

# Supplemental Material

*CBE—Life Sciences Education*

Dees *et al.*

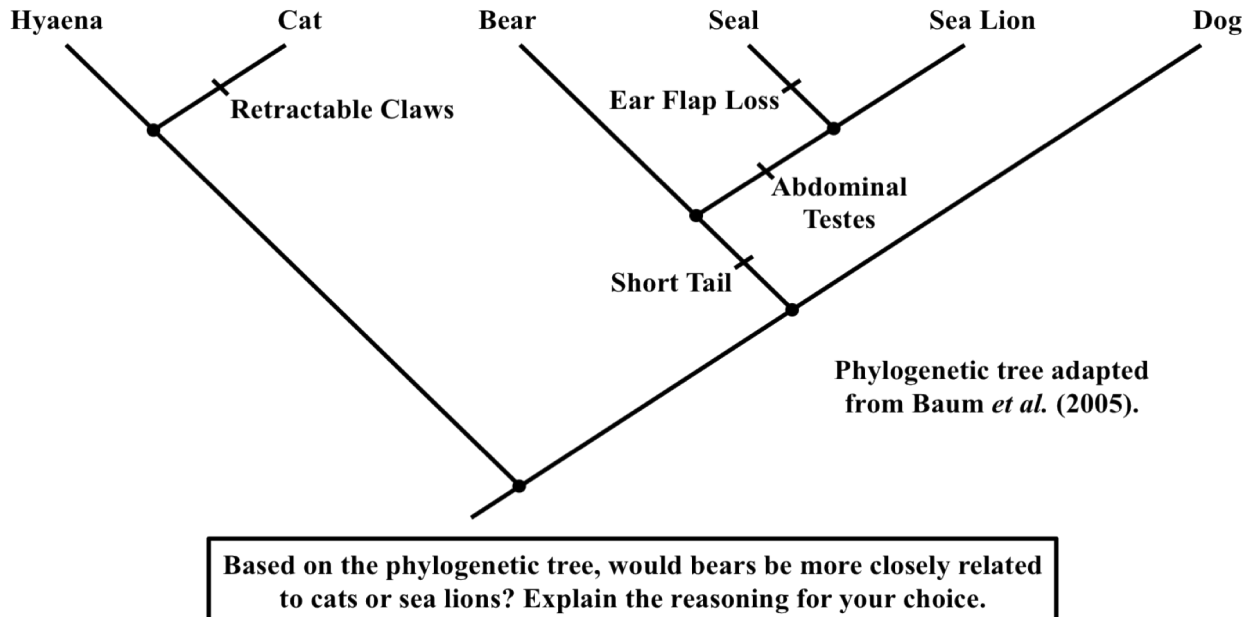
### Appendix: Taxa Relatedness Reasoning Rubric

Category	Brief Description, References, and Student-Generated Example
<i>Most Recent Common Ancestry</i>	<i>Taxa sharing a more recent common ancestor are more closely related to each other than to another taxon.</i> <sup>a, b, c, e, f, h, i, l, m, o, q, r</sup> Example: “Lizards share the same most recent common ancestor with both birds and crocodiles” (Figure S3).
<i>Monophyletic Grouping</i>	<i>Taxa in the same monophyletic group are more closely related to each other than to a taxon outside of the monophyletic group.</i> <sup>d, e, f, l</sup> Example: “The bear is in the same monophyletic group as the sea lion and the seal, thus possessing more of a close relationship” (Figure S1).
Counting Nodes	Taxa relatedness is determined by counting nodes or branches between taxa on phylogenetic trees. <sup>d, e, f, g, h, m, p</sup> Example: “Lizards and birds have less nodes between them than the lizards and crocodiles do” (Figure S3).
Counting Synapomorphies	Taxa relatedness is determined by counting synapomorphies between taxa on phylogenetic trees. Example: “Bears have only one trait different with sea lions and two traits that differ with cats” (Figure S1).
Branch Tip Proximity	Taxa relatedness is determined by perceived distance between taxa on phylogenetic trees. <sup>a, b, d, e, f, g, h, l, m, n, p, q</sup> Example: “The salamander is much closer to the alligator than a red kangaroo on the tree” (Figure 3).
Contemporary Descent	Taxa relatedness is determined by indicating a taxon is descended from another extant taxon. <sup>a, b, d, e, f, g, h, j, l, o, p</sup> Example: “The sea lion branches off from bears, and the cat is on a totally different branch” (Figure S1).
External Insights	Taxa relatedness is determined by knowledge which is not provided by phylogenetic trees. <sup>a, b, d, e, f, j, k, m, r</sup> Example: “The alligators and salamanders are more closely related in characteristics, habitat, geographic location, and behavior” (Figure 3).
Negation Reasoning <sup>#</sup>	Reasoning includes description of how not to interpret taxa relatedness on phylogenetic trees (concurrent with other reasoning in all cases). Example: “A bear and a sea lion have a more recent common ancestor [most recent common ancestry], and you must not pay attention to the tree top because branches can rotate [negation reasoning]” (Figure S1).
Other Responses	Reasoning did not conclusively fall into any of the above categories. Example: “Lizards and birds share a node” (Figure S3).
<i>Italics indicate correct forms of reasoning.</i> <sup>#</sup> Negation reasoning is neither correct nor incorrect.	

<sup>a</sup>Baum *et al.*, 2005; <sup>b</sup>Baum and Offner, 2008; <sup>c</sup>College Board, 2012; <sup>d</sup>Gregory, 2008; <sup>e</sup>Halverson, 2011; <sup>f</sup>Halverson *et al.*, 2011; <sup>g</sup>Meir *et al.*, 2007; <sup>h</sup>Meisel, 2010; <sup>i</sup>Morabito *et al.*, 2010; <sup>j</sup>Novick and Catley, 2007; <sup>k</sup>Novick *et al.*, 2010; <sup>l</sup>Novick *et al.*, 2011; <sup>m</sup>Novick and Catley, 2013; <sup>n</sup>Novick *et al.*, 2012; <sup>o</sup>Omland *et al.*, 2008; <sup>p</sup>Perry *et al.*, 2008; <sup>q</sup>Sandvik, 2008; <sup>r</sup>Smith *et al.*, 2013.

## Supplemental Materials

In addition to the initial homework prompt (Figure 3), the following phylogenetic trees and taxa relatedness questions were placed on subsequent assessments throughout the course.



**Figure S1.** Phylogenetic tree and taxa relatedness question from the individual component of the evolution unit exam. This prompt is flawed and should not be used for measuring understanding of taxa relatedness on phylogenetic trees (see Discussion).

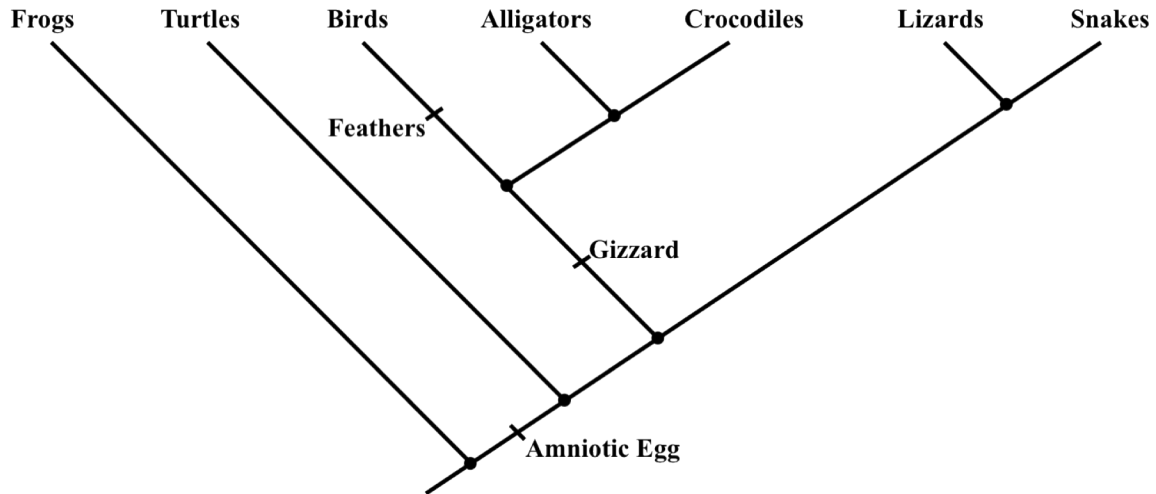
Use the morphological traits shown in Table A to construct a basic phylogenetic tree for plants (any style of phylogenetic tree is fine). Be sure to clearly label all synapomorphies.

Table A. Morphological traits of plants (X = trait possessed by plant).

		Plants					
		Lady Fern	Durum Wheat	Liverworts	Ginkgo	Green Algae	White Spruce
Traits	Seeds		X		X		X
	Needles						X
	Cuticle	X	X	X	X		X
	Flowers		X				
	Stomata	X	X		X		X
	Cones				X		X

Based on the phylogenetic tree of plants you created, would lady ferns be more closely related to liverworts or durum wheat? Explain the reasoning for your choice.

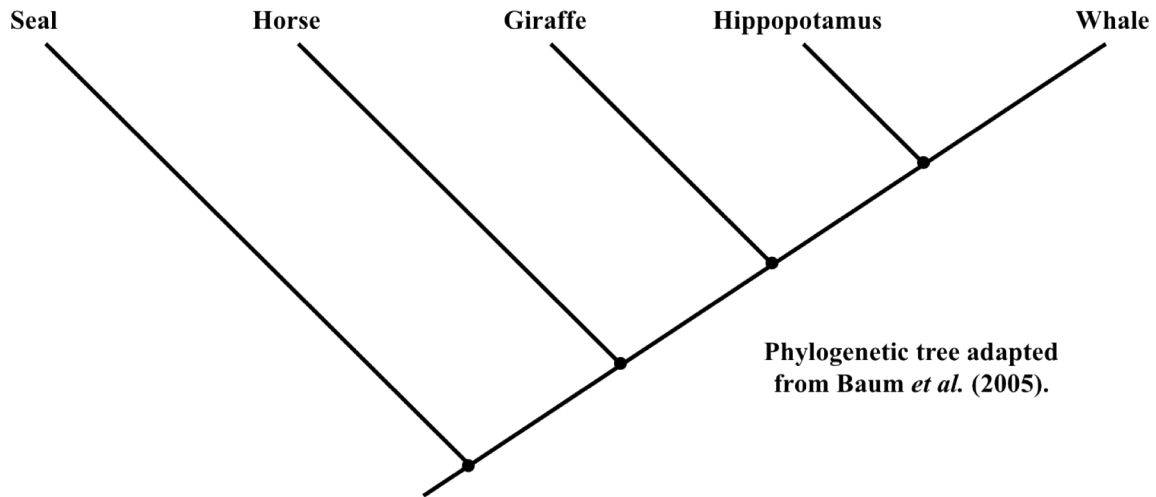
**Figure S2.** Phylogenetic tree construction exercise and taxa relatedness question from the group component of the evolution unit exam. This was the only prompt that required students to build a phylogenetic tree from provided data before answering the taxa relatedness question.



According to the phylogenetic tree, how would you describe the relatedness of lizards to crocodiles and birds? Explain the reasoning for your choice.

(a) Lizards are more closely related to crocodiles than birds.  
 (b) Lizards are more closely related to birds than crocodiles.  
 (c) Lizards are equally related to crocodiles and birds.  
 (d) Lizards are not related to crocodiles and birds.

**Figure S3.** Phylogenetic tree and taxa relatedness question from a review homework completed by individuals in preparation for the comprehensive final exam.



Phylogenetic tree adapted from Baum *et al.* (2005).

According to the phylogenetic tree, how would you describe the relatedness of seals to horses and whales? Explain the reasoning for your choice.

(a) Seals are more closely related to horses than whales.  
 (b) Seals are more closely related to whales than horses.  
 (c) Seals are equally related to horses and whales.  
 (d) Seals are not related to horses and whales.

**Figure S4.** Phylogenetic tree and taxa relatedness question from the individual component of the comprehensive final exam. This was the only phylogenetic tree without labeled synapomorphies.

*The GLIMMIX Procedure*

Model Information	
Data Set	WORK.GROUP
Response Variable	reasoning
Response Distribution	Multinomial (ordered)
Link Function	Cumulative Logit
Variance Function	Default
Variance Matrix Blocked By	id
Estimation Technique	Residual PL
Degrees of Freedom Method	Containment

Class Level Information		
Class	Levels	Values
assessment	2	homework unitexam

Number of Observations Read	47
Number of Observations Used	47

Response Profile		
Ordered Value	reasoning	Total Frequency
1	Incorrec	25
2	DMixed	7
3	Correct	15
<p>The GLIMMIX procedure is modeling the probabilities of levels of reasoning having lower Ordered Values in the Response Profile table.</p>		

Dimensions	
G-side Cov. Parameters	1
Columns in X	4
Columns in Z per Subject	1
Subjects (Blocks in V)	24
Max Obs per Subject	2

*The GLIMMIX Procedure*

Optimization Information	
Optimization Technique	Dual Quasi-Newton
Parameters in Optimization	1
Lower Boundaries	1
Upper Boundaries	0
Fixed Effects	Profiled
Starting From	Data

Iteration History					
Iteration	Restarts	Subiterations	Objective Function	Change	Max Gradient
0	0	2	315.71123579	2.00000000	1.625119
1	0	0	371.82915586	0.09039772	0.496325
2	0	2	402.15449412	2.00000000	2.356E-6
3	0	2	404.79415271	0.92138663	4.59E-6
4	0	2	403.27564941	0.16306621	2.232E-7
5	0	1	403.04953351	0.06319160	8.595E-6
6	0	1	402.90833066	0.02119695	1.047E-6
7	0	1	402.86471333	0.00793665	1.509E-7
8	0	1	402.84715031	0.00288865	2.035E-8
9	0	1	402.8408718	0.00107119	3.143E-9
10	0	1	402.83851465	0.00039502	5.72E-10
11	0	1	402.83764851	0.00014613	1.939E-9
12	0	0	402.83732742	0.00000059	6.842E-6
13	0	0	402.83738859	0.00000001	7.672E-6
14	0	0	402.83738661	0.00000000	7.643E-6

Convergence criterion (PCONV=1.11022E-8) satisfied.

Fit Statistics	
-2 Res Log Pseudo-Likelihood	402.84

*The GLIMMIX Procedure*

Covariance Parameter Estimates			
Cov Parm	Subject	Estimate	Standard Error
Intercept	id	0.05450	0.9277

Solutions for Fixed Effects										
Effect	reasoning	assessment	Estimate	Standard Error	DF	t Value	Pr >  t	Alpha	Lower	Upper
Intercept	Incorrec		-1.7734	0.5673	23	-3.13	0.0047	0.05	-2.9470	-0.5998
Intercept	DMixed		-0.4693	0.4294	23	-1.09	0.2857	0.05	-1.3575	0.4189
assessment		homework	4.1505	0.9194	21	4.51	0.0002	0.05	2.2384	6.0626
assessment		unitexam	0	.	.	.	.	.	.	.

Odds Ratio Estimates					
assessment	_assessment	Estimate	DF	95% Confidence Limits	
homework	unitexam	63.463	21	9.378	429.471

Type III Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
assessment	1	21	20.38	0.0002

**The GLIMMIX Procedure**

Model Information	
Data Set	WORK.STUDENT
Response Variable	reasoning
Response Distribution	Multinomial (ordered)
Link Function	Cumulative Logit
Variance Function	Default
Variance Matrix Blocked By	id
Estimation Technique	Residual PL
Degrees of Freedom Method	Containment

Class Level Information		
Class	Levels	Values
assessment	3	finalexa homework unitexam
class	4	Freshman Junior Senior Sophomor
major	6	Agricult Biologic Natural Other Pre-Prof Undeclar

Number of Observations Read	231
Number of Observations Used	231

Response Profile		
Ordered Value	reasoning	Total Frequency
1	Correct	133
2	DMixed	31
3	Incorrec	67
<p>The GLIMMIX procedure is modeling the probabilities of levels of reasoning having lower Ordered Values in the Response Profile table.</p>		



*The GLIMMIX Procedure*

Dimensions	
G-side Cov. Parameters	1
Columns in X	16
Columns in Z per Subject	1
Subjects (Blocks in V)	88
Max Obs per Subject	3

Optimization Information	
Optimization Technique	Dual Quasi-Newton
Parameters in Optimization	1
Lower Boundaries	1
Upper Boundaries	0
Fixed Effects	Profiled
Starting From	Data

Iteration History					
Iteration	Restarts	Subiterations	Objective Function	Change	Max Gradient
0	0	4	1424.8952227	0.95590583	0.000015
1	0	4	1435.5338276	0.27730906	7.583E-7
2	0	3	1441.7759352	0.35096484	0.000198
3	0	2	1443.5191512	0.11395350	0.000032
4	0	3	1444.1568332	0.05331046	1.665E-7
5	0	2	1444.351661	0.01542820	9.549E-6
6	0	2	1444.4169129	0.00566471	1.016E-6
7	0	2	1444.4376057	0.00170900	1.051E-7
8	0	2	1444.4443734	0.00058293	1.109E-8
9	0	1	1444.44655	0.00019553	0.000108
10	0	1	1444.4475196	0.00006731	0.000017
11	0	1	1444.4475435	0.00000412	0.000011
12	0	0	1444.4475977	0.00000563	5.407E-6
13	0	0	1444.4476114	0.00000056	4.549E-6
14	0	0	1444.4476113	0.00000012	4.514E-6
15	0	0	1444.4476115	0.00000001	4.501E-6

*The GLIMMIX Procedure*

Convergence criterion (PCONV=1.11022E-8) satisfied.

Fit Statistics	
-2 Res Log Pseudo-Likelihood	1444.45

Covariance Parameter Estimates			
Cov Parm	Subject	Estimate	Standard Error
Intercept	id	0.6030	0.3523

## The GLIMMIX Procedure

Solutions for Fixed Effects										
Effect	reasoning	assessment	class	major	Estimate	Standard Error	DF	t Value	Pr >  t	Alpha
Intercept	Correct				-0.8060	1.0978	78	-0.73	0.4650	0.05
Intercept	DMixed				-0.1093	1.0962	78	-0.10	0.9208	0.05
assessment		finalexa			-0.1727	0.3209	140	-0.54	0.5914	0.05
assessment		homework			-0.4620	0.3344	140	-1.38	0.1693	0.05
assessment		unitexam			0	.	.	.	.	.
class			Freshman		0.2193	0.4423	140	0.50	0.6208	0.05
class			Junior		-0.5346	0.4822	140	-1.11	0.2695	0.05
class			Senior		-0.00539	0.4417	140	-0.01	0.9903	0.05
class			Sophomor		0	.	.	.	.	.
major				Agricult	-0.9248	0.8546	140	-1.08	0.2811	0.05
major				Biologic	-0.7939	0.8265	140	-0.96	0.3384	0.05
major				Natural	-0.2405	0.8726	140	-0.28	0.7832	0.05
major				Other	-1.1560	0.9611	140	-1.20	0.2311	0.05
major				Pre-Prof	-0.3815	0.9389	140	-0.41	0.6851	0.05
major				Undeclar	0	.	.	.	.	.
attendance					2.1286	0.9528	140	2.23	0.0271	0.05

*The GLIMMIX Procedure*

Solutions for Fixed Effects						
Effect	reasoning	assessment	class	major	Lower	Upper
Intercept	Correct				-2.9915	1.3795
Intercept	DMixed				-2.2918	2.0731
assessment		finalexa			-0.8071	0.4617
assessment		homework			-1.1232	0.1992
assessment		unitexam			.	.
class			Freshman		-0.6551	1.0937
class			Junior		-1.4880	0.4188
class			Senior		-0.8787	0.8679
class			Sophomor		.	.
major				Agricult	-2.6144	0.7648
major				Biologic	-2.4279	0.8401
major				Natural	-1.9658	1.4847
major				Other	-3.0562	0.7442
major				Pre-Prof	-2.2377	1.4747
major				Undeclar	.	.
attendance					0.2449	4.0124

The GLIMMIX Procedure

Odds Ratio Estimates									
assessment	class	major	attendance	_assessment	_class	_major	_attendance	Estimate	DF
finalexa			0.9365	unitexam			0.9365	0.841	140
homework			0.9365	unitexam			0.9365	0.630	140
	Freshman		0.9365		Sophomor		0.9365	1.245	140
	Junior		0.9365		Sophomor		0.9365	0.586	140
	Senior		0.9365		Sophomor		0.9365	0.995	140
		Agricult	0.9365			Undeclar	0.9365	0.397	140
		Biologic	0.9365			Undeclar	0.9365	0.452	140
		Natural	0.9365			Undeclar	0.9365	0.786	140
		Other	0.9365			Undeclar	0.9365	0.315	140
		Pre-Prof	0.9365			Undeclar	0.9365	0.683	140
			1.9365				0.9365	8.403	140
<b>Effects of continuous variables are assessed as one unit offsets from the mean.                      The AT suboption modifies the reference value and the UNIT suboption modifies the offsets.</b>									

Odds Ratio Estimates									
assessment	class	major	attendance	_assessment	_class	_major	_attendance	95% Confidence Limits	
finalexa			0.9365	unitexam			0.9365	0.446	1.587
homework			0.9365	unitexam			0.9365	0.325	1.220
	Freshman		0.9365		Sophomor		0.9365	0.519	2.985
	Junior		0.9365		Sophomor		0.9365	0.226	1.520
	Senior		0.9365		Sophomor		0.9365	0.415	2.382
		Agricult	0.9365			Undeclar	0.9365	0.073	2.149
		Biologic	0.9365			Undeclar	0.9365	0.088	2.317
		Natural	0.9365			Undeclar	0.9365	0.140	4.414
		Other	0.9365			Undeclar	0.9365	0.047	2.105
		Pre-Prof	0.9365			Undeclar	0.9365	0.107	4.370
			1.9365				0.9365	1.277	55.281
<b>Effects of continuous variables are assessed as one unit offsets from the mean.                      The AT suboption modifies the reference value and the UNIT suboption modifies the offsets.</b>									

*The GLIMMIX Procedure*

<b>Type III Tests of Fixed Effects</b>				
<b>Effect</b>	<b>Num DF</b>	<b>Den DF</b>	<b>F Value</b>	<b>Pr &gt; F</b>
<b>assessment</b>	2	140	0.96	0.3846
<b>class</b>	3	140	0.74	0.5319
<b>major</b>	5	140	0.77	0.5711
<b>attendance</b>	1	140	4.99	0.0271

*The GLIMMIX Procedure*

Model Information	
Data Set	WORK.GROUP
Response Variable	answer
Response Distribution	Binary
Link Function	Logit
Variance Function	Default
Variance Matrix Blocked By	id
Estimation Technique	Residual PL
Degrees of Freedom Method	Containment

Class Level Information		
Class	Levels	Values
assessment	2	homework unitexam
reasoning	3	Correct DMixed Incorrec

Number of Observations Read	47
Number of Observations Used	47

Response Profile		
Ordered Value	answer	Total Frequency
1	Correct	18
2	Incorrec	29
The GLIMMIX procedure is modeling the probability that answer='Correct'.		

Dimensions	
G-side Cov. Parameters	1
Columns in X	6
Columns in Z per Subject	1
Subjects (Blocks in V)	24
Max Obs per Subject	2

*The GLIMMIX Procedure*

Optimization Information	
Optimization Technique	Newton-Raphson with Ridging
Parameters in Optimization	1
Lower Boundaries	1
Upper Boundaries	0
Fixed Effects	Profiled
Starting From	Data

Iteration History					
Iteration	Restarts	Subiterations	Objective Function	Change	Max Gradient
0	0	1	213.81673887	2.00000000	0.371637
1	0	3	238.81277454	2.00000000	4.397E-6
2	0	3	232.47559505	0.47214154	3.415E-8
3	0	2	229.84900721	0.12388102	2.574E-6
4	0	2	229.34598259	0.04189164	4.428E-8
5	0	2	229.14945269	0.01108366	2.38E-10
6	0	1	229.09702361	0.00280908	1.169E-6
7	0	1	229.08337662	0.00068321	6.931E-8
8	0	1	229.08002982	0.00016338	3.965E-9
9	0	1	229.07922761	0.00003888	2.25E-10
10	0	0	229.07903656	0.00000000	4.142E-6

Convergence criterion (PCONV=1.11022E-8) satisfied.

Fit Statistics	
-2 Res Log Pseudo-Likelihood	229.08
Generalized Chi-Square	30.18
Gener. Chi-Square / DF	0.70

Covariance Parameter Estimates			
Cov Parm	Subject	Estimate	Standard Error
Intercept	id	0.9548	2.0644



The GLIMMIX Procedure

Solutions for Fixed Effects										
Effect	assessment	reasoning	Estimate	Standard Error	DF	t Value	Pr >  t	Alpha	Lower	Upper
Intercept			-0.9986	1.2177	23	-0.82	0.4206	0.05	-3.5176	1.5205
reasoning		Correct	3.1474	1.3776	20	2.28	0.0334	0.05	0.2739	6.0210
reasoning		DMixed	0.9271	1.4393	20	0.64	0.5268	0.05	-2.0752	3.9293
reasoning		Incorrec	0	.	.	.	.	.	.	.
assessment	homework		-1.8081	1.2547	20	-1.44	0.1650	0.05	-4.4253	0.8091
assessment	unitexam		0	.	.	.	.	.	.	.

Odds Ratio Estimates							
assessment	reasoning	_assessment	_reasoning	Estimate	DF	95% Confidence Limits	
	Correct		Incorrec	23.276	20	1.315	411.983
	DMixed		Incorrec	2.527	20	0.126	50.873
homework		unitexam		0.164	20	0.012	2.246

Type III Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
reasoning	2	20	3.09	0.0679
assessment	1	20	2.08	0.1650

Estimates									
Label	Estimate	Standard Error	DF	t Value	Pr >  t	Alpha	Lower	Upper	Exponentiated Estimate
correct vs mixed	2.2203	1.2324	20	1.80	0.0867	0.05	-0.3504	4.7911	9.2105

Estimates		
Label	Exponentiated Lower	Exponentiated Upper
correct vs mixed	0.7044	120.43

**The GLIMMIX Procedure**

Model Information	
Data Set	WORK.STUDENT
Response Variable	answer
Response Distribution	Binary
Link Function	Logit
Variance Function	Default
Variance Matrix Blocked By	id
Estimation Technique	Residual PL
Degrees of Freedom Method	Containment

Class Level Information		
Class	Levels	Values
assessment	3	finalexa homework unitexam
reasoning	3	Correct DMixed Incorrec
class	4	Freshman Junior Senior Sophomor
major	6	Agricult Biologic Natural Other Pre-Prof Undeclar

Number of Observations Read	231
Number of Observations Used	231

Response Profile		
Ordered Value	answer	Total Frequency
1	Correct	156
2	Incorrec	75
The GLIMMIX procedure is modeling the probability that answer='Correct'.		

Dimensions	
G-side Cov. Parameters	1
Columns in X	18
Columns in Z per Subject	1
Subjects (Blocks in V)	88
Max Obs per Subject	3

*The GLIMMIX Procedure*

Optimization Information	
Optimization Technique	Newton-Raphson with Ridging
Parameters in Optimization	1
Lower Boundaries	1
Upper Boundaries	0
Fixed Effects	Profiled
Starting From	Data

Iteration History					
Iteration	Restarts	Subiterations	Objective Function	Change	Max Gradient
0	0	3	1001.4839014	0.63939608	9.42E-11
1	0	4	1119.7943116	1.09341653	5.458E-7
2	0	4	1197.9351458	0.48680475	3.231E-9
3	0	3	1245.7517733	0.20024928	6.711E-7
4	0	3	1266.3734522	0.07396460	4.63E-10
5	0	2	1273.2000182	0.02384039	6.628E-7
6	0	2	1275.2571053	0.00715821	5.612E-9
7	0	2	1275.8587	0.00208978	4.13E-11
8	0	1	1276.0328051	0.00060417	1.34E-6
9	0	1	1276.0830059	0.00017451	1.118E-7
10	0	1	1276.0974951	0.00005031	9.291E-9
11	0	1	1276.1016715	0.00001450	7.71E-10
12	0	1	1276.1028749	0.00000418	6.4E-11
13	0	0	1276.1032216	0.00000000	5.736E-6

Convergence criterion (PCONV=1.11022E-8) satisfied.

Fit Statistics	
-2 Res Log Pseudo-Likelihood	1276.10
Generalized Chi-Square	96.32
Gener. Chi-Square / DF	0.44

*The GLIMMIX Procedure*

Covariance Parameter Estimates			
Cov Parm	Subject	Estimate	Standard Error
Intercept	id	2.0784	0.9338

## The GLIMMIX Procedure

Solutions for Fixed Effects										
Effect	assessment	reasoning	class	major	Estimate	Standard Error	DF	t Value	Pr >  t	Alpha
Intercept					-2.2108	1.8629	78	-1.19	0.2389	0.05
assessment	finalex				-5.0182	0.8522	139	-5.89	<.0001	0.05
assessment	homework				-4.6375	0.8699	139	-5.33	<.0001	0.05
assessment	unitexam				0	.	.	.	.	.
reasoning		Correct			3.0645	0.5982	139	5.12	<.0001	0.05
reasoning		DMixed			1.1008	0.8554	139	1.29	0.2003	0.05
reasoning		Incorrec			0	.	.	.	.	.
class			Freshman		-0.4665	0.7435	139	-0.63	0.5314	0.05
class			Junior		-0.5839	0.8643	139	-0.68	0.5004	0.05
class			Senior		0.4084	0.7405	139	0.55	0.5822	0.05
class			Sophomor		0	.	.	.	.	.
major				Agricult	2.6234	1.4489	139	1.81	0.0724	0.05
major				Biologic	2.1208	1.3769	139	1.54	0.1258	0.05
major				Natural	2.9344	1.4558	139	2.02	0.0458	0.05
major				Other	3.4381	1.6781	139	2.05	0.0424	0.05
major				Pre-Prof	3.4190	1.6524	139	2.07	0.0404	0.05
major				Undeclar	0	.	.	.	.	.
attendance					2.8275	1.5906	139	1.78	0.0777	0.05

*The GLIMMIX Procedure*

Solutions for Fixed Effects						
Effect	assessment	reasoning	class	major	Lower	Upper
<b>Intercept</b>					-5.9194	1.4979
<b>assessment</b>	finalexa				-6.7031	-3.3333
<b>assessment</b>	homework				-6.3574	-2.9176
<b>assessment</b>	unitexam				.	.
<b>reasoning</b>		Correct			1.8817	4.2473
<b>reasoning</b>		DMixed			-0.5904	2.7921
<b>reasoning</b>		Incorrec			.	.
<b>class</b>			Freshman		-1.9366	1.0035
<b>class</b>			Junior		-2.2927	1.1249
<b>class</b>			Senior		-1.0557	1.8726
<b>class</b>			Sophomor		.	.
<b>major</b>				Agricult	-0.2413	5.4881
<b>major</b>				Biologic	-0.6015	4.8432
<b>major</b>				Natural	0.05601	5.8127
<b>major</b>				Other	0.1201	6.7560
<b>major</b>				Pre-Prof	0.1520	6.6861
<b>major</b>				Undeclar	.	.
<b>attendance</b>					-0.3174	5.9724

*The GLIMMIX Procedure*

**Odds Ratio Estimates**

<b>assessment</b>	<b>reasoning</b>	<b>class</b>	<b>major</b>	<b>attendance</b>	<b>_assessment</b>	<b>_reasoning</b>	<b>_class</b>	<b>_major</b>	<b>_attendance</b>
finalex				0.9365	unitexam				0.9365
homework				0.9365	unitexam				0.9365
	Correct			0.9365		Incorrec			0.9365
	DMixed			0.9365		Incorrec			0.9365
		Freshman		0.9365			Sophomor		0.9365
		Junior		0.9365			Sophomor		0.9365
		Senior		0.9365			Sophomor		0.9365
			Agricult	0.9365				Undeclar	0.9365
			Biologic	0.9365				Undeclar	0.9365
			Natural	0.9365				Undeclar	0.9365
			Other	0.9365				Undeclar	0.9365
			Pre-Prof	0.9365				Undeclar	0.9365
				1.9365					0.9365

**Effects of continuous variables are assessed as one unit offsets from the mean.  
 The AT suboption modifies the reference value and the UNIT suboption modifies the offsets.**

*The GLIMMIX Procedure*

Odds Ratio Estimates										
assessment	reasoning	class	major	attendance	_assessment	_reasoning	_class	_major	Estimate	DF
finalexa				0.9365	unitexam				0.007	139
homework				0.9365	unitexam				0.010	139
	Correct			0.9365		Incorrec			21.423	139
	DMixed			0.9365		Incorrec			3.007	139
		Freshman		0.9365			Sophomor		0.627	139
		Junior		0.9365			Sophomor		0.558	139
		Senior		0.9365			Sophomor		1.504	139
			Agricult	0.9365				Undeclar	13.782	139
			Biologic	0.9365				Undeclar	8.338	139
			Natural	0.9365				Undeclar	18.809	139
			Other	0.9365				Undeclar	31.126	139
			Pre-Prof	0.9365				Undeclar	30.540	139
				1.9365					16.903	139

Effects of continuous variables are assessed as one unit offsets from the mean.  
 The AT suboption modifies the reference value and the UNIT suboption modifies the offsets.



*The GLIMMIX Procedure*

Odds Ratio Estimates										
assessment	reasoning	class	major	attendance	_assessment	_reasoning	_class	_major	95% Confidence Limits	
finalexa				0.9365	unitexam				0.001	0.036
homework				0.9365	unitexam				0.002	0.054
	Correct			0.9365		Incorrec			6.564	69.918
	DMixed			0.9365		Incorrec			0.554	16.316
		Freshman		0.9365			Sophomor		0.144	2.728
		Junior		0.9365			Sophomor		0.101	3.080
		Senior		0.9365			Sophomor		0.348	6.505
			Agricult	0.9365				Undeclar	0.786	241.787
			Biologic	0.9365				Undeclar	0.548	126.870
			Natural	0.9365				Undeclar	1.058	334.520
			Other	0.9365				Undeclar	1.128	859.171
			Pre-Prof	0.9365				Undeclar	1.164	801.162
				1.9365					0.728	392.438

Effects of continuous variables are assessed as one unit offsets from the mean.  
 The AT suboption modifies the reference value and the UNIT suboption modifies the offsets.

Type III Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
assessment	2	139	17.53	<.0001
reasoning	2	139	13.93	<.0001
class	3	139	0.60	0.6137
major	5	139	1.22	0.3048
attendance	1	139	3.16	0.0777

*The GLIMMIX Procedure*

Estimates									
Label	Estimate	Standard Error	DF	t Value	Pr >  t	Alpha	Lower	Upper	Exponentiated Estimate
<b>reasoning: correct vs mixed</b>	1.9636	0.7798	139	2.52	0.0129	0.05	0.4219	3.5053	7.1252
<b>assessment: final-review</b>	-0.3807	0.4711	139	-0.81	0.4204	0.05	-1.3122	0.5508	0.6834

Estimates		
Label	Exponentiated Lower	Exponentiated Upper
<b>reasoning: correct vs mixed</b>	1.5249	33.2931
<b>assessment: final-review</b>	0.2692	1.7347