LS CWSEI

Carl Wieman Science Education Initiative

UBC Life Sciences

Evaluating interactive activities by measuring student learning gain

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Introduction

A key element in the design and use of interactive activities is to evaluate their effect by measuring student learning gain. The evaluation process may look different from case to case, but should include most of the following steps:

1) matching an activity's learning goals to those of the course or module
2) identifying the appropriate tool(s) for measuring learning gain, i.e. conceptual inventory, exam questions, or iclicker questions
3) assessing student learning before and after activity
4) implementing the activity in class, ideally with a control group
5) identifying questions on which students improved or did not improve
6) revising activity to align goals and actual learning.

I designed an in-class interactive case study activity to facilitate student understanding of population dynamics and followed the above steps to evaluate the activity to ensure maximum student learning.

Methods

The activity

The activity was developed to increase students' understanding of population dynamics which is a topic that often poses a challenge for students.

First trial

The first draft of the activity contained 10 questions which were discussed in class by students using 'peer discussions'. Students' understanding of population dynamics was compared to that of students who had a lecture on the topic.

Second trial

The activity was modified: 1) shortened to 8 questions, 2) more concise questions , and 3) learning goals were added, to maximize students' understanding of important concepts. The activity was used as an optional tutorial where students discussed questions using 'peer discussions'. Students' understanding of population dynamics was compared to that of students who did not participate in the tutorial.

Methods (cont.)

The inventory

The conceptual inventory used to measure student understanding of population dynamics contained 8 questions covering concepts such as carrying capacity, density dependent growth, population regulation, exponential growth and logistic growth.

The questions were validated through about 30 individual “think out load” interviews where students were asked to reason through questions telling the interviewer how they would answer an open-ended question and later in the validation process why they picked a particular answer on a multiple choice question.

Methods (cont.)

Data collection

The conceptual inventory was completed by students in class twice per term (i.e. before and after the activity). 400 students completed the question in the fall of 2011 and about 200 students in the winter of 2012. The course was a semi-transformed (from teacher-centered to learner-centered instruction) second year introductory course in ecology (BIOL 230/304) .

Data analysis

382 students took the conceptual inventory both before and after the activity (170 participated in the activity and 188 participated in the lecture) in 2011. 125 students took the inventory both before and after the activity (44 participated in the activity). Average pre and post test score were calculated as well as normalized gain (post test score – pre test score)/(total possible score – pre test score).

Results

First trial

Students participating in the activity increased their total score from 56% to 71% (standardized learning gain = 32%), while students attending the lecture increased their score from 54% to 70% (standardized learning gain = 33%) . There was therefore no significant difference in the performance of the two groups when all questions were considered. There was, however, a significant difference between the two groups for several of the individual questions. For example, students participating in the activity scored higher on questions that involved data analysis (gain from 25 to 63% vs. 32 to 45%) and comparison between graphs (gain 55 to 74% vs. 56 to 64%) (Fig 1). As for graph interpretation, the results varied. On some questions the activity group had a higher gain, while the lecture group had higher gain on others. The results from the first trial run were used to revise the activity to better meet its learning goals and to more effectively facilitate student learning.

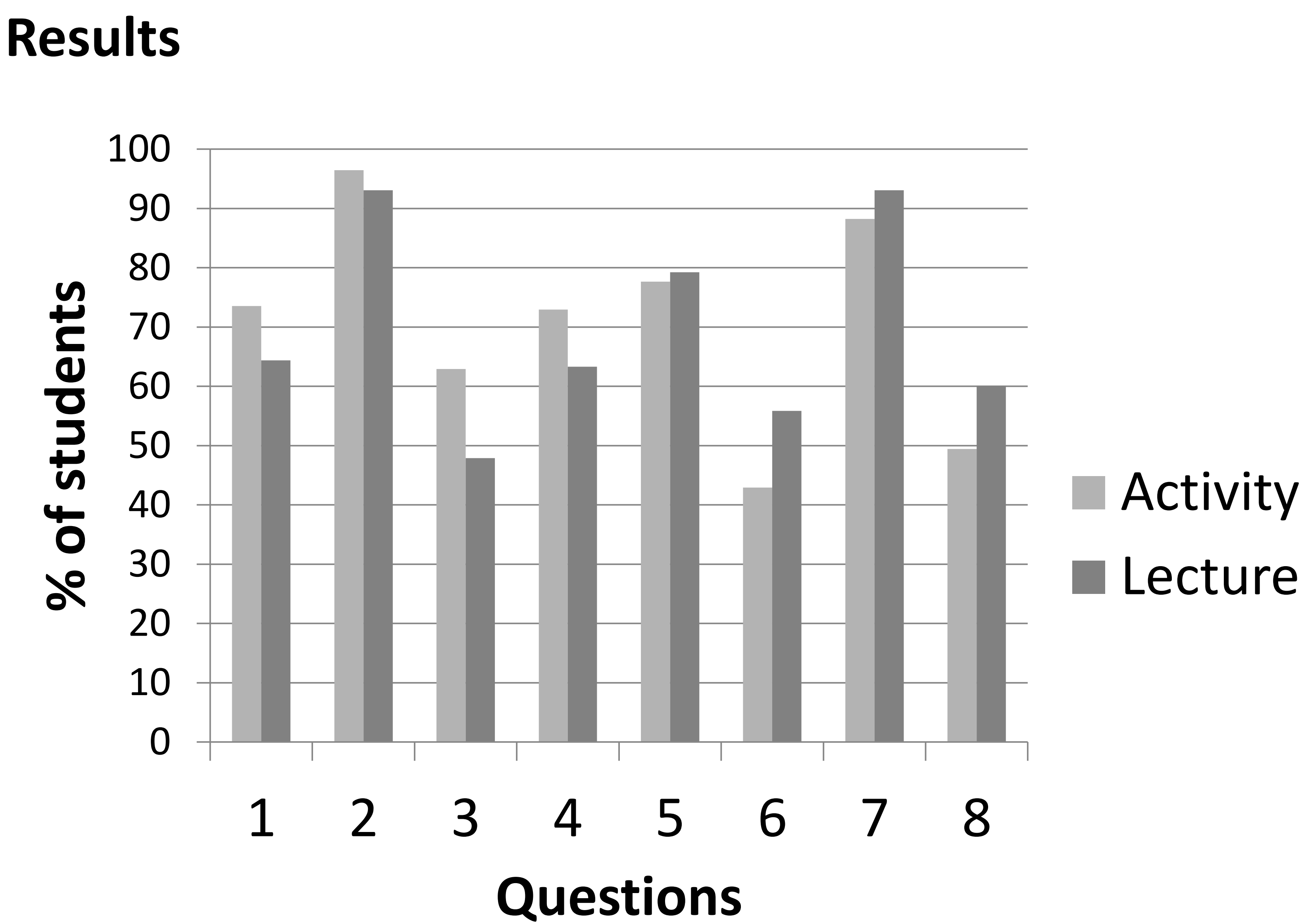
Results
100
90
80
70
60
50
40
30
20
10
0
% of students
1
2
3
4
5
6
7
8
Questions
Activity
Lecture

Figure 1

Results

Second trial

Students participating in the activity scored significantly higher (gain from 51% to 77%; standardized learning gain = 53%),) than students who did not participate (gain from 51% to 66%, standardized learning gain = 31%, Fig 2). Also, students participating in the activity scored higher on all but one question (Fig 3). For example, students participating in the activity scored higher on questions that involved data analysis (gain from 25 to 70% vs. 31 to 62%), comparison between graphs (gain from 53 to 73% vs. 55 to 65%) and graph interpretation (gain from 38 to 70% vs. 36 to 44%), while the question on which they did not score higher tested skills at lower levels (definition and understanding, Table 1).

Results

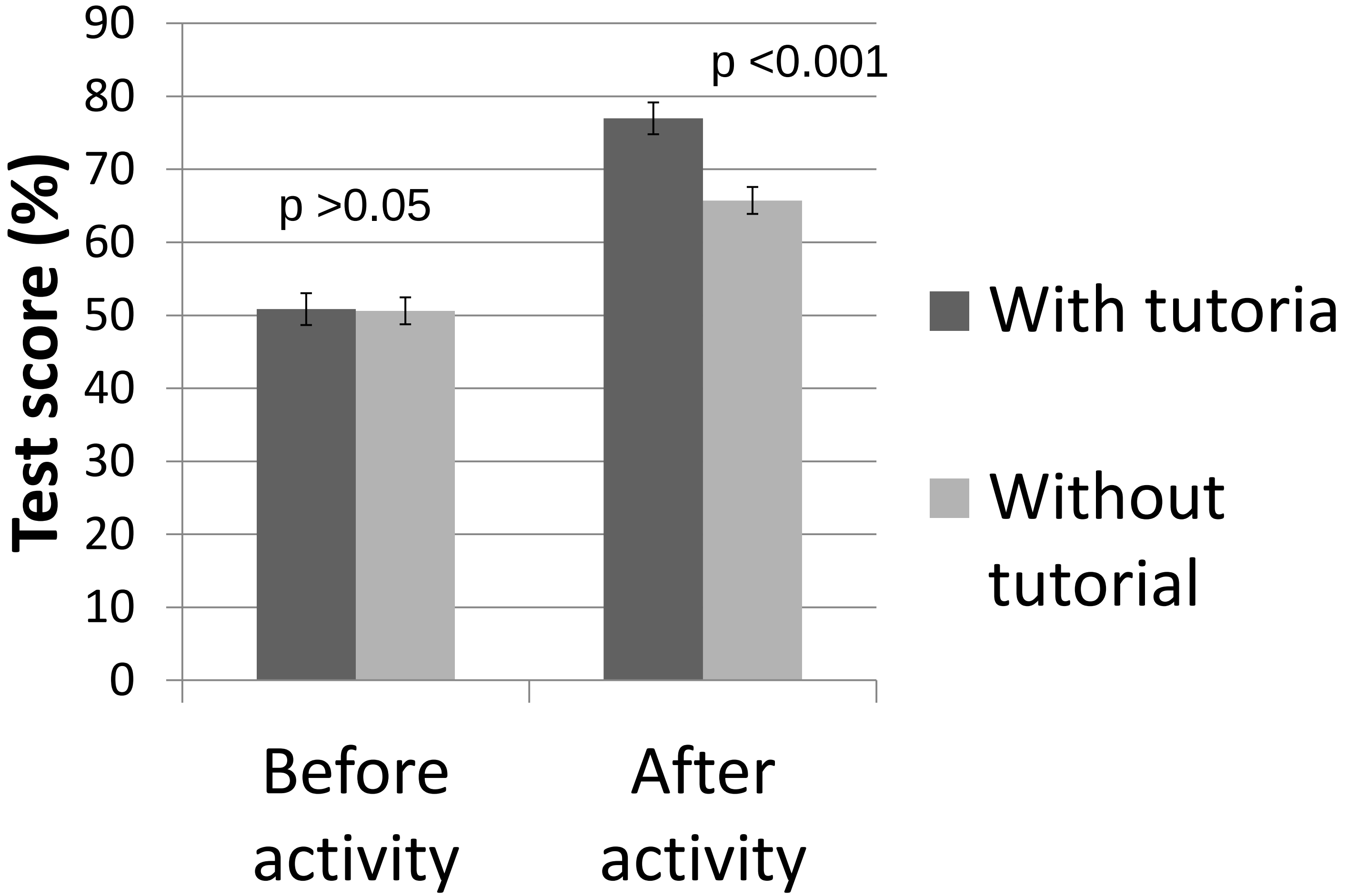

Figure 2

Results

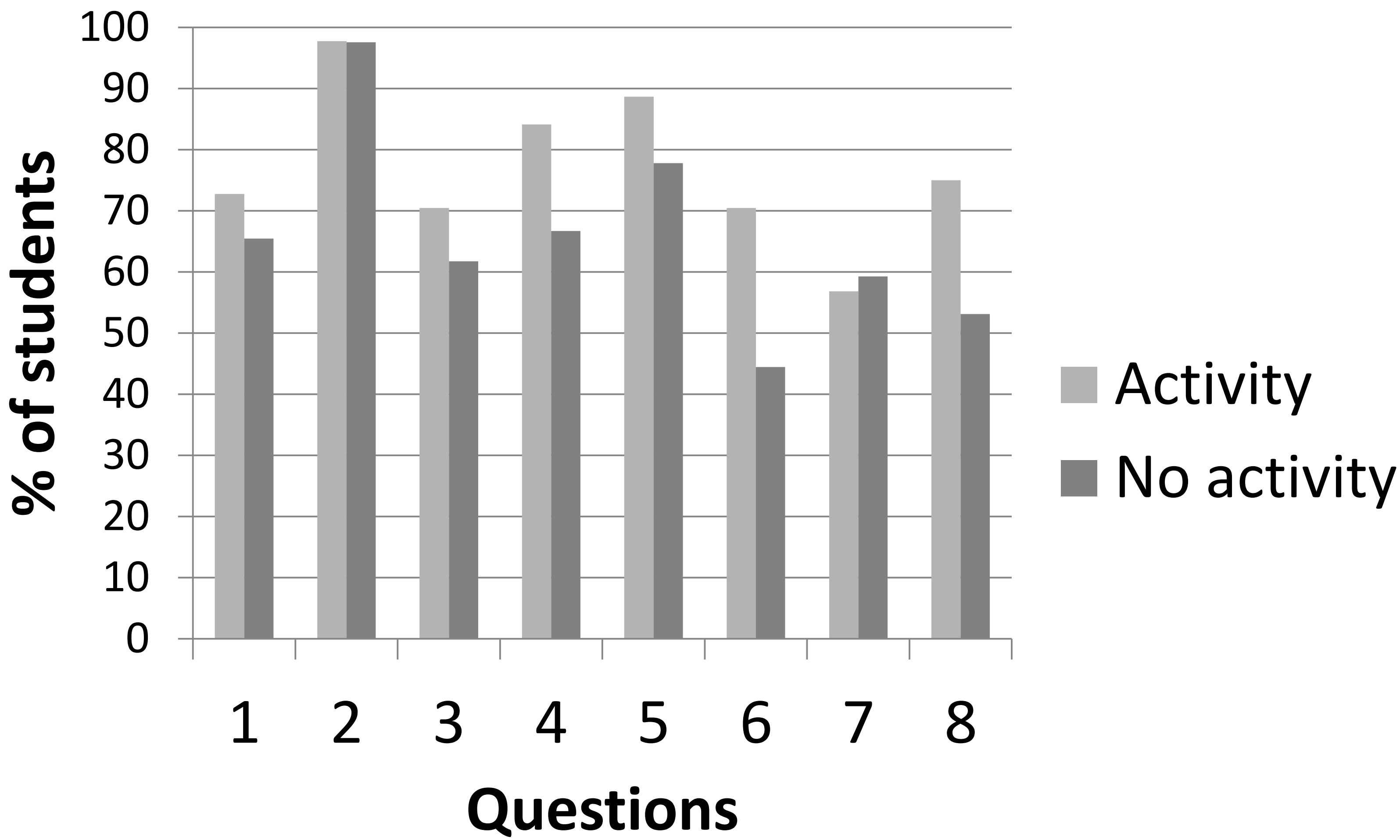

Figure 3

Results

Question	Question type
1	Low level graph comparison and comprehension
2	Low level graph interpretation and comprehension
3	High level data analysis, comprehension, definition
4	High level graph interpretation and comprehension
5	Low level graph interpretation and comprehension
6	High level graph interpretation and comprehension
7	Medium level comprehension
8	Medium level graph interpretation, comprehension, definition

Table 1

Discussion

The results suggest that in-class interactive activities can be superior in increasing student learning compared lectures. However, the success will depend on the design and implementation, which is why activities should be evaluated to ensure maximum student learning. Several iterations may be needed before activity goals are met.

Acknowledgements

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