External Representations in Introductory Statistics

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Motivation

Enrollment in Introductory Statistics continues to show substantial gains, with an increase in enrollment of 11% at 4-year institutions and 87% at 2-year institutions from 2010 to 2015 (Blair et al., 2018).

To support the development of students' ability to think and reason with data, researchers have set forth recommendations for the teaching and learning of statistics at the tertiary level, some of which include:
- produce and interpret graphical displays and numerical summaries (ASA GAISE College Report Revision Committee, 2017).
- the use of multiple external representations (Lem, Onghena, Verschaffel, & Van Dooren, 2013).
- the integration of technology (ASA GAISE College Report Revision Committee, 2017).

Yet, relatively little is known about the current landscape of statistics education (Gould et al., 2018) and the extent to which these recommendations are being taken up in the classroom.

Research Questions

1. What visual summaries are currently used in Introductory Statistics and how prevalent are they?
2. To what extent is technology used in the teaching of Introductory Statistics?
3. Are there relationships between visual summaries and technology?

Data Collection

- Instructors from 80 two- and four-year institutions were invited to participate.
- 148 Instructors responded to our survey (27.2% response rate).
- The survey was designed to shed light on the content and instructional practices currently in place in Introductory Statistics courses.
- Analysis is in early stages.

Institutional, Departmental, and Instructor Demographics
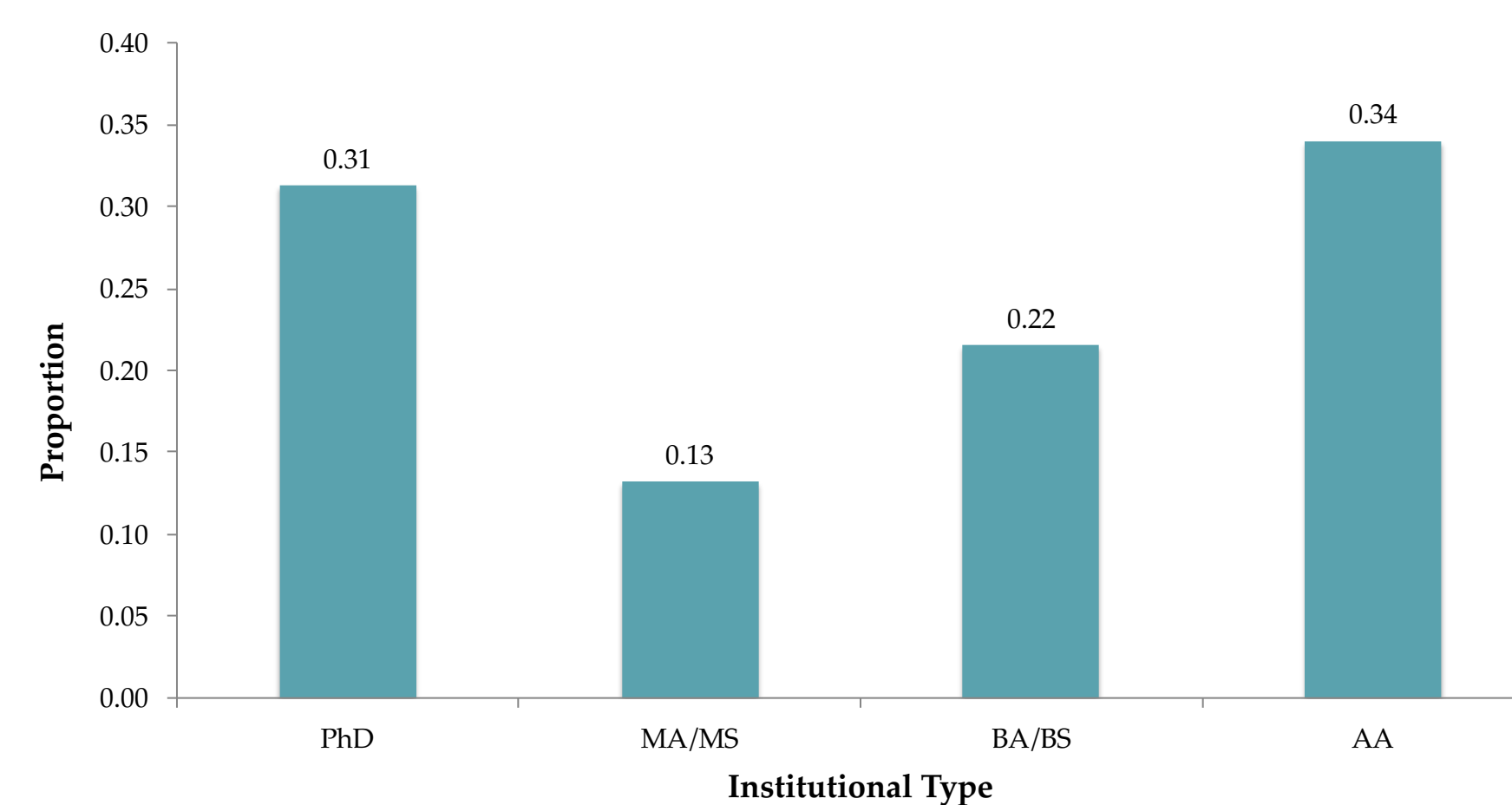
Participating instructors reported working at a variety of institutional levels. Overall, 44% of instructors are teaching at PhD-granting institutions, 22% at Bachelors-granting institutions, and 34% at institutions that offer an Associates degree with at least a concentration in mathematics.
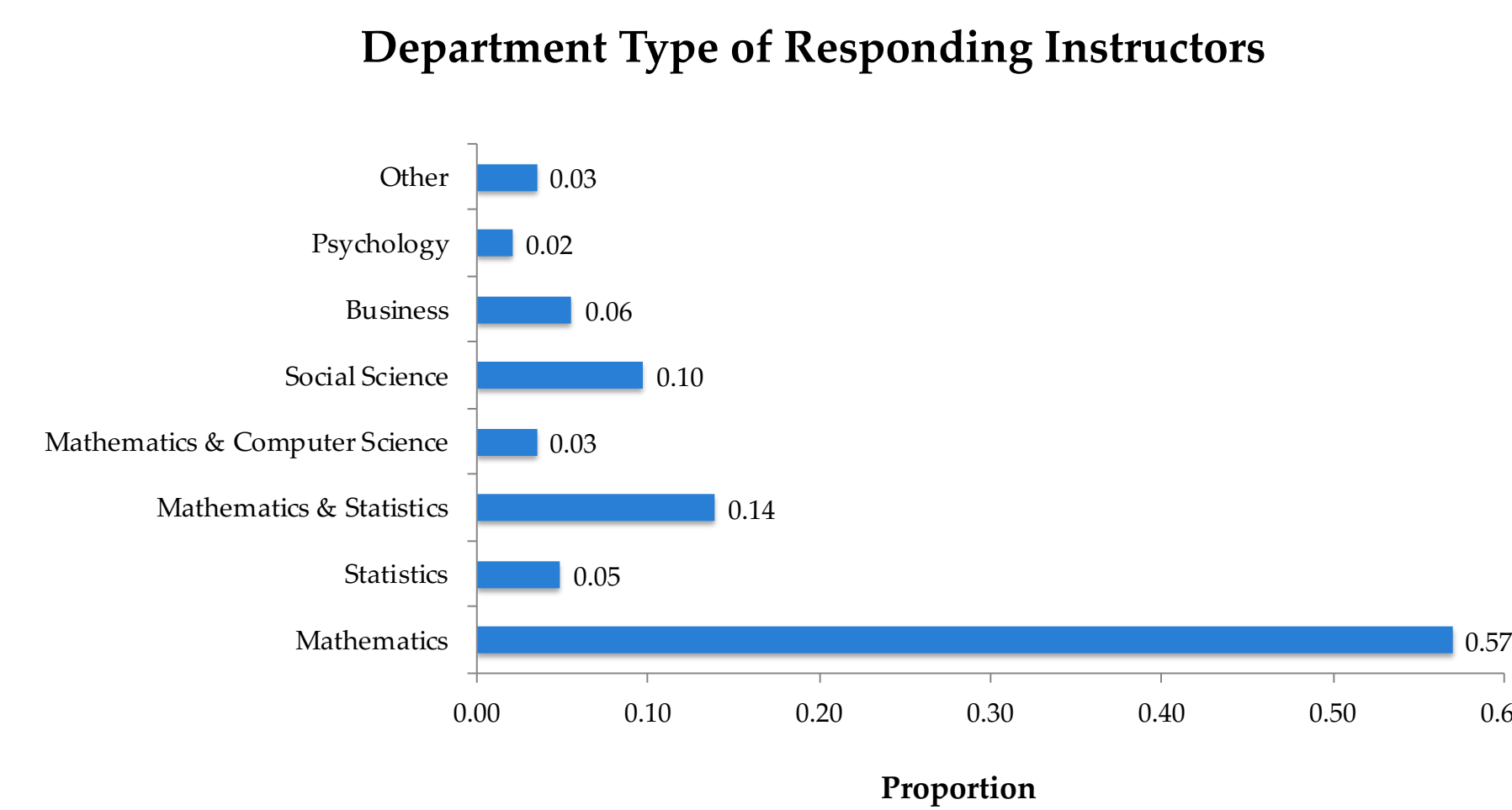

Over half of the participating instructors reported teaching Introductory Statistics for a mathematics department. While not as prevalent, approximately 22% of instructors reported teaching in departments outside of mathematics and statistics. These departments ranged from Business to Public Health.
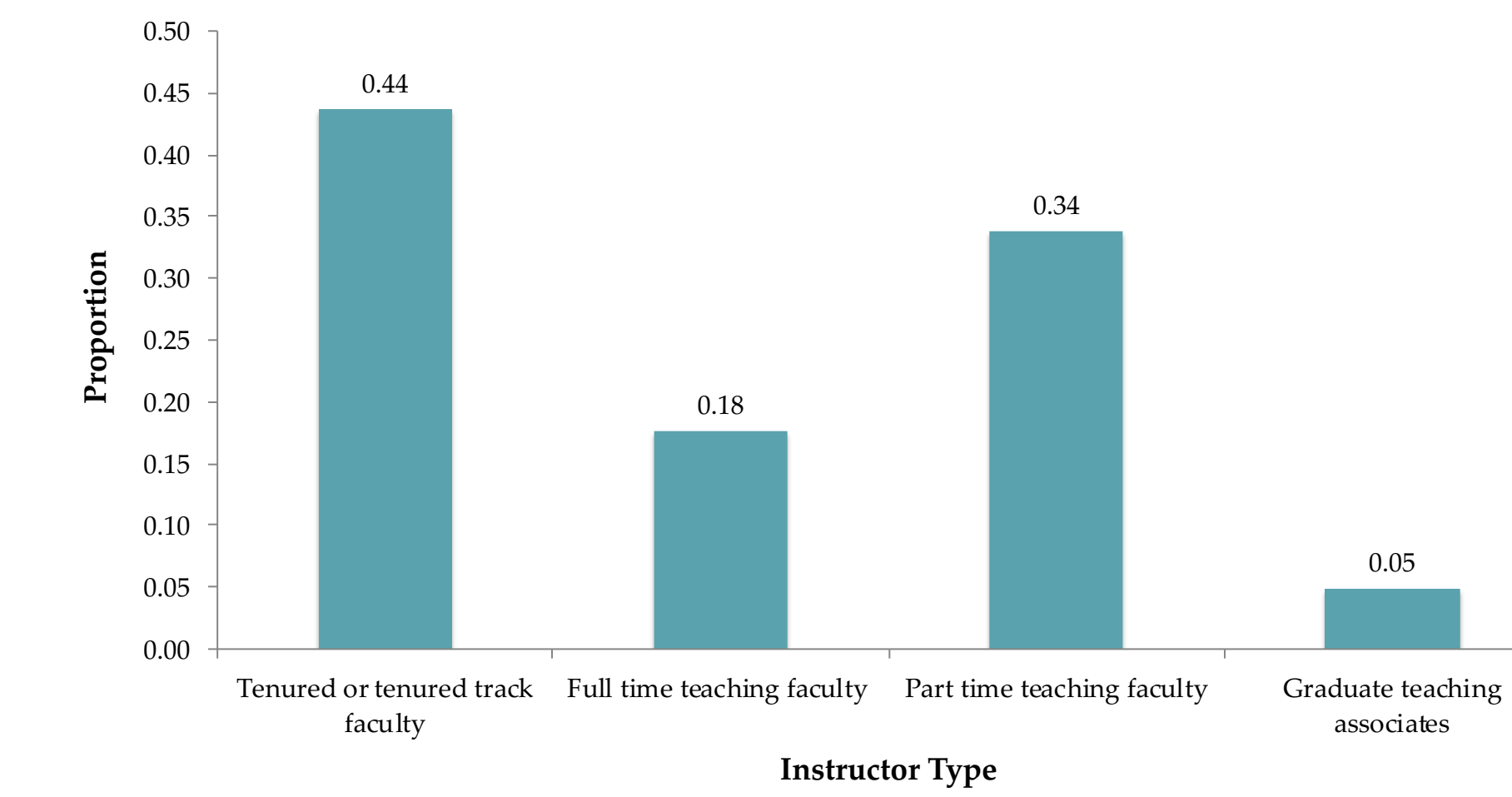

The majority of instructors (78%) were either tenure track faculty (44%) or part-time instructors (34%). Graduate teaching associated were most uncommon (5%) and along with full time teaching faculty comprised less than a quarter of the instructors from our survey.

## Results

External Representations
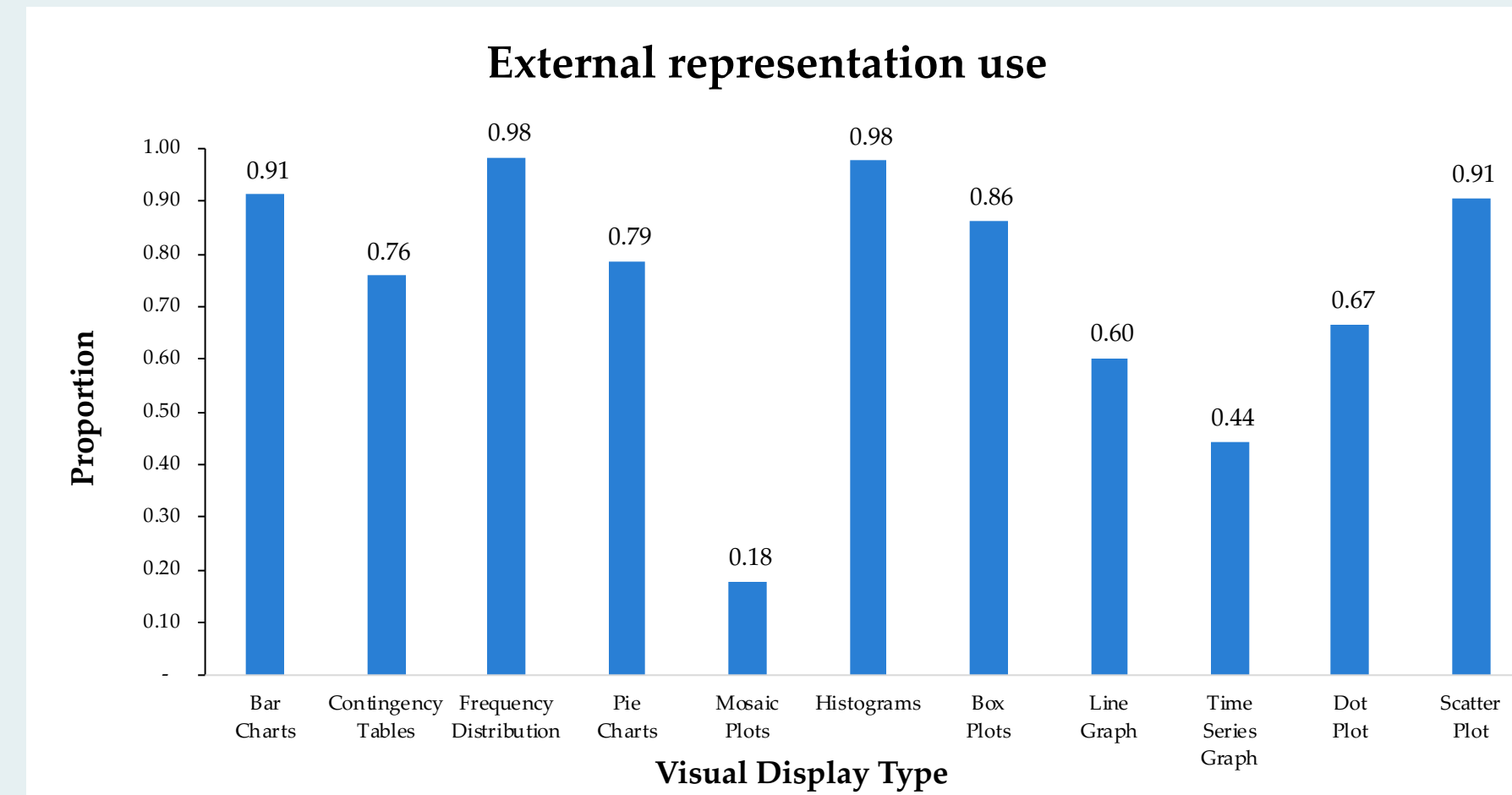
Histograms were used by 98% and related dot plots were used by 67% of reporting instructors. Alternatively, contingency tables were used by 76% and related mosaic plots were used by 18% of reporting instructors. ($\chi^2_{10} = 119.89$, p<0.01)
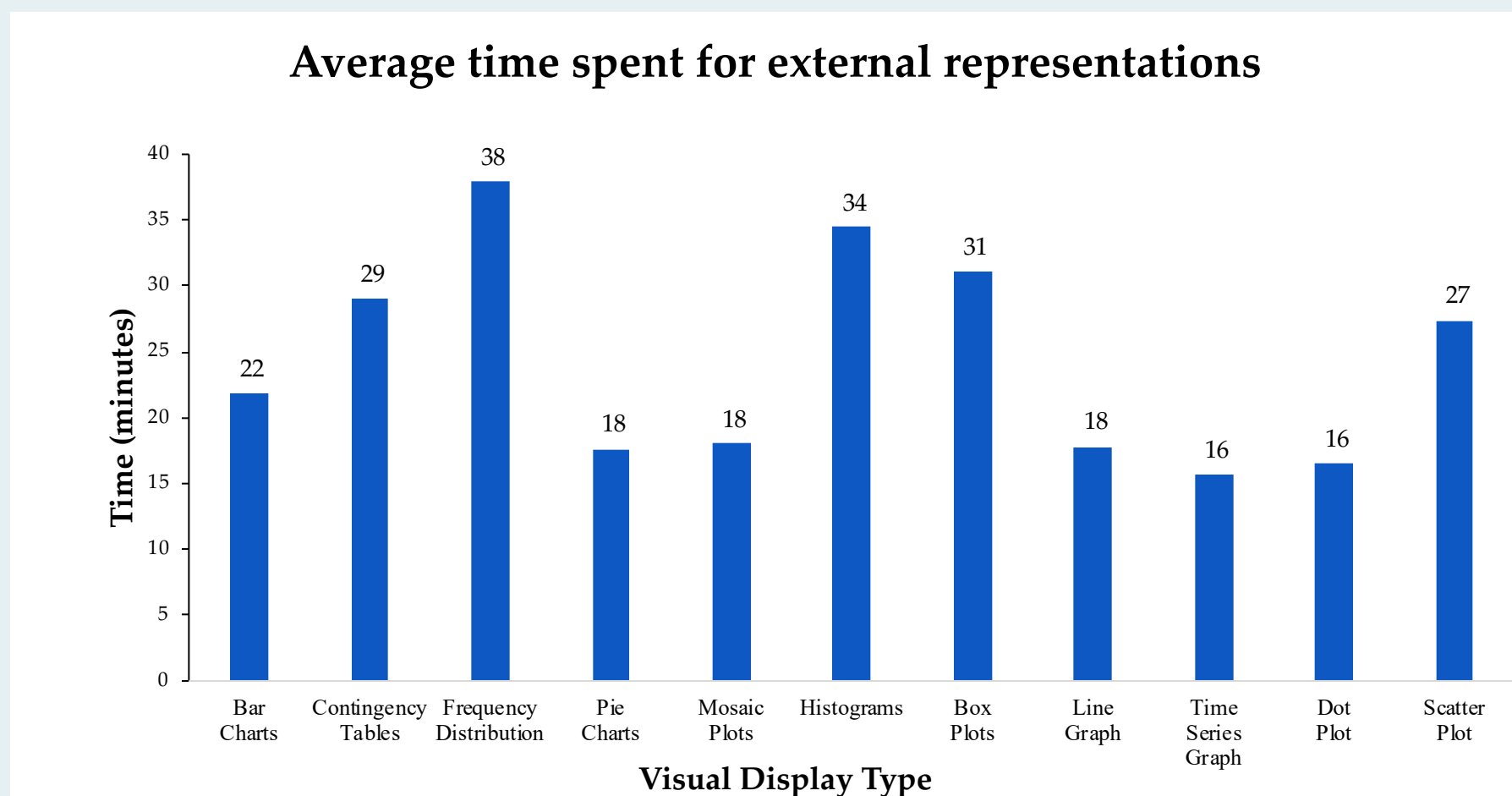

For instructors who used a visual display, the average time spent on the display ranged from 16 to 38 minutes with the most time spent on frequency distributions (38 minutes) and histograms (34 minutes). ($\chi^2_{10} = 63.16$, p<0.01)
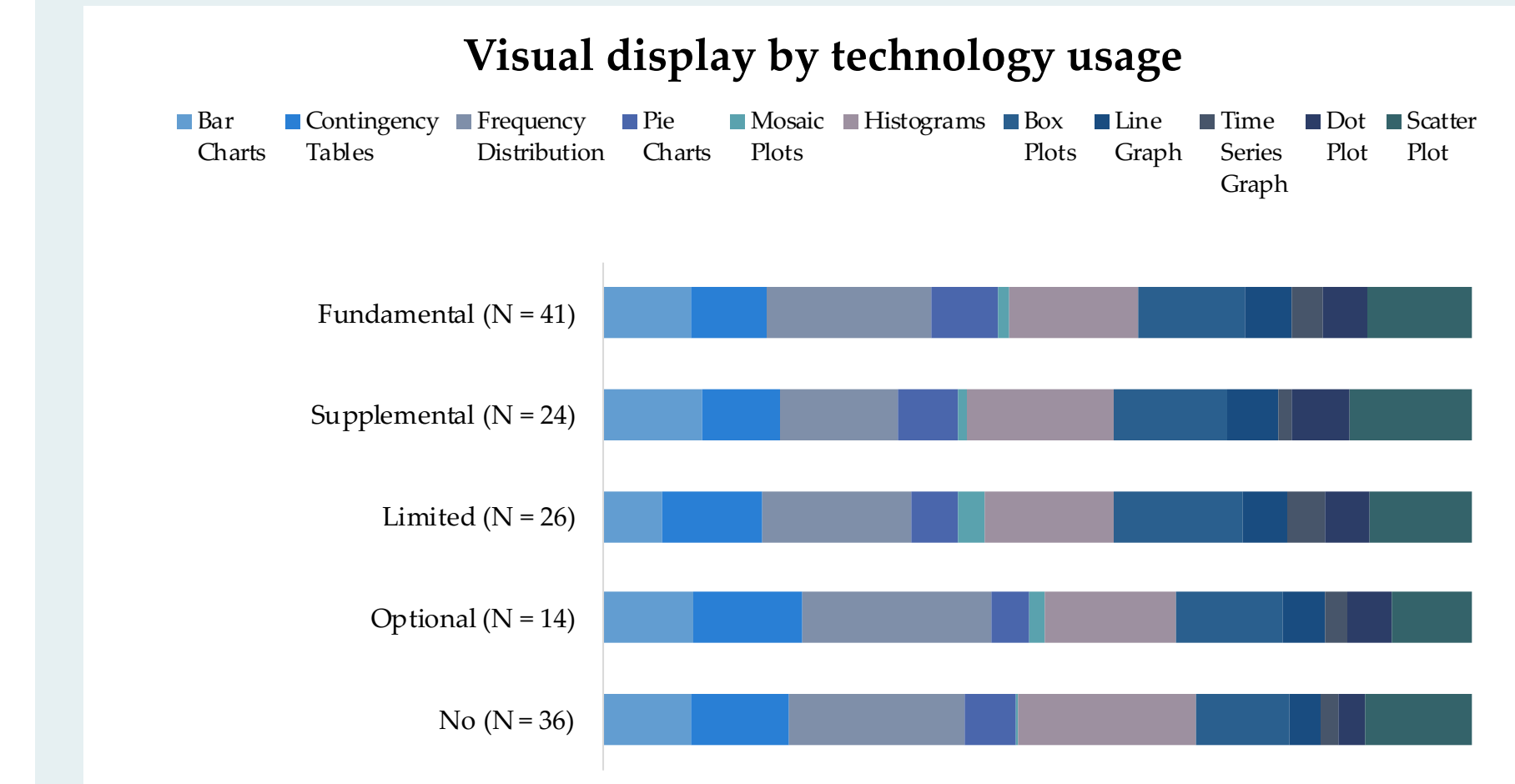
Technology
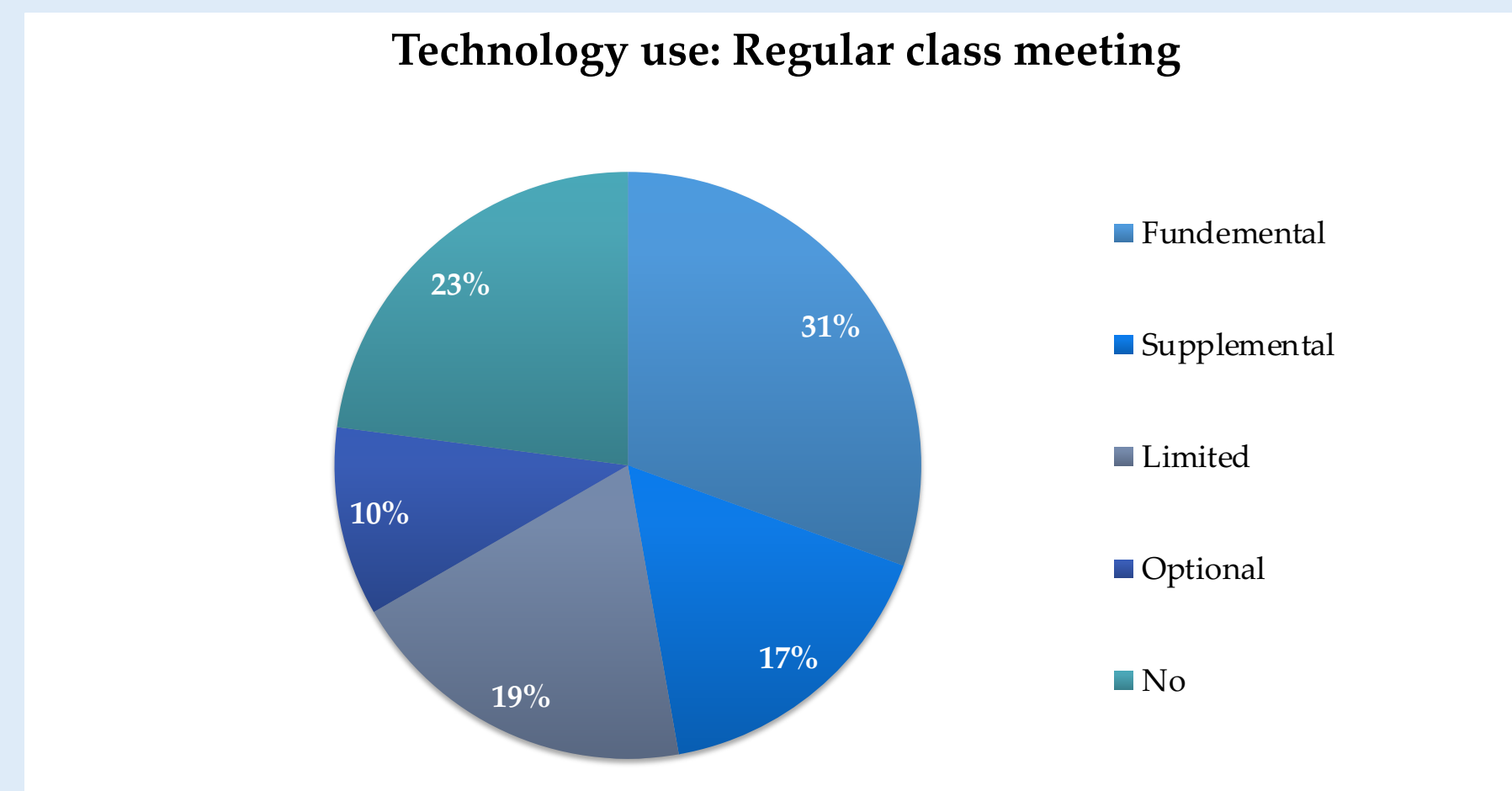
Over half of the instructors reported that technology was not an integral part of their course – with 19% reporting limited use of technology and 33% indicating that technology was not used or optional.
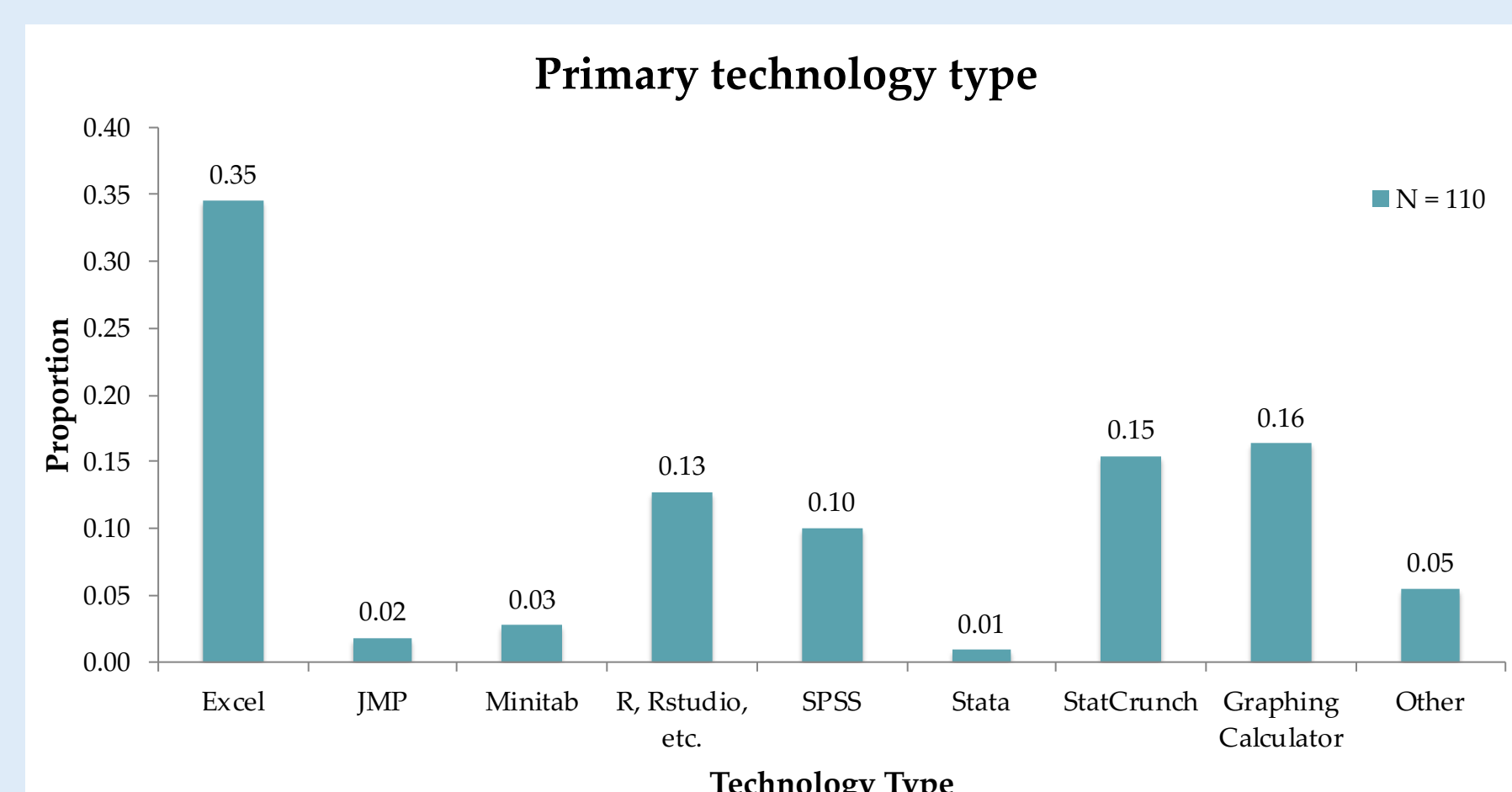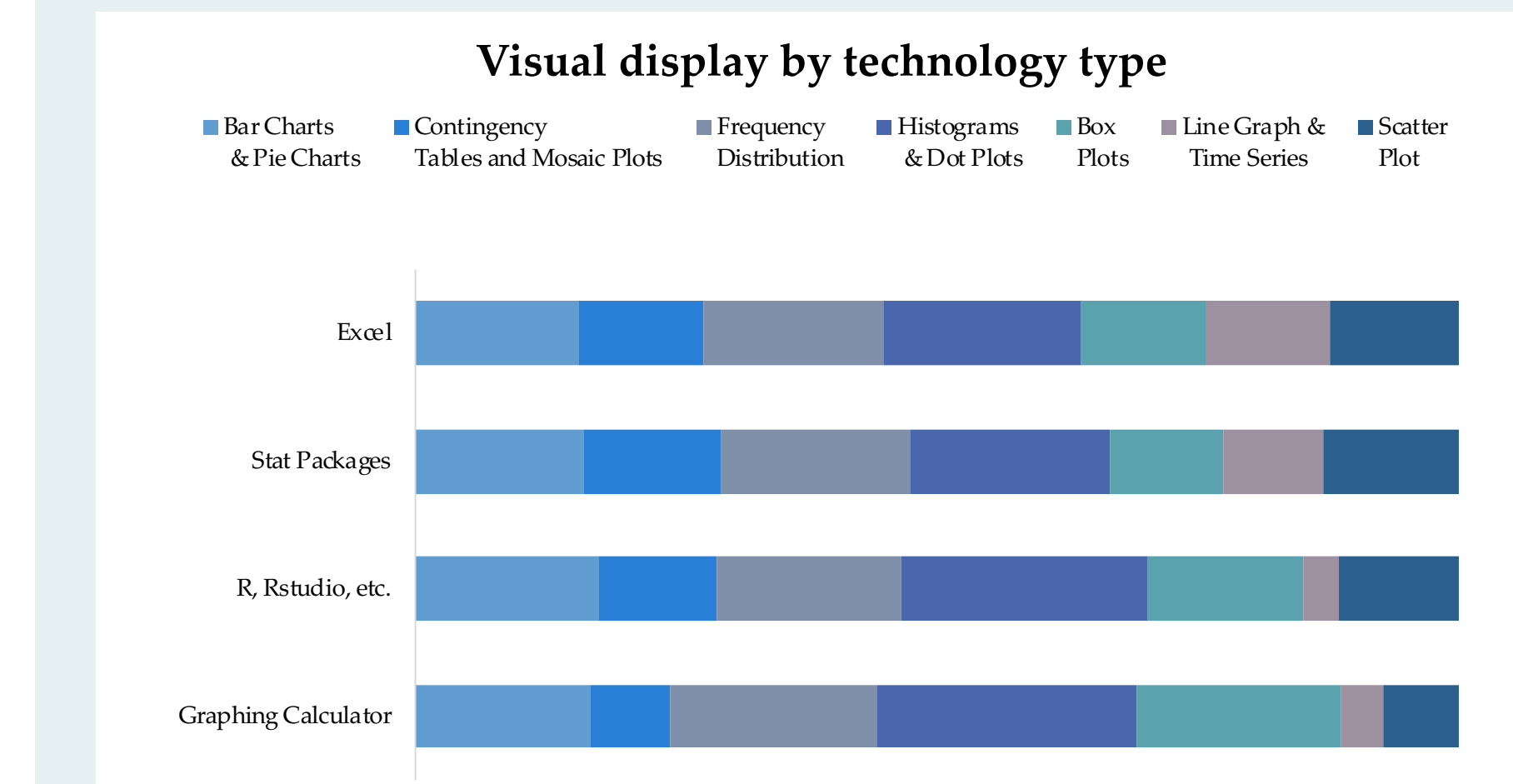

Instructors were most likely to report using Excel or graphing calculators as the primary type of technology in their course, with software designed specifically for statistical analysis reported less frequently.

Relationships

The use of visual displays is fairly consistent across instructor technology usage, with instructors using limited technology spending a lower percentage of visual display instruction time with bar charts and a higher amount with mosaic plots. ($\chi^2_{40} = 26.71$, p = 0.947)

Instructors using Excel were more likely to spend a higher percentage of their visual display instruction time on line graphs and time series graphs and those using graphing calculators were more likely to focus on box plots. ($\chi^2_{18} = 33.50$, p = 0.015)

Findings

- Most visual displays were used by a majority of instructors, with the exception of time series graphs (44%) and mosaic plots (18%), which were used by a minority of instructors.
- Instructors were likely to spend more time on frequency distributions and histograms and less time on time series graphs and dot plots.
- While 31% of instructors reported using technology as a fundamental part of their course, over half reported that technology was not used, optional, or used in a limited capacity.
- Instructors were less likely to report using technology designed for statistical analysis as the primary technology used in their course.
- There does not appear to be a relationship between visual displays and the usage of technology.

Next Steps

Explore what factors (institutional, departmental, instructor) contribute to the use of external representations in these Introductory Statistics courses.

References

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