

Supplemental Material

CBE—Life Sciences Education

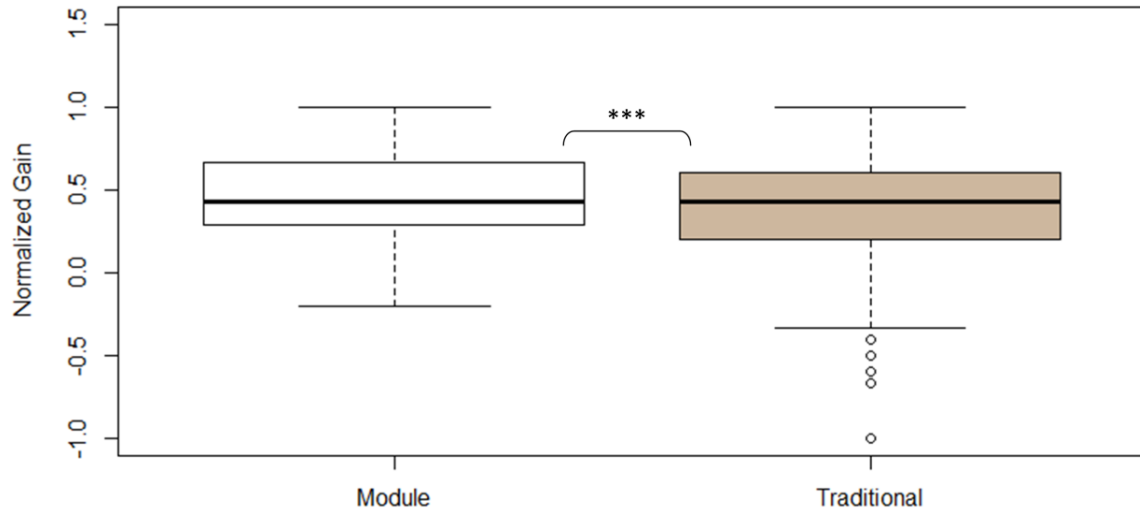
Goff *et al.*

Supplement 1 - Outline of the seven principles of multimedia learning (Mayer and Moreno, 2002)

1. The Multimedia Principle- This principle focuses on the relationship between the narration embedded as part of animation and how it affects student learning. Experimental results show an increase in learning when narrations and visuals are presented together as compared to individually. The multimedia principle is the basis of animation design theory and provides a backbone on which the other principles were designed. A focus on adhering to the presentation of narration and animation together is paramount when producing effective dynamic imagery.
2. The Spatial Continuity Principle- This principle focuses on the presentation of onscreen text and animation together. Experimental results show greater learning when onscreen text is presented in close proximity to the animation which it represents as compared to when text is presented at a farther distance. Animation design based on this principle should focus on assuring that all onscreen text is presented in close proximity to the information which it represents in order to facilitate learning.
3. The Temporal Contiguity Principle- This principle focuses on the student's ability to relate narration and animation within a given time frame. Experimental results show greater learning when corresponding narration and animation are presented at the same time rather than temporally disparate. This shows a need for proper timing built into animation design.
4. The Coherence Principle- This principle focuses on the exclusion of extraneous information from the animation. Experimental results show that greater learning was achieved when all extra music, words, video, etc. are excluded from animation design rather than included. Presumably, these extraneous additions introduce distraction rather than promote learning when incorporated into animation design.
5. Modality Principle- This principle focuses on the differences in the learning outcome when animation is accompanied by narration versus onscreen text. Experimental results show greater learning when voice narration coincides with animation as compared to onscreen text. In theory, presenting information in a text format overloads the learner from a visual processing perspective. This can be alleviated as a part of animation design when the verbal information is presented through narration rather than onscreen text.
6. Redundancy Principle- This principle focuses on the incorporation of animation, narration, and onscreen text simultaneously as a part of educational multimedia design. Experimental results show greater learning when animation and narration are presented simultaneously in the absence of onscreen text. Similar to the modality principle and the coherence principle, the presentation of narration and redundant onscreen text can overload the learners' working memory capacity.
7. Personalization Principle- This principle focuses on the way in which narration is presented as a part of animation design. Experimental results show that narration presented in a conversational format

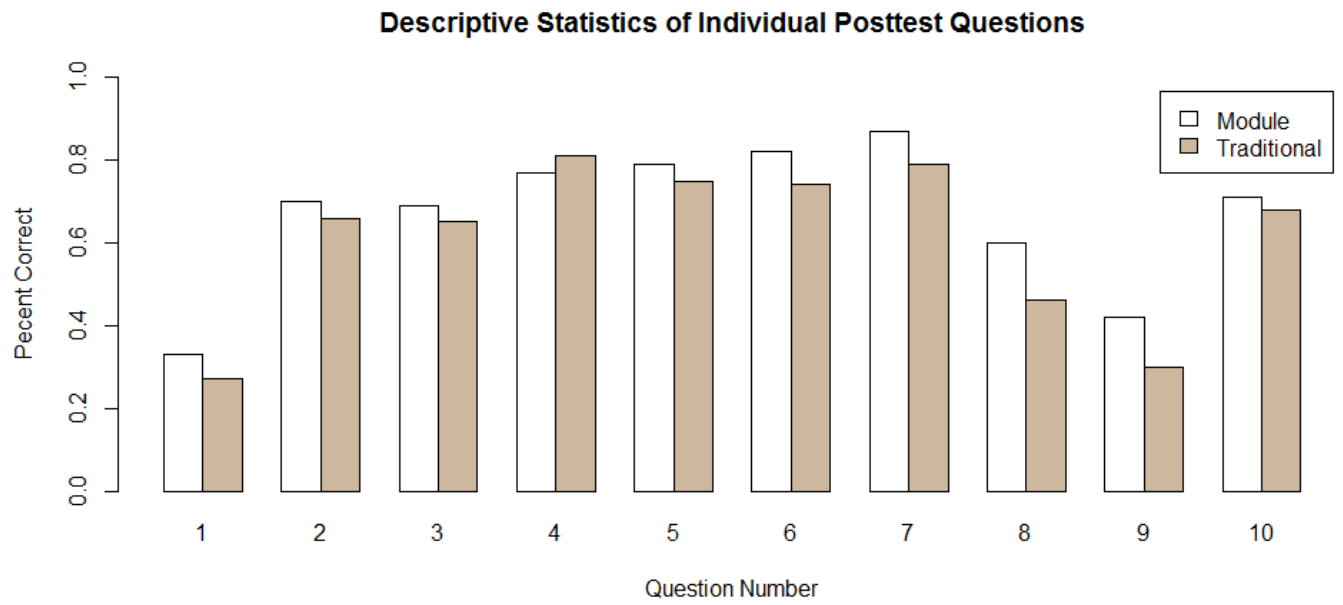
promotes greater learning than narration that is presented in a formal format. Speech format allows for the learner to personalize the content presented and therefore take ownership in the learning process.

Normalized Gain Comparison For Meiosis Module



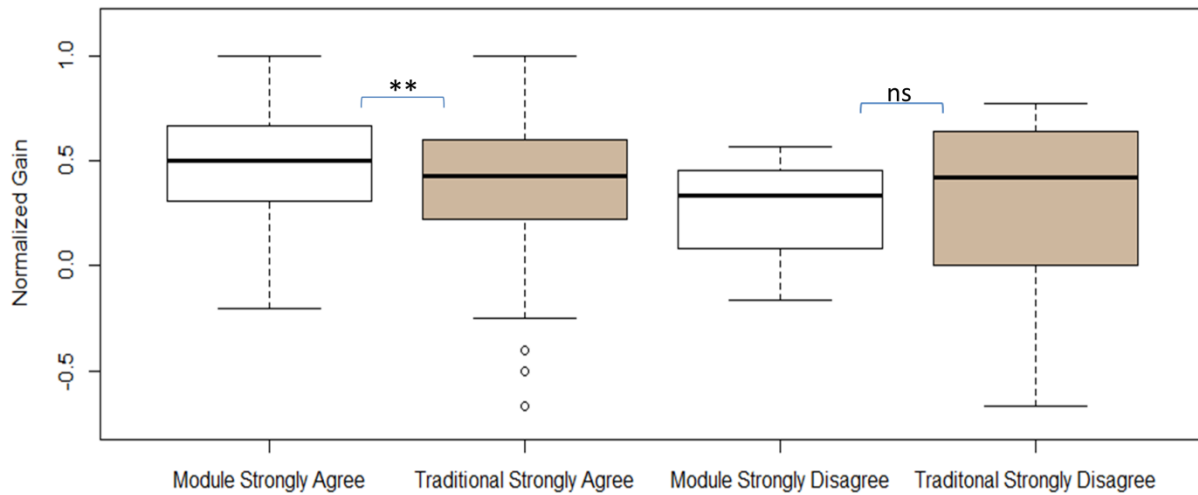
Normalized Gain Score Meiosis Learning Module		
	Module	Traditional
Min	-0.20	-1.67
1st Quart	0.29	0.20
Median	0.43	0.43
Mean	0.47	0.34
3rd Quart	0.67	0.60
Max	1.00	1.00
Std. Dev.	0.26	0.38
95 % CI	0.07 > μ > 0.19	

Supplement 2- Summary data of scores comparing meiosis learning module and traditional lecture treatment.



Supplement 3- Descriptive statistics of individual posttest questions by treatment group.

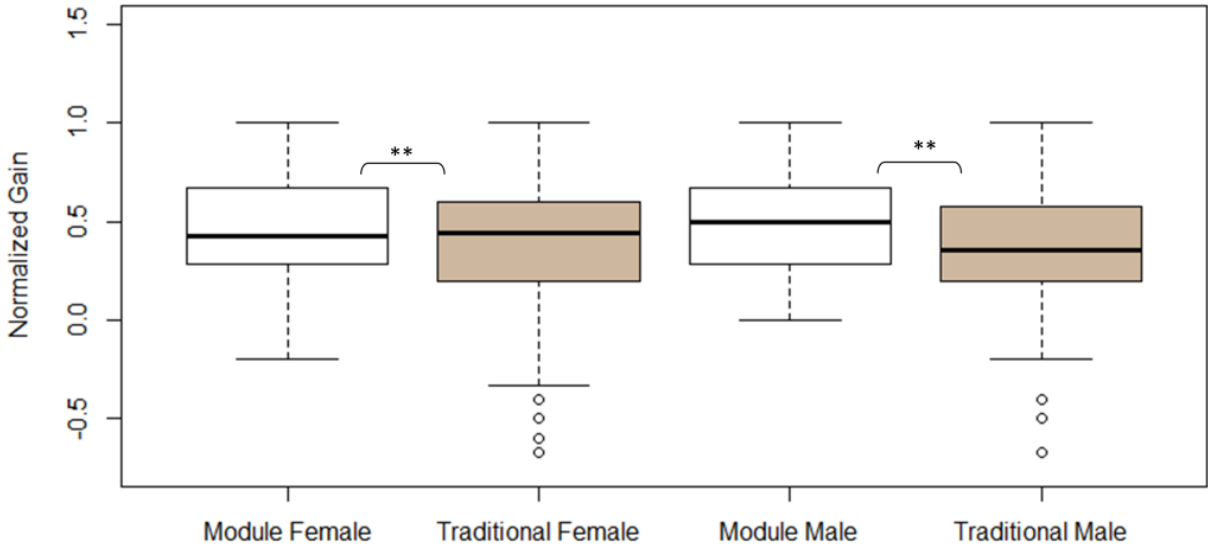
Normalized Gain By Self-Identification of Multimedia Learner



	Normalized Gain Score Meiosis Learning Module			
	Multimedia Learner (Strongly Agree)		Multimedia Learner (Strongly Disagree)	
	Module	Traditional	Module	Traditional
Min	-0.20	-1.00	-0.17	-0.67
1st Qu.	0.32	0.22	0.08	0.08
Median	0.50	0.43	0.33	0.42
Mean	0.49	0.36	0.25	0.28
3rd Qu.	0.67	0.60	0.45	0.61
Max	1.00	1.00	0.57	0.78
SD	0.27	0.39	0.38	0.51
95% CI	0.03 > μ > 0.23		-0.75 > μ > 0.67	

Supplement 4- Summary data of scores comparing meiosis learning module and traditional lecture treatment as a function of student preference for multimedia learning.

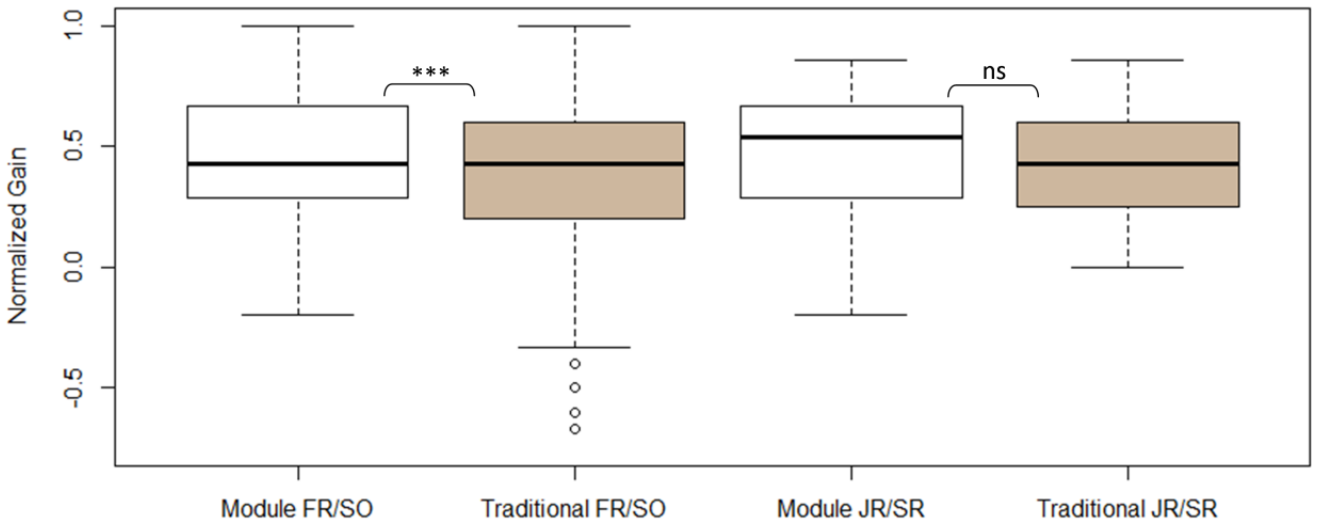
Normalized Gain By Student Gender



	Normalized Gain Score Meiosis Learning Module			
	Female		Male	
	Module	Traditional	Module	Traditional
Min	-0.20	-1.67	0.00	-1.00
1st Qu.	0.29	0.20	0.29	0.20
Median	0.43	0.44	0.50	0.35
Mean	0.47	0.35	0.49	0.32
3rd Qu.	0.67	0.60	0.67	0.57
Max	1.00	1.00	1.00	1.00
SD	0.27	0.37	0.25	0.40
95% CI	0.05 > μ > 0.19		0.06 > μ > 0.28	

Supplement 5- Summary data of scores comparing meiosis learning module and traditional lecture treatment as a function of student gender.

Normalized Gain By Student Year in School



	Normalized Gain Score Meiosis Learning Module			
	Underclassmen (FR/SO)		Upperclassmen (JR/SR)	
	Module	Traditional	Module	Traditional
Min	-0.20	-1.67	-0.20	0.00
1st Qu.	0.29	0.20	0.31	0.25
Median	0.43	0.43	0.54	0.43
Mean	0.48	0.37	0.47	0.43
3rd Qu.	0.67	0.60	0.67	0.60
Max	1.00	1.00	0.86	0.86
SD	0.26	0.39	0.30	0.24
95% CI	0.08 > μ > 0.20		-0.17 > μ > 0.24	

Supplement 6- Summary data of scores comparing meiosis learning module and traditional lecture treatment as a function of student year in school.