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Querying Incoming Student Skills & Attitudes Questionnaire (ISSAQ) Data for Insights into Student Potential for Success in General Chemistry I

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Querying ISSAQ Data for Insights into Student Potential for Success in General Chemistry I

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What is ISSAQ?

- Incoming Student Skills and Attitudes Questionnaire
  - Assess student's behavior, strategies, and mindset using non-cognitive factors related to student success[1]
    - Behavioral, motivational, emotional, and social domains
    - Each domain is further broken down into 12 factors that comprise student success
      - Organizational, quality focus, engagement
      - Goal commitment, persistence, effort focus
      - Calmness, coping strategies, self-efficacy
      - Sense of belonging, institutional commitment, help-seeking
  - Students were asked a series of questions pertaining to these factors and receive a score based on how they answered the questions

1. https://www.dukesissaq.com/about-issaq

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ISSAQ Scores

- Guide
  - An area of strength
- Engage
  - An area in which you could benefit from additional work
- Support
  - This should be a primary area of focus to improve

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Our Questions

1. Using the ISSAQ data, are there single ISSAQ factors, or combinations of ISSAQ factors, that correlate with success in CHEM 131?

2. Are there ISSAQ factors associated with students who thrive in CHEM 131 that set them apart?

3. Are there ISSAQ factors associated with success in CHEM 131 that are different for students who self-select into CHEM 280?

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Data Analysis

- Students' final course grades were used as a proxy for success in CHEM 131.

- Course grades of C- or higher are classified as successes because students in most majors are then able to move on to the next course in sequence (CHEM 132). These grades are designated as "Successful" and "Pass".

- Withdrawals and grades of D or F are not considered successful. These grades have been designated as "Unsuccessful" and "DFW".

- Summary of the data set:
  - Fall 2022: F22 had 239 students in CHEM 131
    - 190 students were successful (Pass)
    - 49 students were unsuccessful (DFW)
  - Spring 2023: S23 had 232 students in CHEM 131
    - 184 students were successful (Pass)
    - 48 students were unsuccessful (DFW)

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Data Analysis

- For domain and individual ISSAQ factors
  - Compared distribution of Guide / Engage / Support between Pass and DFW outcomes to identify differences in responses between the two populations
    - The populations were further distinguished by which semester they were enrolled in CHEM 131: Fall 2022 or Spring 2023 for parts of the analysis
  - The Fisher exact test was used to determine whether these differences in distributions were significant

- For ISSAQ index score
  - Compared distribution of index scores between pass and DFW outcomes to identify differences in distribution of index scores between student outcomes
  - Used Fisher exact test to determine whether "visual" differences in distributions were significant

- For factor analysis of individual ISSAQ factors
  - Principle Axis Factoring (with varimax rotation) was used to investigate possible existence of latent variables composed of one or more ISSAQ factors

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Domain-level analysis of success in CHEM 131

Behavioral	Guide	Engage	Support	p
PASS	21.05%	61.05%	17.89%	0.245
DFW	14.97%	66.67%	18.37%	

Motivational	Guide	Engage	Support	p
PASS	21.05%	35.44%	43.51%	0.745
DFW	19.05%	38.78%	42.18%	

Emotional	Guide	Engage	Support	p
PASS	23.86%	51.58%	24.56%	0.940
DFW	24.49%	52.38%	23.13%	

Social	Guide	Engage	Support	p
PASS	26.84%	65.09%	8.07%	0.369
DFW	30.61%	59.18%	10.20%	

- Notable, but statistically nonsignificant, observations
- Support percentages of successful vs. unsuccessful results are within ~2% of each other for all domains
- Guide and Engage percentages are within ~3% for Motivational and Emotional domains
- ~6% more successful students in the Guide category of the Behavioral domain
- ~4% more unsuccessful students into the Guide category of the Social domain
- n = 717 total responses (from 239 students) who enrolled in CHEM 131 during Fall 2022
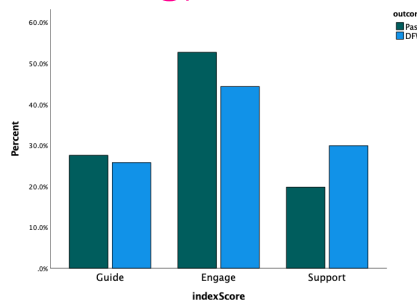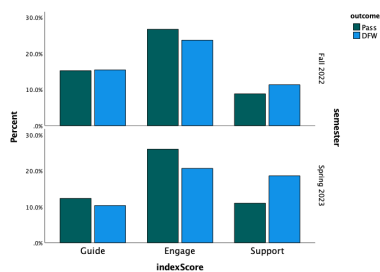
Differences are nonsignificant at the $p < 0.05$ level

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Initial analysis of ISSAQ data categories and student success: Social (Help seeking)

Help seeking	n	Guide	Engage	Support	p
F22 Pass	190	30.0%	52.6%	17.4%	0.651
F22 DFW	49	30.6%	46.9%	22.4%	
S23 Pass	184	25.0%	52.7%	22.3%	0.113
S23 DFW	48	20.8%	41.7%	37.5%	
Total PASS	374	27.5%	52.7%	19.8%	0.106
Total DFW	97	25.8%	44.3%	29.9%	

A larger population of DFW students report in the Support column with a 15% increase for the S23 cohort and a 10% increase in the Total data.

Initially exciting! Ultimately statistically nonsignificant. Each initial analysis was also represented graphically (see examples on this slide). The data for the Support percentages in Help seeking was the most initially significant and potentially actionable when considering student success in CHEM 131. However, upon statistical analysis, this visibly large difference was statistically irrelevant with p values of 0.651 and 0.113.

Differences are nonsignificant at the $p < 0.05$ level

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Analysis of Social Data

Inst. Commitment	n	Guide	Engage	Support	p
F22 Pass	190	5.8%	94.2%	5.8%	1.000
F22 DFW	49	6.1%	93.9%	6.1%	
S23 Pass	184	0.0%	95.1%	4.9%	0.716
S23 DFW	48	0.0%	93.8%	6.3%	
Total Pass	374	2.9%	94.7%	5.3%	0.803
Total DFW	97	3.1%	93.8%	6.2%	

No evidenced impact based on this data.

Sense of Belonging	n	Guide	Engage	Support	p
F22 Pass	190	50.5%	48.4%	1.1%	0.239
F22 DFW	49	61.2%	36.7%	2.0%	
S23 Pass	184	57.1%	40.2%	2.7%	0.358
S23 DFW	48	47.9%	45.8%	6.3%	
Total Pass	374	53.7%	44.4%	1.9%	0.358
Total DFW	97	54.6%	41.2%	4.1%	

No discernable trends beyond very few students being in the Support rating.

Differences are nonsignificant at the $p < 0.05$ level

Analysis of Behavioral Data

Organization	n	Guide	Engage	Support	p
F22 Pass	190	24.2%	55.8%	20.0%	0.237
F22 DFW	49	22.4%	67.3%	10.2%	
S23 Pass	184	22.8%	63.0%	14.1%	0.251
S23 DFW	48	25.0%	52.1%	22.9%	
Total Pass	374	23.5%	59.4%	17.1%	1.000
Total DFW	97	23.7%	59.7%	15.6%	

Roughly 76% of all students in the Fall 22 and Spring 23 semesters self-selected into the engage or support categories.

Engagement	n	Guide	Engage	Support	p
F22 Pass	190	23.2%	72.1%	4.7%	0.308
F22 DFW	49	18.4%	71.4%	10.2%	
S23 Pass	184	16.3%	76.1%	7.6%	0.695
S23 DFW	48	18.8%	70.8%	10.4%	
Total Pass	374	19.8%	74.1%	6.2%	0.359
Total DFW	97	18.6%	71.1%	10.3%	

Roughly 81% of all students in the Fall 22 and Spring 23 semesters self-selected into the engage or support categories.

Quality Focus	n	Guide	Engage	Support	p
F22 Pass	190	15.8%	55.3%	28.9%	0.078
F22 DFW	49	4.1%	61.2%	34.7%	
S23 Pass	184	13.6%	54.9%	31.5%	0.399
S23 DFW	48	20.8%	54.2%	25.0%	
Total Pass	374	14.7%	55.1%	30.2%	0.842
Total DFW	97	12.5%	57.7%	29.9%	

From this table, it is worth mentioning that only 4% of the DFW students in F22 said that they currently practiced quality focus. This led to more of those students having higher percentages in the engage and support categories. In general though, ~86% of all students in the Fall 22 and Spring 23 semesters self-selected into the engage or support categories.

Differences are nonsignificant at the $p < 0.05$ level

Analysis of Motivational Data

Goal Commit	n	Guide	Engage	Support	p
F22 Pass	190	14.2%	59.5%	26.3%	0.739
F22 DFW	49	14.3%	65.3%	20.4%	
S23 Pass	184	12.0%	63.0%	25.0%	0.509
S23 DFW	48	6.3%	64.6%	29.2%	
Total Pass	374	13.1%	61.3%	25.7%	0.736
Total DFW	97	10.3%	65.0%	24.8%	

Roughly 88% of all students in the Fall 22 and Spring 23 semesters self-selected into the engage or support categories.

Effort Focus	n	Guide	Engage	Support	p
F22 Pass	190	19.5%	46.8%	33.7%	0.631
F22 DFW	49	22.4%	51.0%	26.5%	
S23 Pass	184	17.9%	48.4%	33.7%	0.206
S23 DFW	48	27.1%	35.4%	37.5%	
Total Pass	374	18.7%	47.6%	33.7%	0.408
Total DFW	97	24.8%	43.2%	32.0%	

Roughly 78% of all students in the Fall 22 and Spring 23 semesters self-selected into the engage or support categories.

Persistence	n	Guide	Engage	Support	p
F22 Pass	190	29.5%	0.0%	70.5%	0.282
F22 DFW	49	20.4%	0.0%	79.6%	
S23 Pass	184	25.0%	0.0%	75.0%	0.852
S23 DFW	48	22.9%	0.0%	77.1%	
Total Pass	374	27.3%	0.0%	72.8%	0.300
Total DFW	97	21.7%	0.0%	78.4%	

Roughly 76% of all students in the Fall 22 and Spring 23 semesters self-selected into the support categories.

Differences are nonsignificant at the $p < 0.05$ level

Analysis of Emotional Data

Calmness	n	Guide	Engage	Support	p
F22 Pass	190	33.2%	27.9%	38.9%	0.575
F22 DFW	49	40.8%	26.5%	32.7%	
S23 Pass	184	22.8%	30.4%	46.7%	0.832
S23 DFW	48	18.8%	33.3%	47.9%	
Total Pass	374	28.1%	29.1%	42.8%	0.877
Total DFW	97	29.9%	29.9%	40.2%	

The 7% higher Guide response for F22 DFW students is evident. There is a shift from Guide to Support responses (+10%) for all S23 respondents.

Coping Strategies	n	Guide	Engage	Support	p
F22 Pass	190	16.8%	56.8%	26.3%	0.385
F22 DFW	49	10.2%	67.3%	22.4%	
S23 Pass	184	11.4%	60.3%	28.3%	0.344
S23 DFW	48	4.2%	66.7%	29.2%	
Total Pass	374	14.2%	58.6%	27.3%	0.140
Total DFW	97	7.2%	67.0%	25.8%	

There is a 6%+ higher population of successful students in the Guide rating, mostly from the Engage rating.

Self-Efficacy	n	Guide	Engage	Support	p
F22 Pass	190	21.6%	70.0%	8.4%	0.417
F22 DFW	49	22.4%	63.3%	14.3%	
S23 Pass	184	19.0%	70.7%	10.3%	0.383
S23 DFW	48	20.8%	62.5%	16.7%	
Total Pass	374	20.3%	70.3%	9.4%	0.176
Total DFW	97	21.6%	62.9%	15.5%	

Most of the population for all success rates fell in the Engage rating. ~6% more DFW students earned the Support rating.

Differences are nonsignificant at the $p < 0.05$ level

Analysis of ISSAQ index scores

We also looked at potential relationship between students' index score and success in GC and found no significant difference in distribution of index scores between "Pass" and "DFW" for Fa22, Sp23, or combined

Differences are nonsignificant at the $p < 0.05$ level

Fisher Exact Test, $p = 0.872$

Fisher Exact Test, $p = 0.299$

Fisher Exact Test, $p = 0.897$
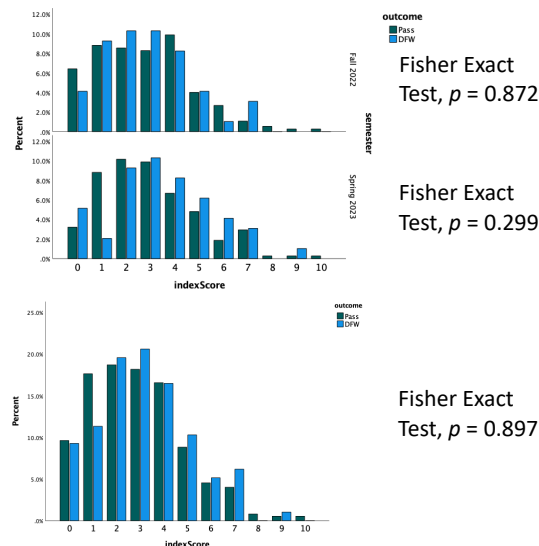
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Analysis of (groups of) ISSAQ factors

- There might be some relationships between successful grade outcomes and one or more ISSAQ factors
- We performed factor analysis to investigate a few questions:
  - Do multiple components of ISSAQ data map onto common "latent variables"?
  - If so, are these latent variables similar or different for students with successful and unsuccessful grade outcomes in CHEM 131?

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Factor Analysis: Unsuccessful grade outcomes

- Do multiple ISSAQ components map onto common factors?
- 2 latent variables were identified. Multiple ISSAQ factors map onto both latent variables

Factor Matrix[a,b]

	Factor		
	1	2	3
organization	.416		
qualFocus			
engagement	.657		
goalCommitment	.433		
persistence	.588		
effortFocus	.532	−.414	
calmness		.401	
coping	.424		
selfEfficacy	.609		
senseBelonging	.511	.521	
instCommitment		.523	
helpSeeking	.552	.449	

Extraction Method: Principal Axis Factoring.
a. 3 factors extracted. 14 iterations required.
b. Only cases for which outcome = DFW are used in the analysis phase.

- Rotating factor matrices can clarify interpretation
- Latent variables identified in rotated matrix are shown to right

Rotated Factor Matrix[a,b]

	Factor		
	1	2	3
organization		.402	
qualFocus	.452		
engagement	.702		
goalCommitment		.443	
persistence	.521		
effortFocus	.758		
calmness			.458
coping		.425	
selfEfficacy		.467	
senseBelonging			.729
instCommitment			.586
helpSeeking		.694	

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization.[a,b]
a. Rotation converged in 5 iterations.
b. Only cases for which outcome = DFW are used in the analysis phase.

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Factor Analysis: Successful grade outcomes

- Do multiple ISSAQ components map onto common factors?
- 2 latent variables were identified. Latent variable 2 was composed of "calmness" and "helpSeeking". Latent variable 1 was composed of all remaining factors

Factor Matrix[a,b]

	Factor		
	1	2	3
organization	.498		
qualFocus	.565		
engagement	.577		
goalCommitment	.440		
persistence	.504		
effortFocus	.575		
calmness		.464	
coping	.500		
selfEfficacy	.540		
senseBelonging	.488		
instCommitment			
helpSeeking		.408	

Extraction Method: Principal Axis Factoring.
a. 3 factors extracted. 14 iterations required.
b. Only cases for which outcome = Pass are used in the analysis phase.

- Rotating factor matrices can clarify interpretation
- Latent variables identified in rotated matrix are shown to right

Rotated Factor Matrix[a,b]

	Factor		
	1	2	3
organization	.486		
qualFocus	.578		
engagement	.657		
goalCommitment			
persistence	.594		
effortFocus	.544		
calmness			.566
coping		.494	
selfEfficacy		.535	
senseBelonging		.586	
instCommitment			
helpSeeking		.534	

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization.[a,b]
a. Rotation converged in 5 iterations.
b. Only cases for which outcome = Pass are used in the analysis phase.

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Summary of ISSAQ components comprising identified latent variables

Successful grade outcomes

Rotated Factor Matrix[a,b]

	Factor 1	Factor 2	Factor 3
organization	.486		
qualFocus	.578		
engagement	.657		
goalCommitment			
persistence	.594		
effortFocus	.544		
calmness			.566
coping		.494	
selfEfficacy		.535	
senseBelonging		.586	
instCommitment			
helpSeeking		.534	

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization.[a,b]

a. Rotation converged in 5 iterations.

b. Only cases for which outcome = Pass are used in the analysis phase.

Unsuccessful grade outcomes

Rotated Factor Matrix[a,b]

	Factor 1	Factor 2	Factor 3
organization		.402	
qualFocus	.452		
engagement	.702		
goalCommitment		.443	
persistence	.521		
effortFocus	.758		
calmness			.458
coping		.425	
selfEfficacy		.467	
senseBelonging			.729
instCommitment			.586
helpSeeking		.694	

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization.[a,b]

a. Rotation converged in 5 iterations.

b. Only cases for which outcome = DFW are used in the analysis phase.

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Conclusions

- The differences in distributions between Pass (successful) and DFW (unsuccessful) grade outcomes for any of the individual or domain level ISSAQ factors for both semesters were not significant

- Initial analysis of distributions were not statistically significant. Factor analysis was required to investigate combinations of ISSAQ factors to potentially identify latent variables, how they were composed, and whether there were differences between latent variables identified in students with successful and unsuccessful grade outcomes

- Latent Variables that were identified in factor analysis were composed of different ISSAQ factors for Pass and DFW grade outcomes
  - The ways that different ISSAQ factors were related were different for successful and unsuccessful outcomes

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Comments, Recommendations, and Next Actions

- How can we test for fit to identified latent variables? Is it possible to analyze subgroups of students (demographics, potential risk factors, etc.) to see if they respond to ISSAQ items in ways similar to previous students with successful or unsuccessful grade outcomes?

- Are there collaborators who can be approached/identified who might be able to identify ways to operationalize the differences in how latent variables were composed for successful and unsuccessful grade outcomes?

  - Are there things that jump out (to people with different backgrounds from us) about the combinations of ISSAQ factors that we have identified for out latent variables that point to specific interventions as potentially helpful for some, or all, our CHEM 131 students?

  - Possible collaborators: Educational Psychology, Counseling center, etc.

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