Supplemental Material

CBE—Life Sciences Education

Butz and Branchaw

Validity and Reliability Evidence

Validity Evidence

1) Evidence based on **test content**, which is also often referred to as content validity, provides information on the degree to which the instrument aligns with the construct it is intended to measure.

2) Evidence of **response processes** provides information of whether respondents are responding to the instrument in the way in which it was intended, and whether instrument scores can be interpreted similarly across different groups of respondents.

3) Evidence based on **internal structure** provides information on the extent to which items related to one another and align to the instrument constructs and the proposed framework (i.e., factor structure), and how the instrument works across different groups. This is often examined through an exploratory or confirmatory factor analysis. In the case of confirmatory factor analysis, hypothesized measurement models can be tested and evidence of model-data fit examined through the use of different fit statistics, including chi-square (X^2), Root Mean Square Error of Approximation (RMSEA), and Comparative Fit Index (CFI).

4) Evidence based on **relations to other variables** includes evidence of convergent and discriminant validity (i.e., the extent to which constructs relate to other instruments in the expected way) and evidence of criterion validity, or the extent to which an instrument predicts a given outcome. Not all types of validity evidence are needed in order to consider whether an instrument is "valid;" instead, different types of validity evidence provide information on whether the instrument scores can be interpreted in the way in which they were intended (AERA et al., 2014).

Reliability measures the extent to which a score on an instrument is consistent across multiple administrations (AERA et al. 2014). Cronbach's coefficient alpha is often used as an estimate of internal consistency reliability and is calculated by examining the relationship between scores on individual items within a given construct. Reliability and internal consistency provide another source of information about the expected consistency of scores across different administrations.

Original Meta-Learning Objectives

- Develop disciplinary knowledge.
- Develop technical research skills.
- Develop research communication skills.
- Develop logical/critical thinking skills.
- Develop understanding of the research environment.
- Establish & maintain professional relationships/ Develop effective interpersonal communication skills
- Develop research leadership & mentoring skills.
- Develop responsible and ethical research practices.
- Develop Identity as a researcher.
- Develop independence as a researcher.
- Develop confidence as a researcher and in pursuing a research career.
- Advance equity and inclusion in the research environment.
- Develop skills to deal with personal differences in the research environment.
- Explore and pursue a research career.

Hypothesized Conceptual Framework (Stage 2)

Research Skills
- Develop disciplinary knowledge.
- Develop technical research skills.
- Develop research communication skills.
- Develop logical/critical thinking skills.
- Develop understanding of the research environment.
- Develop responsible and ethical research practices.

Interpersonal Skills
- Establish & maintain professional relationships/ Develop effective interpersonal communication skills
- Develop research leadership & mentoring skills.

Research Attitudes & Beliefs
- Develop Identity as a researcher.
- Develop independence as a researcher.
- Develop confidence as a researcher and in pursuing a research career.

Equity & Inclusion Awareness & Skills
- Advance equity and inclusion in the research environment.
- Develop skills to deal with personal differences in the research environment.

Professional & Career Development Skills
- Explore and pursue a research career.

Conceptual Framework supported by Evidence of Internal Structure (Stage 4)

Research Comprehension & Communication Skills
- Develop disciplinary knowledge.
- Develop research communication skills.
- Develop logical/critical thinking skills.
- Develop understanding of the research environment.
- Develop responsible and ethical research practices.
- Develop effective interpersonal communication skills.

Practical Research Skills
- Develop ability to design a research project
- Develop ability to conduct a research project

Research Ethics
- Develop responsible and ethical research practices.

Researcher Identity
- Develop identity as a researcher.

Researcher Confidence & Independence
- Develop independence as a researcher.
- Develop confidence as a researcher.

Equity & Inclusion Awareness & Skills
- Advance equity and inclusion in the research environment.
- Develop skills to deal with personal differences in the research environment.

Professional & Career Development Skills
- Explore and pursue a research career.
- Develop confidence in pursuing a research career.

Figure S1. Evolution of Entering Research Meta-Learning Objectives and Conceptual Framework

Table S1

Evolution of the Entering Research Learning Assessment Items: Decisions at Each Stage of Development

Item at Stage 2	Item Decision at Stage 2	Item Decision at Stage 3	Item Decision at Stage 4
Research Comprehension & Communication Skills			
Understand the theory and concepts guiding your (*their*) research project.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Connect your (*their*) research experience to what you (*they*) have learned in courses.	REMOVE$_{TM}$ – low factor loading	---	---
Communicate the context, methods, and results of your (*their*) research.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Tailor your (*their*) research communications for different audiences (e.g., general public, disciplinary conference, etc.).	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Use logic and evidence to interpret data.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Use logic and evidence to build arguments and draw conclusions from data.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Make connections between your (*their*) research and societal issues.	REVISE$_{TM}$ - Communicate the relevance of your (*their*) research to others.	RETAIN$_{TM}$	RETAIN$_{TM}$
Analyze Data	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Work in the research environment comfortably.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Accept and use criticism of your (*their*) research to improve your (*their*) research.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Understand that the process of discovery is iterative and never ending.	RETAIN$_{T}$; REVISE$_{M}$ - Understand (*Demonstrate understanding*) that	RETAIN$_{TM}$	RETAIN$_{TM}$

	the process of discovery is iterative and never ending.		
Listen for understanding and comprehension regarding your (*their*) research project.	REVISE$_{TM}$ - Demonstrate understanding and comprehension regarding your (*their*) research project.	RETAIN$_{TM}$	RETAIN$_{TM}$
Ask questions to clarify your (*their*) understanding of your (*their*) research project.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Align your (*their*) research experience goals and expectations with your research mentor's (*your goals and expectations*).	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Practice regular and open communication with your mentor (*you*).	RETAIN$_{TM}$	REVISE$_T$ - Practice regular and open communication with your research mentor.; RETAIN$_M$	RETAIN$_{TM}$
Practice regular and open communication with research team members.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Mentor others learning to do research.	REMOVE$_{TM}$ – Low factor loading	---	---
Be yourself when working in the research environment. (*Seem to be acting like themselves when working in the research environment*).	REMOVE$_{TM}$ – Factor loading inconsistent with framework	---	---
Practical Research Skills			
Design and conduct a research project.	RETAIN$_{TM}$	REVISED$_{TM}$ - Design a research project	RETAIN$_{TM}$
Keep detailed research records (e.g., a lab/field notebook).	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
	NEW$_{TM}$ - Conduct Research.	RETAIN$_{TM}$	RETAIN$_{TM}$
	NEW$_{TM}$ - Do experiments.	RETAIN$_{TM}$	RETAIN$_T$; REMOVE$_M$ – Improved model-data fit
	NEW$_{TM}$ - Collect data.	RETAIN$_{TM}$	RETAIN$_{TM}$

	NEW$_{TM}$ - Use the tools, materials, and equipment needed to conduct research.	RETAIN$_{TM}$	RETAIN$_{TM}$
	NEW$_{TM}$ - Understand the safety precautions relating to your (*their*) research.	RETAIN$_{TM}$	RETAIN$_{TM}$
	NEW$_{TM}$ - Work effectively with the subject of study (e.g., mathematical models, mice, plants, rock formations).	RETAIN$_{TM}$	RETAIN$_{TM}$
	NEW$_{TM}$ - Formulate a research question/ hypothesis.	RETAIN$_{TM}$	RETAIN$_{TM}$
	NEW$_{TM}$ - Rationalize your (*their*) research question based on the literature.	REVISE$_{TM}$ - Make a case for your (*their*) research question based on the literature.	RETAIN$_{TM}$
	NEW$_{TM}$ - Determine the appropriate experimental approach to your (*their*) research question.	REVISE$_{TM}$ -Determine the appropriate experimental approach to investigate your (*their*) research question.	RETAIN$_{TM}$
	NEW$_{TM}$ - Determine an analysis plan/statistical methods to analyze your data.	RETAIN$_{TM}$	RETAIN$_{TM}$
		NEW$_{TM}$ - Make detailed observations.	RETAIN$_{TM}$
Research Ethics			
Identify forms of unethical practices or research misconduct.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Understand the consequences of unethical practices or research misconduct.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Take action to address unethical practices or research misconduct.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Researcher Identity			
Think of yourself as a scientist/researcher (*Behave like a researcher*).	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{T;}$ REMOVE$_{M}$ – Improved model-data fit

Feel like you belong in research (*Act like they belong in research*).	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Call yourself (*themselves*) a researcher when talking to others.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_T$; REMOVE$_M$ – Improved model-data fit
	NEW$_M$ - Behave like a researcher in your discipline.	NEW$_T$ - Behave like a researcher in your discipline. RETAIN$_M$	RETAIN$_{TM}$
	NEW$_{TM}$ - Fit in with the research culture of your discipline.	RETAIN$_{TM}$	RETAIN$_{TM}$
	NEW$_{TM}$ - Fit in with the culture of your research group.	RETAIN$_{TM}$	RETAIN$_{TM}$
Researcher Confidence & Independence			
Work independently on your (*their*) research project.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Determine the next steps in your (*their*) research project.	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Investigate and solve problems when they arise in your (*their*) research (e.g. troubleshoot).	RETAIN$_{TM}$	RETAIN$_{TM}$	RETAIN$_{TM}$
Be confident (*Demonstrate confidence*) in conducting research.	REVISE$_M$ - Be confident (C*onfidence*) in conducting research.	REVISE$_T$ - Confidence in conducting research.; RETAIN$_M$	RETAIN$_{TM}$
Be confident (*Demonstrating confidence*) in coping with challenges when they arise in your (*their*) research project.	REVISE$_M$ - Be confident (*Confidence*) in coping with challenges when they arise in your (*their*) research project.	REVISE$_T$ - Confidence in coping with challenges when they arise in your (*their*) research project.	RETAIN$_{TM}$
Be confident (*Demonstrating confidence*) in staying motivated and committed to your (*their*) research project when things do not go as planned.	REVISE$_M$ - Be confident (*Confidence*) in staying motivated and committed to your (*their*) research project when things do not go as planned.	REVISE$_T$ - Confidence in staying motivated and committed to your (*their*) research project when things do not go as planned.	RETAIN$_{TM}$
Be confident (*Demonstrating confidence*) in completing your (*their*) research training.	REVISE$_M$ - Be confident (*Confidence*) in completing your (*their*) research training.	REVISE$_T$ - Confidence in completing your (*their*) research training.	RETAIN$_{TM}$
Equity & Inclusion Awareness & Skills			

Identify the biases and prejudices that you (*they*) have about others.	RETAIN_TM	RETAIN_T; REMOVE_M – Mentor & expert feedback	RETAIN_T
Identify the biases and prejudices that others may have about you (*them*).	RETAIN_TM	RETAIN_T; REMOVE_M – Mentor & expert feedback	RETAIN_T
Understand the impact of biases on your (*their*) interactions with others in a research environment.	RETAIN_TM	RETAIN_T; REMOVE_M – Mentor & expert feedback	RETAIN_T
Work effectively with others in a research environment whose personal backgrounds are different from your (*their*) own.	RETAIN_TM	RETAIN_TM	REMOVE_TM – Improved model-data fit
Understand how others might experience research differently based on their identity (e.g. race, socioeconomic status, first-generation status, etc.)	RETAIN_TM	RETAIN_TM	RETAIN_TM
Advocate for others who may be marginalized or excluded from the research environment.	RETAIN_TM	RETAIN_TM	RETAIN_TM
Professional & Career Development Skills			
Explore possible research career pathways.	RETAIN_TM	RETAIN_T; REVISE_M - Explore (*Demonstrate understanding of*) possible research career pathways.	RETAIN_TM
Set research career goals.	RETAIN_TM	RETAIN_TM	RETAIN_TM
Develop a plan to pursue a research career (determine the next step in your [*their*] training)	RETAIN_TM	RETAIN_TM	RETAIN_TM
Meet and establish relationships with research professionals in your (*their*) field (network).	RETAIN_TM	RETAIN_TM	REMOVE_TM – Improved model-data fit
Be confident (*Demonstrating confidence*) in pursuing a career in research.	REVISE_M - Be confident (*Confidence*) in pursuing a career in research.	REVISE_T - Confidence in pursuing a career in research	RETAIN_TM

Note. Respondents were asked, "How much did you (*your trainee*) gain in your (*their*) ability to do the following over the course of your (*their*) research experience?" Mentor item versions are noted in italics. T and M subscripts represent *trainee* and *mentor,* respectively. Revisions to items at Stage 2 were based on pilot tester feedback and decisions by the research team to improve item clarity based on the results of the Exploratory Factor Analysis. Revisions to items at Stage 3 were based on feedback from content experts and decisions by the research team to improve item clarity and alignment between trainee and mentor items.

Table S2

Comparison of Factor Loadings for Mentor Version of ERLA

Subscale and Item		Factor Loadings	
		Treatment of *did not observe*	
		Treated as "no gain"	Treated as missing
Research Comprehension & Communication Skills			
1	Understand the theory and concepts guiding their research project.	.806	.822
22	Communicate the context, methods, and results of their research.	.851	.872
12	Tailor their research communications for different audiences (e.g., general public, disciplinary conference, etc.).	.649	.744
21	Use logic and evidence to interpret data.	.845	.852
39	Use logic and evidence to build arguments and draw conclusions from data.	.904	.902
16	Communicate the relevance of their research to others	.776	.794
5	Analyze data.	.711	.747
25	Work in the research environment comfortably.	.849	.866
40	Accept and use criticism of their research to improve their research.	.792	.822
26	Demonstrate understanding that the process of discovery is iterative and never ending.	.801	.813
11	Demonstrate understanding and comprehension regarding their research project.	.828	.842
7	Ask questions to clarify their understanding of their research project.	.775	.766
36	Align their research experience goals and expectations with your goals and expectations	.792	.864
2	Practice regular and open communication with you	.786	.784
31	Practice regular and open communication with your research team members.	.788	.835
Practical Research Skills			
8	Design a research project.	.818	.839
15	Keep detailed research records (e.g., a lab/field notebook).	.674	.735
41	Conduct a research project	.847	.881

No.	Item		
27	Collect data	.682	.781
18	Use the tools, materials, and equipment needed to conduct research.	.787	.855
28	Demonstrate understanding of the safety precautions relating to their research.	.679	.757
33	Work effectively with the subject of study (e.g., chemicals, mathematical models, mice, plants, rock formations)	.814	.896
10	Formulate a research question/hypothesis.	.798	.804
30	Make a case for their research question based on literature	.776	.793
14	Determine the appropriate experimental approach to investigate their research question	.805	.861
43	Determine an analysis plan/statistical methods to analyze their data	.796	.832
47	Make detailed observations.	.860	.894
Research Ethics			
3	Identify forms of unethical practices or research misconduct.	.845	.875
17	Demonstrate understanding of the consequences of unethical practices or research misconduct	.909	.943
37	Take action to address unethical practices or research misconduct.	.885	.848
Researcher Identity			
38	Act like they belong in research.	.903	.929
35	Behave like a researcher in your discipline.	.898	.919
9	Fit in with the research culture of your discipline.	.875	.885
29	Fit in with the culture of your research group	.758	.854
Researcher Confidence & Independence			
19	Work independently on their research project.	.755	.815
4	Determine the next steps in their research project.	.797	.806
44	Investigate problems when they arise in their research (e.g. troubleshoot).	.876	.903
32	Confidence in conducting research.	.919	.930
42	Confidence in coping with challenges when they arise in their research project.	.887	.902
13	Confidence in staying motivated and committed to their research project when things do not go as planned.	.809	.843
46	Confidence in completing their research training.	.925	.928

Equity & Inclusion Awareness & Skills			
45	Demonstrate understanding of how others might experience research differently based on their identity (e.g. race, socioeconomic status, first-generation status, etc.)	.938	.890
23	Advocate for others who may be marginalized or excluded from the research environment.	.878	.905
Professional & Career Development Skills			
34	Demonstrate understanding of possible research career pathways.	.892	.898
6	Set research career goals.	.889	.835
24	Develop a plan to pursue a research career (determine the next step in their training)	.888	.877
20	Confidence in pursuing a career in research.	.889	.905

Note. Question stem for each item was "how much did your trainee gain in their ability to do the following over the course of their research experience?" The first column reports the final fit statistics and factor loadings of the ERLA scale for mentors, with *did not observe* scored the same as *no gain.* The second column reports the final factor loadings of the ERLA scale for mentors, with *did not observe* treated as missing.

Table S3.1

Correlations between ERLA Subscales for Trainees

ERLA Subscale	1	2	3	4	5	6	7
1. Research Comprehension & Communication Skills	---	.967	.715	.953	.970	.651	.825
2. Practical Research Skills	.962	---	.770	.930	.970	.645	.799
3. Research Ethics	.715	.765	---	.724	.704	.855	.697
4. Research Identity	.924	.904	.702	---	.969	.650	.923
5. Researcher Confidence & Independence	.970	.965	.703	.951	---	.657	.844
6. Equity & Inclusion Awareness & Skills	.687	.677	.879	.647	.683	---	.627
7. Professional & Career Development Skills	.825	.795	.696	.915	.844	.643	---

Note. All correlations are significant at *p* < .001. The bottom half of the diagonal presents the correlations for the full version of the trainee ERLA; the top half of the diagonal presents the correlations for the version of the trainee ERLA that aligns with the mentor ERLA.

Table S3.2

Correlations between ERLA Subscales for Mentors

ERLA Subscale	1	2	3	4	5	6	7
1. Research Comprehension & Communication Skills	---	.950	.716	.974	.975	.729	.840
2. Practical Research Skills	.932	---	.731	.926	.963	.720	.825
3. Research Ethics	.533	.599	---	.732	.684	.805	.674
4. Research Identity	.975	.918	.544	---	.943	.713	.852
5. Researcher Confidence & Independence	.965	.919	.493	.938	---	.750	.879
6. Equity & Inclusion Awareness & Skills	.580	.632	.837	.549	.578	---	.666
7. Professional & Career Development Skills	.759	.744	.534	.794	.771	.522	---

Note. All correlations are significant at *p* < .001. The bottom half of the diagonal presents the correlations when responses of *did not observe* were scored the same as *no gain*; the top half of the diagonal presents the correlations when responses of *did not observe* were treated as missing.

Table S4

Means, Standard Deviations, and Spearman Correlations Between Trainee and Mentors' Scores on ERLA Subscales

ERLA Subscale	M(SD) Trainee	M(SD) Mentor	Correlation of Mentor/Trainee Scores
1. Research Comprehension & Communication Skills	4.43 (0.57)	4.28 (0.72)	.183*
2. Practical Research Skills	4.25 (0.72)	4.01 (0.88)	.152
3. Research Ethics	3.83 (1.00)	2.82 (1.34)	-.009
4. Research Identity	4.24 (0.77)	4.25 (0.92)	.162
5. Researcher Confidence & Independence	4.32 (0.69)	4.22 (0.89)	.216*
6. Equity & Inclusion Awareness & Skills	3.77 (1.15)	3.17 (1.58)	.160
7. Professional & Career Development Skills	4.06 (0.95)	3.80 (1.15)	.054

Note. Ns= 109-121*.* Responses for ERLA subscale could range from 1 (*no gain*) to 5 (*great gain*).
* $p < .05$.

Analysis of Trainee/Mentor Alignment on ERLA as Predictive of Research Trainee Outcomes

We were interested in understanding whether the degree to which trainee/mentor alignment on the ERLA is predictive of trainees' rating of the research experience or the quality of the mentoring relationship. We examined this using a moderated regression approach, as difference scores can be used to assess similarity but have been shown to be insufficient at examining the relationship between alignment and other variables (Rogers, Wood, & Furr, 2018). Based on the recommendations of Rogers et al. (2018), we used moderated regression to investigate this question by first standardizing trainee and mentor scores on each of the seven subscales of the ERLA and then calculating an interaction term (e.g., (ZRCC$_{trainee}$ x ZRCC$_{mentor}$). Using stepwise multiple regression in SPSS, we first entered the standardized trainee and mentor scores on each subscale as a main effect, and then examined whether the interaction term contributed significantly to the prediction of trainees' ratings of the research experience or quality of the research mentoring relationship. For example:

$\hat{y} = b_0 + b_1X_1 + b_2X_2 + b_3X_1X_2$

ResearchExperience$_{trainee}$ = $b_0 + b_1$(RCC$_{trainee}$) + b_2(RCC$_{mentor}$) + b_3(RCC$_{trainee}$*RCC$_{mentor}$)

MentoringRelationship$_{trainee}$ = $b_0 + b_1$(RCC$_{trainee}$) + b_2(RCC$_{mentor}$) + b_3(RCC$_{trainee}$*RCC$_{mentor}$)

In this example, a significant interaction effect would mean that alignment (i.e., similarity) between trainees' and mentors' scores on the ERLA subscale for Research Comprehension and Communication Skills is associated with trainee's ratings of the research experience overall or of the overall quality of the mentoring relationship.

Results tables for each of the regression models, including model fit statistics, can be found in Tables S5 – S11. Across all regression models, trainees' self-reported gains of each dimension of the ERLA were significantly and positively related to trainee's ratings of the research experience and the overall quality of their research mentoring relationship. However, there were no instances where the main effect of mentors' ratings of trainee's gains on the ERLA or the interaction of trainee and mentors' assessments (i.e., the degree to which trainee and mentors' score alignment varied across levels of quality of the mentoring relationship or research experience) were significantly related to trainee ratings of the research experience or quality of the mentoring relationship.

Assuming that better alignment of scores would reflect better relationships between research trainees and their mentors, we tested the hypothesis that the degree of alignment of the trainee/mentor scores would reflect the trainees' perceptions of the research experience or the overall quality of the research mentoring relationship. However, we were not able to detect any significant relationships. It may be that the dependent variables chosen for our analyses are not outcomes for

which the degree of alignment between trainees and their mentors matters. These dependent variables are based on trainee's ratings of their research experience and quality of the mentoring relationship; both of which rely heavily on the trainee's satisfaction, not necessarily on the trainee's learning gains. Indeed, a trainee could be very satisfied with their research experience or mentoring relationship, but have minimal learning gains. This possible explanation of our findings aligns well with the literature on student evaluations of teaching, which suggests that students' evaluations of courses or teaching are not necessarily related to metrics of student learning (Uttl, White, & Gonzalez, 2017). Given that mentees tended to rate their overall research experience and quality of the research mentoring relationship highly (4.5 and 4.4, respectively on a 5-point scale), the lack of variability in our outcome variables suggests that mentees in our sample were satisfied with their research experience and mentoring relationship, regardless of the degree to which their assessment of gains aligned with their mentors. We anticipate that a better dependent variable with which to assess the implications of trainee/mentor assessment alignment (or misalignment) may be the measure of a trainee's ability to accurately assess their learning gains as described above. We will test this hypothesis in future research.

References

Rogers, K. H., Wood, D., & Furr, R. M. (2018). Assessment of similarity and self-other agreement in dyadic relationships: A guide to best practices. *Journal of Social and Personal Relationships, 35,* 112-134. doi: 10.1177/0265407517712615

Uttl, B., White, C. A., & Gonzalez, D. W. (2017). Meta-analysis of faculty's teaching effectiveness: Student evaluation of teaching ratings and student learning are not related. *Studies in Educational Evaluation, 54,* 22-42. https://doi.org/10.1016/j.stueduc.2016.08.007

Table S5

Prediction of Research Experience Outcomes from Research Comprehension and Communication Skills (RCC) Alignment

| | Research Experience Outcomes | | | |
| | Research Experience Overall | | Overall Quality of Mentoring Relationship | |
Variable	Model 1 *B*	Model 2 *B*	Model 1 *B*	Model 2 *B*
Constant	4.781***	4.787***	4.735***	4.741***
$RCC_{trainee}$	.258***	.255***	.216***	.213***
RCC_{mentor}	-.007	-.008	.018	.019
$RCC_{trainee}$ x RCC_{mentor}		-.040		-.045
R^2	.216	.221	.171	.177
F	16.125***	10.940***	11.870***	8.195***
ΔR^2		.004		.006
ΔF		.662		.871
AIC	164.044	162.718	164.552	163.444

Note. All independent variables were standardized (i.e., converted to *z*-scores) prior to analysis. Akaike's Information Criterion (AIC) is a measure of model fit and was calculated using the following formula: $n*\ln(SSE/n)+2k$, where k = 1+ number of predictors in the model).

* $p < .05$. ** $p < .01$. ***$p < .001$

Table S6

Prediction of Research Experience Outcomes from Practical Research Skills (PRS) Alignment

| Variable | Research Experience Outcomes | | | |
| | Research Experience Overall | | Overall Quality of Mentoring Relationship | |
	Model 1 *B*	Model 2 *B*	Model 1 *B*	Model 2 *B*
Constant	4.777***	4.783***	4.731***	4.739***
$PRS_{trainee}$	.223***	.218***	.209***	.200***
PRS_{mentor}	-.013	-.018	.012	.005
$PRS_{trainee}$ x PRS_{mentor}		-.033		-.051
R^2	.157	.161	.157	.168
F	10.769**	7.344***	10.623***	7.604***
ΔR^2		.004		.011
ΔF		.572		1.478
AIC	153.139	151.726	160.399	159.907

Note. All independent variables were standardized (i.e., converted to *z*-scores) prior to analysis. Akaike's Information Criterion (AIC) is a measure of model fit and was calculated using the following formula: $n*\ln(SSE/n)+2k$, where k = 1+ number of predictors in the model).

 * $p < .05$. ** $p < .01$. ***$p < .001$

Table S7

Prediction of Research Experience Outcomes from Research Ethics (RE) Alignment

| Variable | Research Experience Outcomes | | | |
| | Research Experience Overall | | Overall Quality of Mentoring Relationship | |
	Model 1 *B*	Model 2 *B*	Model 1 *B*	Model 2 *B*
Constant	4.776***	4.777***	4.746***	4.748***
$RE_{trainee}$	.156**	.151**	.160**	.150**
RE_{mentor}	.022	.021	-.006	-.009
$RE_{trainee}$ x RE_{mentor}		-.045		-.086
R^2	.082	.089	.097	.127
F	4.715*	3.412*	5.587***	5.000**
ΔR^2		.007		.030
ΔF		.822		3.552
AIC	132.186	131.027	145.224	146.816

Note. All independent variables were standardized (i.e., converted to *z*-scores) prior to analysis. Akaike's Information Criterion (AIC) is a measure of model fit and was calculated using the following formula: $n*\ln(SSE/n)+2k$, where k = 1+ number of predictors in the model).

 * $p < .05$. ** $p < .01$. ***$p < .001$

Table S8

Prediction of Research Experience Outcomes from Researcher Identity (RID) Alignment

Variable	Research Experience Overall		Overall Quality of Mentoring Relationship	
	Model 1 *B*	Model 2 *B*	Model 1 *B*	Model 2 *B*
Constant	4.768***	4.776***	4.720***	4.721***
$RID_{trainee}$	.275***	.268***	.254***	.253***
RID_{mentor}	-.018	-.029	.017	.015
$RID_{trainee}$ x RID_{mentor}		-.035		-.007
R^2	.210	.214	.212	.212
F	15.275***	10.376***	15.208***	10.061***
ΔR^2		.005		.000
ΔF		.665		.028
AIC	158.589	157.268	165.977	164.003

Note. All independent variables were standardized (i.e., converted to *z*-scores) prior to analysis. Akaike's Information Criterion (AIC) is a measure of model fit and was calculated using the following formula: $n*\ln(SSE/n)+2k$, where k = 1+ number of predictors in the model).
 * $p < .05$. ** $p < .01$. ***$p < .001$

Table S9

Prediction of Research Experience Outcomes from Researcher Confidence and Independence (RCI) Alignment

| | Research Experience Outcomes | | | |
| | Research Experience Overall | | Overall Quality of Mentoring Relationship | |
Variable	Model 1 *B*	Model 2 *B*	Model 1 *B*	Model 2 *B*
Constant	4.783***	4.791***	4.738***	4.744***
$RCI_{trainee}$	.270***	.267***	.214***	.212***
RCI_{mentor}	-.011	-.014	.011	.010
$RCI_{trainee}$ x RCI_{mentor}		-.048		-0.40
R^2	.238	.244	.169	.174
F	18.249***	12.469***	11.716***	8.004***
ΔR^2		.006		.005
ΔF		.930		.651
AIC	167.379	166.332	164.290	162.956

Note. All independent variables were standardized (i.e., converted to *z*-scores) prior to analysis. Akaike's Information Criterion (AIC) is a measure of model fit and was calculated using the following formula: $n*\ln(SSE/n)+2k$, where k = 1+ number of predictors in the model).
 * $p < .05$. ** $p < .01$. ***$p < .001$

Table S10

Prediction of Research Experience Outcomes from Equity and Inclusion Awareness and Skills (EIA) Alignment

| Variable | Research Experience Outcomes | | | |
| | Research Experience Overall | | Overall Quality of Mentoring Relationship | |
	Model 1 B	Model 2 B	Model 1 B	Model 2 B
Constant	4.783***	4.785***	4.731***	4.738***
$EIA_{trainee}$	.107*	.108*	.157**	.162**
EIA_{mentor}	.060	.058	.040	.034
$EIA_{trainee}$ x EIA_{mentor}		-.018		-.055
R^2	.055	.056	.104	.116
F	3.062	2.063	6.004**	4.465**
ΔR^2		.001		.012
ΔF		.116		1.347
AIC	128.883	127.003	142.124	141.502

Note. All independent variables were standardized (i.e., converted to *z*-scores) prior to analysis. Akaike's Information Criterion (AIC) is a measure of model fit and was calculated using the following formula: $n*\ln(SSE/n)+2k$, where k = 1+ number of predictors in the model).

* $p < .05$. ** $p < .01$. ***$p < .001$

Table S11

Prediction of Research Experience Outcomes from Professional and Career Development Skills (PDS) Alignment

Variable	Research Experience Outcomes			
	Research Experience Overall		Overall Quality of Mentoring Relationship	
	Model 1 *B*	Model 2 *B*	Model 1 *B*	Model 2 *B*
Constant	4.787***	4.790***	4.741***	4.742***
PDS$_{trainee}$	.175***	.175***	.172***	.172***
PDS$_{mentor}$	-.022	-.025	.008	.006
PDS$_{trainee}$ x PDS$_{mentor}$		-.040		-.027
R^2	.100	.106	.108	.111
F	6.303**	4.405**	6.748**	4.579**
ΔR^2		.005		.003
ΔF		.649		.324
AIC	149.612	157.780	158.258	156.588

Note. All independent variables were standardized (i.e., converted to *z*-scores) prior to analysis. Akaike's Information Criterion (AIC) is a measure of model fit and was calculated using the following formula: $n*\ln(SSE/n)+2k$, where k = 1+ number of predictors in the model).
 * $p < .05$. ** $p < .01$. ***$p < .001$

Entering Research Learning Assessment (ERLA) Paired Surveys

The *Entering Research* Learning Assessment (ERLA) paired surveys were validated with undergraduate and graduate research trainees. The seven scales, each of which assesses an area of trainee development, may be used independently or together as a comprehensive assessment of trainee learning gains. The parallel trainee/mentor versions of the instrument can be used to assess the degree of alignment between trainees' self-assessment of their gains and mentors' assessment of their trainee's gains. This instrument is also available from the authors. For more information on the psychometric properties of the scale, item ordering and scoring, contact Dr. Janet Branchaw and Dr. Amanda Butz at enteringresearch@education.wisc.edu.

Entering Research Learning Assessment – Trainee

How much did you gain in your ability to do the following over the course of your research experience?

	no gain	a little gain	moderate gain	good gain	great gain
1. Understand the theory and concepts guiding your research project.	O	O	O	O	O
2. Practice regular and open communication with your research mentor.	O	O	O	O	O
3. Think of yourself as a scientist/researcher.	O	O	O	O	O
4. Identify forms of unethical practices or research misconduct.	O	O	O	O	O
5. Determine the next steps in your research project.	O	O	O	O	O
6. Analyze data.	O	O	O	O	O
7. Identify the biases and prejudices that you have about others.	O	O	O	O	O
8. Set research career goals.	O	O	O	O	O
9. Ask questions to clarify your understanding of your research project.	O	O	O	O	O
10. Design a research project.	O	O	O	O	O
11. Fit in with the research culture of your discipline.	O	O	O	O	O
12. Formulate a research question/ hypothesis.	O	O	O	O	O
13. Demonstrate understanding and comprehension regarding your research project.	O	O	O	O	O
14. Tailor your research communications for different audiences (e.g., general public, disciplinary conference, etc.)	O	O	O	O	O
15. Do experiments.	O	O	O	O	O

How much did you gain in your ability to do the following over the course of your research experience?

	no gain	a little gain	moderate gain	good gain	great gain
16. Confidence in staying motivated and committed to your research project when things do not go as planned.	O	O	O	O	O
17. Determine the appropriate experimental approach to investigate your research question.	O	O	O	O	O
18. Keep detailed research records (e.g., a lab/field notebook).	O	O	O	O	O
19. Communicate the relevance of your research to others.	O	O	O	O	O
20. Understand the consequences of unethical practices or research misconduct.	O	O	O	O	O
21. Use the tools, materials, and equipment needed to conduct research.	O	O	O	O	O
22. Work independently on your research project.	O	O	O	O	O
23. Confidence in pursuing a career in research.	O	O	O	O	O
24. Use logic and evidence to interpret data.	O	O	O	O	O
25. Communicate the context, methods, and results of your research.	O	O	O	O	O
26. Advocate for others who may be marginalized or excluded from the research environment.	O	O	O	O	O
27. Develop a plan to pursue a research career (determine the next step in your training).	O	O	O	O	O
28. Work in the research environment comfortably.	O	O	O	O	O

How much did you gain in your ability to do the following over the course of your research experience?

	no gain	a little gain	moderate gain	good gain	great gain
29. Understand that the process of discovery is iterative and never ending.	O	O	O	O	O
30. Collect data.	O	O	O	O	O
31. Understand the safety precautions relating to your research.	O	O	O	O	O
32. Fit in with the culture of your research group.	O	O	O	O	O
33. Make a case for your research question based on the literature.	O	O	O	O	O
34. Practice regular and open communication with your research team members.	O	O	O	O	O
35. Identify the biases and prejudices that others may have about you.	O	O	O	O	O
36. Confidence in conducting research.	O	O	O	O	O
37. Work effectively with the subject of study (e.g., mathematical models, mice, plans, rock formations).	O	O	O	O	O
38. Call yourself a researcher when talking to others.	O	O	O	O	O
39. Explore possible research career pathways.	O	O	O	O	O
40. Behave like a researcher in your discipline.	O	O	O	O	O
41. Align your research experience goals and expectations with your research mentor's.	O	O	O	O	O
42. Take action to address unethical practices or research misconduct.	O	O	O	O	O
43. Feel like you belong in research.	O	O	O	O	O

How much did you gain in your ability to do the following over the course of your research experience?

	no gain	a little gain	moderate gain	good gain	great gain
44. Use logic and evidence to build arguments and draw conclusions from data.	O	O	O	O	O
45. Accept and use criticism of your research to improve your research.	O	O	O	O	O
46. Understand the impact of biases on your interactions with others in a research environment.	O	O	O	O	O
47. Conduct a research project.	O	O	O	O	O
48. Confidence in coping with challenges when they arise in your research project.	O	O	O	O	O
49. Determine an analysis plan/statistical methods to analyze your data.	O	O	O	O	O
50. Investigate problems when they arise in your research (e.g. troubleshoot).	O	O	O	O	O
51. Understand how others might experience research differently based on their identity (e.g. race, socioeconomic status, first-generation status, etc.)	O	O	O	O	O
52. Confidence in completing your research training.	O	O	O	O	O
53. Make detailed observations.	O	O	O	O	O

ERLA – Trainee Scoring: The item numbers corresponding to each area of trainee development are listed below. Area of trainee development sub-scores can be calculated by summing the score for each item and dividing by the total number of items. Individual items should be scored as follows: *no gain* (1); a little gain (2); moderate gain (3); good gain (4); great gain (5).

Research Comprehension and Communication Skills (15 items): 1, 2, 6, 9, 13, 14, 19, 24, 25, 28, 29, 34, 41, 44, 45.

Practical Research Skills (13 items): 10, 12, 15, 17, 18, 21, 30, 31, 33, 37, 47, 49, 53.

Research Ethics (3 items): 4, 20, 42.

Researcher Identity (6 items): 3, 11, 32, 38, 40, 43.

Researcher Confidence and Independence (7 items): 5, 16, 22, 36, 48, 50, 52.

Equity and Inclusion Awareness and Skills (5 items): 7, 26, 35, 46, 51.

Professional and Career Development Skills (4 items): 8, 23, 27, 39.

Entering Research Learning Assessment – Mentor

How much did your [trainee/student researcher] gain in their ability to do the following over the course of their research experience? If you did not observe your [trainee/student researcher] engaged in a particular skill, please select "did not observe."

	no gain	a little gain	moderate gain	good gain	great gain	did not observe
1. Understand the theory and concepts guiding their research project.	O	O	O	O	O	O
2. Practice regular and open communication with you.	O	O	O	O	O	O
3. Identify forms of unethical practices or research misconduct.	O	O	O	O	O	O
4. Determine the next steps in their research project.	O	O	O	O	O	O
5. Analyze data.	O	O	O	O	O	O
6. Set research career goals.	O	O	O	O	O	O
7. Ask questions to clarify their understanding of their research project.	O	O	O	O	O	O
8. Design a research project.	O	O	O	O	O	O
9. Fit in with the research culture of your discipline.	O	O	O	O	O	O
10. Formulate a research question/hypothesis.	O	O	O	O	O	O
11. Demonstrate understanding and comprehension regarding their research project.	O	O	O	O	O	O
12. Tailor their research communications for different audiences (e.g., general public, disciplinary conference, etc.).	O	O	O	O	O	O
13. Confidence in staying motivated and committed to their research project when things do not go as planned.	O	O	O	O	O	O
14. Determine the appropriate experimental approach to investigate their research question	O	O	O	O	O	O
15. Keep detailed research records (e.g., a lab/field notebook).	O	O	O	O	O	O

How much did your [trainee/student researcher] gain in their ability to do the following over the course of their research experience? If you did not observe your [trainee/student researcher] engaged in a particular skill, please select "did not observe."

	no gain	a little gain	moderate gain	good gain	great gain	did not observe
16. Communicate the relevance of their research to others	O	O	O	O	O	O
17. Demonstrate understanding of the consequences of unethical practices or research misconduct	O	O	O	O	O	O
18. Use the tools, materials, and equipment needed to conduct research.	O	O	O	O	O	O
19. Work independently on their research project.	O	O	O	O	O	O
20. Confidence in pursuing a career in research.	O	O	O	O	O	O
21. Use logic and evidence to interpret data.	O	O	O	O	O	O
22. Communicate the context, methods, and results of their research.	O	O	O	O	O	O
23. Advocate for others who may be marginalized or excluded from the research environment.	O	O	O	O	O	O
24. Develop a plan to pursue a research career (determine the next step in their training)	O	O	O	O	O	O
25. Work in the research environment comfortably.	O	O	O	O	O	O
26. Demonstrate understanding that the process of discovery is iterative and never ending.	O	O	O	O	O	O
27. Collect data	O	O	O	O	O	O
28. Demonstrate understanding of the safety precautions relating to their research.	O	O	O	O	O	O
29. Fit in with the culture of your research group	O	O	O	O	O	O
30. Make a case for their research question based on literature	O	O	O	O	O	O

How much did your [trainee/student researcher] gain in their ability to do the following over the course of their research experience? If you did not observe your [trainee/student researcher] engaged in a particular skill, please select "did not observe."

	no gain	a little gain	moderate gain	good gain	great gain	did not observe
31. Practice regular and open communication with your research team members.	O	O	O	O	O	O
32. Confidence in conducting research.	O	O	O	O	O	O
33. Work effectively with the subject of study (e.g., chemicals, mathematical models, mice, plants, rock formations)	O	O	O	O	O	O
34. Demonstrate understanding of possible research career pathways.	O	O	O	O	O	O
35. Behave like a researcher in your discipline.	O	O	O	O	O	O
36. Align their research experience goals and expectations with your goals and expectations	O	O	O	O	O	O
37. Take action to address unethical practices or research misconduct.	O	O	O	O	O	O
38. Act like they belong in research.	O	O	O	O	O	O
39. Use logic and evidence to build arguments and draw conclusions from data.	O	O	O	O	O	O
40. Accept and use criticism of their research to improve their research.	O	O	O	O	O	O
41. Conduct a research project	O	O	O	O	O	O
42. Confidence in coping with challenges when they arise in their research project.	O	O	O	O	O	O
43. Determine an analysis plan/statistical methods to analyze their data	O	O	O	O	O	O
44. Investigate problems when they arise in their research (e.g. troubleshoot).	O	O	O	O	O	O
45. Demonstrate understanding of how others might experience research differently based on their identity (e.g. race, socioeconomic status, first-generation status, etc.)	O	O	O	O	O	O
46. Confidence in completing their research training.	O	O	O	O	O	O
47. Make detailed observations.	O	O	O	O	O	O

ERLA – Mentor Scoring: The item numbers corresponding to each area of trainee development are listed below. Area of trainee development sub-scores can be calculated by summing the score for each item and dividing by the total number of items. Individual items should be scored as follows: *no gain/did not observe* (1); a little gain (2); moderate gain (3); good gain (4); great gain (5).

Research Comprehension and Communication Skills (15 items): 1, 2, 5, 7, 11, 12, 16, 21, 22, 25, 26, 31, 36, 39, 40.

Practical Research Skills (12 items): 8, 10, 14, 15, 18, 27, 28, 30, 33, 41, 43, 47.

Research Ethics (3 items): 3, 17, 37.

Researcher Identity (4 items): 9, 29, 35, 38.

Researcher Confidence and Independence (7 items): 4, 13, 19, 32, 42, 44, 46.

Equity and Inclusion Awareness and Skills (2 items): 23, 45.

Professional and Career Development Skills (4 items): 6, 20, 24, 34.