RESEARCH ARTICLE

Effects of self-experimentation during practical classes on student learning [version 1; peer review: 2 approved with reservations]

A.M. de Leão e Neves Eduardo ¹, E.C. Campos Caldas Rosa²,
A. Fonseca Welker ¹

¹Postgraduate Program in Health Sciences and Technologies, University of Brasília, Ceilandia, Federal District, Brazil

²Postgraduate Program in Health Sciences, University of Brasília, Asa Norte, Federal District, Brazil

V1 First published: 11 Sep 2019, 8:1623
<https://doi.org/10.12688/f1000research.20285.1>
 Latest published: 11 Sep 2019, 8:1623
<https://doi.org/10.12688/f1000research.20285.1>

Abstract

Background: This article reports an experiment based on the measurement of the academic achievement of students submitted to self-experiments during practical classes compared with students who attended regular practical classes (control group) to assess whether this intervention could help assess the influence of self-experiments on student learning. **Methods:** This study involved 71 students in the second terms of the degree of Bachelor of Pharmaceutical Sciences, studying the Cell Biology unit. Experiments were conducted using the students themselves as subjects under conditions that mimic situations observed in daily life, fasting and ingestion of carbohydrates. The performance of students in health college student assessments and the degree of motivation in performing these experiments was assessed at the Anhanguera college, Brasília, Brazil. In total, 33 students (46.5%) participated actively in the experiment and the rest only observed the experiment carried out by the first group. In Cell Biology, the students study cell types, cell components and their respective functions, during one term, with a total workload of 60 h. **Results:** In the test that preceded the experiment carried out in the present study, the grades of the students that participated actively and of those that only observed were not statistically different ($p > 0.05$). In the test applied after the experiment, both groups reached higher grades ($p < 0.01$), but the individuals that participated actively in the experiment obtained higher grades than those that only observed it ($p < 0.05$). **Conclusions:** The findings of this study indicate that active learning, in which the students use their own organism and blood in practical classes, can increase their grades in knowledge tests. The teaching tool showed in the present study is a positive alternative for university students in health sciences.

Open Peer Review

Approval Status ? ?

	1	2
version 1
11 Sep 2019	view	view
1. Dakota Armour , Queen's University Belfast, Belfast, UK		
Timothy L Dornan , Queen's University Belfast, Belfast, UK		
2. Fabrizio Consorti , University "Sapienza" of Rome, Rome, Italy		
Any reports and responses or comments on the article can be found at the end of the article.		

Keywords

Self-experiment, active-learning method, motivation to study, practical class

Corresponding authors: A.M. de Leão e Neves Eduardo (annamaly07@hotmail.com), E.C. Campos Caldas Rosa (erica.cccaldasrosa@gmail.com), A. Fonseca Welker (welker.af@gmail.com)

Author roles: **de Leão e Neves Eduardo AM:** Conceptualization, Formal Analysis, Investigation, Methodology, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; **Campos Caldas Rosa EC:** Formal Analysis, Writing – Original Draft Preparation, Writing – Review & Editing; **Fonseca Welker A:** Supervision, Writing – Original Draft Preparation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: The authors received support from the Higher Education Personnel Improvement Coordination (CAPES). *The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.*

Copyright: © 2019 de Leão e Neves Eduardo AM *et al.* This is an open access article distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

How to cite this article: de Leão e Neves Eduardo AM, Campos Caldas Rosa EC and Fonseca Welker A. **Effects of self-experimentation during practical classes on student learning [version 1; peer review: 2 approved with reservations]** F1000Research 2019, 8:1623 <https://doi.org/10.12688/f1000research.20285.1>

First published: 11 Sep 2019, 8:1623 <https://doi.org/10.12688/f1000research.20285.1>

Introduction

Several studies have shown that active learning is more attractive and generates more interaction than passive methods¹⁻⁴. Among active-learning strategies, some studies^{5,6} point out that practices that mimic routine activities increase learning compared to practices without this characteristic. For example, the use of virtual patients by medical students can increase their degree of learning⁵, and the use of case-based learning increases deep learning, the involvement of students, and their interest in content^{6,7}. Problem-based learning (PBL), which frequently involves simulations of real situations (e.g., diagnosis of a hypothetical patient with some symptoms), has been an important tool to improve knowledge retention⁸⁻¹⁰. Another active-learning strategy that may increase academic achievement is the use of self-monitoring and self-assessment methods¹¹⁻¹⁴. For example, after answering questions of a knowledge test, when students are allowed to see their colleagues' answers and revise their own answers, the number of correct answers increases¹⁵. Evidence indicates that practices that involve both routine activities and self-monitoring promote even greater attraction of students for classes^{16,17}, as well as greater interaction during classes¹. A previous study submitted university students to the ingestion of pizza and pasta and the measurement of biochemical parameters¹⁸. This method made it possible to cover important topics of metabolism in the final exam and to show how the metabolic machinery of the human organism reacts to different diets. In the period when this method was applied, the grades were higher than in previous periods. However, there was no control group, which hindered assessing the real efficiency of this method¹⁸. Other studies in which the students used their own body (self-experiments) did not investigate the influence of this practice on learning¹⁹. The few reports on self-experiments frequently involve activities that are not part of the students' routine²⁰.

As far as we know, there are no studies on the impact on learning of practical classes using the students' own bodies in routine situations. A experiment based on the measurement of the academic achievement of students submitted to self-experiments during practical classes compared with students who attended regular practical classes (control) could help assess the influence of self-experiments on student learning. The present study shows a new active-learning method, which is more efficient than the methods commonly used in classrooms.

The present study aimed at analyzing the impact of self-experiments under conditions that mimic everyday situations – fasting and ingestion of carbohydrate-rich oral solution with glucose and fructose – on the achievement in exams of university students of health sciences and their degree of motivation and satisfaction in carrying out those experiments.

Methods

Experimental design

To analyze the impact of self-experimentation on learning in health sciences, randomly selected students from one class of university students studying Pharmacy participated actively in one experiment, whereas the other part only followed the

study as observers. The students actively participating in the research were randomly divided into three subgroups: groups 1 and 2 (those who ingested glucose and fructose oral solutions, respectively) and group 3 (the fasting group). The experiment allowed the students to study some of the content comprised in Cell Biology. It involved the collection of blood samples of the students at times that mimic everyday situations – fasting and ingestion of different carbohydrates. In addition, the effect of the experiment on the degree of motivation and satisfaction of students was assessed. According to a sample calculation performed using G*Power 3.1 software, the group should contain a total of 71 students of the second term the Bachelor of Pharmaceutical Sciences (33 active and 38 observers 38) to achieve a statistical power of 60% to achieve the objectives. A total of 33 students (46.5%) were randomly assigned to participate actively in the experiment and the rest observed the experiment carried out by the first group. In Cell Biology, the students study cell types, cell components and their respective functions, during one term, with a total workload of 60 h. The assessment of the students' knowledge levels occurred through two written, closed-notes, and closed-book tests and the application of questionnaires on the topics studied in the classroom. The tests were the same for all groups. The study took place in March-April 2015.

Procedures of the control and treatment groups

After eight weeks of classes, the teacher applied the first individual test that assessed the knowledge level of the students about cell biology, which included lipids, carbohydrates, and cell organelles. The test results were revealed in the next class, one week later. After the first written test, the teacher (A.M.L.N.E.) told the students about the experiment that she intended to carry out and all agreed to participate. An anthropometric questionnaire was applied to the students, after they agreed to participate in the project and provided written informed consent. Then, a biochemical experiment was performed by the students. All students that participated actively in the experiment were asked to fast overnight for 12 h. The first capillary blood sample was collected in the morning after 12 h of fasting, at the beginning of class, by some trained students of the same class together with the researcher responsible for the project. The students that took part in the experiments had two other capillary blood samples collected at 30 and 120 min and were randomly assigned to one of the following conditions: fasting (fasting group), ingestion of 1 g/kg of glucose solution (glucose group, 17 students), and ingestion of 1 g/kg fructose solution (fructose group, 16 students). The fructose and glucose solutions were prepared with 5 ml/kg of water. The control group only observed sample collection and the experiment, i.e., observed all procedures, but did not donate blood or ingest any solution. The experiment was carried out in two class days separated by a week. In addition to taking part in or only observing the experiments, all students studied the content of the subject cell biology under the same teaching methodology: audiovisual aided lectures, in which the teacher allowed and stimulated student participation with questions and observations. The subtopics taught were: lipids, carbohydrates, proteins, enzymes, and cell metabolism, all correlated with the central topic of the subject. After the practical/experimental

part of the course, all students answered a questionnaire, available as *Extended data*²¹, in the classroom, with questions about motivation and the importance of the practical class to learning. After carrying out the experiment and answering the questionnaire in the classroom, all students did a second individual test with the contents of the subject Cell Biology.

Ethics and consent

This research project was approved by the Research Ethics Committee registered through the Research Ethics Committees (CEPs, acronym in Portuguese) and the National Research Ethics Commission (CONEP, acronym in Portuguese) also known as the CEP/CONEP system (approval number 19059513.3.0000.5372 and expert review n° 434.935). Written informed consent from all subjects involved was obtained for participation in the study.

Statistical analysis

To test for the homogeneity of qualitative variables between the “control/observer” and “active” groups, we used the Fisher exact test. To compare grades between groups before and after the intervention, we used the Mann-Whitney test. To test whether the grades before and after the intervention differed between groups, we used the Wilcoxon test. The software used for the analysis was R 3.0.1.

Results

Learning indicators

The objective of applying two tests about the topics of Cell Biology was to analyze the impact of self-experiments under

conditions that mimic everyday situations – fasting, ingestion of water and carbohydrate oral solution ingestion (glucose or fructose) – on the achievement of university students of health sciences. In the test that preceded the experiment carried out in the present study, the grades of the students that participated actively and of those that only observed were similar ($p > 0.05$). In the test applied after the experiment, both groups reached higher grades ($p < 0.01$), but the individuals that participated actively in the experiment obtained higher grades than those that only observed it ($p < 0.05$; [Figure 1](#) and [Table 1](#)). Test results for each student are available as *Underlying data*²¹.

Considering the differences between the subgroups of the students who participated in the experiment, there was no significant difference in grades among the subgroups fasting, glucose, and fructose ($p > 0.05$). Considering the differences within subgroups, only the students of the glucose and fructose groups showed an increase in their grades after the experiment ($p < 0.05$; [Figure 2](#), [Table 2](#))

Perception of practical classes

Over 90% of the students answered that learning is deeper when they have practical classes, that they are more important than theoretical classes, and that they are essential for learning. Over 70% of the students stated having high motivation. There was no difference in the distribution of answers in the questionnaire between the individuals that participated actively in the experiment and those that only observed it ([Table 3](#)). Raw survey results are available as *Underlying data*²¹.

Figure 1. Effect of self-experiments on learning. Comparison of achievement in tests between students who participated actively in the experiments and students who only observed them. * $p < 0.05$.

Table 1. Descriptive statistics of the tests before and after self-experimentation by observer and active groups.

Test	Active experiment participant?	N	Average	SE	1°Q	2°Q	3°Q	p-value ¹
Before self-experimentation	No	38	6.49	0.18	5.50	6.50	7.00	0.074
	Yes	33	6.92	0.20	6.50	7.00	8.00	
After self-experimentation	No	38	7.33	0.24	7.00	7.00	8.00	0.017
	Yes	33	8.11	0.23	7.00	8.50	9.00	

¹ Mann-Whitney test. SE, standard error.

Figure 2. Effect of self-experiments on learning. Comparison of achievement in tests by students who participated actively in the experiment among the groups fasting, glucose, and fructose *: $p < 0.05$.

Discussion

This study showed that students that provide blood samples for biochemical experiments in practical classes obtained higher grades than students that only observed the experiment. After the application of this teaching method, the group of students that participated actively in the practical classes (by providing blood samples) obtained higher grades than the group of students that only observed the experiment. However, both groups increased their grades, as shown by the learning assessment tests. This increase in learning corroborates the results generated by several authors, which indicate the efficacy of active-learning methods and several studies that showed an increase in learning through the use of active learning^{22–25}. Nevertheless, most studies whose authors affirm that active-learning methods are better than others are based on theory, as they do not show experimental results or do not use proper control groups²⁶. Several studies with a proper control

group did not observe differences in learning between active-learning methods and passive, traditional methods^{4,27,28}. Finally, some studies show that the use of active learning methods can even result in lower grades^{29,30}.

These differences in results obtained with different learning methods suggest that other factors affect the efficacy of these methods and can occur regardless of the teaching method being more or less active. One of those factors seems to be the teacher's behavior. For example, a teaching improvement tends to occur when teachers propose problems and questions, and stimulate a working atmosphere that give students freedom to take risks, make mistakes, and learn from their own mistakes³¹. Indeed, the attractiveness of educational activities developed is higher in the physical presence of the teacher^{32,33}. Hence, we expect the learning strategies that provide the best learning atmosphere to be also the most efficient. The most

Table 2. Frequency and descriptive statistics for the active group.

Variables		Participants, n [†]	% [†]
Total		33	100
Sex	Female	27	81.8%
	Male	6	18.2%
Motivation	Low	1	3.0%
	Medium	8	24.2%
	High	24	72.7%
Learning is deeper in practical classes	No	2	6.1%
	Yes	31	93.9%
Practical classes are more interesting than theoretical classes	No	3	9.1%
	Yes	30	90.9%
Practical classes are essential for learning	No	1	3.0%
	Yes	32	97.0%
Blood glucose levels			
Glucose group, mg/dL*	Fasting	86.0	[84.5; 93.0]
	30 min	141.0	[120.0; 146.0]
	120 min	103.0	[99.5; 119.5]
Fructose group, mg/dL*	Fasting	87.0	[69.0; 90.0]
	30 min	96.0	[91.0; 100.0]
	120 min	88.0	[84.5; 95.0]
Fasting group, mg/dL*	Fasting	89.0	[82.0; 92.5]
	30 min	98.0	[90.5; 100.0]
	120 min	88.0	[85.0; 95.0]
Age, years*		26.0	[20.0; 33.0]
Height, m*		1.6	[1.6; 1.7]
Motivation to participate in practical classes [‡]		10.0	[7.0; 10.0]

[†]Unless indicated.

*Quantitative variables (median, interquartile range).

Table 3. Descriptive statistics for the questions (Q1-Q5) answered by the students in active and observer groups.

Variables		Participated in the experiment					p-value*
		No (N=38)		Yes (N=33)			
Motivation	Low	4	10.5%	1	3.0%	0.427	
	Medium	11	28.9%	8	24.2%		
	High	23	60.5%	24	72.7%		
Learning is deeper in practical classes	No	1	2.6%	2	6.1%	0.594	
	Yes	37	97.4%	31	93.9%		
Practical classes are more interesting than theoretical classes	No	5	13.2%	3	9.1%	0.716	
	Yes	33	86.8%	30	90.9%		
Classes in which the student participates actively are more motivating than regular classes	No	2	5.3%	0	0.0%	0.495	
	Yes	36	94.7%	33	100.0%		
Practical classes are essential for learning	No	3	7.9%	1	3.0%	0.618	
	Yes	35	92.1%	32	97.0%		

*By Fisher's exact test.

striking result of the present study was the higher increase in grades of the group of students that participated actively in practical classes compared to the group of students that only observed them. This finding corroborates positive results of methods that involve self-assessment of learning by the students¹⁵. To our knowledge, this is the first study that shows that a teaching method in which the students assess their own body promotes deeper learning. Other studies have already showed that classes involving education of students using their own body as a subject can bring benefits^{19,18}, but no study has used control groups. One explanation for this phenomenon would be that this method ensures deep compulsory involvement of the student, which could increase their degree of attention and focus in the experiment and avoid distractions.

The results obtained by the students during the practical class could show them how the human organism responds to common everyday situations. In the groups that ingested carbohydrates, there was an increase in blood sugar and this increase was higher in the group that ingested glucose than in the group that ingested fructose. Similar to our experiment, several studies intended to measure blood sugar at the ingestion of glucose and fructose solutions^{34,35,36}, and the everyday diet of people^{18,19}. The lack of difference in grades in the test after the experiment among the subgroups that participated actively in the experiment (fasting, glucose, and fructose) indicates that the collection of one's blood increases information comprehension and retention about the entire practical class and not only the result of one's own organism or one's own group. Hence, those that ingested glucose understood what occurs when one ingests fructose or remains fasting. This method may be more attractive to the students and may drive their attention. The data of the analysis of the three groups that participated in the experiment also corroborate that. The significant increase in the grades only in the subgroups that ingested glucose and fructose and not in the grades of the subgroup that remained fasting suggests that the ingestion of solutions helped the students reach deeper learning compared to the students who only donated blood. The method used in the present study involves different forms of active participation and at the same time a study about the students' own bodies at everyday situations and provides an active visceral learning.

Surprisingly, the motivation and satisfaction in doing experiments, which was measured through a questionnaire, did not differ among subgroups. This result was unexpected, as more active learning methods tend to generate more interest^{1,2}. However, the lack of difference may be due to the participation, as observers, of the students that did not use their own bodies in the practical classes. This explanation is corroborated by the fact that over 90% of the students answered that practical classes are more interesting and provide deeper learning. Other studies showed different values. For example, although medical students and residents subjected to active learning are more engaged and interact more with each other (43%)

and with the teacher (57%), they reported lower perception of the objectives of learning⁴. In another study, most medical students studying clinical biochemistry (73%) opined that an active-learning method was more motivating, aroused the interest in the subject, and increased learning⁶. Another explanation for the results of our study is a possible insensitivity of the questions used in the questionnaire to subtle perceptions of students. Maybe the application of qualitative questions could better define the relationship between motivation and teaching method.

We conclude that active learning, in which the students use their own organism and blood in practical classes, can increase their grades in knowledge tests. This method led to an increase in learning compared to the control group, which only observed the experiments. In addition, the analysis of the three subgroups that participated actively in the experiment showed that the students who ingested glucose and fructose solutions had a significant increase in their grades, whereas those students who remained fasting did not. Such a difference suggests that a method that combines two different strategies, active learning and self-assessment, increases attention. The teaching tool showed in the present study is a positive alternative for university students in health sciences.

Data availability

Underlying data

Figshare: Eduardo et al datasheet. <https://doi.org/10.6084/m9.figshare.9725522.v2>²¹.

This project contains the following underlying data:

- Eduardo et al.2019 dataset2 observers.xls.xlsx (survey and test results for each student).
- Eduardo et al.2019 dataset1.xls (blood glucose levels before and after the experiment for each student actively participating in self-experimentation)

Extended data

Figshare: Eduardo et al datasheet. <https://doi.org/10.6084/m9.figshare.9725522.v2>²¹.

This project contains the following extended data:

- QUESTIONNAIRE.docx (English translation of the questionnaire given to each student).

Data are available under the terms of the [Creative Commons Attribution 4.0 International license](#) (CC-BY 4.0).

Acknowledgments

The authors thank all participants in the study for assistance with data collection and Faculdade Anhanguera de Brasilia (FAB) and CAPES for support during the study.

References

1. Everly MC: **Are students' impressions of improved learning through active learning methods reflected by improved test scores?** *Nurse Educ Today*. 2013; **33**(2): 148–51.
[PubMed Abstract](#) | [Publisher Full Text](#)
2. Ghosh S, Dawka V: **Combination of didactic lecture with problem-based learning sessions in physiology teaching in a developing medical college in Nepal.** *Adv Physiol Educ*. 2000; **24**(1): 8–12.
[PubMed Abstract](#) | [Publisher Full Text](#)
3. Goldhaber DD, Brewer DJ: **Does teacher certification matter? High school teacher certification status and student achievement.** *Educational Evaluation and Policy Analysis*. 2000; **22**(2): 129–145.
[Publisher Full Text](#)
4. Haidet P, Morgan RO, O'Malley K, et al.: **A Controlled Trial of Active Versus Passive Learning Strategies in a Large Group Setting.** *Adv Health Sci Educ Theory Pract*. 2004; **9**(1): 15–27.
[PubMed Abstract](#) | [Publisher Full Text](#)
5. Edelbring S, Broström O, Henriksson P, et al.: **Integrating virtual patients into courses: follow-up seminars and perceived benefit.** *Med Educ*. 2016; **46**(4): 417–25.
[PubMed Abstract](#) | [Publisher Full Text](#)
6. Joshi KB, Nilawar AN, Thorat AP: **Effect of case based learning in understanding clinical biochemistry.** *International Journal of Biomedical and Advance Research*. 2014; **5**(10): 516–518.
[Publisher Full Text](#)
7. Kulak Ve, Newton G: **Um guia para usar baseado em casos de aprendizagem no ensino de bioquímica.** *Biochem Mol Biol Educ*. 2014; **42**: 457–473.
[PubMed Abstract](#) | [Publisher Full Text](#)
8. Parikh A, McReelis K, Hodges B: **Student feedback in problem based learning: a survey of 103 final year students across five Ontario medical schools.** *Med Educ*. 2001; **35**(7): 632–636.
[PubMed Abstract](#) | [Publisher Full Text](#)
9. Prince KJ, Van Eijs PW, Boshuizen HP, et al.: **General competencies of problem-based learning (PBL) and non-PBL graduates.** *Med Educ*. 2005; **39**(4): 394–401.
[PubMed Abstract](#) | [Publisher Full Text](#)
10. Stevenson FT, Bowe CM, Gandour-Edwards R, et al.: **Paired basic science and clinical problem-based learning faculty teaching side by side: do students evaluate them differently?** *Med Educ*. 2005; **39**: 194–201.
[PubMed Abstract](#) | [Publisher Full Text](#)
11. Dobson JL, Linderholm T: **The effect of selected “desirable difficulties” on the ability to recall anatomy information.** *Anat Sci Educ*. 2014.
[PubMed Abstract](#) | [Publisher Full Text](#)
12. Larsen DP, Butler AC, Roediger HL 3rd: **Repeated testing improves long-term retention relative to repeated study: a randomised controlled trial.** *Med Educ*. 2009; **43**(12): 1174–81.
[PubMed Abstract](#) | [Publisher Full Text](#)
13. Rivers WP: **Autonomy at all costs: An ethnography of metacognitive self-assessment and self-management among experienced language learners.** *The Modern Language Journal*. 2001; **85**(2): 279–290.
[Publisher Full Text](#)
14. Yang WM, Xu XZ: **Self assessment in second-language learning.** *USChina Foreign Language*. 2008; **6**(56): 20–24.
15. Agrawal S, Norman GR, Kevin WE: **Influences on medical students' self-regulated learning after test completion.** *Med Educ*. 2012; **46**(3): 326–35.
[PubMed Abstract](#) | [Publisher Full Text](#)
16. Harasym PH, Tsai TC, Munshi FM: **Is problem-based learning an ideal format for developing ethical decision skills?** *Kaohsiung J Med Sci*. 2013; **29**(10): 523–9.
[PubMed Abstract](#) | [Publisher Full Text](#)
17. Khan BA, Ali F, Vazir N, et al.: **Students' perceptions of clinical teaching and learning strategies: a Pakistani perspective.** *Nurse Educ Today*. 2012; **32**(1): 85–90.
[PubMed Abstract](#) | [Publisher Full Text](#)
18. Passos RM, Sé AB, Wolff VL, et al.: **Pizza and pasta help students learn metabolism.** *Adv Physiol Educ*. 2006; **30**(2): 89–93.
[PubMed Abstract](#) | [Publisher Full Text](#)
19. Hopper MK, Maurer LW: **Laboratory exercise: study of digestive and regulatory processes through the exploration of fasted and postprandial blood glucose.** *Adv Physiol Educ*. 2013; **37**(3): 254–263.
[PubMed Abstract](#) | [Publisher Full Text](#)
20. Consorti F, Mancuso R, Piccolo A, et al.: **Evaluation of the acceptability of Peer Physical Examination (PPE) in medical and osteopathic students: a cross sectional survey.** *BMC Medical Education*. 2013; **13**: 111.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
21. Eduardo AM, Rosa EC, Welker AF: **Eduardo et al datasheet.** figshare. Dataset. 2019.
22. Cruz SC, Carvalho AA: **Produção de Vídeo com o Movie Maker: Um Estudo Sobre o Envolvimento dos Alunos de 9.º. Ano na Aprendizagem.** 2007.
[Reference Source](#)
23. Erwin TD, Rieppi R: **Comparing multimedia and traditional approaches in undergraduate psychology classes.** *Teaching of Psychology*. 1999; **26**: 58–61.
[Publisher Full Text](#)
24. Narula N, Ahmed L, Rudkowski J: **An evaluation of the '5 Minute Medicine' video podcast series compared to conventional medical resources for the internal medicine clerkship.** *Med Teach*. 2012; **34**(11): e751–5.
[PubMed Abstract](#) | [Publisher Full Text](#)
25. Wiecha JM, Chetty VK, Pollard T, et al.: **Web-based versus face-to-face learning of diabetes management: the results of a comparative trial of educational methods.** *Fam Med*. 2006; **38**(9): 647–52.
[PubMed Abstract](#)
26. Nascimento GP: **Estudo Controlado da Efetividade de um Instrumento que Acopia Aprendizagem Ativa e Tecnologia: Criação de Vídeos pelos Estudantes.** *Dissertação de Mestrado*. UnB. Brasília. 2014.
[Reference Source](#)
27. Chao SH, Brett B, Wiecha JM, et al.: **Use of an online curriculum to teach delirium to fourth-year medical students: a comparison with lecture format.** *J Am Geriatr Soc*. 2012; **60**(7): 1328–32.
[PubMed Abstract](#) | [Publisher Full Text](#)
28. Schreiber BE, Fukuta J, Gordon F: **Live lecture versus video podcast in undergraduate medical education: A randomised controlled trial.** *BMC Med Educ*. 2010; **10**: 68.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
29. Brewer DJ, Goldhaber D: **Why don't schools and teachers seem to matter?** *J Hum Resour*. 1997; **32**(3): 505–523.
[Publisher Full Text](#)
30. Schwerdt G, Wuppermann AC: **Is traditional teaching really all that bad? A within-student between-subject approach.** *Econ Educ Rev*. 2011; **30**(2): 365–379.
[Publisher Full Text](#)
31. Biggs J, Tang C: **Teaching for quality learning. at university: What the student does.** McGraw-Hill Education (UK), 2011.
[Reference Source](#)
32. Ali WG: **Caring and Effective Teaching Behavior of Clinical Nursing Instructors In Clinical Area as Perceived by Their Students.** *J Educ Prat*. 2012; **3**(7): 15–27, 2012.
[Reference Source](#)
33. Warwick P, Mercer N, Kershner R, et al.: **In the mind and in the technology: the vicarious presence of the teacher in pupil's learning of science in collaborative group at the interactive whiteboard.** *Comput Educ*. 2010; **55**: 350–62.
[Publisher Full Text](#)
34. Abraha A, Humphreys SM, Clark ML, et al.: **Efeito agudo da frutose na lipemia pós-prandial em indivíduos diabéticos e não-diabéticos.** *British Journal of Nutrition*. 1998; **80**: 169–175.
[PubMed Abstract](#) | [Publisher Full Text](#)
35. Bidwell AJ: **Impact of Physical Activity on Postprandial Lipidemia and Glycemic Control after Chronic Fructose Ingestion.** *Exercise Science - Dissertations*. 2012; **8**.
[Reference Source](#)
36. Zawiasa A, Nowicki M: **Acute effects of fructose consumption on uric acid and plasma lipids in patients with impaired renal function.** *Metabolism*. 2013; **62**(10): 1462–1469.
[PubMed Abstract](#) | [Publisher Full Text](#)

Open Peer Review

Current Peer Review Status: ? ?

Version 1

Reviewer Report 16 April 2020

<https://doi.org/10.5256/f1000research.22287.r62044>

© 2020 Consorti F. This is an open access peer review report distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Fabrizio Consorti

Faculty of Medicine and Dentistry, Department of Surgical Sciences, University "Sapienza" of Rome, Rome, Italy

The manuscript deals with a very interesting and intriguing topic, as a special instance of the broader topic of active learning. Therefore, even if it is a small-scale trial, it deserves interest.

The main problem is the lack of theoretical foundation, that in my opinion causes an inconsistent interpretation of the results. Actually the authors saw a very good track of interpretation when they wrote "The method used in the present study involves different forms of active participation and at the same time a study about **the students' own bodies** at everyday situations and provides **an active visceral learning**." (page 7, first column). I suggest that they should dig into this topic, using the concepts and theoretical background of the "embodiment" to drive the Discussion.

I suggest some reading at this proposal, just as examples (I'm not the author of any of these articles...) to focus the idea of "learning with/about own body":

- Body pedagogics: embodied learning for the health professions. Kelly M, Ellaway R, Scherpbier A, King N, Dornan T. Med Educ. 2019 Oct;53(10):967-977. doi: 10.1111/medu.13916¹
- On the Education About/of Radical Embodied Cognition. van der Kamp J, Withagen R, Orth D. Front Psychol. 2019 Nov 5;10:2378. doi: 10.3389/fpsyg.2019.02378. eCollection 2019.²
- Neuroscience of Virtual Reality: From Virtual Exposure to Embodied Medicine. Riva G, Wiederhold BK, Mantovani F. Cyberpsychol Behav Soc Netw. 2019 Jan;22(1):82-96. doi: 10.1089/cyber.2017.29099.gri. Epub 2018 Sep 5.³
- Learning through the senses. van der Schaaf M. Med Educ. 2019 Oct;53(10):960-962. doi: 10.1111/medu.13943.⁴

The lack of theoretical foundation is also reflected by some of the statement of the manuscript:

- Page 3 , 1st column - "Problem-based learning (PBL), which frequently involves simulations

of real situations”: that’s Case-based Learning (CBL), another active method.

- Page 5, first paragraph of the Discussion: the authors quote single studies to support they claim about the inconclusiveness of research about the superiority of active learning methodologies, but we have plenty of high-grade evidence about this topic. When meta-analyses are available, they should be quoted in the Discussion, instead of a “cherry-picking” approach to low grade evidence. I list just some, as an example:

Effectiveness of various innovative learning methods in health science classrooms: a meta-analysis. Kalaian SA, Kasim RM. *Adv Health Sci Educ Theory Pract*. 2017 Dec;22(5):1151-1167. doi: 10.1007/s10459-017-9753-6.⁵

The effectiveness of the problem-based learning teaching model for use in introductory Chinese undergraduate medical courses: a systematic review and meta-analysis. Zhang Y, Zhou L, Liu X, Liu L, Wu Y, Zhao Z, Yi D, Yi D. *PLoS One*. 2015 Mar 30;10(3):e0120884. doi: 10.1371/journal.pone.0120884.⁶

Does problem-based learning work? A meta-analysis of evaluative research. Vernon DT, Blake RL. *Acad Med*. 1993 Jul;68(7):550-63. doi: 10.1097/00001888-199307000-00015.⁷

Thistlethwaite JE, Davies D, Ekeocha S, et al. The effectiveness of case-based learning in health professional education. A BEME systematic review: BEME Guide No. 23. *Med Teach*. 2012;34(6):e421–e444. doi:10.3109/0142159X.2012.680939.⁸

- Page 5, second paragraph of the Discussion: I cannot understand why here the authors discuss the role of teacher, an element that had no relevance in their experiment. Further, the references supporting this paragraph are of studies on high school students.

Some more comments:

- Abstract (and also in the text, at the end of the Introduction): the goal of the study is described as “to assess whether this intervention could help assess the influence of self-experiments on student learning.”. I suggest that the goal of the study should be better expressed with reference to a research hypothesis “we hypothesize that the intervention will produce a better ... than ...”. So, the goal is to confirm or refuse the hypothesis
- Page 3, first column “The few reports on self-experiments frequently involve activities that are not part of the students’ routine”. There is only one reference, so either you add “as for example in...” or you add some more references.
The same problem is at page 5, end of 1st column “Nevertheless, **most studies** whose authors affirm that active-learning methods are better than others are based on theory, as they do not show experimental results or do not use proper control groups (26).” I also highlighted “most studies”, because it is a statement that should be supported by data. Only a systematic review could support this statement. See also my comment about the use of high-grade evidence in Discussion.
- Experimental design, page 3, 2nd column:
second line: “dived” for divided
“According to a sample calculation performed using G*Power 3.1 software, the group should contain a total of 71 students of the second term the Bachelor of Pharmaceutical

Sciences (33 active and 38 observers 38) to achieve a statistical power of 60% to achieve the objectives." I cannot understand because the groups are different in number of students.

- Figure 1: I guess that the labels of the columns are inverted, because the score is higher before than after. The vertical axis is not clear, it seems that the students gave only 8% of right answers.
- Table 1, second cell: "self-experimentation", please correct.
- Table 2: I find no use in intertwining the data of glycemia with the descriptive data. They are not experimental data. On the contrary, the descriptive data of the control group are missing, so the reader can only guess that the two groups were comparable for sex and age.
- Discussion, page 7, 1st column, "The significant increase in the grades only in the subgroups that ingested glucose and fructose and not in the grades of the subgroup that remained fasting". This statement seems to be contradictory with what stated few lines before "The lack of difference in grades in the test after the experiment among the subgroups that participated actively in the experiment (fasting, glucose, and fructose)".
- Discussion, page 7, beginning – "This finding corroborates positive results of methods that involve self-assessment of learning by the students (15)." In the international literature of medical education (and in reference 15) self-assessment is intended as evaluation of outcomes of learning by the students themselves and not as measuring something upon themselves, like the glycemia.
- Few lines below "But s no study has used control groups", please cancel the "s".

References

1. Kelly M, Ellaway R, Scherpbier A, King N, et al.: Body pedagogics: embodied learning for the health professions. *Med Educ.* **53** (10): 967-977 [PubMed Abstract](#) | [Publisher Full Text](#)
2. van der Kamp J, Withagen R, Orth D: On the Education About/of Radical Embodied Cognition. *Front Psychol.* 2019; **10**: 2378 [PubMed Abstract](#) | [Publisher Full Text](#)
3. Riva G, Wiederhold BK, Mantovani F: Neuroscience of Virtual Reality: From Virtual Exposure to Embodied Medicine. *Cyberpsychol Behav Soc Netw.* 2019; **22** (1): 82-96 [PubMed Abstract](#) | [Publisher Full Text](#)
4. van der Schaaf M: Learning through the senses. *Med Educ.* **53** (10): 960-962 [PubMed Abstract](#) | [Publisher Full Text](#)
5. Kalaian SA, Kasim RM: Effectiveness of various innovative learning methods in health science classrooms: a meta-analysis. *Adv Health Sci Educ Theory Pract.* 2017; **22** (5): 1151-1167 [PubMed Abstract](#) | [Publisher Full Text](#)
6. Zhang Y, Zhou L, Liu X, Liu L, et al.: The effectiveness of the problem-based learning teaching model for use in introductory Chinese undergraduate medical courses: a systematic review and meta-analysis. *PLoS One.* 2015; **10** (3): e0120884 [PubMed Abstract](#) | [Publisher Full Text](#)
7. Vernon DT, Blake RL: Does problem-based learning work? A meta-analysis of evaluative research. *Acad Med.* 1993; **68** (7): 550-63 [PubMed Abstract](#) | [Publisher Full Text](#)

8. Thistlethwaite JE, Davies D, Ekeocha S, Kidd JM, et al.: The effectiveness of case-based learning in health professional education. A BEME systematic review: BEME Guide No. 23. *Med Teach*. 2012; **34** (6): e421-44 [PubMed Abstract](#) | [Publisher Full Text](#)

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 15 April 2020

<https://doi.org/10.5256/f1000research.22287.r62046>

© 2020 Dornan T et al. This is an open access peer review report distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Dakota Armour

Centre for Medical Education, Queen's University Belfast, Belfast, UK

Timothy L Dornan

Centre for Medical Education, Queen's University Belfast, Belfast, UK

An important strength of this article is that it shows how teachers can help students learn a potentially dull topic actively by making scientific concepts personally relevant and interesting. There is growing interest in the application of embodiment theory in the field of health professions education so using students' own bodies as a learning tool, which is a topically relevant feature of the intervention, is another strength of the article.

There are, though, threats to the validity of the research, which prevent us agreeing with the authors' claim that their *'teaching method in which students assess their own body promotes deeper understanding'*. The authors took a classical scientific experimental approach but there were shortcomings in various aspects of the research design:

1. The authors did not frame a null hypothesis. This is a shortcoming because classical experiments depend on enabling researchers to reject a null hypothesis: in reality, we could not find any clearly-articulated hypothesis, which is particularly important when taken together with comment 4, below.
2. Blinding as to whether a participant is subjected to the experimental or the control condition is an important feature of experiments. In reality, participants in this research knew what group they were in and observed members of other groups. It is plausible that this knowledge influenced participants' mindsets and confidence levels and plausible, therefore, that this influenced the outcomes of the post-intervention tests. We have no way of knowing how strong that influence may have been, and even in which direction, but it may well have confounded the results of the experiment.
3. The randomisation protocol is not described and the information available makes us question the rigour with which this was done.
4. The authors do not appear to have defined, before the experiment, which statistical comparisons would allow them to draw inferences. As a result, they appear to have relied on post-hoc comparisons, and used the 5% level as an absolute arbiter of difference or lack of difference. The snag is that these comparisons were confounded by small but potentially important differences in baseline test scores, which directionally favoured the intervention over the control condition. The authors are at risk of Type II statistical error (false negative) when they conclude that there was no difference between the active and control groups in the pre-intervention test scores because, with larger numbers of subjects, there could have been. In reality, the difference in scores between groups was $0.1 > p > 0.05$, which is not much above the 5% level that is deemed significant.
5. We suggest that a comparison between absolute difference in scores from pre to post intervention, adjusted for the confounding effect of baseline levels, would have been a more appropriate analysis and that, at least with the numbers included in this experiment, no statistically significant difference would have been found.
6. Figure 1 appears to contradict findings stated in the text and we found it hard to understand.
7. We would expect any empirical article to include, in the discussion, consideration of the strengths and limitations of the study.
8. We could not work out if there were two questionnaires - one assessing knowledge - or just a questionnaire assessing motivation and satisfaction? Wording needs clarification- *'The assessment of students' knowledge levels occurred through two written, closed-notes and closed-book tests and the application of questionnaires on the topics in the classroom'*. If questionnaires and tests assessed knowledge, detail is needed to illustrate how data from

the two sources were amalgamated.

9. No detail was given about the questionnaire on satisfaction and motivation.

10. There are two typos on page 7. Paragraph one 'but s no' and paragraph two missing full stop 'may drive their attention'.

Conclusion:

On methodological grounds, we feel the authors cannot reject the null hypothesis that their intervention was ineffective. That is a shame because it might have been! It is more plausible that an active learning approach would be of educational value than that it would not be of educational value, but the study did not show this.

We suggest that the authors were not just let down by flaws in their research design, but by their decision to subject education to classical scientific methodology. Regehr¹ has urged education researchers to move from the 'imperative of proof' (which was unsuccessfully applied here) to the 'imperative of representing complexity well', which the authors' intervention, but not their evaluation, sought to do. Education is not so simple as comparing a pill and a placebo. Learners are complex, their subject matter is complex, and learning environments are complex.

The education community is waking up to the fact that classical scientific experimentation, which is predicated on reducing complex systems to intervention-control comparisons, is ill-suited to complex social systems like education. Qualitative research, in the right hands, can examine relationships between conditions, mechanisms and outcomes in complex learning environments.² So whilst we are still in the dark about whether this particular intervention was effective, the study highlighted the need for education researchers both to conduct their work rigorously, and to extend their methodological skills-set.

Dakota Armour (medical student) and Tim Dornan (doctor and education researcher)

References

1. Regehr G: It's NOT rocket science: rethinking our metaphors for research in health professions education. *Med Educ.* 2010; **44** (1): 31-9 [PubMed Abstract](#) | [Publisher Full Text](#)
2. Dornan T, Kelly M: What use is qualitative research?. *Med Educ.* **51** (1): 7-9 [PubMed Abstract](#) | [Publisher Full Text](#)

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

No

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Medical education research

We confirm that we have read this submission and believe that we have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however we have significant reservations, as outlined above.

The benefits of publishing with F1000Research:

- Your article is published within days, with no editorial bias
- You can publish traditional articles, null/negative results, case reports, data notes and more
- The peer review process is transparent and collaborative
- Your article is indexed in PubMed after passing peer review
- Dedicated customer support at every stage

For pre-submission enquiries, contact research@f1000.com

F1000Research