Web-based Interactive Landform Simulation Model - Grand Canyon (WILSIM-GC) and Its Advantages in Enhancing Students' Learning

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ABSTRACT

- The Web-based Interactive Landform Simulation Model – Grand Canyon (WILSIM-GC) is a free educational tool (see http://serc.carleton.edu/landform/).
- It is a physically based model that simulates bedrock channel erosion, cliff retreat, and base level change (Pelletier, 2010).
- It is implemented as a trusted Java applet utilizing the recent developments in Java technology that allows for fast computation and dynamic visualization.
- Students will be able to change a few parameters and observe the result in animation, cross-section, and profile.
- Students were randomly assigned to a treatment group (using WILSIM-GC) and a control group (using traditional paper-based material) to learn the land-forming processes in the Grand Canyon.
- Pre- and post-tests results show that both the interactive simulation and traditional paper-based approaches are effective in helping students learn landform evolution processes.
- There are several advantages and affordances of the simulation approach:

➢ The improvement effect from pre- to post-test scores was large for the treatment group, but small to moderate for the control group.

➢ For those questions requiring higher-level thinking, the percentage of students answering correctly was higher in the treatment group than in the control group.

➢ Attitudinal survey indicates that students generally favor the interactive simulation approach.

➢ These advantages should be leveraged and integrated with traditional methods in designing better curricular materials, including materials for online or hybrid courses and flipped classrooms.

1. WILSIM-GC

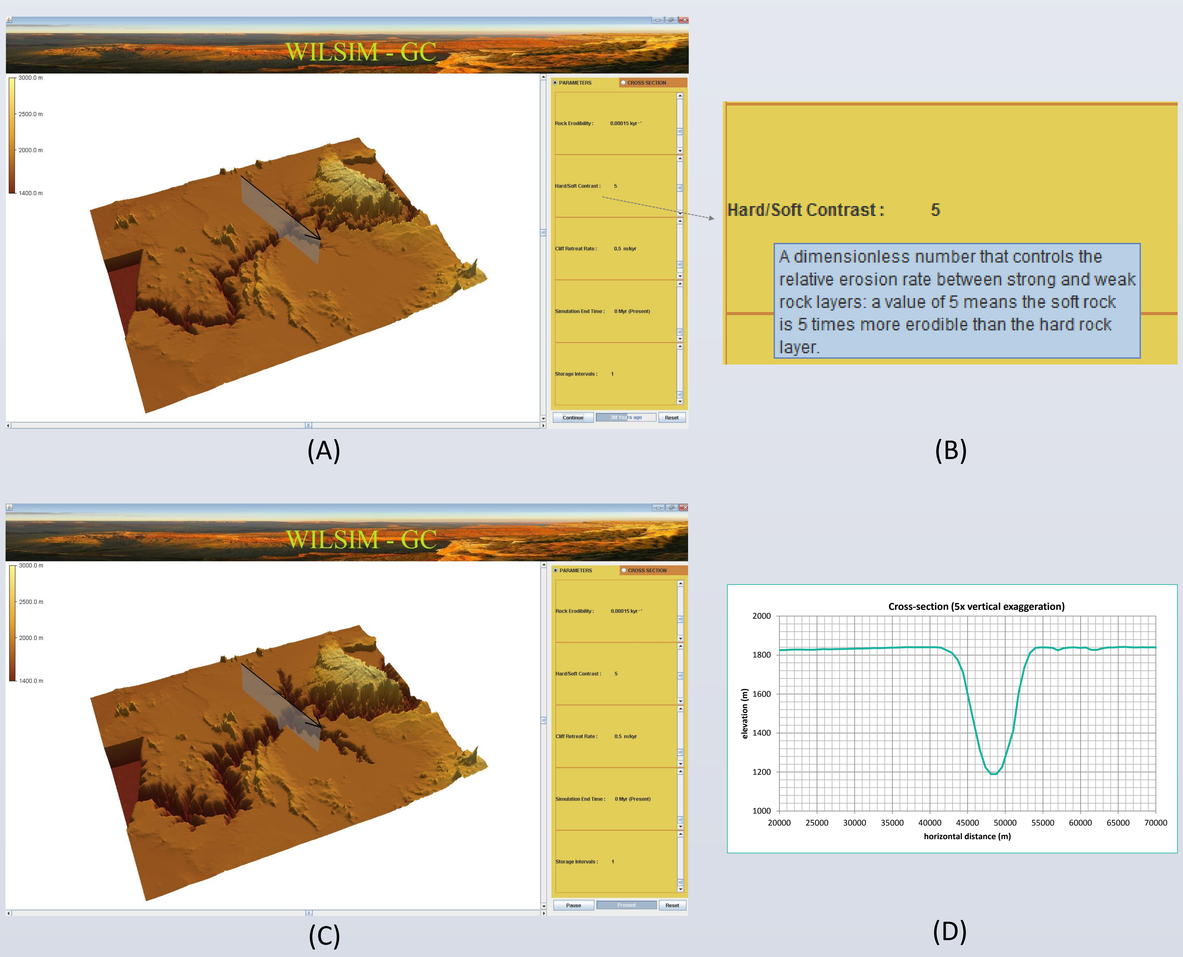

Figure 1. Screenshots of WILSIM-GC, (A): at about 3 million years ago (Ma), (B) : at present; (C): Help tooltip as mouse hovers parameter; (D) cross-section created in Excel with saved cross-section data. The transparent plane in (A) and (B) with arrow shows the location of the cross-section.

2. Treatment/Control Experiment Design

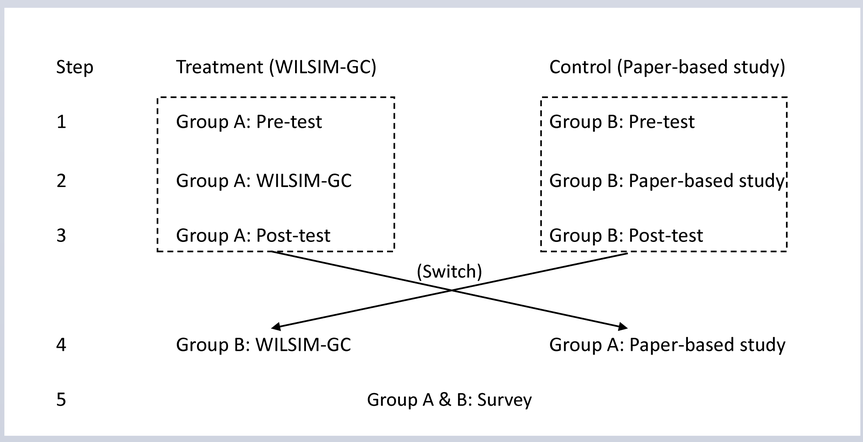

Figure 2 Diagram illustrating the procudure of the control/treatment experiment. Dashed boxes shows the pre/post comparison between the control and treatment groups. To ensure both groups have the same experience, they switch after completing the post-test. The attitudinal survey was conducted at the end.

3. RESULTS

Table 1. Two-tailed independent t-test of **pre-test** scores between groups

Group	n	Mean	St Dev	t	p
Control	23	64.78	13.99	0.5592	0.5791
Treatment	20	62.00	18.55		

Note: H_0: $\mu_{control} = \mu_{treatment}$; H_1: $\mu_{control} \neq \mu_{treatment}$

Table 2. One-tailed dependent t-test of pre- and post-test scores within group

Group	test	N	Mean	St Dev	t	p	Cohen's d
Control	Pre-test	23	64.78	18.55	-1.9538	0.0318*	0.40
	Post-test	23	72.17	15.65			
Treatment	Pre-test	20	62.00	13.99	-4.4171	0.0001***	1.06
	Post-test	20	76.50	13.48			

Note: H_0: $\mu_{pre} = \mu_{post}$; H_1: $\mu_{pre} < \mu_{post;}$ $*p < 0.05$, $*** p < 0.001$

Table 3. One-tailed independent t-test of score growth between groups

Group	n	Mean	St Dev	t	p	Cohen's d
Control	23	7.39	18.15	1.4191	0.0817†	0.43
Treatment	20	14.50	14.68			

Note: H_0: $\mu_{control} = \mu_{treatment}$; H_1: $\mu_{control} < \mu_{treatment;}$ † $p < 0.10$

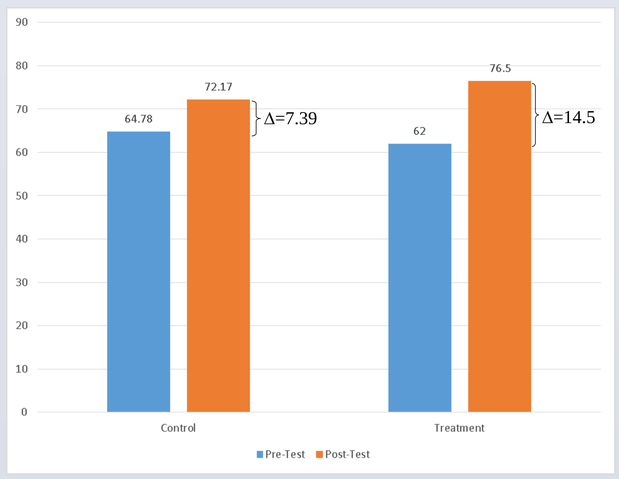

Figure 3. Comparison of score improvements from pre- to post-tests between control and treatment groups. The improvement for treatment group is larger despite slightly lower pre-test score.

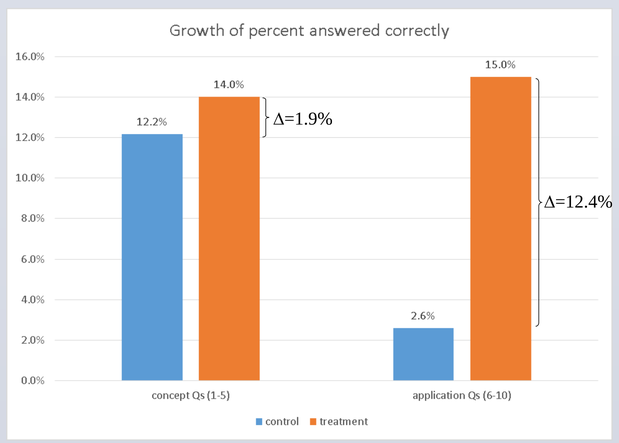

Figure 4. Comparison of growth of percent answer correctly. The growth between control and treatment group for the concept questions (#1-#5) are small, but for the application questions (#6-#10) is large (6.5 times larger).

4. Conclusions

➢ WILSIM-GC is effective in enhancing students' learning.

➢ WILSIM-GC promotes higher level thinking.

➢ Students generally favor the interactive simulation approach.

➢ WILSIM-GC should be integrated with traditional methods to achieve best results.

5. Reference cited

Pelletier, J.D. 2010. Numerical modeling of the late Cenozoic geomorphic evolution of Grand Canyon, Arizona, Geological Society of America Bulletin, 122:595-608.

6. Acknowledgement

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