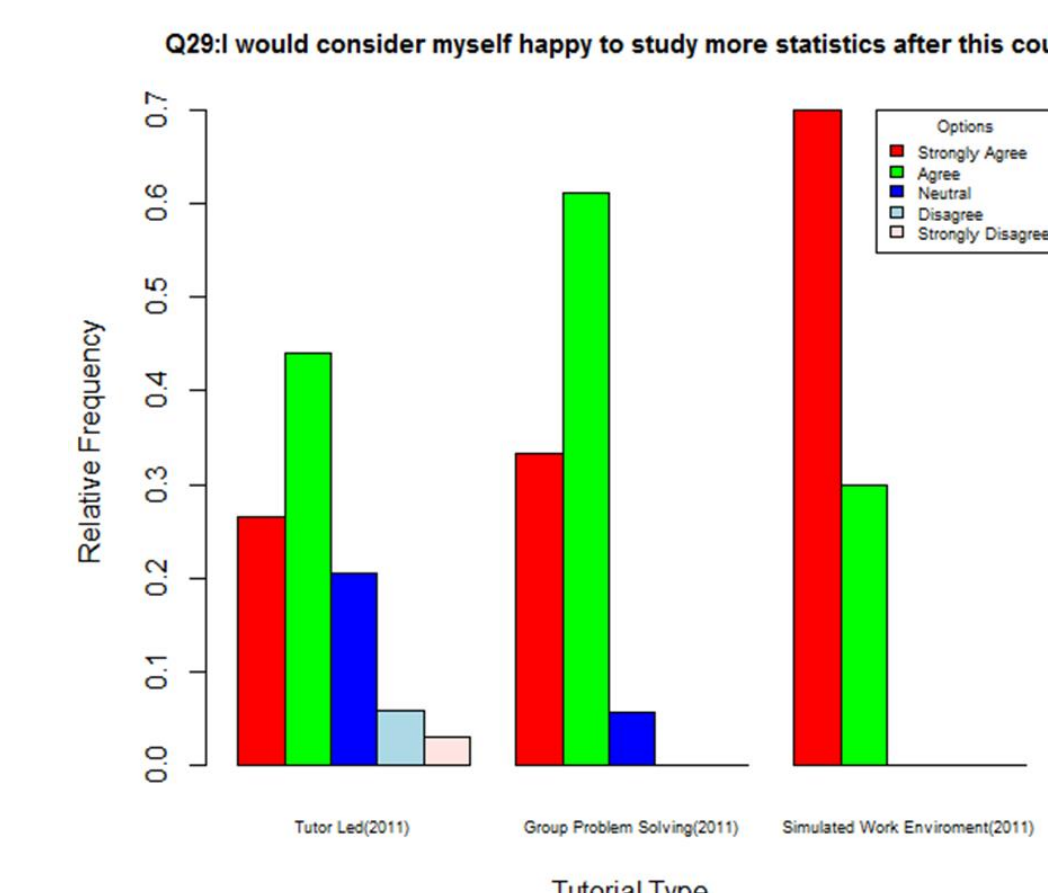
```
lm(formula = CaosDiff ~ as.factor(ca_TestYr))
```

```
Residuals:
Min 1Q Median 3Q Max
-62.389 -15.389 -2.223 16.444 62.944
```

```
Coefficients: Estimate Std. Error t value Pr(>|t|)
(Intercept) -2.944 2.708 -1.087 0.279
as.factor(ca_TestYr)2011 14.333 3.579 4.004 9.4e-05 ***
---
Signif. codes: '***' 0.001
```



RESULT 4: Students in group 3 had significantly better attitude at the end of the course than the other groups.



Cumulative Link Model : Analysis of Ordinal Response Variables

```
as.factor(pos_happystodystatsaftercourse) ~ as.factor(pos_TutDay1to3)
```

```
link threshold nobS logLik AIC niter max.grad cond.H
logit flexible 62 -67.58 147.17 5(0) 2.01e-07 2.2e+01
```

```
Coefficients: Estimate Std. Error z value Pr(>|z|)
as.factor(pos_TutDay1to3)2 -0.8153 0.5562 -1.466 0.14266
as.factor(pos_TutDay1to3)3 -2.1724 0.7819 -2.778 0.00546 **
---
```

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Conclusions

- Students in each group had similar attitudes at the start of term for both years.
- Students in Group 3 displayed a significantly stronger interest in studying more statistics compared to other groups. P-Value= 0.00546.
- SATS showed attitudes at Week 7 were better in year 2 than year 1.
- Interest of the students were better in the second year, this may be due to the changes made in the design and delivery of materials.
- Students performed better in Year 2 on CAOS – this validated the changes we made to the course for year 2

References

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- Vygotsky, L. S. (1929), The Problem of the Cultural Development of the Child, *Journal of Genetic Psychology*, 36:415 – 434
- Kolb, D. A. Experiential learning: Experience as the source of learning and development, Englewood Cliffs, NJ: Prentice-Hall, 1984.
- C. Schau, J. Stevens, T. Dauphinee, A. Del Vecchio The Development and Validation of the Survey of Antitudes toward Statistics, Educational and Psychological Measurement, 55 (1995), pp. 868–875
- delMas, R., Garfield, J., Ooms, A., & Chance, B. (2007). Assessing students' conceptual understanding after a first course in statistics. *Statistics Education Research Journal*, 6(2), 28-58.