



Gap Analysis and Data Visualization:

Creating a More Equitable Assessment Culture in Higher Education

Tuesday, October 11, 2022 | Billie Anderson, Ph.D. and Dea Marx, Ed.D.

Overview

- Define gap analysis and motivation
- Background
- Gap analysis for Capstone-like course(s)
- Gap analysis for gateway courses
- Culturally responsive assessments
- Plan for gap analysis implementation and expected impact

Consent Script for Exempt Research

My name is Billie Anderson, and I am performing research related to applying and visualizing gap analyses using assessment data. Throughout this presentation, you will be asked several questions related to your data visualization preferences and your ideas about your interest in performing this type of gap analysis and barriers. The questions will be asked using Kahoot! Your participation is entirely voluntary; you may skip any questions or choose to stop participating at any time. No personally identifying information is being collected.

Questions about the research study? Please contact Billie Anderson at 816-235-2301 (billie.anderson@umkc.edu).

Questions or concerns about your rights as a research participant? Please call the UMKC Research Compliance at 816-235-5927.



Define gap analysis and motivation

Gap analysis

- A gap analysis determines if a difference exists between an academic program's expectations of students' performance and results obtained through assessment.
- Examine these differences using demographic categories, i.e., gender and ethnicities.
- UMKC has a focus on diversity as part of its mission.

Background

Background – Gap analysis in higher education

- The origins of a gap analysis comes from the business field of quality assurance (Parasuraman et al., 1985).
- Quality assurance model, 1985; defined as the difference between what a customer expects to receive and what is receive, does a gap exists or not (Headley & Choi, 1992).

Background – Gap analysis in higher education

Researchers aligned and applied the concept of gap analysis from quality management into higher education.

- Hampton, G. M. (1993). Gap Analysis of College Student Satisfaction as a Measure of Professional Service Quality. *Journal of Professional Services Marketing*, 9(1), 115–128.
- Hrnciar, M., & MadzĀk, P. (2013). Improving the Quality of Higher Education in Central Europe: Approach Based on GAP Analysis. *Higher Education Studies*, 3(4), 75–88.
- Yooyen, A., Pirani, M., & Mujtaba, B. G. (2011). Expectations versus Realities of Higher Education: Gap Analysis and University Service Examination. *Contemporary Issues in Education Research*, 4(10), 25–36.

Background – Gap analysis in higher education

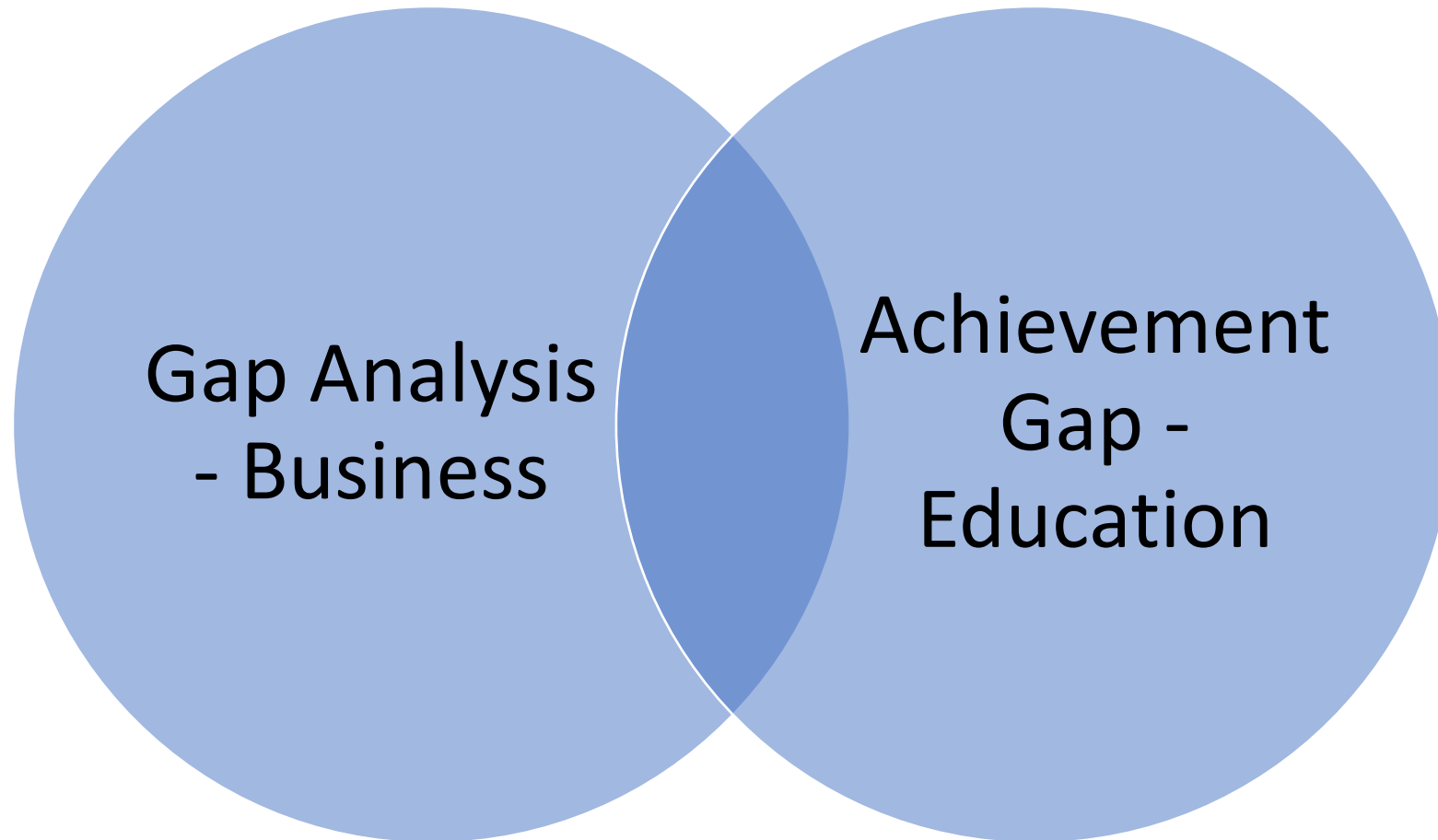
Researchers applied the gap analysis from quality management into nursing programs.

- Fater, K. (2013). Gap Analysis: A Method to Assess Core Competency Development in the Curriculum. *Nursing Education Research*, 34(2), 101–105.
- Beauvais, A., Kazer, M., Aronson, B., Conlon, S., Forte, P., Fries, K., Hahn, J., Hullstrung, R., Levvis, M., McCauley, P., Morgan, P., Perfetto, L., Rebeschi, L., Solernou, S., Spain, P., & Sundean, L. (2017). After the Gap Analysis: Education and Practice Changes to Prepare Nurses of the Future. *Nursing Education Perspectives*, 38(5), 250–254.

Background- Gap analysis in higher education

- Higher Education research traditionally defines gap analysis as an achievement gap.
- Historically, achievement gaps meant “differences in scores on state or national achievement tests between various student demographic groups” (Anderson et al., 2007, p. 547).
- Over the last 20 years, focused research efforts studied achievement gaps among White and Black/African American ethnic groups using national test scores or GPA (Roach, 2000; Lee, 2002; Espenshade & Radford, 2009; Martin et al., 2017; Taylor et al., 2021).
- Norman et al. (2001) provides a historical background and context for some of the reasons for achievement gaps among White and Black/African American students.

Our contributions focus on the intersection



Where this study contributes

- Highly influenced by
 - Bensimon, E. M. (2005). Closing the achievement gap in higher education: An organizational learning perspective. *New Directions for Higher Education*, 2005(131), 99–111.
- Address problems in higher education- inequality in educational outcomes for historically underserved groups who are experiencing the greatest achievement gaps from the perspective of organizational learning theory.

Where this study contributes

- We propose that the theory and processes of organizational learning can help researchers and practitioners understand and address the structural and cultural obstacles that prevent colleges and universities from producing equitable educational outcomes.
- How? By examining cognitive frameworks of diversity, deficit, and equity.

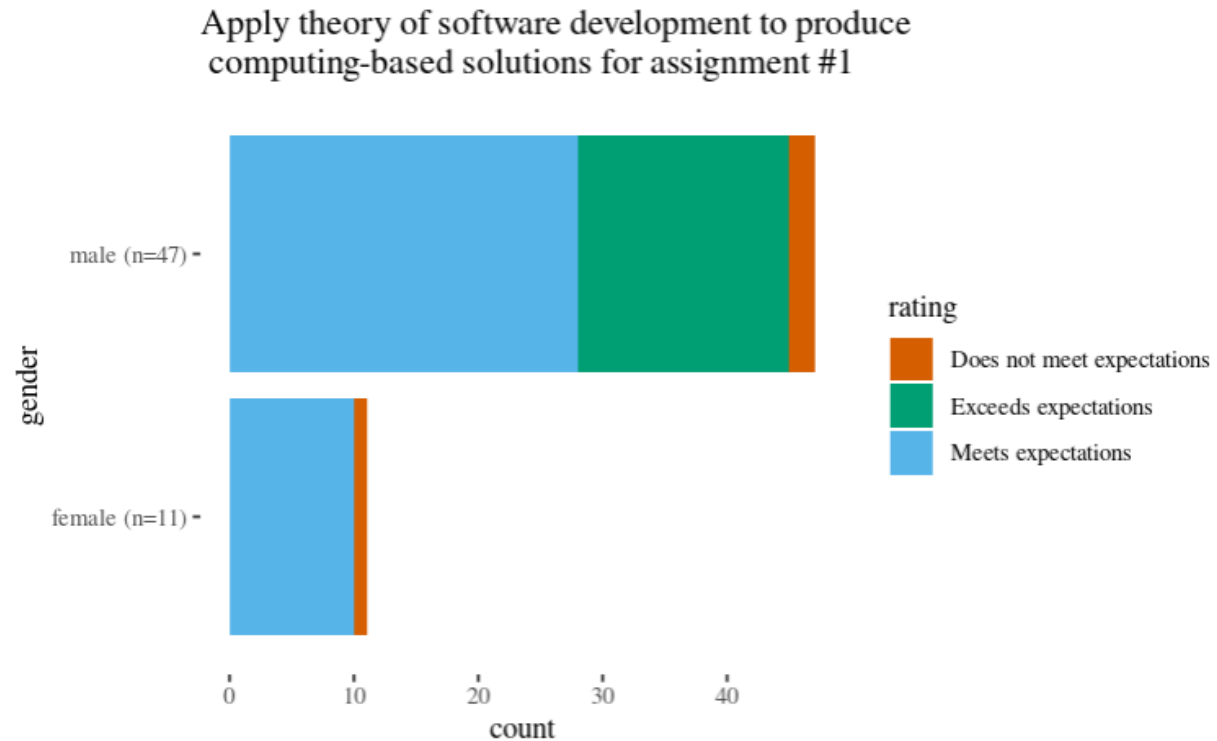
“Disaggregation of student outcome data by race and ethnicity is not an institutionalized practice, and this contributes to the invisibility of unequal college outcomes for underrepresented minorities” (Bensimon, p.p. 99-100).

Gap Analysis for Capstone-like courses

Gap Analysis for Capstone-like courses

- Used curriculum maps and assessment plans to determine several 'Capstone' courses with individual assessed student signature assignments.
- Collected the individual student assessments as data.
- Combined demographic data with evaluations to determine if any gaps exist for certain demographic subpopulations.

Upper-Divisional Computer Science Course



Test	Test statistic	P-value	Effect size	Signif (Yes or No)
H_0 : scores among males and females are the same H_1 : scores are different	-2.27 (permutation)	0.0234	-0.30	Yes
	161 (Mann-Whitney)	0.0209	-0.30	Yes

Poll: Which visualization would you select?

Scenario: You are working as a data analyst in the Provost Office of Assessment. You have been asked to examine student performance for a data analytics program.

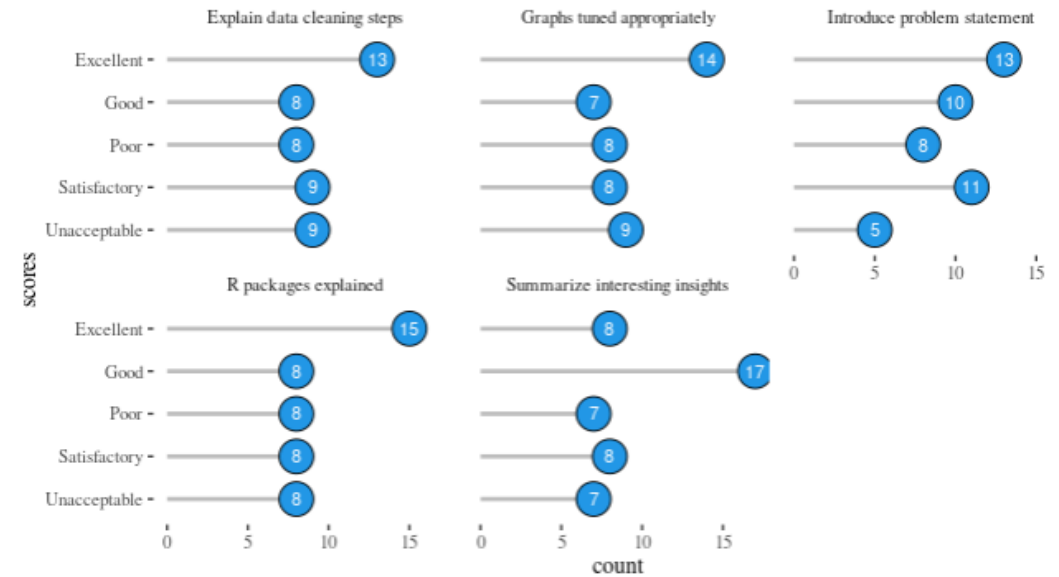
You begin by creating visuals to help you understand student performance on five student learning outcomes.

Poll: Which visualization would you select?

5 Program Learning Outcomes - Data Analytics Program
Bar Chart



5 Program Learning Outcomes - Data Analytics Program
Lollipop Chart

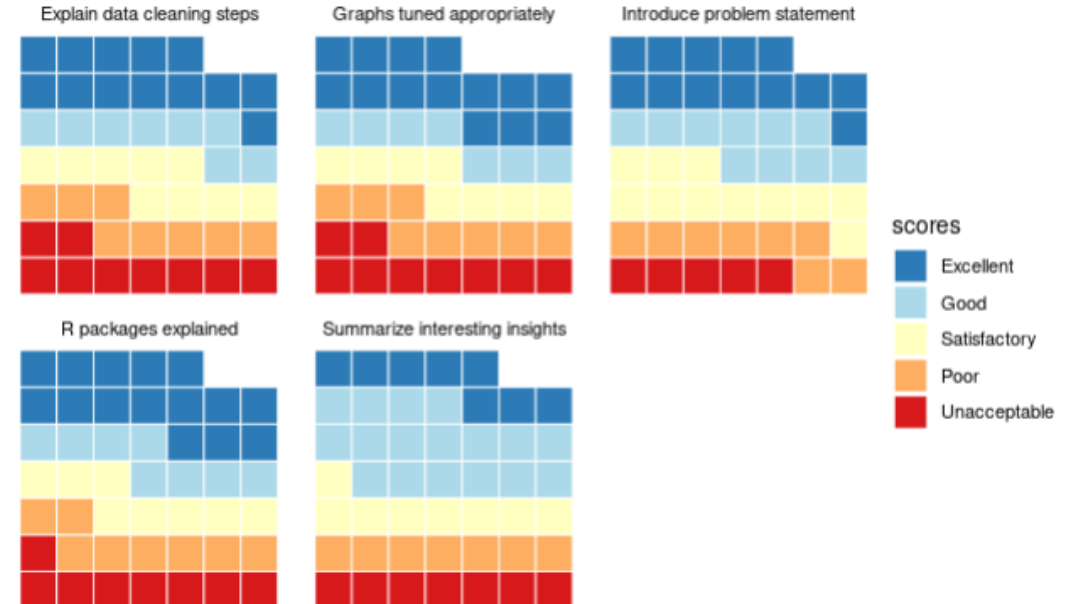


Poll: Which visualization would you select?

5 Program Learning Outcomes - Data Analytics Program
Stacked Bar Chart



5 Program Learning Outcomes - Data Analytics Program
Waffle Chart



Poll: Which visualization would you select?

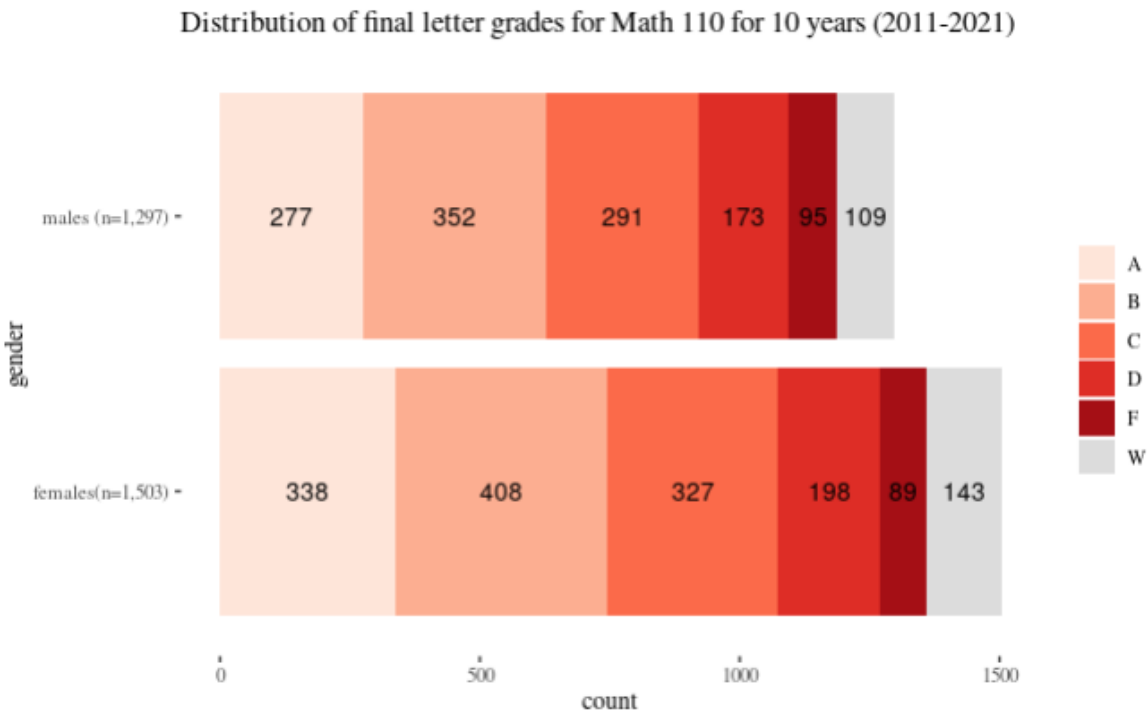


Gap analysis for gateway courses

Math 110

Aggregated over 10 years

Final grades Likert scores (gender)



test	test statistic	p-value	effect size	signif (yes or no)
H_0 : scores among males and females are the same H_1 : scores are different	0.33 (permutation)	0.70	-0.007	no
	986,024 (Mann-Whitney)	0.60	-0.01	no

Math 110

Longitudinal over 10 years

Final grades Likert scores (gender)

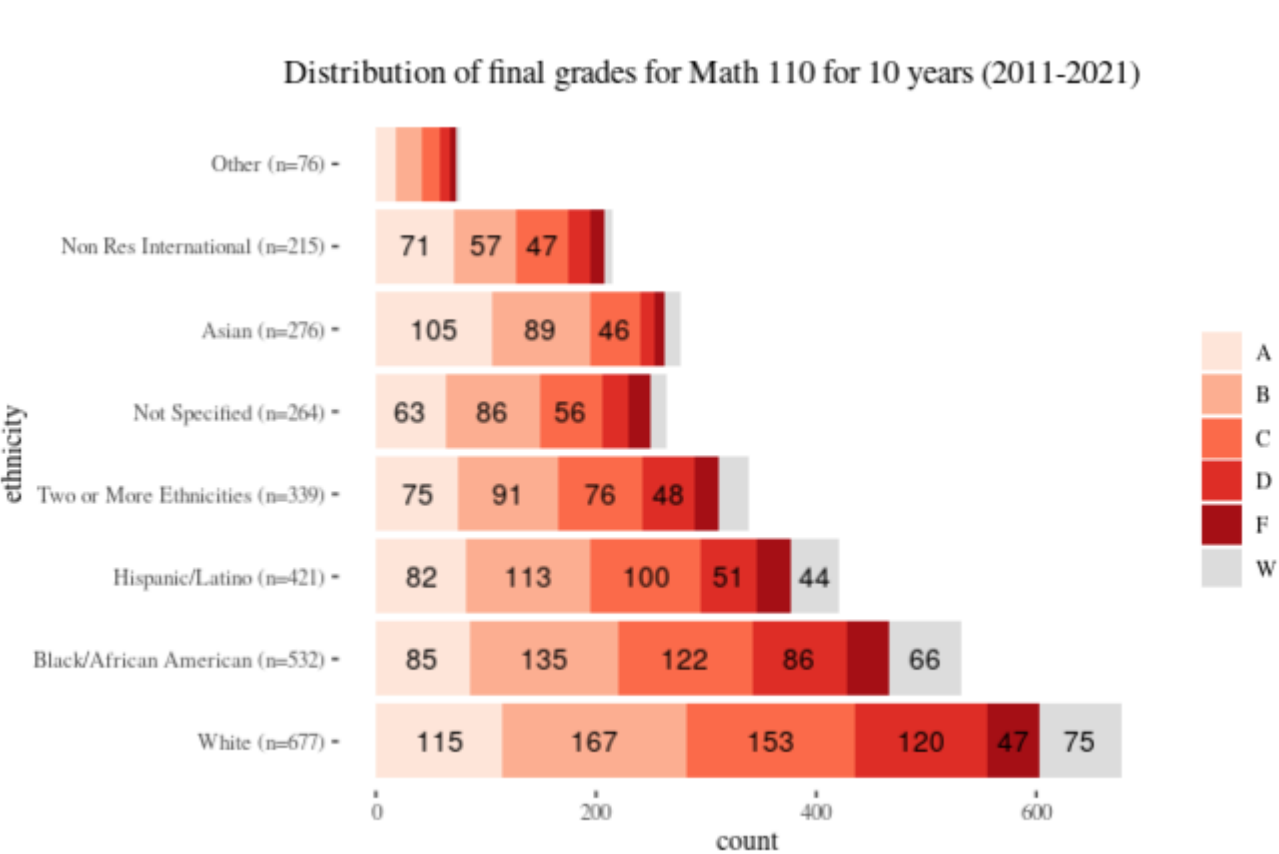


year	test statistic	p-value	effect size	signif (yes or no)
2011	2,867	0.50	-0.06	no
2012	8,029	0.80	-0.01	no
2013	8,970	0.80	-0.01	no
2014	8,880	0.90	-0.004	no
2015	9,970	0.70	-0.03	no
2016	7,994	0.80	-0.02	no
2017	9,964	0.60	-0.03	no
2018	8,334	0.70	-0.02	no
2019	6,521	0.50	-0.05	no
2020	8,146	0.50	-0.04	no
2021	3,556	0.60	-0.04	no

Math 110

Aggregated over 10 years

Final grades Likert scores (ethnicity)



test	test statistic	p-value	effect size	signif (yes or no)
H_0 : scores among ethnicities are the same H_1 : scores are different	122 (Kruskal-Wallis)	< 0.0001	0.04	yes

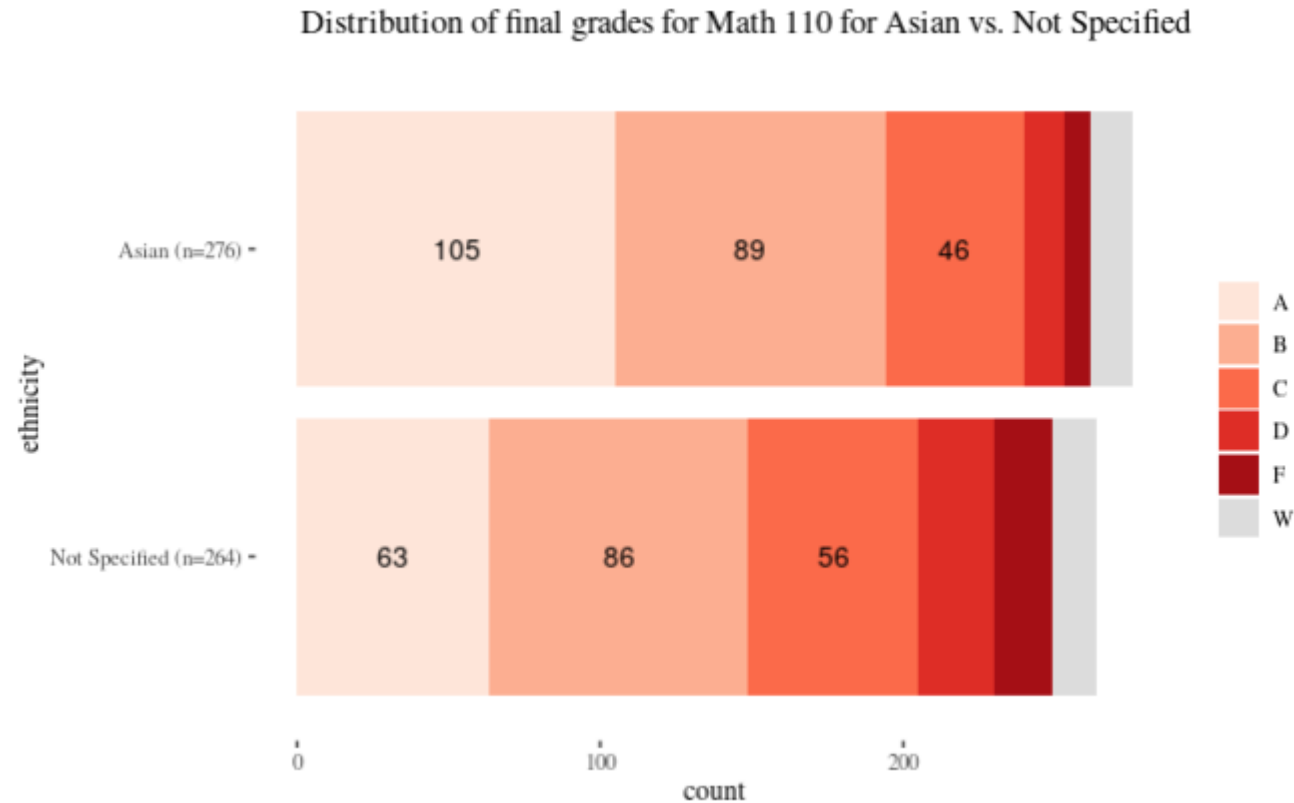
Math 110

Aggregated over 10 years

Final grades Likert scores - post hoc tests (ethnicity)

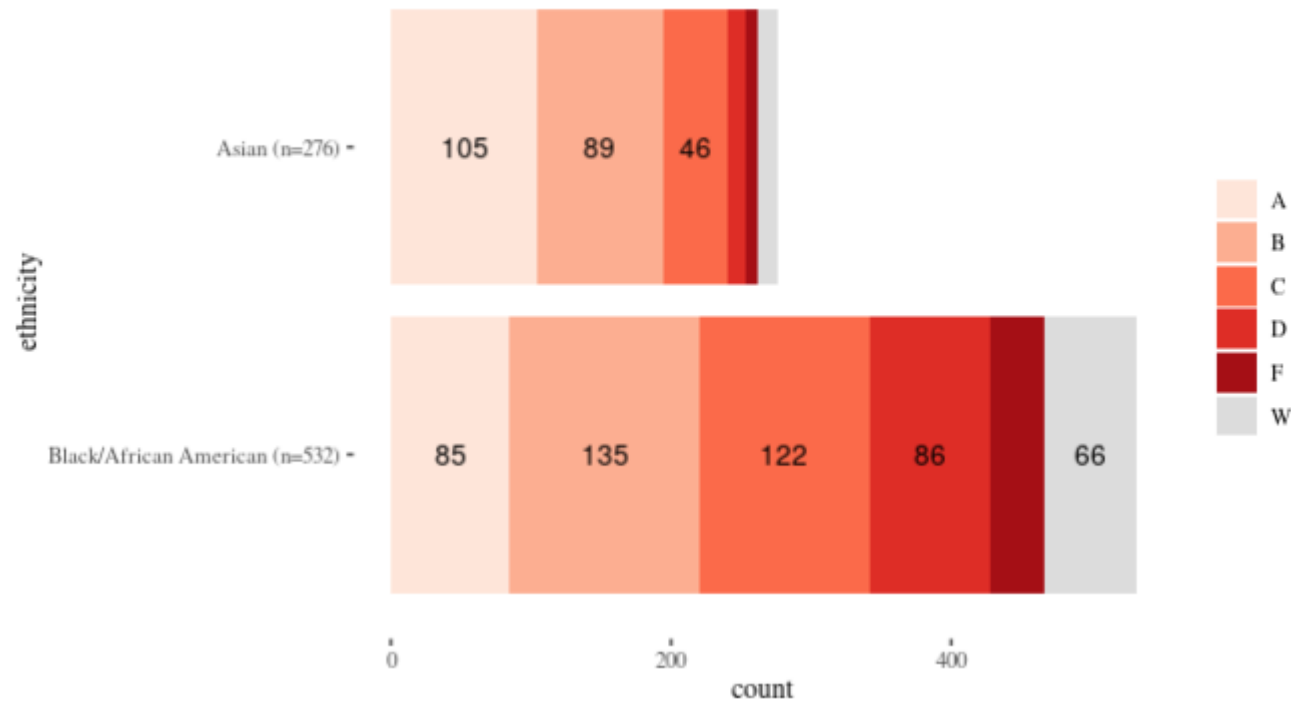
Significant Differences
Asian vs. Black/African American
Asian vs. Hispanic/Latino
Asian vs. Not Specified
Asian vs. Two or More Ethnicities
Asian vs. White
Black/African American vs. Non Res International
Black/African American vs. Not Specified
Hispanic/Latino vs. Non Res International
Non Res International- vs. Two or More Ethnicities
Non Res International vs. White
Not Specified vs. White

What is the 'direction' of the significant differences?



What is the 'direction' of the significant differences?

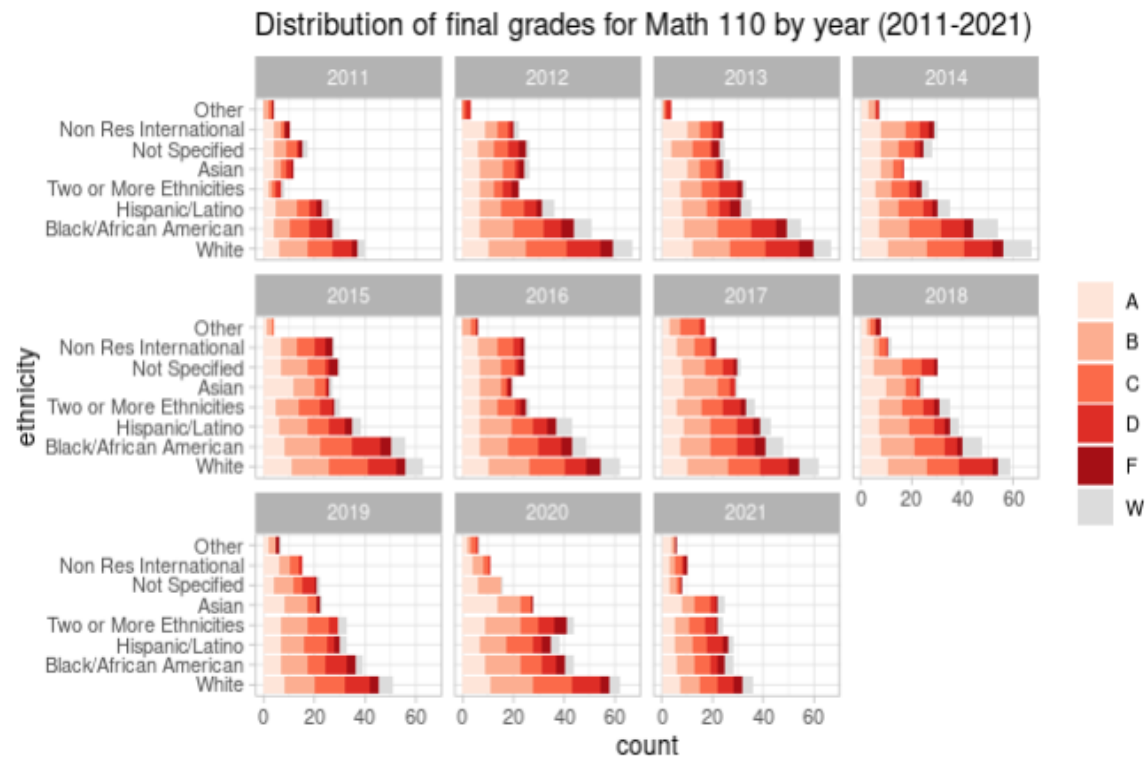
Distribution of final grades for Math 110 for Asian vs. Black/African American



Math 110

Longitudinal over 10 years

Final grades Likert scores (ethnicity)



year	test statistic	p-value	effect size	signif (yes or no)
2011	5.3	0.60	-0.01	no
2012	12	0.09	0.02	no
2013	8.7	0.30	0.007	no
2014	19	0.009	0.05	yes
2015	16	0.03	0.03	yes
2016	16	0.02	0.04	yes
2017	15	0.20	0.07	yes
2018	9.9	0.20	0.01	no
2019	13	0.07	0.03	no
2020	25	0.0009	0.08	yes
2021	7.5	0.40	0.003	no

Math 110

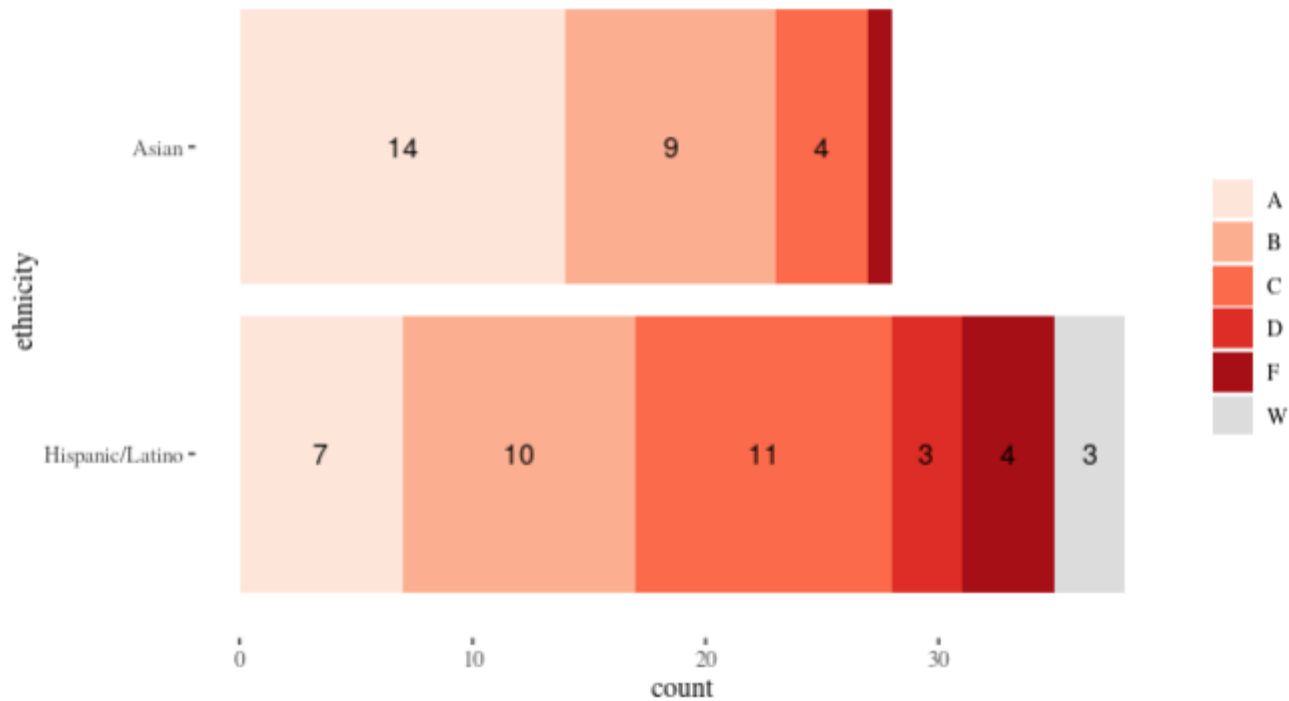
Aggregated over 10 years

Final grades Likert scores - post hoc tests for 2020 (ethnicity)

Significant Differences
Asian vs. Hispanic/Latino
Asian vs. -Two or More Ethnicities
Asian vs. White

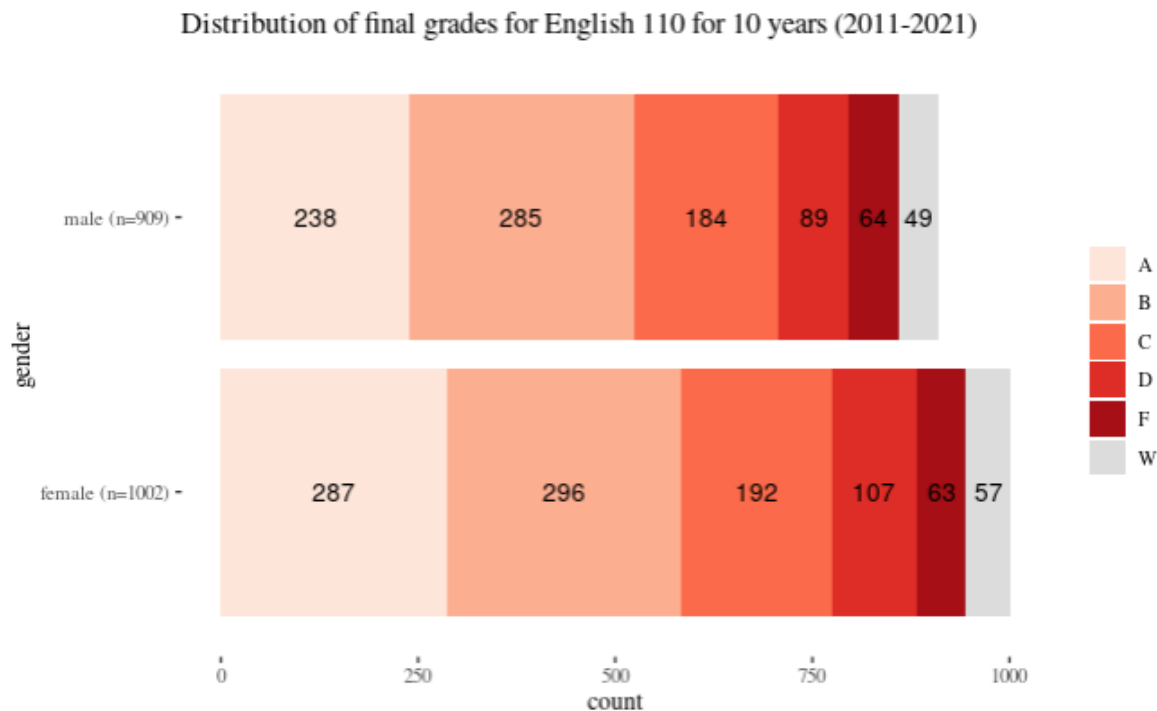
What is the 'direction' of the significant differences?

Distribution of final grades for Math 110 for Asian vs. Hispanic/Latino for 2020



English 110

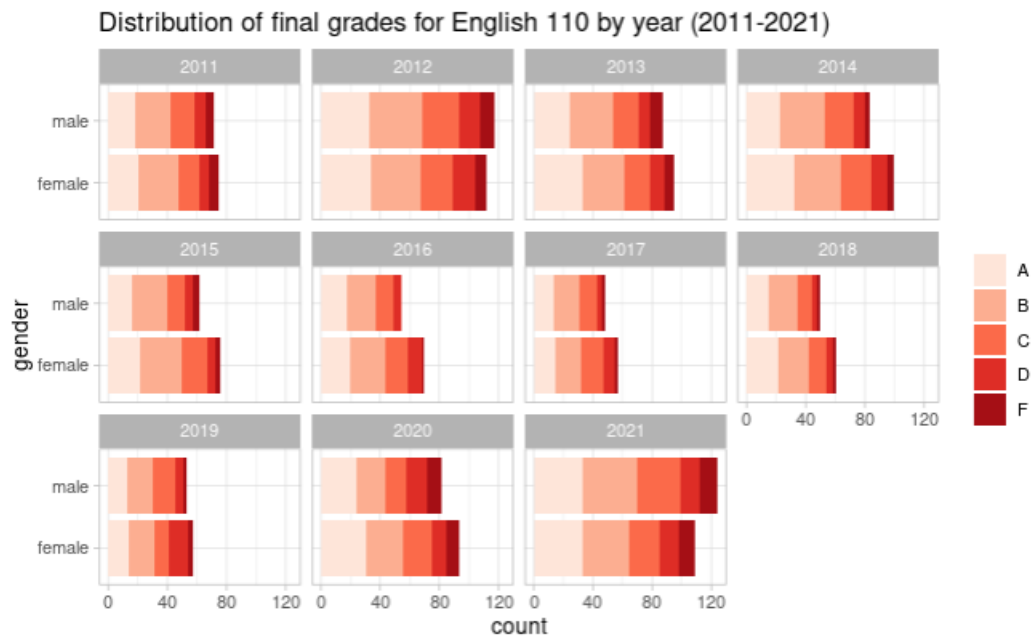
aggregated over 10 years (gender)



test	test statistic	p-value	effect size	signif (yes or no)
H_0 : scores among males and females are the same H_1 : scores are different	0.43 (permutation)	0.70	-0.02	no
	462,966 (Mann-Whitney)	0.50	-0.01	no

English 110

Longitudinal over 10 years (gender)

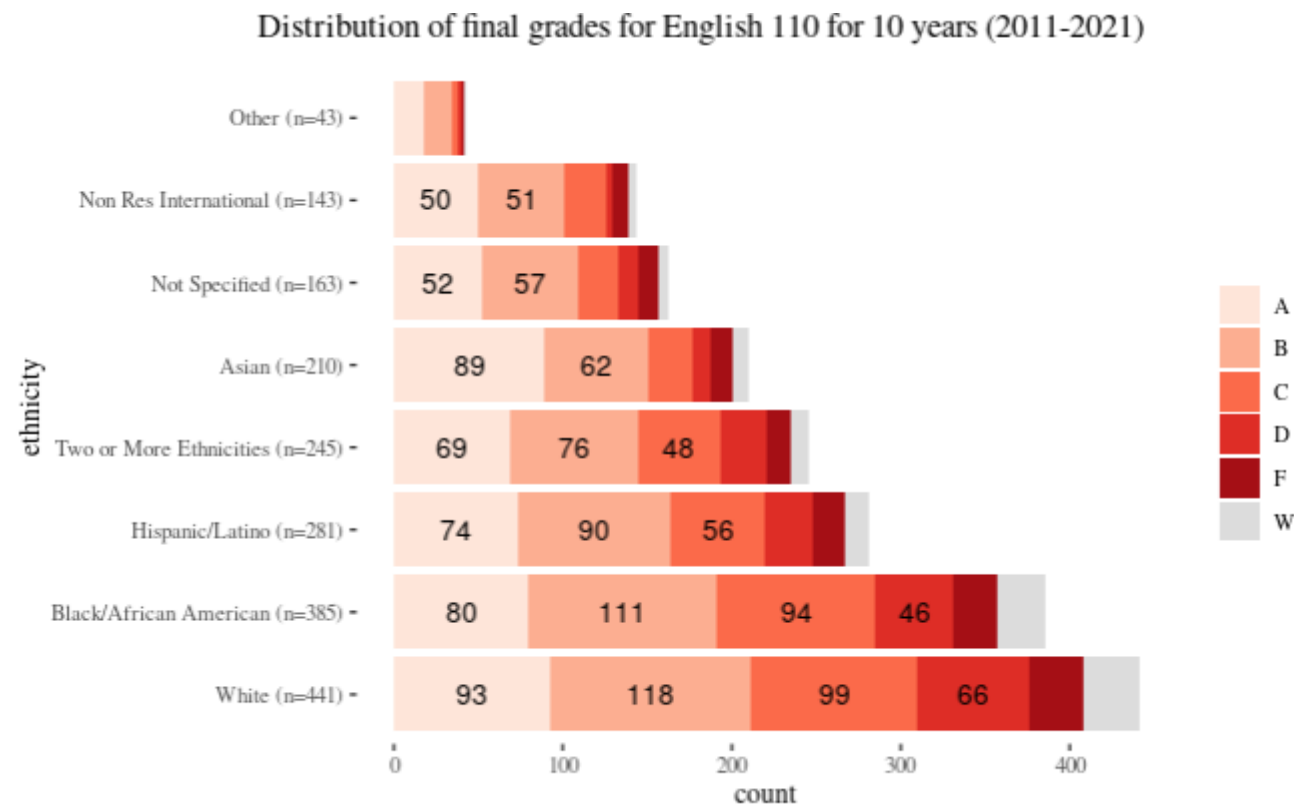


year	test statistic	p-value	effect size	signif (yes or no)
2011	2,734	0.80	-0.02	no
2012	2,408	0.70	-0.04	no
2013	1,180	0.80	-0.02	no
2014	1,686	0.80	-0.02	no
2015	1,235	0.50	-0.06	no
2016	1,032	0.50	-0.06	no
2017	836	0.30	-0.12	no
2018	928	0.90	-0.02	no
2019	946	0.60	-0.06	no
2020	3,345	0.60	-0.04	no
2021	3,082	0.90	-0.01	no

English 110

Aggregated over 10 years

Final grades Likert scores (ethnicity)



test	test statistic	p-value	effect size	signif (yes or no)
<div>H₀: scores among ethnicities are the same</div> <div>H₁: scores are different</div>	73 (Kruskal-Wallis)	< 0.0001	0.03	yes

English 110

Aggregated over 10 years

Final grades Likert scores - post hoc tests (ethnicity)

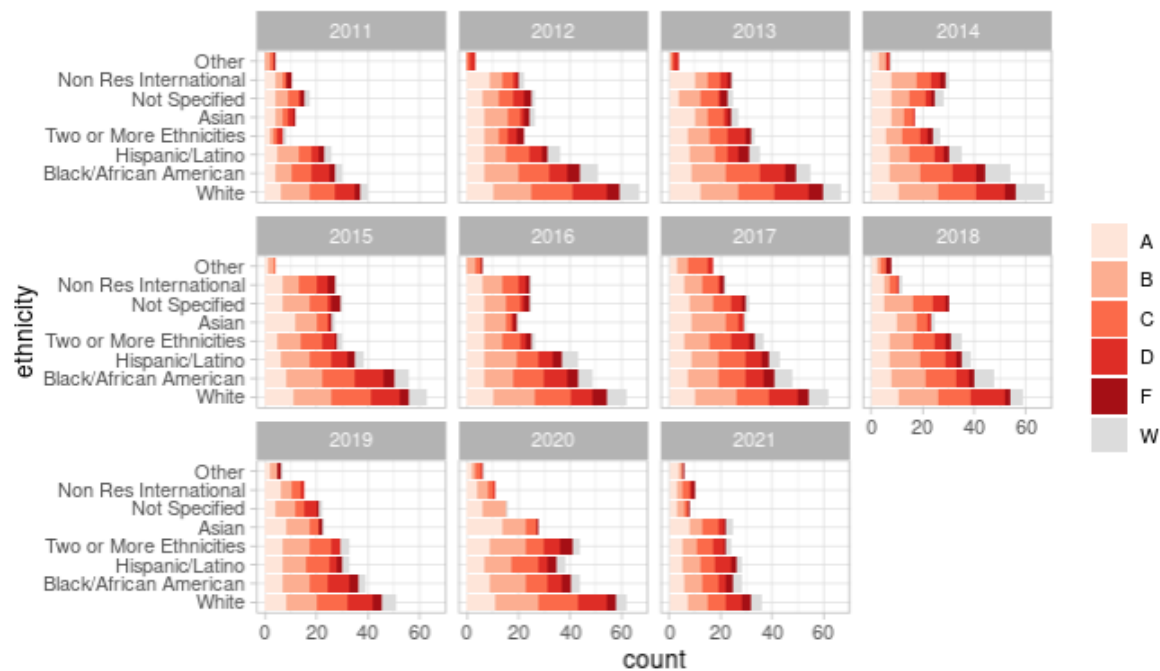
Significant Differences
Other vs. Black/African American
Other vs. White
Asian vs. Black/African American
Asian vs. Hispanic/Latino
Asian vs. White
Black/African American vs. Non Res International
Black/African American vs. Not Specified
White vs. Non Res International
White vs. Not Specified

English 110

Longitudinal over 10 years

Final grades Likert scores (ethnicity)

Distribution of final grades for English 110 by year (2011-2021)



year	test statistic	p-value	effect size	signif (yes or no)
2011	5.0	0.70	0.01	no
2012	12	0.10	0.02	no
2013	12	0.10	0.03	no
2014	12	0.10	0.03	no
2015	9.7	0.20	0.02	no
2016	9.5	0.20	0.02	no
2017	10	0.20	0.03	no
2018	11	0.20	0.04	no
2019	8	0.20	0.02	no
2020	8.5	0.30	0.009	no
2021	6.1	0.50	0.006	no

Poll: Gap analysis at your university?



Poll: Faculty resistance to gap analysis



Culturally Responsive Assessments

Culturally Responsive Assessments

- Can assessments be culturally biased?
- Standardized Testing
- Discovering patterns
- Faculty Resistance

Plan for Implementation and Expected Impact

Plan for Implementation

- Handout for considering a gap analysis (on conference website - <https://assessmentinstitute.iupui.edu/>).

Expected Impact

- By providing disaggregated data analyses, especially in well-visualized and accessible formats, academic programs can identify groups displaying achievement patterns beyond or below stated learning expectations.
- When gaps are identified, plans may be made for assessment and curriculum changes. For example:
 - culturally responsive assessments could be employed
 - encourage faculty to create assignments that have levels of creativity

Research has shown that when creative assessments are implemented that allow students to create something unique, the differences in performance among gender and racial groups are minimal (Kim & Zabelina, 2015).

Expected Impact

- Our study opened the conversation for assessment innovation through conducting gap analyses among different ethnic and gender groups.
- It is now our responsibility to focus on creating culturally appropriate measures of student learning – in which students from diverse identities can experience equitable acknowledgement of their academic achievements (Montenegro & Jankowski 2017) .

References

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Best Practices for Visualizing Assessment Data

Two texts by Cole Knafllic provide comprehensive best practices for creating and communicating with data visualizations. The texts are *Storytelling with Data* (Knafllic, 2015) and *Storytelling with Data Let's Practice* (Knafllic, 2020). Cole Knafllic can take data visualization methods and techniques from the disciplines of data visualization, information visualization, and data communication and boil the concepts down to an easy-to-implement manner for applied analysts.

Stephen Few has written multiple books on data visualization (Few, 2004b, 2006, 2021). And, in a similar manner as Cole Knafllic, he condenses down a lot of data visualization design content into an easy-to-digest form. His books 'speak' to the analyst that is trying to visualize

Much of the data that analysts work with is categorical in nature. Categorical data is different from continuous (quantitative data) in the sense that categorical data places objects, items, people etc... into categories that can either be named or ordered. There are two types of categorical data: nominal and ordinal data. Nominal data are categories that can be named. For example, your favorite drink (wine, beer, soda, water), country of origin (North America, Europe, Africa), or your favorite activity (reading, exercising, gardening). Ordinal data are categories that have a natural order to them (Olympic medals: gold, silver, bronze; performance on an assignment: Excellent, Good, Fair, Poor; how many times a week do you exercise: never, once a week, twice a week, more than three times a week). Stephen Few has a great white paper that describes the appropriate graph for a given data type (Few, 2004a).

Likert scale is ordinal data that is used extensively in surveys and in higher education assessment activities to evaluate academic programs (Dwivedi & Pandey, 2021).

Some Resources to Get Started:

Cole Knafllic periodically hosts 'data viz challenges' on her website (<https://www.storytellingwithdata.com/>). In one challenge, Pew Research Center data was used that was related to what tools teenagers used to research. The winner created a diverging stacked bar chart. The blog contains Cole Knafllic's discussion as to why this is the best way to visualize the different types of research tools teenagers use (Knafllic, 2012).

Stephen Few has a data visualization blog as well (*Stephen Few – Blog*, n.d.). He periodically posts best practices for organizing and graphing ordinal data (*Visual Business Intelligence – Ordinal Malpractice*, 2020).

Assessment Institute 2022

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References

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Handout for Considering a Gap Analysis

A gap analysis is defined as the difference that exists between an academic program's expectations of students' performance and results obtained through assessment. These differences can be examined among gender and ethnic groups.

The presenters investigated to determine if there was an achievement gap using final grades (and withdraws) from introductory level English and Math courses.

Below are some high-level decisions that need to be made and questions that need to be answered to successfully implement a gap analysis from an assessment standpoint.

- Decide whether your gap analysis is going to be performed at the course or program level. It is recommended when beginning the process, start at the program level.
- Determine whether knowing if a gap existed or not would be helpful.
- Establish whether a gap analysis would assist faculty.
- Establish whether a gap analysis would proactively help students.

Questions to guide the process:

- How would information about gap analysis would be helpful for faculty and administrators at your school?
- What changes would you envision being made based on gap analysis?
- What is needed to prepare faculty to receive information about a gap in instruction?
- Decide if a gap analysis would guide curriculum and assessment personnel.
- How do you meet the possible resistance from faculty if a gap is identified?
- Who is responsible for implementing changes targeted to decrease the gap?
- How do you create accountability for those changes?