

COMPUTING FACULTY INTERNATIONALIZATION PERCEPTIONS: AN EXPLORATORY DATA ANALYSIS USING R

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ABSTRACT

This paper summarizes the results of a faculty internationalization perception survey completed by 70 computing faculty. Applying a data exploration methodology, the survey data was visualized and repeatedly tested using the R environment for statistical computing and graphics. Following the visualization and testing, three hypotheses were generated to be used in future projects.

Keywords: Computing, Internationalization, Faculty, Perception, R

INTRODUCTION

Internationalization

Internationalization in higher education is “The process of integrating an international, intercultural or global dimension into the purpose, functions or delivery of post-secondary education” (Knight, 2003, p. 2). International activities can include study abroad programs, international research, and enrollment of international students, among many others. John Hudzik writes that “The ultimate purpose behind internationalization is better connection of institutions to a changing local and global environment and providing more relevant service to society and clientele under these changing realities. Internationalization can be a means to prepare graduates for life and work in a global market of products, services, and ideas” (2011). As trade, travel, and technology effectively erase borders, internationalization seems more necessary than ever.

Despite this apparent necessity, university faculty members’ perceptions of internationalization remain mixed. The literature on this topic reflects two communication gaps that help explain the apparent ambivalence. The first is a gap between internationalization as an institutional goal and internationalization as a faculty undertaking: Michael Stohl noted in 2007 that at Purdue University where he had served as Dean of International Programs, “it is not clear that even after almost 15 years of task forces, grant programs and spirited endorsement by senior university administrators that most faculty members had internalized the ‘cause’ of internationalization” (2007, p. 362). The second and related gap is a lack of communication between institutions’ study abroad or international offices and their faculty. Giedt et al. find that “many study abroad offices have been somewhat removed from the institution’s faculty or its academic core, and thereby not truly integrated into academic departments” (Giedt, Golcek, & Ghosh, 2015, p. 174). These disconnects are problematic because faculty play a central role in building study abroad participation.

Perceptions vary among academic departments as well as between faculty and administrators. The notion that internationalization work belongs to certain academic fields more than others persists despite recommendations from accrediting bodies such as the American Assembly of Collegiate Schools of Business in favor of an internationalized curriculum (Meier & Smith, 2016). This perception is perhaps rooted in larger philosophical differences between disciplines about the purpose of university education. One study notes that STEM faculty might view study abroad opportunities as “distractions from gaining valuable disciplinary competencies such as research and technical skills” (Giedt, Golcek, & Ghosh, 2015, p. 175). Humanities fields have been more likely to see intercultural competency as more relevant to their subject matter and methods than do faculty in STEM, business, and similar areas.

Beyond disciplinary differences, faculty view internationalization activities as reserved for post-tenure faculty members who have already fulfilled expectations in research. More broadly, many institutions do not recognize internationalization work in tenure and promotion reviews at all. Rampold et al. explain that “the contemporary reward system is one that seldom recognizes the international activities of faculty and, therefore, serves as a barrier” to faculty

engagement in study abroad programs (Rampold, Bunch, Cater, Blackburn, & Burnett, 2018, p. 236). With time and money in short supply, faculty will naturally focus their work in areas for which they know will be rewarded at evaluation time.

Instrument Development

The Faculty Internationalization Perceptions Survey (FIPS) was developed out of the dissertation research of Dr. John Criswell while at the University of Missouri-Columbia (Criswell, 2014). Following a broad literature review, a pilot survey, and extensive content analysis by professionals in the field, Criswell would conclude the assessment of his instrument design and theoretical model by validating it using Confirmatory Factor Analysis. The initial set of 20 questions was eventually reduced to 10, loading across four constructs: institutional support, financial support, faculty expectations, and faculty rewards. A fifth factor, international experience, was discarded because it failed to adequately load in the model. The second factor, financial support, was split off from institutional support based on question scope, revealing the nuances of the “disconnect between what the institution says, and what kinds of tangible support the faculty members receive” (Criswell, 2014, p. 90). The construct of institutional support “refers to the institution having an infrastructure in place that promotes internationalization and that faculty members can tap into in their efforts to internationalize” (Criswell & Zhu, 2015, p. 33). Faculty expectations references the presumption that faculty will attend international conferences, engage in international research, engage in international curricular adjustments, and develop international programs. The last construct, faculty rewards, speaks to the extrinsic motivators for engaging faculty: promotion, tenure, and compensation.

Initial testing by Criswell (2014) verified usefulness of the instrument by identifying for differences within and between institutions examined. Specifically the effect of institutional support was found to be significant: $F(2,283) = 4.777, p = .009$ with post hoc analyses using Tukey’s test identifying the source of the difference. Utilizing an analysis of variance, financial support similarly showed the effect of an institution’s financial support to be significant: $F(2,283) = 5.360, p = .005$. Again, a post hoc analysis using Tukey revealed the source of the difference identified. Further analysis of variance affirmed that the other two facts—faculty expectations and rewards— “showed that there were no significant differences between them” (Criswell, 2014, p. 102).

It is for this reason and to further examine the disconnect between communication and follow-through that our investigation prioritizes the constructs of institutional support and financial support. The exploratory research of this group addressed the limitations identified by Criswell (2014) in his dissertation research by attempting to further legitimize the instrument and refine the factors with additional variables. Our initial efforts to *enhance the model* with additional questions are critical first steps in validating FIPS and positioning it as an emerging and valuable tool to measure faculty perceptions of support for internationalization.

Computing Faculty

The primary goal of this research is hypothesis generation that we anticipate will be used in future research focusing on computing faculty. We include in this population faculty who teach in information technology, information systems, computer science, or other related domains. This grouping is similar to how the Joint Task Force for Computing Curricula 2005, a cooperative project of The Association for Computing Machinery (ACM), the Association for Information Systems (AIS), and the Computer Society (IEEE-CS), viewed the field. In their Overview Report, the authors noted "Computing consists of several fields, and many respected colleges and universities offer undergraduate degree programs in several of them such as computer science, computer engineering, information systems, information technology, software engineering, and more" (Joint Task Force on Computing Curricula, 2005).

RESEARCH METHODOLOGY

Our research centered upon the following research question: Do significant differences exist amongst computing faculty members’ perceptions of support for internationalization? Specifically, we were interested in exploring whether demographic characteristics or professional experiences might account for any differences. Such differences were initially highlighted by Criswell (2014) in his pioneering research.

Given the investigative nature of our research we opted to adopt a data exploration methodology, which has been described as “the art of looking at your data, rapidly generating hypotheses, quickly testing them, then repeating again and again and again. The goal of data exploration is to generate many promising leads that you can later explore in more depth” (Grolemund & Wickham, 2017). A data exploration methodology differs from the more traditional inferential approach in that the same data is visualized and tested repeatedly. The ability to visualize the data in a variety of forms is a major advantage of this methodology, or as John Turkey suggested, “The greatest value of a picture is when it forces us to notice what we never expected to see” (1977, p. iv).

A consequence of this visualize and explore approach is that we may not generalize the findings, but we may use these findings to create hypotheses to be used on different or expanded datasets. Grolemund and Wickham (2017) eloquently described these two distinct tasks as *hypothesis generation* and *obj*. The primary objective of this project is hypothesis generation. We anticipate that our hypotheses will be confirmed in subsequent projects with larger datasets. A secondary objective is to assess the utility of using R, a free software environment for statistical computing and graphics, for such investigations. In support of the secondary objective, we have provided notes on the R tools we opted to use in our analysis.

After receiving Institutional Review Board approval, we hosted our instrument online using Google Forms. Key to this project were three statements related to faculty perceptions of institutional support (InstSp) and three questions about financial support (FinSp). Respondents were asked to indicate to what extent they agreed with the following statement concerning the campus where they were currently working:

- InstSp1:** Top leaders express verbal and written support for internationalization.
- InstSp2:** Institutional mission/vision statements specifically reference an international dimension (e.g. global, international, world, multinational).
- InstSp3:** Top leaders express support for faculty participation in international activities.
- FinSp1:** Adequate funding for international teaching is available.
- FinSp2:** Adequate funding for international research is available.
- FinSp3:** Adequate funding for international conferences is available.

In addition, a series of questions about demographic characteristics and professional experiences were included.

RESULTS

Descriptive Statistics

A total of 70 usable responses were collected. The demographic characteristics of the sample population are shown in Table 1 and the professional experiences are shown in Table 2.

Table 1. Demographic Characteristics

Characteristic	Count	Percent
<i>Gender</i>		
Female	27	0.38571
Male	40	0.57143
Prefer not to answer	3	0.04286
<i>Faculty Status (FacStatus)</i>		
Fulltime Non-tenure Track	5	0.07143
Fulltime Tenure Track	14	0.20000
Fulltime Tenured	36	0.51429
Part-time	15	0.21429

Table 2. Demographic Characteristics

<i>Speak Second Language (Lang)</i>		
No	23	0.33333
Yes	46	0.66667
<i>Lived Outside Country (LiveOut)</i>		
Yes	39	0.56522
No	30	0.43478

Table 3. Professional Experiences

Experiences	Count	Percent
<i>Student Exchange (StuExch)</i>		
No	55	0.79710
Yes	14	0.20290
<i>Faculty Exchange (FacExch)</i>		
No	57	0.82609
Yes	12	0.17391
<i>International Research (IntRes)</i>		
No	34	0.49275
Yes	35	0.50725
<i>International Teaching (IntTea)</i>		
No	43	0.62319
Yes	26	0.37681

Data Visualization

The real advantage of data exploration is in visualizing the data. R simplifies the process by providing a number of useful plot alternatives (R Core Team, 2019). Below we present a small selection of the plots we completed. In the interest of brevity, we have only included plots that lead to hypotheses or that illustrated the power of using R for this type of exploration. For example, in Figure 1 we show the impact of time spent outside one's home country (LiveOut) on Institutional Support (InstSp), which is the sum of questions InstSp1, InstSp2, and InstSp3. We have added FacStatus to the plot to permit the visualization of this characteristic.

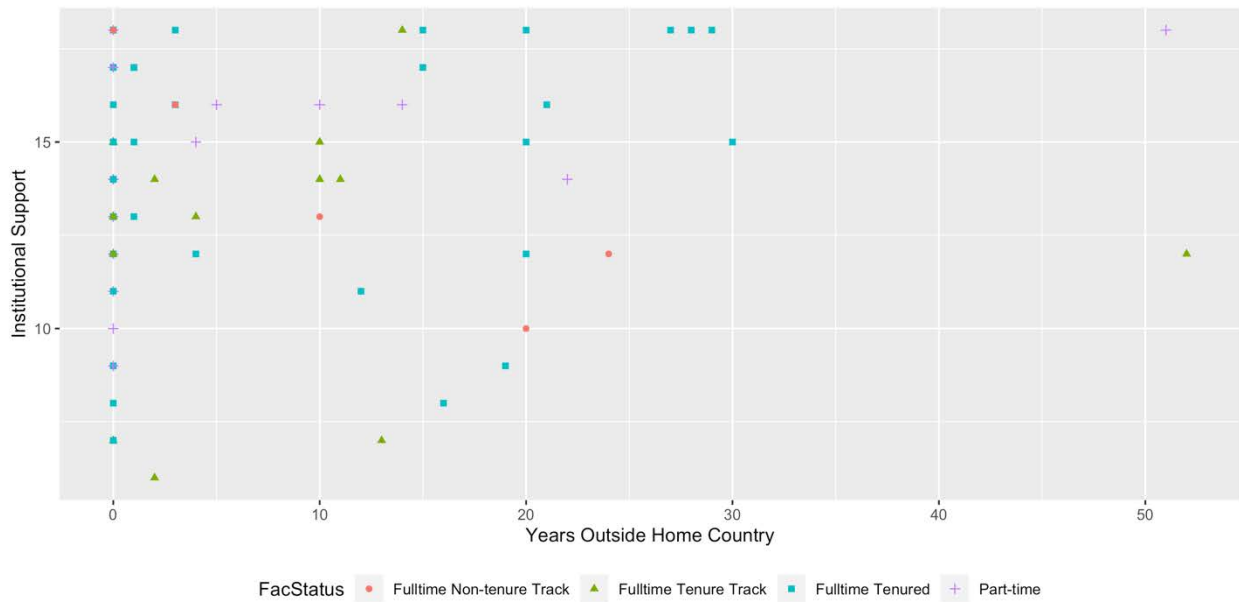


Figure 1. Institutional Support - Years Outside Country

We improved the plot in Figure 1 by using R's jitter function that adds “a small amount of noise to a numeric vector” (R Core Team, 2019). This jitter provides more fidelity in the plot. In addition, we used the R function `geom_smooth()` to draw a line which “aids the eye in seeing patterns in the presence of overplotting” (Wickham, 2016). The impact of these two features are highlighted in Figure 2 and was subsequently used in our plots to improve clarity.

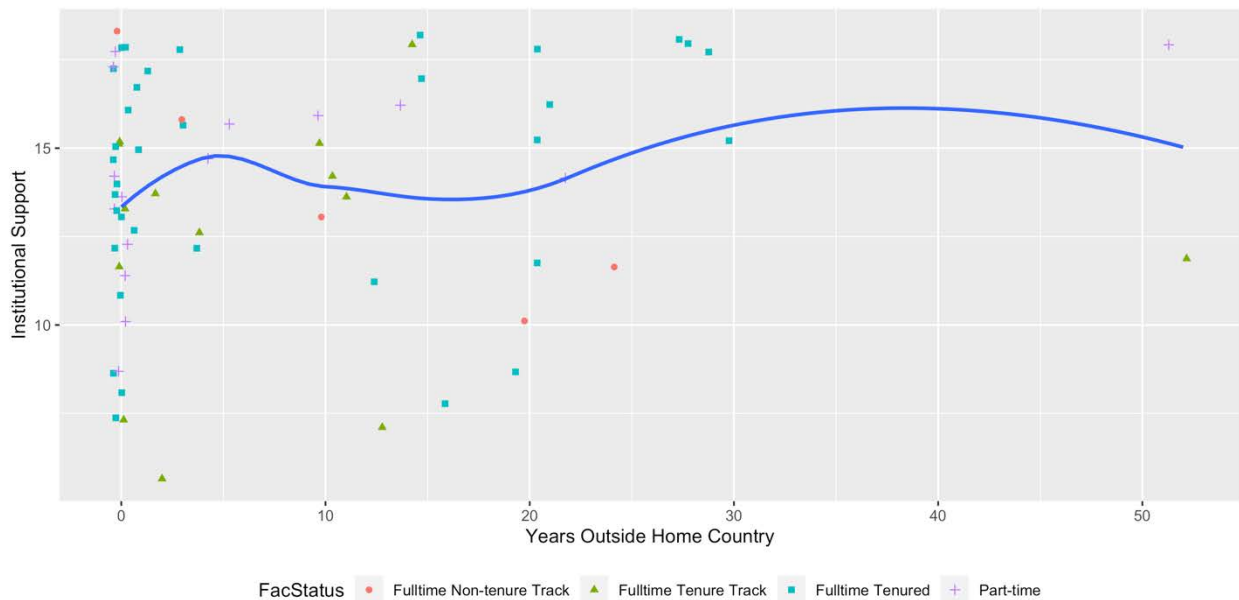


Figure 2. Institutional Support - Years Outside Country with Jitter and Smooth

Once we visualized the data in various plots, we concentrated on the plot(s) that seemed to highlight interesting findings. For example, the data in Figure 2 appeared to be indicating a finding worth pursuing, perhaps showing increased support over time. At that point it was necessary to complete a statistical test, and, in this case, we

decided an analysis of variance (ANOVA) was appropriate. There was a not significant difference in mean Institutional Support [$F(1,67) = 1.716, p = 0.195$] based on Years Outside Home Country.

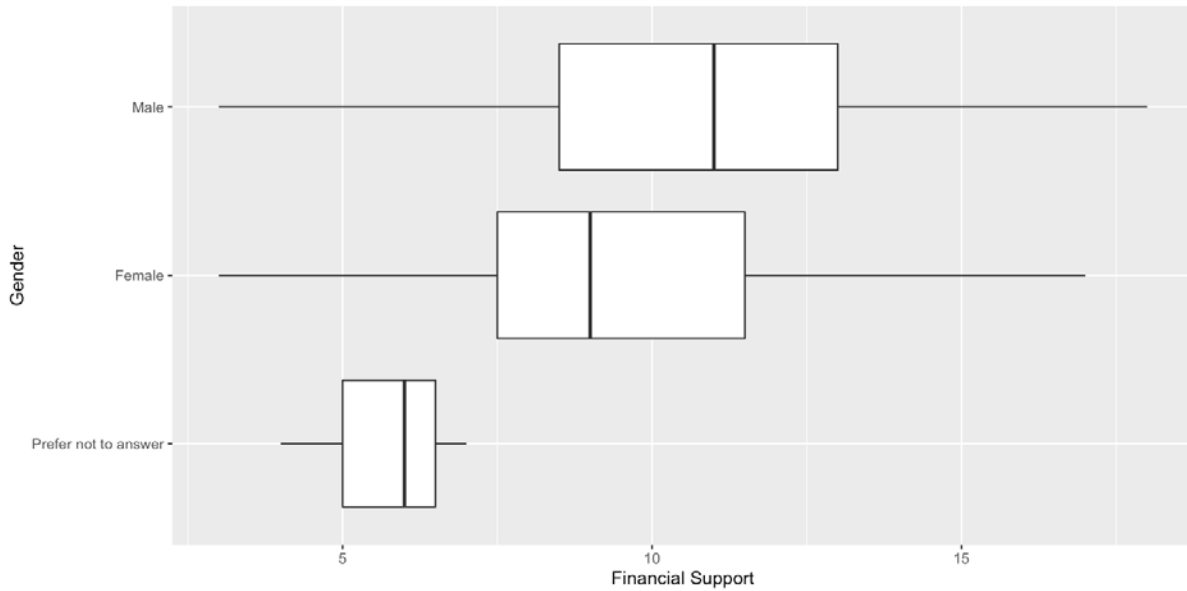


Figure 3. Financial Support - Gender Boxplot

The second set of variables considered was visualized using R's `geom_boxplot` function, that “compactly displays the distribution of a continuous variable. It visualizes five summary statistics (the median, two hinges and two whiskers), and all ‘outlying’ points individually” (Wickham, 2016). The results of the plot are in Figure 3, which showed a difference worthy of an ANOVA test. There was a not significant difference in mean Financial Support [$F(2,67) = 2.61, p = 0.081$] between Gender categories at the 0.05 alpha level. There was a significant difference at the 0.10 so it may be worth considering this hypothesis when evaluating a larger sample.

The third data considered were Institutional Support and International Teaching (respondents were asked, “Have you participated in international teaching?”). Our visualization is shown in Figure 4. The plot suggested a difference, so an ANOVA was completed. There was a significant difference in mean Financial Support [$F(1,67) = 4.355, p = 0.0407$] between reported International Teaching categories. Post hoc analysis (Tukey HSD) indicate there was a significant difference between Yes and No ($p = 0.040706$). This finding should be developed into a hypothesis for a future project.

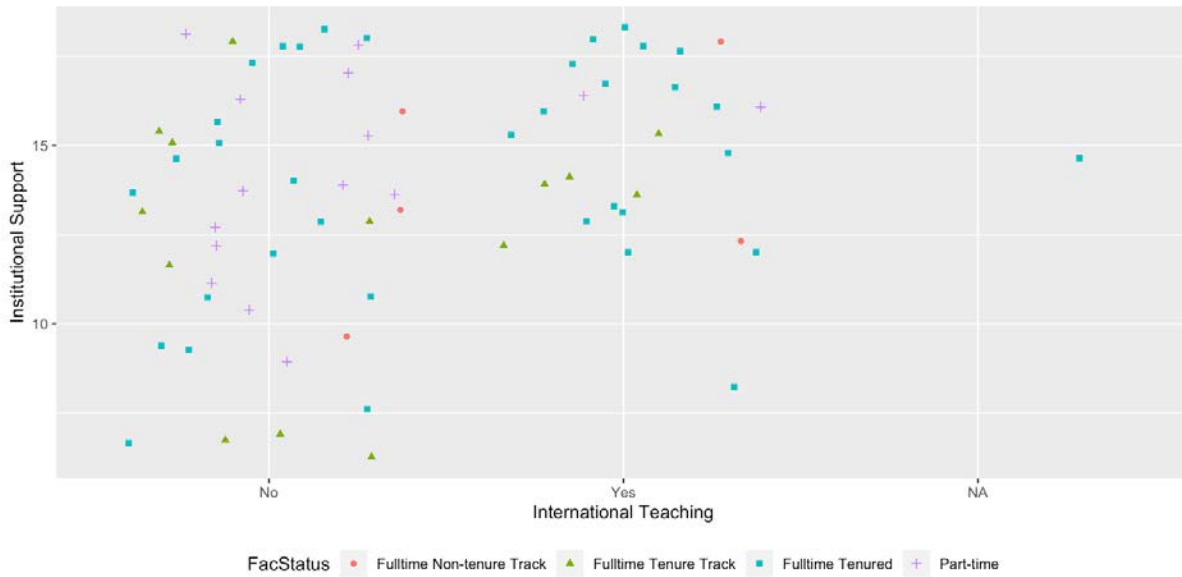


Figure 4. Institutional Support - International Teaching - Faculty Status

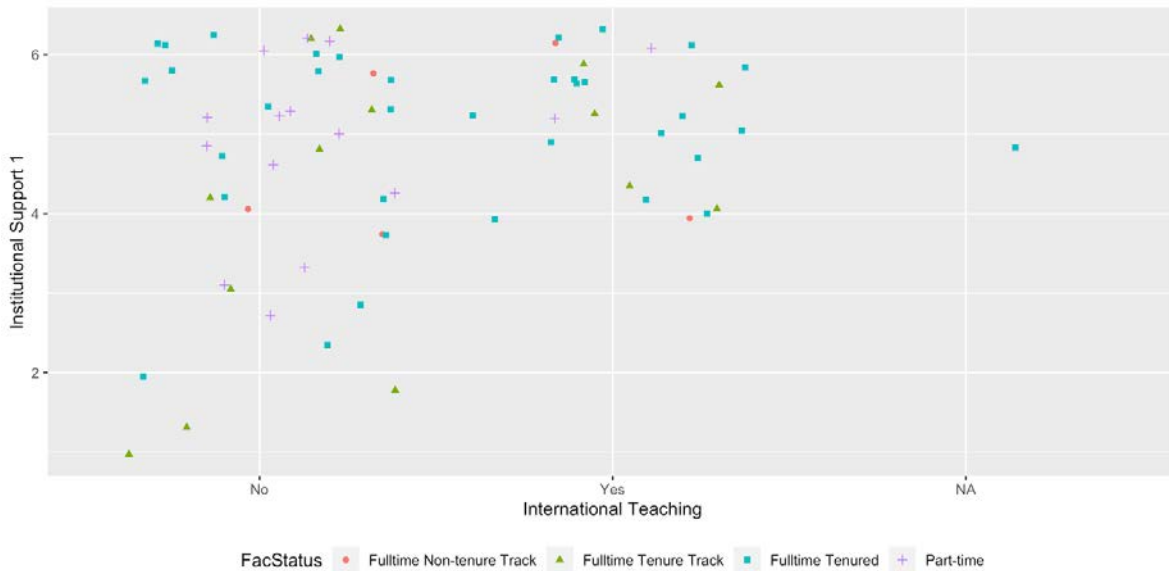


Figure 5. Institutional Support 1 - International Teaching - Faculty Status

We decided to explore which component(s) of Institution Support contributed to the significant difference by plotting each of the three statements (InstSp1, InstSp2, and InstSp3). The most interesting plot is shown in Figure 5, where the impact of InstSp1 (Top leaders express verbal and written support for internationalization) is apparent. There was a significant difference in mean Financial Support [$F(1,67) = 4.497, p = 0.0377$] between reported International Teaching categories. Post hoc analysis (Tukey HSD) indicated there was a significant difference between Yes and No ($p = 0.0376608$).

The effect of speaking a second language was gauged through the question “Do you speak a language other than your native tongue?” The plot of Financial Support–Language is shown in Figure 6. An ANOVA suggests there was a significant difference in mean Financial Support [$F(1,67) = 7.084, p = 0.00973$] between reported Language categories. Post hoc analysis (Tukey HSD) indicated there was a significant difference between Yes and No ($p = 0.0097265$).

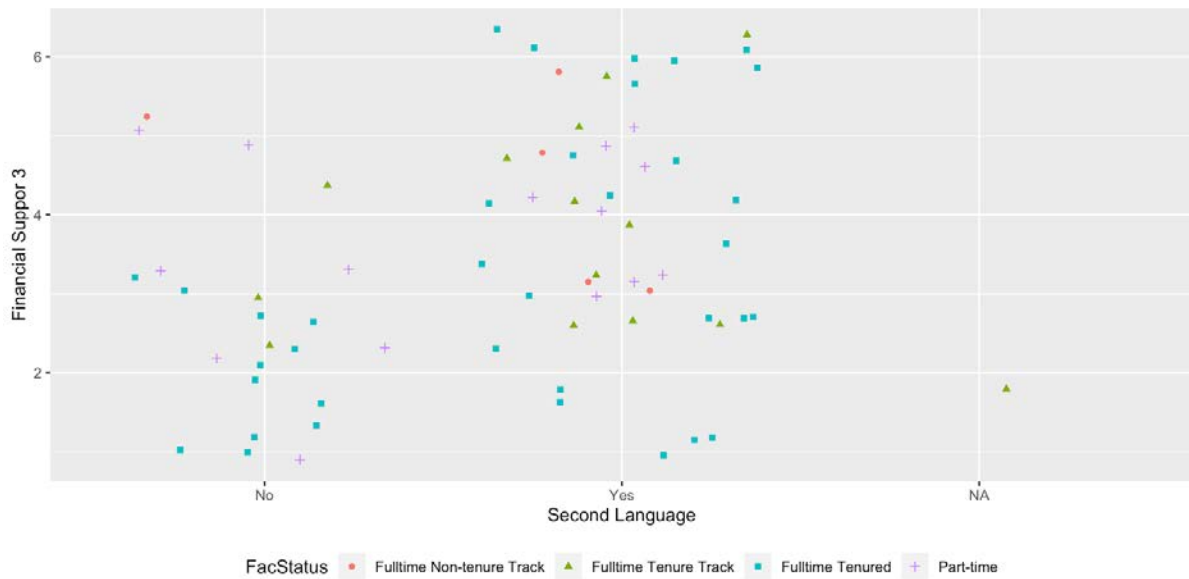


Figure 6. Financial Support - Language

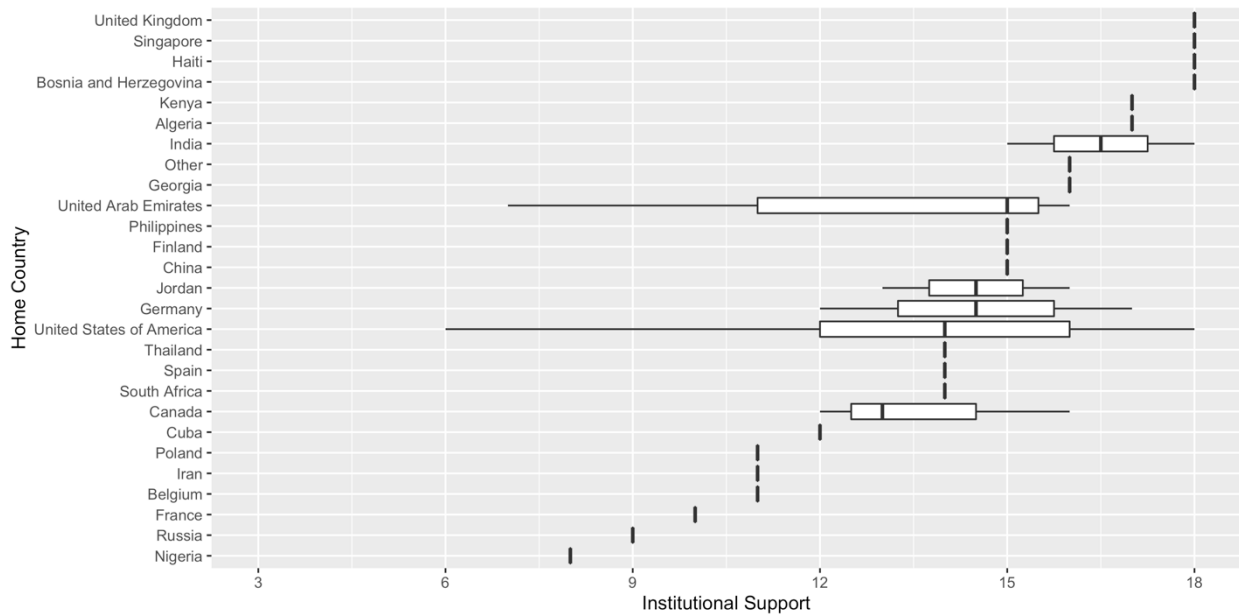


Figure 7. Institutional Support - Country of Origin

The final data visualized was based on country of origin (respondents were asked “What is your country of origin?”). Figure 6 shows Institutional Support while Figure 7 illustrates Financial Support. Subsequent ANOVAs suggested there was a not significant difference in mean Institutional Support [$F(26,43) = 0.74, p = 0.791$] between countries and there was a not significant difference in mean Financial Support [$F(26,43) = 922, p = 0.579$] between countries. We did note that many countries had an $n = 1$, so it may be worth considering a country-based hypothesis in a larger sample.

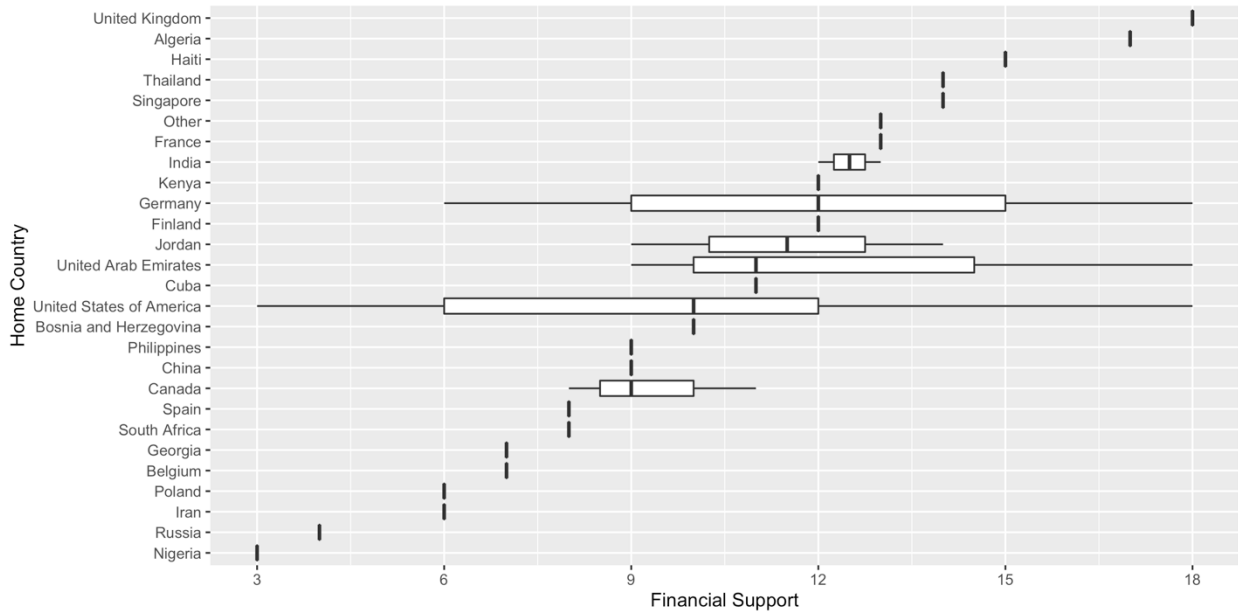


Figure 8. Financial Support - Country of Origin

Hypotheses Generation

Table 3 summarizes the visualizations that will be used to generate hypotheses based on significance.

Table 4. Hypotheses to be Generated

	Demographic Characteristic					Professional Experience			
	Gender	Country	LiveOut	Lang	Fac Status	StuEx	FacEx	IntRes	IntTea
InstSp	N	N	N	N	N	N	N	N	Y *
FinSp	Y .	N	N	Y **	N	N	N	N	N
Significance codes: *** = 0.001 ** = 0.01 * = 0.05 . = 0.1									

The resultant hypotheses are:

H₁: Faculty who have international teaching experience and faculty who do not have international teaching experience have the same perception of institutional support.

H₂: Female faculty and male faculty have the same perception of financial support.

H₃: Unilingual faculty and multilingual faculty have the same perception of financial support.

SUMMARY

This paper summarized the results of a faculty internationalization perception survey completed by 70 computing faculty. The primary objective of this project was hypothesis generation. A major limitation of our visualize and explore approach is that we may not generalize the findings. By applying a data exploration methodology, we visualized and repeatedly tested the data using the R environment for statistical computing and graphics. Following

the visualization and testing, we generated three hypotheses to be used in future projects. The secondary objective was to assess the utility of using R for such investigations. The researchers conclude that R is very good environment for visualization, repeated testing, and hypotheses generation.

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