Causal Mechanisms In Basic Science Education – Do They Aid In Recall And Application Performance?

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Introduction

- Curriculum integration is recognized as a critical component of undergraduate medical education[1]
- Utilization of causal mechanisms, statements that guide students in making purposeful connections between two disciplines, is one approach to curricular integration
- Integrating basic sciences with clinical sciences using causal mechanisms results in improved student diagnostic performance[2-4]
- Remains unknown if utilizing causal mechanisms in context of teaching different basic sciences results in better understanding and application of those disciplines

Aims and Objectives

- **Aim:** investigate effects of integrated instruction with causal mechanisms on medical students' learning of pituitary gland embryology and histology

OBJECTIVE
Determine effect of causal mechanism-oriented instruction on medical students' immediate and delayed (1-week) recall and application of content as measured by:

- Overall test scores
- Histology subscore
- Embryology subscore
- Recall subscore
- Application subscore

Methods

- Study approved by Oakland University's Institutional Review Board (IRB# 1406127-1)
- Second-year medical students at OUWB were invited to enroll in a 3-phase experimental study (Figure 1)

Methods (continued)

- **Phase I-** participants took a brief pre-test through Qualtrics (online survey platform) covering foundational histology/embryology concepts, to ensure high and low-performing participants were randomly distributed between the experimental and control groups
- **Phase II-** participants watched a 13-minute video on embryology and histology of the pituitary gland. Only the experimental group's video contained causal mechanisms linking the disciplines
- In a proctored setting, participants completed counterbalanced immediate and delayed post-tests (15 multiple choice questions of histology and embryology) during **phases II** and **III**, respectively, to assess recall and application. Questions were created in alignment with Blooming Anatomy Tool[5] level 1 (recall) and 3 (application) questions
- 2-way ANOVA compared the groups' overall test scores and subscores over time (1st and 2nd post-tests)

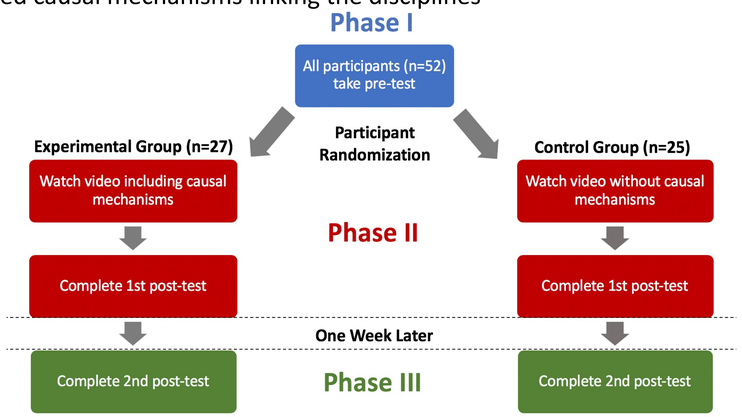

Figure 1. Study Design. In phase I, participants were randomized into the study groups and completed the histology/embryology pretest. In phase II, participants watched their group's respective video and completed the 1st post-test. One week later, participants took 2nd post-test (phase III).

Results

No significant differences (2-way ANOVA with Bonferroni correction) were observed between groups on immediate or delayed tests: overall score (p=0.48), histology subscore (p=0.42), embryology subscore (p=0.78), recall subscore (p=0.64), and application subscore (p=0.61) (Figure 2)

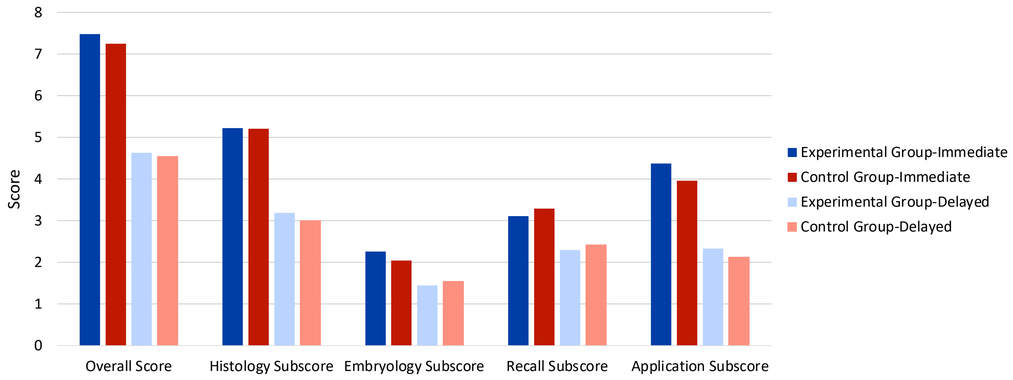

Figure 2. Post-test scores. No significant differences (n=52, p>0.05, 2-way ANOVA) between immediate and delayed post-testing scores for experimental and control groups.

Conclusion

- Instruction with causal mechanisms did not result in better recall and application of pituitary embryology and histology in this specific context.
- Lack of differences between groups may be due to temporal integration[6] (proximity) of embryology and histology instruction afforded to all
- Given the large number of variables investigated, it would have been ideal to have a larger sample size and use post-tests with more items; however, medical student participants have limited availability
- Future reiterations will mimic realistic video-learning conditions (e.g. permitting pausing of video)
- Additional research investigating the relationship between proximity and medical student learning outcomes is warranted

References

1. AAMC-HHMI Committee. Scientific foundations for future physicians. *Assoc Am Med Coll*. 2009. https://www.hhmi.org/sites/default/files/Programs/aamc-hhmi-2009-report.pdf. Accessed January 9, 2019.
2. Woods NN, Neville A, Levinson A., Howey E, Oczkowski W, Norman G. The Value of Basic Science in Clinical Diagnosis. *Acad Med*. 2006;81(10):S124-S127. https://insights.ovid.com/pubmed?pmid=17001122. Accessed January 4, 2019
3. Lisk K, Agur AMR, Woods NN. Exploring cognitive integration of basic science and its effect on diagnostic reasoning in novices. *Perspect Med Educ*. 2016. doi:10.1007/s40037-016-0268-2
4. Baghdady MT, Pharoah MJ, Regehr G, Lam EWN, Woods NN. *The Role of Basic Sciences in Diagnostic Oral Radiology*.; 2009. http://www.jdentaled.org/content/jde/73/10/1187.full.pdf. Accessed January 5, 2019.
5. Thompson AR, O'Loughlin VD. The Blooming Anatomy Tool (BAT): A discipline-specific rubric for utilizing Bloom's taxonomy in the design and evaluation of assessments in the anatomical sciences. *Anat Sci Educ*. 2015;8(6):493-501. doi:10.1002/ase.1507
6. Harden RM. The integration ladder: A tool for curriculum planning and evaluation. *Med Educ*. 2000;34(7):551-557. doi:10.1046/j.1365-2923.2000.00697.x

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