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Supplementary Information for

Postdocs' Lab Engagement Predicts Trajectories of Ph.D. Students' Skill Development

David F. Feldon, Kaylee Litson, Soojeong Jeong, Jennifer Blaney, Jina Kang, Candace Miller, Kimberly Griffin, Josipa Roksa

David F. Feldon

Email: david.feldon@usu.edu

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Figures S1

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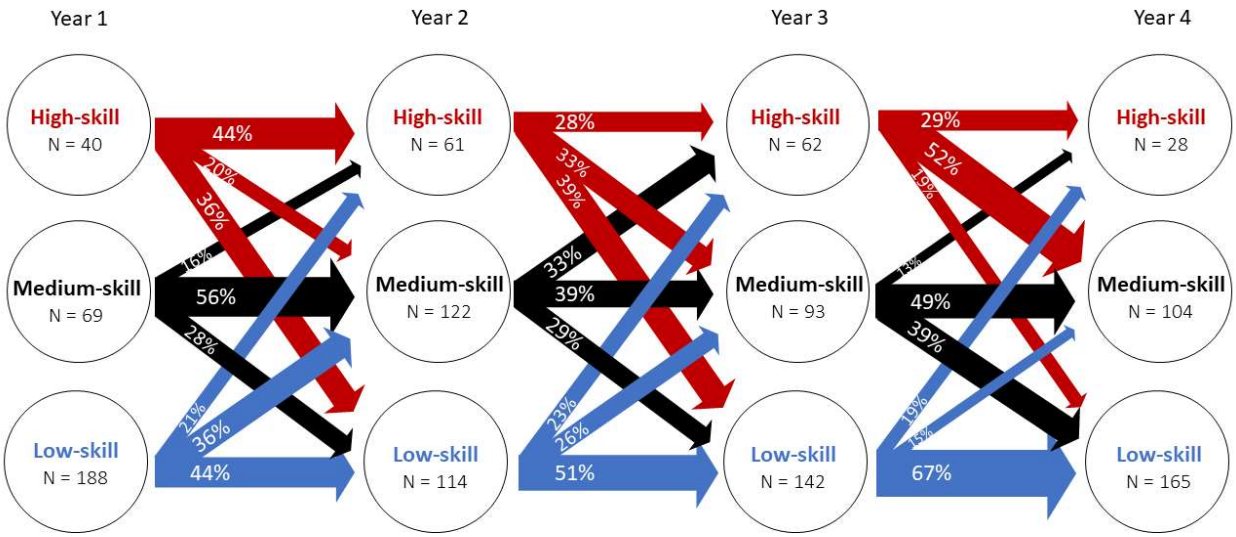

Figure S1. Transition probabilities of the three LPTA subgroups across time.

Table S1. Rubric instructions, criteria, and rater intraclass correlations (ICC).

Instructions and Rubric for Graduate Research Reports and Proposals

INSTRUCTIONS TO SCORERS:

Using the point values provided, indicate the appropriate level achieved for each criterion by the papers that have been provided to you. A technique some people find useful for scoring is called "the wedge." For each criterion, first decide if the response is in the top or bottom half of the rating scale. Then focus on the two criteria within that "half" of the scale. For example, if a response is in the upper half of the rating scale, is it more like the intermediate response or the proficient response? Once you decide on a rating (e.g. "intermediate"), does the description of the intermediate level match the response in question, or is it a little better or a little worse? **You may use "+" and "–" to indicate if a response does not fit clearly within a category.** For example, 2- would indicate a response whose quality most closely aligns with intermediate but which is slightly less proficient than a typical intermediate response; 1+ would indicate a response that is slightly better than the average novice response. Plus and minus notations correspond to an increase or decrease of 0.25 from the whole number associated with the proficiency level category. Inter-rater reliability is determined through two-way, random effects intraclass correlations (ICCs). Scores used for analysis reflect the mean scores by plank across two arbitrarily assigned raters.

Student Proficiency Scoring Level			
0 Not addressed 0+	**1 - Novice 1+**	**2 - Intermediate 2+**	**3 - Proficient 3+**

A "Not addressed" response may either be completely missing (0) or something is written, but it is completely irrelevant (0+).

There is no expectation for a majority of the papers to achieve any particular score. Just place the quality of each paper as accurately as you can on the scales provided.

Criteria	Not Addressed (0)	Novice (1 ± 0.25)	Intermediate (2 ± 0.25)	Proficient (3 ± 0.25)
ICC = 0.881	**Introduction: Context**			
Writer provides a clear sense of what is known and what gaps exist in our knowledge. Background information is accurate, relevant and provides a clear rationale for the objectives in terms of the "big picture" and why the question is important/interesting in the field of biological sciences.	• The importance of the question is not addressed. • How the question relates within the broader context of biology is not addressed. • Background information is missing or contains major inaccuracies. • Background information is accurate, but irrelevant or too disjointed to make relevance clear •	• The writer provides vague or generic references to the broader context of their field. • Connection between broad research question and specific proposal objectives is vague or poorly reasoned. • The writer provides a generic or vague rationale for the importance of the question.	• The writer provides some sense of what is known about the research question topic. • Rationales are reasonable, but may have gaps or theoretical issues. • The writer provides one solid explanation of why the question is of interest to others.	• The writer describes the current gaps in our understanding of this field and explains how this research will help fill those gaps. • The connections to the stated objectives are persuasive and compelling. • The writer provides a clear sense of why this knowledge is of broad interest to researchers in his/her field
ICC = 0.969	**Use of Primary Literature**			
Relevant literature is reasonably complete and present in both the Introduction/context and Discussion sections. Use of the literature demonstrates the intellectual merit of the proposed research and specifies how it relates to other work in the field. Citations follow an accepted format for the field and are accurate.	• Primary literature references are absent or irrelevant. May contain website or secondary references	• Lit review is weak. • Background information is overly narrow or overly general (only partially relevant). • Primary literature references are severely limited. • Citations are at least partially correctly formatted. • A bibliography is provided, but there are no in-text citations.	• Lit review is strong in one section, usually introduction or discussion. • Background information has the appropriate level of specificity to provide relevant context. • Primary literature references are more extensive (at least one citation for each major concept)	• Lit review is strong in multiple sections, including introduction and discussion. • Background information has the appropriate level of specificity to provide concise and useful context to aid the reader's understanding. • Primary literature references indicate an

Criteria	Not Addressed (0)	Novice (1 ± 0.25)	Intermediate (2 ± 0.25)	Proficient (3 ± 0.25)
			• Primary literature references are all correctly formatted.	extensive literature search was performed. • Primary literature references are properly and accurately cited
ICC = 0.911	**Objectives/Hypotheses/Conjectures: Plausible and consider alternatives**			
Research questions and expected findings are clearly stated and approachable using proposed methods. Note: For experimental studies or when otherwise appropriate, specific hypotheses should be stated. As appropriate, plausible alternative explanations / mechanisms / hypotheses should be explained and the proposed research design will allow investigators to distinguish among them.	• No hypothesis is indicated. • The hypothesis is stated but too vague or confused for its value to be determined • A clearly stated, but not testable hypothesis is provided. • A clearly stated and testable, but trivial hypothesis is provided.	• The objectives/hypotheses/ conjectures may be compared with a "null" alternative which is usually just the absence of the expected result. • Tests only allow for assessment of overall design (i.e., does not differentiate by design elements/ explanations). • Tests are vague or confounded.	• Objectives/hypotheses/ conjectures are clearly stated and tests will produce reasonably clean results. • May have small confounding factors, unaddressed assumptions or gaps in logic.	• Results will be clean and unambiguous. Results will clearly and unequivocally distinguish among possible explanations. • Results will anticipate potential criticisms/alternative explanations and address them.
ICC = 0.888	**Methods: Controls/Replication**			
Appropriate controls (including appropriate replication) are present and explained.	• Controls and/or replication are nonexistent, • Controls and/or replication may have been present, but just not described or • Controls and/or replication were described but were inappropriate.	• Controls consider one major relevant factor • Replication is modest (weak statistical power).	• Controls take <u>most</u> relevant factors into account • Controls include positive and negative controls if appropriate • Replication is appropriate (average sample size with reasonable statistical power). •	• Controls consider <u>all</u> relevant factors • Controls have become methods of differentiating between multiple hypotheses. • Replication is robust • (sample size is larger than average for the type of study).

Criteria	Not Addressed (0)	Novice (1 ± 0.25)	Intermediate (2 ± 0.25)	Proficient (3 ± 0.25)
ICC = 0.942	**Methods: Experimental design or plan**			
Data collection plan, experimental design, or solution approach is likely to produce salient and fruitful results (i.e. addresses the research objectives posed).	• Explanations of more than one major component are absent.	• are inappropriate, poorly thought-out, or unlikely to work. • may be poorly explained (appropriateness cannot be determined).	• are appropriate and previously shown to work. • are explained in sufficient detail. • if novel, no preliminary data.	• are both appropriate and previously fruitful. • may be novel or especially insightful (application of previously developed techniques to new questions, or new methodology with extensive testing).
ICC = 0.893	**Anticipated or Attained Results: Data selection**			
Data and mathematical insights will be informative and relevant to the objectives posed. Any data produced or described will be comprehensive, appropriate, and accurate.	• Data described or presented are too incomplete or haphazard to provide a reasonable basis for testing the hypothesis	• Vague, imprecise, or poorly considered predictions are present, but described in words only. • Collecting limited data. • At least one relevant dataset per hypothesis is provided but some necessary data are missing or inaccurate. • Reader can satisfactorily evaluate some but not all of writer's conclusions.	• Predictions or findings include some form of data representation, i.e. graphs or tables. • Data collected/planned consider most confounding factors. • Data or statements of previous results are relevant, accurate and complete with only minor gaps, errors or ambiguities • Reader can fully evaluate whether the addressed hypotheses were or will be supported or rejected with the data provided.	• Predicted data (PROPOSALS ONLY) include all possible outcomes of the described protocol with complete data representation. • Comprehensive data collection. • Data or statements of anticipated/attained results are relevant, rigorous, accurate and comprehensive. • Reader can fully evaluate validity of conclusions and assumptions. • Data may be synthesized or manipulated in a novel way to provide additional insight.

Criteria	Not Addressed (0)	Novice (1 ± 0.25)	Intermediate (2 ± 0.25)	Proficient (3 ± 0.25)
ICC = 0.818	**Anticipated or Attained Results: Data analysis**			
Interpretive framework and/or statistical methods are appropriate for research objectives. Rationale for the choice of methods is explained clearly. Expected or attained evidence for data's validity, reliability, and or statistical significance (as appropriate to the proposed study) are indicated.	• No analysis is described or performed. • Attained or predicted statistics are provided but are inappropriate, inaccurate or incorrectly performed or interpreted so as to provide no value to the reader.	• A rationale for the methods of analysis is offered. • Little description of the process of analysis, e.g. what statistics are or will be used is provided. • Appropriate, accurate descriptive statistics only are provided. • Inferential statistics are provided/described but either incorrectly performed or interpreted or an inappropriate test was used. • Appropriate, correct inferential statistics are provided/described, but lack sufficient explanation.	• A rationale for the method(s) of analysis is explained. • For at least half of the presented/anticipated data types, the process and predicted outcome of statistical analysis are described. • Appropriate inferential (comparative) statistical analysis is properly performed/described and reasonably well explained. • Explanation of significant value may be limited or rote (e.g. use of $p<0.05$ only)	• A rationale for the methods of analysis is thoroughly explained. • The process and predicted/attained outcome of statistical analysis is described for all data types presented. • Statistical analysis is appropriate, correct and clearly explained • includes a description of what constitutes a significant value and why that value was chosen as the threshold (may choose values beyond $p<0.05$).
ICC = 0.953	**Predicted / Preliminary or Reported Results: Presentation of data, examples, or figures**			
Quantitative data should be presented using appropriate unit labels. If graphs are used, axes are appropriately labeled and scaled, and captions are informative and complete. Figures and	• Labels or units are consistently missing which prevent the reader from being able to derive any useful information from the graph.	• contains some errors in or omissions of labels, scales, units etc., but the reader is able to derive some relevant meaning from each figure.	• contains only minor mistakes that do not interfere with the reader's understanding and the figure's/example's meaning is clear without the reader referring to the text.	• contains no mistakes • uses a format or graph type which highlights relationships between the data points or other relevant aspects of the data.

examples are accurate, complete, and self-explanatory.	• Presentation of data is in an inappropriate format or graph type • Captions are consistently missing, confusing, or indecipherable.	• is technically correct but inappropriate format prevents the reader from deriving meaning or using it. Captions are missing or inadequate.	• Use graph types or table formats that are appropriate for data type or information communicated. • includes captions that are at least somewhat useful.	• may be elegant, novel, or otherwise allow unusual insight into data • has informative, concise and complete captions.

Criteria	**Not Addressed (0)**	**Novice (1 ± 0.25)**	**Intermediate (2 ± 0.25)**	**Proficient (3 ± 0.25)**
ICC = 0.873	**Discussion: Conclusions based on Predicted or Attained results**			
Conclusion could be clearly and logically drawn from predicted results. A logical chain of reasoning from objectives/ hypotheses/conjectures to conclusions are clearly and persuasively explained.	• Conclusions have little or no basis in data provided. • Connections between hypothesis, data and conclusion are non-existent, limited, vague or otherwise insufficient to allow reasonable evaluation of their merit. • Conflicting data are not addressed.	• Conclusions have some direct basis in the predicted results, but may contain some gaps in logic or data or are overly broad. • Connections between objectives / hypotheses / conjectures, results, and conclusions are present but weak. • Conflicting or missing results are poorly addressed.	• Conclusions are clearly and logically drawn from and bounded by the predicted results with few gaps in logic. • A reasonable and clear chain of logic from objectives / hypotheses / conjectures to results to conclusions is made. • Conclusions attempt to discuss or explain conflicting or missing results.	• Conclusions are completely justified by results. • Connections between objectives/hypotheses/ conjectures, results, and conclusions are comprehensive and persuasive. • Conclusions address and logically conflicting results. • Synthesis of results may generate new insights.
ICC = 0.883	**Discussion: Remaining questions / Alternative interpretations**			

Limitations of findings and remaining questions to be answered in relation to the phenomenon of interest are discussed. Alternative explanations of the predicted data are considered and weighted against conclusions. How this study relates to other knowledge in the field is clearly discussed.	• are not provided • are trivial or irrelevant • are mentioned but not discussed or eliminated.	• Little discussion of the potential implications of alternative outcomes. • No alternative explanations are presented. • Little discussion of limitations of results.	• Not all possible outcomes are discussed, or large gaps in logic exist. • Alternative explanations are considered for some outcomes. • Some discussion of limitations of results.	• There is a comprehensive discussion of the implications of multiple possible outcomes. • Includes a discussion of multiple possible alternative explanations. • Comprehensive discussion of limitations of results.
ICC = 0.898	**Discussion: Limitations of design**			
Limitations of the data and/or experimental design and corresponding implications discussed.	• are not discussed.	• are discussed in a trivial way (e.g. "human error" is the major limitation invoked).	• are relevant, but not addressed in a comprehensive way • Conclusions fail to address or overstep the bounds indicated by the limitations	• are presented as factors modifying the author's conclusions. • Conclusions take these limitations into account.

ICC = 0.894	**Discussion: Implications of research**			
Paper gives a clear indication of the implications and direction of the research in the future.	• are not addressed.	• are vague, implausible (not possible with current technologies or methodologies), trivial or off topic.	• are useful, but indicate incomplete knowledge of the field (suggest research that has already been done or is improbable with current methodologies) • suggest a fruitful line of research, but lack detail to indicate motivations for or implications of the future research.	• are salient, plausible and insightful • suggest work that would fill knowledge gaps and move the field forward.

ICC = 0.869	**Writing Quality**			
Grammar, word usage and organization facilitate the reader's understanding of the paper.	• Grammar and spelling errors detract from the meaning of the paper. • Word usage is frequently confused or incorrect. • Subheadings are not used or poorly used. • Information is presented in a haphazard way.	• Grammar and spelling mistakes do not hinder the meaning of the paper. • General word usage is appropriate, although use of technical language is may have occasional mistakes. • Subheadings are used and aid the reader somewhat. • There is some evidence of an organizational strategy though it may have gaps or repetitions.	• Grammar and spelling have few mistakes. • Word usage is accurate and aids the reader's understanding. • Distinct sections of the paper are delineated by informative subheadings. • A clear organizational strategy is present with a logical progression of ideas.	• Correct grammar and spelling. • Word usage facilitates reader's understanding. • Informative subheadings significantly aid reader's understanding. • A clear organizational strategy is present with a logical progression of ideas. There is evidence of an active planning for presenting information; this paper is easier to read than most.

Table S2. Means and standard deviations for research skills.

Variable	Mean Y1	SD Y1	Mean Y2	SD Y2	Mean Y3	SD Y3	Mean Y4	SD Y4
INT	1.90	0.73	2.17	0.68	1.89	0.70	1.95	0.86
LIT	1.53	1.06	1.93	0.96	1.51	1.12	1.62	1.19
HYP	1.44	0.90	1.70	0.85	1.60	0.90	1.61	0.93
CTR	1.29	0.86	1.59	0.80	1.41	0.91	1.57	0.80
EXP	1.91	0.68	2.13	0.62	1.95	0.68	2.02	0.71
SEL	0.85	0.86	1.27	0.87	1.54	0.91	1.69	0.84
ANA	0.58	0.74	0.85	0.89	1.13	1.03	1.24	0.81
PRE	0.52	0.85	1.17	1.04	1.30	1.11	1.38	1.22
CON	1.03	0.88	1.29	0.87	1.54	0.90	1.69	0.94
ALT	0.82	0.90	1.16	0.97	1.07	0.96	1.24	1.02
LIM	0.90	0.93	1.21	1.00	1.00	0.88	1.15	1.02
IMP	1.29	0.91	1.49	0.84	1.38	0.85	1.59	0.94

Table S3. False Discovery Rate Analyses for Predicting Positive LTA Transitions from Time 2 to Time 3. OR = odds ratio; *i* = test number; FDR = false discovery rate; CI = confidence interval. When the *p*-value was less than the FDR value, the result was statistically significant, and the text of the row is bolded.

					FDR Adj. 95% CI	
Variable	OR	*p*	*i*	FDR	Lower CI	Upper CI
Primary Research: Junior Grad	**0.14**	**0.017**	**78**	**0.050**	**0.03**	**0.70**
Controls: Undergrad	**0.37**	**0.023**	**77**	**0.049**	**0.16**	**0.88**
Formulates Hypotheses: Other Faculty	**1.92**	**0.025**	**76**	**0.049**	**1.08**	**3.42**
Data Collection: Junior Grad	**0.22**	**0.031**	**75**	**0.048**	**0.06**	**0.89**
Reformulating Hypotheses: PI	**2.80**	**0.033**	**74**	**0.047**	**0.19**	**41.20**
Primary Research: Senior Grad	**3.85**	**0.037**	**73**	**0.047**	**1.06**	**13.91**
Data Collection: Other Faculty	**2.41**	**0.038**	**72**	**0.046**	**1.03**	**5.63**
Controls: Other Faculty	**2.76**	**0.042**	**71**	**0.046**	**1.01**	**7.52**
Reformulating Hypotheses: Postdoc	**0.45**	**0.043**	**70**	**0.045**	**0.32**	**0.65**
Experimental Design: Other Faculty	2.14	0.050	69	0.044	0.98	4.71
Social Peer Interactions	0.31	0.082	68	0.044	0.08	1.21
Controls: Postdoc	0.57	0.091	67	0.043	0.29	1.12
Interprets Results: Other Faculty	1.72	0.101	66	0.042	0.88	3.37
Formulates Hypotheses: Postdoc	0.52	0.107	65	0.042	0.23	1.19
Formulates Hypotheses: Undergrad	0.38	0.111	64	0.041	0.11	1.32
Data Collection: PI	0.61	0.117	63	0.040	0.31	1.17
Academic Peer Interactions	0.38	0.132	62	0.040	0.10	1.43
Experimental Design: Undergrad	0.50	0.136	61	0.039	0.19	1.31
Interprets Results: Postdoc	0.62	0.136	60	0.038	0.32	1.21
Controls: Lab Tech	2.07	0.138	59	0.038	0.74	5.77
Identifies Questions: Undergrad	0.44	0.142	58	0.037	0.14	1.42
Experimental Design: Postdoc	0.60	0.178	57	0.037	0.27	1.33
Statistical Analysis: Undergrad	0.56	0.186	56	0.036	0.22	1.41
Lab Discussion: Undergrad	0.70	0.188	55	0.035	0.39	1.25

Statistical Analysis: Senior Grad	1.72	0.195	54	0.035	0.71	4.20
Identifies Questions: Other Faculty	1.53	0.209	53	0.034	0.74	3.15
Faculty Interaction Occurrence	0.87	0.212	52	0.033	0.68	1.11
Reformulating Hypotheses: Other Faculty	1.45	0.229	51	0.033	0.55	3.81
Formulates Hypotheses: Lab Tech	0.63	0.230	50	0.032	0.27	1.45
International Student Status (International = 1, Domestic = 0)	1.70	0.285	49	0.031	0.58	5.00
Formulates Hypotheses: Senior Grad	1.62	0.300	48	0.031	0.59	4.43
Gender (Male = 1, Female = 0)	1.36	0.304	47	0.030	0.71	2.64
Statistical Analysis: Other Faculty	1.53	0.306	46	0.029	0.62	3.79
Data Collection: Senior Grad	1.59	0.333	45	0.029	0.55	4.58
Primary Research: PI	0.29	0.359	44	0.028	0.01	5.69
Identifies Questions: Junior Grad	1.35	0.360	43	0.028	0.65	2.80
Experimental Design: Junior Grad	0.67	0.394	42	0.027	0.24	1.90
Primary Research: Undergrad	0.79	0.416	41	0.026	0.42	1.50
Reformulating Hypotheses: Senior Grad	1.53	0.427	40	0.026	0.24	9.56
Identifies Questions: PI	2.01	0.484	39	0.025	0.21	19.10
Identifies Questions: Lab Tech	0.71	0.487	38	0.024	0.23	2.16
Primary Research: Other Faculty	1.29	0.497	37	0.024	0.55	3.02
Interprets Results: Undergrad	0.80	0.512	36	0.023	0.36	1.75
Controls: Junior Grad	0.80	0.517	35	0.022	0.36	1.76
Statistical Analysis: Postdoc	0.80	0.526	34	0.022	0.35	1.82
Lab Discussion: Senior Grad	0.64	0.530	33	0.021	0.13	3.27
Formulates Hypotheses: Junior Grad	0.81	0.585	32	0.021	0.33	1.99
Experimental Design: Senior Grad	1.32	0.587	31	0.020	0.40	4.32
Reformulating Hypotheses: Lab Tech	0.79	0.603	30	0.019	0.34	1.83
Statistical Analysis: Lab Tech	0.86	0.646	29	0.019	0.41	1.83
Lab Discussion: Lab Tech	1.15	0.647	28	0.018	0.55	2.44
Statistical Analysis: PI	1.15	0.655	27	0.017	0.54	2.47
Lab Discussion: Other Faculty	0.90	0.674	26	0.017	0.48	1.67

Formulates Hypotheses: PI	1.37	0.682	25	0.016	0.22	8.68
Identifies Questions: Postdoc	0.85	0.714	24	0.015	0.28	2.53
Primary Research: Postdoc	1.23	0.715	23	0.015	0.30	5.00
Faculty Interaction Quality	1.01	0.716	22	0.014	0.92	1.12
Experimental Design: Lab Tech	1.13	0.748	21	0.013	0.45	2.80
Reformulating Hypotheses: Undergrad	0.76	0.755	20	0.013	0.14	4.15
First-Generation College Status (First-Gen = 1, Continuing-Gen = 0)	0.92	0.794	19	0.012	0.43	2.00
Data Collection: Undergrad	0.92	0.803	18	0.012	0.39	2.17
Interprets Results: Junior Grad	0.90	0.808	17	0.011	0.29	2.79
Data Collection: Postdoc	0.92	0.813	16	0.010	0.39	2.18
Primary Research: Lab Tech	0.94	0.822	15	0.010	0.44	1.99
Identifies Questions: Senior Grad	1.07	0.878	14	0.009	0.34	3.32
Experimental Design: PI	1.07	0.880	13	0.008	0.33	3.45
Lab Discussion: PI	1.18	0.889	12	0.008	0.05	26.47
Reformulating Hypotheses: Junior Grad	1.05	0.893	11	0.007	0.36	3.05
Under-Represented Minority Status (URM = 1, Majority = 0)	0.97	0.903	10	0.006	0.44	2.11
Interprets Results: Senior Grad	0.94	0.912	9	0.006	0.22	4.01
Data Collection: Lab Tech	1.05	0.913	8	0.005	0.32	3.37
Interprets Results: Lab Tech	1.03	0.913	7	0.004	0.44	2.43
Lab Discussion: Junior Grad	1.03	0.942	6	0.004	0.27	4.00
Controls: Senior Grad	1.03	0.949	5	0.003	0.24	4.48
Lab Discussion: Postdoc	0.98	0.966	4	0.003	0.24	4.08
Controls: PI	1.02	0.969	3	0.002	0.24	4.38
Interprets Results: PI	1.01	0.976	2	0.001	0.29	3.52
Statistical Analysis: Junior Grad	1.00	0.997	1	0.001	0.24	4.11

Table S4. False Discovery Rate Analyses for Predicting Positive LTA Transitions from Time 3 to Time 4. OR = odds ratio; *i* = test number; FDR = false discovery rate; CI = confidence interval. When the *p*-value was less than the FDR value, the result was statistically significant, and the text of the row is bolded.

					FDR Adj. 95% CI	
Variable	OR	*p*	*i*	FDR	Lower CI	Upper CI
Lab Discussion: Post-Doc	**5.14**	**0.004**	**78**	**0.050**	**1.69**	**15.60**
Reformulating Hypotheses: Other Faculty	**1.59**	**0.007**	**77**	**0.049**	**1.07**	**2.35**
Lab Discussion: Senior Grad	**4.50**	**0.012**	**76**	**0.049**	**1.38**	**14.59**
Interprets Results: Other Faculty	**0.36**	**0.036**	**75**	**0.048**	**0.14**	**0.95**
Data Collection: PI	**0.34**	**0.043**	**74**	**0.047**	**0.12**	**0.98**
Lab Discussion: Junior Grad	0.19	0.057	73	0.047	0.03	1.08
Primary Research: Undergrad	0.39	0.058	72	0.046	0.14	1.05
Identifies Questions: Senior Grad	0.23	0.060	71	0.046	0.05	1.10
Statistical Analysis: Junior Grad	3.19	0.062	70	0.045	0.91	11.18
Identifies Questions: Other Faculty	0.43	0.066	69	0.044	0.17	1.09
Primary Research: Post-Doc	3.42	0.069	68	0.044	0.87	13.51
Statistical Analysis: Other Faculty	0.42	0.070	67	0.043	0.16	1.11
Experimental Design: Other Faculty	0.48	0.107	66	0.042	0.19	1.22
International Student Status (International = 1, Domestic = 0)	5.18	0.116	65	0.042	0.61	44.08
Controls: Junior Grad	2.08	0.130	64	0.041	0.77	5.64
Interprets Results: Undergrad	0.41	0.138	63	0.040	0.12	1.41
Interprets Results: Junior Grad	2.58	0.146	62	0.040	0.67	9.94
Formulates Hypotheses: Post-Doc	1.91	0.152	61	0.039	0.75	4.87
Reformulating Hypotheses: Lab Tech	1.65	0.152	60	0.038	0.80	3.41
Interprets Results: Lab Tech	2.23	0.153	59	0.038	0.69	7.19
Experimental Design: Junior Grad	2.10	0.168	58	0.037	0.68	6.48
Data Collection: Junior Grad	2.67	0.168	57	0.037	0.60	11.87

Primary Research: PI	3.72	0.173	56	0.036	0.49	28.41
Controls: Undergrad	0.52	0.196	55	0.035	0.18	1.51
Primary Research: Senior Grad	2.26	0.219	54	0.035	0.55	9.21
Controls: Other Faculty	0.55	0.229	53	0.034	0.19	1.58
Identifies Questions: Post-Doc	2.11	0.271	52	0.033	0.49	8.99
Controls: Lab Tech	0.68	0.295	51	0.033	0.31	1.50
Identifies Questions: PI*	0.57	0.341	50	0.032	0.16	2.05
Reformulating Hypotheses: Post-Doc	7.33	0.356	49	0.031	0.72	74.75
Lab Discussion: Undergrad	1.61	0.358	48	0.031	0.52	4.92
Academic Peer Interactions	1.82	0.359	47	0.030	0.44	7.52
Identifies Questions: Lab Tech	2.02	0.388	46	0.029	0.34	12.02
Controls: Post-Doc	1.57	0.393	45	0.029	0.49	4.96
Interprets Results: Senior Grad	1.54	0.407	44	0.028	0.49	4.85
Data Collection: Undergrad	1.33	0.432	43	0.028	0.59	3.01
Data Collection: Other Faculty	0.69	0.443	42	0.027	0.24	2.00
Reformulating Hypotheses: Senior Grad	5.38	0.466	41	0.026	0.67	43.29
Lab Discussion: PI*	0.43	0.479	40	0.026	0.03	6.17
Experimental Design: Lab Tech	1.57	0.489	39	0.025	0.36	6.80
Statistical Analysis: PI	0.71	0.496	38	0.024	0.22	2.25
Faculty Interaction Quality	0.96	0.523	37	0.024	0.81	1.12
Social Peer Interactions	0.33	0.523	36	0.023	0.01	17.36
Under-Represented Minority Status (URM = 1, Majority = 0)	1.25	0.555	35	0.022	0.52	2.99
Formulates Hypotheses: Lab Tech*	0.80	0.561	34	0.022	0.32	1.97
Faculty Interaction Occurrence	0.90	0.572	33	0.021	0.59	1.38
Primary Research: Other Faculty	0.77	0.580	32	0.021	0.26	2.29
Interprets Results: PI	0.53	0.589	31	0.020	0.04	8.09
Formulates Hypotheses: Junior Grad	1.30	0.595	30	0.019	0.41	4.12
Experimental Design: PI	1.36	0.621	29	0.019	0.31	5.84
Reformulating Hypotheses: Junior Grad	2.11	0.622	28	0.018	0.62	7.17

Identifies Questions: Undergrad	0.66	0.636	27	0.017	0.08	5.46
Data Collection: Senior Grad	0.78	0.648	26	0.017	0.21	2.85
Experimental Design: Undergrad	0.65	0.656	25	0.016	0.06	6.67
Formulates Hypotheses: Other Faculty	0.80	0.673	24	0.015	0.21	2.97
Interprets Results: Post-Doc	1.32	0.682	23	0.015	0.25	6.89
Experimental Design: Senior Grad	1.24	0.700	22	0.014	0.31	4.90
Primary Research: Junior Grad	0.66	0.701	21	0.013	0.05	9.52
Data Collection: Post-Doc	0.78	0.739	20	0.013	0.12	5.10
Experimental Design: Post-Doc	1.21	0.760	19	0.012	0.26	5.68
Statistical Analysis: Undergrad	1.30	0.761	18	0.012	0.14	11.72
Lab Discussion: Other Faculty	1.13	0.780	17	0.011	0.37	3.48
Statistical Analysis: Senior Grad	0.82	0.782	16	0.010	0.13	5.13
Statistical Analysis: Post-Doc	1.17	0.800	15	0.010	0.24	5.73
Primary Research: Lab Tech	1.12	0.818	14	0.009	0.30	4.27
Formulates Hypotheses: Undergrad	0.77	0.824	13	0.008	0.04	16.67
Identifies Questions: Junior Grad	1.13	0.827	12	0.008	0.24	5.27
First-Generation College Status (First-Gen = 1, Continuing-Gen = 0)	0.89	0.840	11	0.007	0.18	4.46
Formulates Hypotheses: PI	0.85	0.887	10	0.006	0.04	20.08
Controls: Senior Grad	1.07	0.900	9	0.006	0.26	4.38
Gender (Male = 1, Female = 0)	0.94	0.907	8	0.005	0.21	4.24
Controls: PI	1.05	0.916	7	0.004	0.30	3.72
Statistical Analysis: Lab Tech	1.07	0.923	6	0.004	0.16	7.20
Lab Discussion: Lab Tech	1.03	0.960	5	0.003	0.19	5.63
Reformulating Hypotheses: Undergrad	2.85	0.970	4	0.003	0.07	113.93
Data Collection: Lab Tech	0.99	0.985	3	0.002	0.14	6.78
Formulates Hypotheses: Senior Grad	1.00	0.997	2	0.001	0.16	6.46
Reformulating Hypotheses: PI*	2.08	1.000	1	0.001	2.08	2.08

* Original odds ratio values were computed with cell containing 0, resulting in extraneous values that were uninterpretable. To interpret the findings, we incremented the count in each cell by one.

Table S5. False Discovery Rate Analyses for Predicting Positive LGC Trajectory. OR = odds ratio; *i* = test number; FDR = false discovery rate; CI = confidence interval. When the *p*-value was less than the FDR value, the result was statistically significant, and the text of the row is bolded.

					FDR Adj. 95% CI	
Variable	OR	*p*	*i*	FDR	Lower CI	Upper CI
Lab Discussion: Post-Doc	**4.20**	**0.004**	**78**	**0.050**	**1.59**	**11.10**
Identifies Questions: Lab Tech	2.22	0.049	77	0.049	1.00	4.93
Lab Discussion: Lab Tech	0.62	0.053	76	0.049	0.38	1.01
Formulates Hypotheses: Other Faculty	1.83	0.060	75	0.048	0.97	3.45
Statistical Analysis: PI	0.55	0.061	74	0.047	0.29	1.04
Reformulating Hypotheses: PI	0.43	0.065	73	0.047	0.17	1.07
Formulates Hypotheses: Lab Tech	1.85	0.074	72	0.046	0.93	3.67
Interprets Results: Post-Doc	1.85	0.094	71	0.046	0.88	3.87
Lab Discussion: PI*	2.80	0.096	70	0.045	0.81	9.65
International Student Status (International = 1, Domestic = 0)s6	0.53	0.101	69	0.044	0.24	1.16
Reformulating Hypotheses: Lab Tech	1.88	0.111	68	0.044	0.84	4.18
Lab Discussion: Undergrad	0.65	0.130	67	0.043	0.37	1.16
Primary Research: Junior Grad	2.47	0.137	66	0.042	0.71	8.56
Lab Discussion: Other Faculty	1.35	0.147	65	0.042	0.88	2.06
Interprets Results: PI	0.51	0.148	64	0.041	0.20	1.32
Gender (Male = 1, Female = 0)	0.76	0.150	63	0.040	0.48	1.21
Identifies Questions: PI	0.26	0.163	62	0.040	0.04	1.91
Formulates Hypotheses: PI	0.41	0.190	61	0.039	0.10	1.68
Experimental Design: PI	1.45	0.211	60	0.038	0.78	2.69
Primary Research: PI	4.22	0.216	59	0.038	0.37	47.97
Social Peer Interactions	2.65	0.261	58	0.037	0.43	16.27
Primary Research: Undergrad	0.68	0.261	57	0.037	0.36	1.28
Data Collection: Junior Grad	2.03	0.261	56	0.036	0.54	7.62

Statistical Analysis: Junior Grad	1.64	0.282	55	0.035	0.62	4.35
Identifies Questions: Other Faculty	1.32	0.295	54	0.035	0.75	2.34
Primary Research: Other Faculty	1.30	0.311	53	0.034	0.75	2.26
Under-Represented Minority Status (URM = 1, Majority = 0)	0.73	0.321	52	0.033	0.34	1.57
Controls: Junior Grad	1.32	0.329	51	0.033	0.72	2.41
Statistical Analysis: Lab Tech	1.33	0.372	50	0.032	0.67	2.64
Primary Research: Senior Grad	0.58	0.374	49	0.031	0.16	2.16
First-Generation College Status (First-Gen = 1, Continuing-Gen = 0)	1.47	0.378	48	0.031	0.82	2.61
Experimental Design: Post-Doc	1.41	0.385	47	0.030	0.60	3.34
Identifies Questions: Undergrad	0.65	0.405	46	0.029	0.21	1.99
Formulates Hypotheses: Senior Grad	0.77	0.417	45	0.029	0.38	1.56
Data Collection: Senior Grad	0.74	0.451	44	0.028	0.30	1.80
Interprets Results: Undergrad	0.72	0.456	43	0.028	0.28	1.89
Data Collection: Lab Tech	0.78	0.461	42	0.027	0.37	1.65
Identifies Questions: Senior Grad	0.83	0.511	41	0.026	0.44	1.57
Experimental Design: Other Faculty	0.83	0.511	40	0.026	0.43	1.58
Experimental Design: Junior Grad	1.26	0.513	39	0.025	0.57	2.76
Academic Peer Interactions	1.40	0.528	38	0.024	0.42	4.66
Data Collection: PI	1.23	0.564	37	0.024	0.55	2.74
Data Collection: Other Faculty	0.75	0.566	36	0.023	0.24	2.34
Controls: Senior Grad	0.82	0.569	35	0.022	0.36	1.85
Experimental Design: Lab Tech	1.22	0.572	34	0.022	0.54	2.78
Statistical Analysis: Post-Doc	1.20	0.580	33	0.021	0.56	2.53
Reformulating Hypotheses: Undergrad	0.66	0.588	32	0.021	0.11	4.01
Experimental Design: Senior Grad	0.81	0.612	31	0.020	0.30	2.16
Primary Research: Lab Tech	1.16	0.625	30	0.019	0.57	2.34
Faculty Interaction Occurrence	1.05	0.660	29	0.019	0.82	1.33
Experimental Design: Undergrad	1.24	0.678	28	0.018	0.36	4.30

Identifies Questions: Post-Doc	1.15	0.695	27	0.017	0.49	2.72
Statistical Analysis: Undergrad	1.16	0.695	26	0.017	0.47	2.85
Controls: PI	0.90	0.710	25	0.016	0.47	1.75
Interprets Results: Junior Grad	1.15	0.714	24	0.015	0.46	2.85
Data Collection: Post-Doc	1.15	0.717	23	0.015	0.46	2.87
Data Collection: Undergrad	1.10	0.755	22	0.014	0.53	2.27
Lab Discussion: Junior Grad	1.10	0.781	21	0.013	0.46	2.61
Controls: Post-Doc	1.09	0.792	20	0.013	0.49	2.39
Reformulating Hypotheses: Post-Doc	1.10	0.798	19	0.012	0.43	2.80
Formulates Hypotheses: Undergrad	0.87	0.819	18	0.012	0.20	3.88
Statistical Analysis: Other Faculty	1.08	0.819	17	0.011	0.47	2.48
Interprets Results: Lab Tech	0.95	0.837	16	0.010	0.50	1.81
Primary Research: Post-Doc	0.91	0.843	15	0.010	0.26	3.15
Statistical Analysis: Senior Grad	1.10	0.855	14	0.009	0.30	4.02
Faculty Interaction Quality	0.99	0.868	13	0.008	0.90	1.10
Formulates Hypotheses: Post-Doc	0.96	0.901	12	0.008	0.39	2.38
Controls: Other Faculty	1.04	0.901	11	0.007	0.43	2.54
Controls: Undergrad	0.94	0.907	10	0.006	0.25	3.63
Reformulating Hypotheses: Senior Grad	0.96	0.919	9	0.006	0.34	2.70
Formulates Hypotheses: Junior Grad	1.03	0.921	8	0.005	0.39	2.72
Reformulating Hypotheses: Junior Grad	1.03	0.921	7	0.004	0.40	2.64
Identifies Questions: Junior Grad	1.03	0.937	6	0.004	0.35	3.03
Lab Discussion: Senior Grad	0.95	0.943	5	0.003	0.14	6.63
Controls: Lab Tech	0.98	0.959	4	0.003	0.36	2.67
Reformulating Hypotheses: Other Faculty	1.01	0.967	3	0.002	0.43	2.36
Interprets Results: Senior Grad	0.99	0.972	2	0.001	0.24	4.05
Interprets Results: Other Faculty	1.00	0.997	1	0.001	0.43	2.33

* Original odds ratio values were computed with cell containing 0, resulting in extraneous values that were uninterpretable. To interpret the findings, we incremented the count in each cell by one.

Table S6. Representative quotes from interview participants by theme regarding postdoc support.

Theme	Quote
Hands-on Instruction and Mentorship	"So postdocs in the lab, especially the postdoc that took me in, [was] my mentor when I first started as a rotation student, so I work alongside with him. He has been fantastic, and he has provided a lot of the mentoring aspect that my PI, for example, when he's not around in terms of actual techniques, this postdoc has been instrumental for that."
Academic and Professional Feedback	"The postdoc that I mentioned before, he's also looking into going into industry, and so we've had a lot of really great conversations about how to look for jobs and just sharing advice…he's been really great, but career-wise I know that even if he leaves before me or I leave before him that he would be someone I could send an email to and say, hey, would you look over my CV, or would you look over my resume, and he would, so that's been really nice."
Career Role Models	"We've had some postdocs recently for the first time in our lab who have been able to get jobs at other universities, and just seeing what that process looks like and what the prospects are and what the expectations are. It's been really informative, I think."
Personal Support	"…definitely taught me like, when you have a problem with someone or something, look within yourself first before just blaming everyone else. And she was a really great, like, yeah, I don't know...spiritual guidance, in my first year."

Table S7. Model fit information for LPA solutions. BIC = Bayesian Information Criterion

No. of classes	Loglikelihood	No. of free parameters	BIC	Entropy
Year 1 (n=232)				
1	-3493.33	24	7117.38	
2	-2966.47	37	6134.46	0.95
3	-2814.45	50	5901.23	0.95
4	-2729.99	63	5803.13	0.92
5	-2654.40	76	5722.76	0.93
Year 2 (n=229)				
1	-3473.02	24	7076.45	
2	-2831.54	37	5864.13	0.96
3	-2662.23	50	5596.15	0.94
4	-2595.91	63	5534.14	0.93
5	-2542.40	76	5497.76	0.91
Year 3 (n=198)				
1	-3110.34	24	6347.61	
2	-2484.22	37	5164.10	0.95
3	-2319.99	50	4904.38	0.94
4	-2253.46	63	4840.07	0.95
5	-2189.14	76	4780.19	0.94
Year 4 (n=146)				
1	-2297.19	24	4713.98	
2	-1767.94	37	3720.27	0.96
3	-1643.49	50	3536.15	0.96
4	-1592.64	63	3499.26	0.93
5	-1539.54	76	3457.84	0.97

Table S8. Model fit information for LPTA. BIC = Bayesian Information Criterion

Model	Loglikelihood	No. of free parameters	BIC	Entropy
Without measurement equivalence	-9422.33	212	20051.73	.67
With measurement equivalence	-9777.84	92	20079.51	.65

Table S9. Model fit information for LGC analyses. BIC = Bayesian Information Criterion

No. of Classes	Loglikelihood	No. of free parameters	BIC	Entropy
1	-13024.35	91	26566.83	
2	-12148.13	131	25042.14	0.86
3	-11684.45	171	24342.53	0.91
4	-11352.03	211	23905.43	0.91
5	-11177.92	251	23784.97	0.91
6	-11002.33	291	23661.53	0.91