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Research Design, Program Evaluation, Learning Assessment,
Statistical Analysis, and Instruction in Education and Technology

Formative Evaluation of *Kinetic City After School*

An Interactive Web Site & Adventure

(http://www.kineticcity.com)

Report for

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Kinetic City After School is an informal learning program based on an interactive, episodic World Wide Web site under development by AAAS (the American Association for the Advancement of Science). Supported by a grant from the National Science Foundation, the program provides users with a variety of episodic adventures intended to teach children about science and to help them better comprehend the complexities of the world around them. Research findings reported here focus on science information presented in association with the "Human Organism Zone" and the "Physical Setting Zone," both of which are now featured on the Kinetic City web site.

EVALUATION GOALS

The primary purpose for the research encompassed by this report is to inform decision making about the educational content of the Web site and associated learning activities. Towards this end, both descriptive and explanatory findings are reported, based upon feedback obtained from children in Grades 3–6 about their performance of project activities. Formative evaluation efforts were designed to be naturalistic studies that are intended to inform the decision-making process. Researchers looked for patterns in the quantitative and qualitative data specified in the following section of this report.

METHODS

Research for this project involved written feedback about performance of project activities offline and online use of the project's Web site in its designated informal educational context with the appropriate target group (i.e., elementary students). During this research effort, the *Kinetic City* Web site presented an interactive adventure, titled "Kinetic City: Mission to Vearth." Written feedback was elicited from students at four sites and analyzed to discern the degree to which Web site elements were able to meet project learning goals. The audience for this study participated in the evaluation in the following manner:

Formative research, extending for two months beginning April, 2001, involved placing the project's Web site and learning activities in their designated context (i.e., informal after school learning programs) with the appropriate elementary school age target group. The purpose for this phase of evaluation is to examine the effectiveness of the Web site and associated activities under approximately normal use conditions with the intention of implementing changes to the Web site that will better serve the learning needs of its users. Toward this end, pre- and post-use surveys were administered to assess students' acquisition of science information and changes in their interests and attitude toward science as a consequence of using the Web site and performing project designed activities.

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After responding to a pre-use survey at the beginning of April, all of the sample students performed activities contained on the Web site, but without the use of a computer. In addition, students at three of the four participating sites (the Test Group) also accessed the Web site and performed online activities for an average of approximately seven hours. In contrast, students at the fourth site (the Control Group) did not access the project's Web site. At the beginning of June, the students responded to a post-use survey.

Questions on the post-use survey included the pre-use content questions and additional questions to assess students' reactions to the *Kinetic City* Web site, as described below.

Questionnaires

Demographic and Background Variables. The pre-use questionnaire established respondents' status with respect to demographic classification variables (gender, grade level, and school), background classification variables (computer experience, experience exploring the World Wide Web, access to the Internet from home, and the types of things they like to do on the Internet.)

Web Site Appeal. Post-use respondents chose one of five scaled statements to indicate their overall rating of the *Kinetic City* Web site. Users also explained what they liked and did not like about the Web site and why.

Science Interests. Students identified their attitudes about science both prior to and after using the *Kinetic City* Web site. They also reported their attitudes about problem-solving assignments they are asked perform in school.

Science Knowledge. Both the pre-use and post-use questionnaires included a knowledge test to assess understanding of science content associated with the Web site's learning goals. Thirteen multiple-choice questions and three open-ended questions comprised a 24-point test about the topics covered in project activities. To gain insight into additional knowledge gained, post-use students were also asked if they learned anything about science that they did not know before visiting the *Kinetic City* Web site. If so, they were asked to specify what they had learned.

SAMPLE

The following are participant demographics for this formative evaluation study:

Pre- and Post-Use Written Surveys

As specified in Table 1, a total of 58 elementary school students (29 males, 29 females) from 4 urban field-test sites performed project designed learning activities. In addition, 35 of these students (the Test Group) visited the project's Web site and engaged in activities associated with the "Kinetic City: Mission to Vearth" interactive adventure. The other 23 students (the Control Group) did not access the project's Web site. All of the sample students responded to written surveys before and after performing the activities and visiting the Web site.

Table 1. Field-Test Sites

School Site	*City/Burrow*	*State*	*Setting*	*Boys*	*Girls*	*N*	*Group*
Edgewood Terrace	Washington	DC	Urban	4	4	8	*Test*
P.S. 50	Manhattan, NY	NY	Urban	6	6	12	*Test*
P.S. 200	Brooklyn, NY	NY	Urban	8	7	15	*Test*
P.S. 143	Queens, NY	NY	Urban	11	12	23	*Control*
			Total	***29***	***29***	***58***	

Table 2 specifies the demographic attributes of the 58 students who participated in this evaluation research (largely of minority ethnicity and/or recent immigrants). At the time of the study, 12 of the sample students (20.7%) were third graders, 27 students (46.6%) were fourth graders, , 14 students (24.1%) were fifth graders, and 5 students (8.6%) were in the sixth grade. Note that there are an equal number of female and male participants.

Table 2. Distribution of Gender by Grade

N	*Categories*	*Number (Percent)*

58	**Third** *Male* *Female* **Fourth** *Male* *Female* **Fifth** *Male* *Female* **Sixth** *Male* *Female*	**12** **(20.7%)** *6 (10.3%)* *6 (10.3%)* **27** **(46.6%)** *16 (27.6%)* *11 (19.0%)* **14** **(24.1%)** *5 (8.6%)* *9 (15.5%)* **5 (8.6%)** *2 (3.5%)* *3 (5.2%)*
58	**Female**, total **Male**, total	29 (50.0%) 29 (55.0%)

RESULTS

As noted in the Sample section, above, elementary students at four urban, informal learning sites participated in this evaluation research. Thus, a total of 58 students (29 males, 29 females) provided feedback about project activities. As previously specified, all of the sample students performed activities contained on the Web site, but without the use of a computer. The 35 students who formed the Test Group also accessed the Web site and performed online activities for an average of approximately seven hours. The 23 students who formed the Control Group did not access the project's Web site.

Prior Computer Experience

As specified in Figure 3, a little more than one-fourth (29.3%) reported that their abilities are "Advanced." Similar percentages (24.1%) rated their abilities as "Above Average or Average" and 22.4% rated themselves as "Just Beginning" computer users.

Table 3. Self-Reported Ability to Use a Computer*

Variable	*N*	*Categories*	*Percent*
Computer Background	58	Advanced	29.3%
		Above Average	24.1%
		Average	24.1%
		Just Beginning	22.4%

*Totals may not equal exactly 100.0% due to rounding.

Prior Internet Experience

As indicated in Figure 4, of the 58 students in the sample, 41.4% reported that they are "Advanced" Web explorers. Another 17.2% indicated that they are "Above Average" explorers and nearly one-fourth (24.1%) view themselves as "Average" explorers. The remaining 17.2% of the sample describe themselves as "Just Beginning" Web explorers. Approximately half (51.4%) of the Test Group reported that they are able to visit the Internet from home.

Table 4. Self-Reported Experience With Exploring the World Wide Web*

Variable	*N*	*Categories*	*Percent*
Internet Background	58	Advanced	41.4%
		Above Average	17.2%
		Average	24.1%
		Just Beginning	17.2%

*Totals may not equal exactly 100.0% due to rounding.

Prior to visiting the *Kinetic City* Web site, students were asked to describe what types of things they do on the Internet, if anything. Responses were sorted into categories and presented in Table 5, on the following page.

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Table 5. What Students Do On The Internet

Category	*Responses*
Play games	38
Search for information	12
Educational Web sites	11
Chat rooms	10
Explore	10
Listen to music	9
Help with homework	5
Nickelodeon Web site	3
Cartoon network	3
Shop	2
Check e-mail	1
Wrestling Web sites	1

Attitudes About Problem-Solving Assignments

Prior to performing project activities or visiting the project's Web site, participants in this study were asked to indicate which of the sentences contained in Table 6 best describes how they feel about school assignments that ask them to solve problems. The smallest percentage of respondents (8.6%) reported that they like solving problems. Slightly more than half of the students (51.7%) indicated that they like solving problems, but not a lot. The remaining 39.7% of the sample reported not liking to solve problems at all.

Table 6. Attitudes About Problem-Solving Assignments

Variable	*N*	*Categories*	*Percent*
Problem Solving	58	I like solving problems a lot.	8.6%
		I like solving problems, but not a lot.	51.7%
		I don't like solving problems at all.	39.7%

Pre- and Post-Use Attitudes About Science

To probe for changes in the students' attitudes about science, they were asked at the beginning and end of this study to complete the sentence stem: "I think science is . . . ." by checking as many of the stems contained in Table 7, on the following page, as are expressive of their feelings. Note that while the feeling that science is something they can do increased for members of the Test Group, it decreased for members of the Control Group. Similarly, the feeling that science is fun decreased for Control Group students who only performed activities offline. This finding suggests that the use of the Web site plays a role in maintaining the enjoyment of science activities.

Table 7. Pre- and Post-Use Attitudes about Science

		Pre-Use Count		Post-Use Count	
Variable	*Sentence Stem* **I think science is. . .**	*Test Group*	*Control Group*	*Test Group*	*Control Group*
Attitudes About Science	something I can do.	14	12	23	6
	boring.	4	2	2	4
	fun.	25	18	24	8
	interesting.	21	13	23	14
	too hard.	3	6	1	1
	something I would like to know more about.	16	13	12	12
	not for me.	2	4	2	4
	important.	16	13	20	10
	uninteresting.	1	2	1	1

Rating the *Kinetic City* Web Site

After using the *Kinetic* Web site for an average of approximately 7 hours, Test Group members were asked to provide an overall rating of the Web site. On average, respondents gave the Web site a 4.46 rating on a five-point Likert scale ranging from 1 (Very Poor) to 5 (Very Good). As specified in Table 8, approximately half of the students (51.4%) rated the site as "Very Good." Another 42.9% of the test sample rated the Web site as "Good" and 5.7% rated it as "Average." None of the Test Group members rated the Web site as either "Poor" or "Very Poor." The ratings were found to be independent of gender, grade, site location, prior computer or Internet experience, and interest in problem solving activities.

Table 8. Overall Rating of the *Kinetic City* Web Site by Post-Use Sample

Variable	*N*	*Categories*	*Percent*
Appeal	35	Very Good	51.4%
		Good	42.9%
		Average	5.7%
		Poor	0.0%
		Very Poor	0.0%

Asked to specify the word that best describes the Web site, respondents offered the adjectives listed in Table 9, on the following page.

Table 9. Word That Best Describes the *Kinetic City* Web Site

N	*Categories*	*Responses*
35	Cool	8
	Fun	7
	Interesting	5
	OK	4
	Great	3
	Science	2
	Wow!	1
	Fantastic	1
	Exciting	1
	Nice	1
	Colorful	1
	Confusing	1

What Students Like ***Most*** About the Web Site

After an average of seven hours of use, students were asked an open-ended question about what they liked *most* about the *Kinetic City* Web site. Responses indicating a liked feature were sorted into categories presented in Table 9. Note that the five highest ranked categories of things students liked are games, learning, characters, projects/activities, and movies. Table 10 displays these results and specifies the numbers of times each of these categories was mentioned.

Table 10. What Students Like ***Most*** About Kinetic City Web Site

Categories	*Responses*
Games	23
Learning	6
Characters	3
Projects	2
Movies	2
Adventure	1
Body Parts	1
Graphics	1
Everything	1

What Students Like ***Least*** About the Web Site

After an average of seven hours of use, students were asked an open-ended question about what they liked *least* about the *Kinetic City* Web site. Six respondents reported that there was "nothing" that they didn't like about the Web site. The following are the other written comments that were offered

by students (Numbers in parenthesis specify the number of similar responses.):

- *"The characters talk too fast." (2)*
- *"It was a little hard."*
- *"It's hard without teacher's help."*
- *"Too much learning."*

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- *"Learning."*
- *"Answering questions." (2)*
- *"Reading."*
- *"That it explains every last piece of disgusting info. on your insides."*
- *"It's slow." (6)*
- *"Sometimes the games can be confusing."*
- *"The smart art."*
- *"The evil people."*

Comprehensibility and Readability

Of the 35 Test Group members, 34 reported that components of the *Kinetic City* Web site are comprehensible and that it is easy to understand how to perform project activities. Similarly, 34 of the Test Group members indicated that words contained in the Web site are easy to understand. Asked to describe anything about the Web site that they this is confusing, six students reported that is "nothing" about the site that they found to be confusing. Other respondents offered the following comments:

- *"It was confusing when I signed on."*
- *"Current attack."*
- *"Activities."*
- *"The questions are hard."*
- *"At first the games were confusing."*
- *"Nothing at all, only maybe something of the games."*
- *"The names they are using."*
- *"What is Vearth?"*
- *All the things you have to click and things should go where they point."*
- *"Some body parts."*

Self-Reports of Learning From the Web Site

All of the students in the Test Group, except one, readily acknowledged that they had learned something about science from the *Kinetic City* Web site. The following explanatory comments were offered by students who reported having learned students (Numbers in parenthesis specify the number of similar responses.):

- *"I learned about the planets and parts of the body."*
- *"I learned what a nerve is."*

- *"What organs are." (2)*
- *"What cartilage is. What organs there are."*
- *"How long the small intestine is."*
- *"About what goes on inside your body."*
- *"About my body."*

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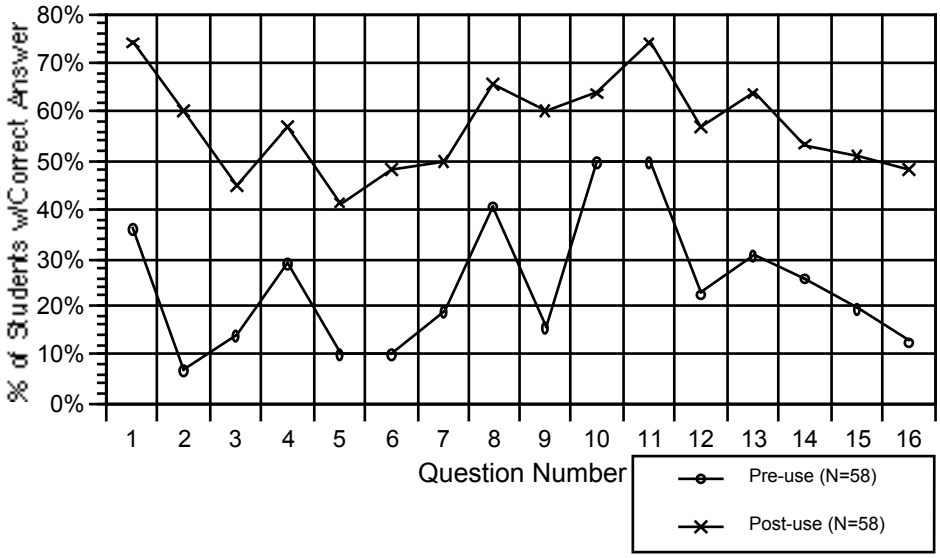
- *"Human body parts and how to keep them healthy."*
- *"Human body parts." (4)*
- *"I learned that we use science everyday."*
- *"I learned a lot, like body organs and weather."*
- *"I learned about human body parts and pollution."*
- *"About erosion, nature, the body."*
- *"About erosion." (3)*
- *"How big some mountains are."*
- *"I learned too many things."*

Measured Learning Outcomes

Learning from *Kinetic City* Web site content was assessed via 16 content questions administered on both the pre- and post-use surveys. Figure 1 shows the distribution of the students' achievement scores for each content question on both pre-use and post-use surveys.

Figure 1. Distribution of Test Scores by Question for Pre- and Post-Use Surveys



There are 24 points that were attainable on the 16 question test portion of the survey. The post-use mean achievement score for the whole sample was 12.4, significantly higher than the pre-use mean score (M = 5.4), as tested by a paired t-test, t (1,57) = 11.64, $p \leq .0001$. Thus, the learning outcomes resulting from performance of *Kinetic City* activities would initially appear to be statistically significant for all of the sample students. However, with an interest in interaction effects, ANOVAs with interactions and nested factors were calculated for Survey (i.e., Pre, Post) and individual demographic/

background variables of Treatment (i.e., Project activities, Project activities + Web site use), Gender, School, Computer experience, Internet experience, Science attitudes, and Problem-Solving attitudes. One interaction was significant: Treatment, $F(1, 21) = 26.45$, $p \leq 0.0001$.

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Thus, using the *Kinetic City* Web site had a significantly greater positive impact on students' science knowledge than did performing project activities without the benefit of access to the *Kinetic City* Web site. The increase in scores for the students who used the Web site and performed project activities (9.6 points) is generally triple the increase in scores of the students who only performed project activities (3.1 points).

Further examination of the differences between Test Group and Control Group learning outcomes reveals that on the 16 content questions administered on both the pre- and post-use surveys, Test Group students scored significantly higher on 14 questions after using the *Kinetic City Web* site for an average of seven hours. The only items for which the comparison of results on the pre- and post-use surveys did not reach significance related to: (1) the Hawaiian Islands starting out as underwater volcanoes, and to (2) a glacier being a big, slow moving sheet of ice. However, the pre-use scores on these questions were so high as to make virtually any improvement statistically insignificant. Table 11 presents the Test Group's pre- and post-use survey results for each individual item and the level of statistical significance reached when pre- and post-use results are compared.

Table 11. Comparison of ***Test Group*** Pre- and Post-Use Test Results for Content Questions

Topic of Content Question	*Pre-Use Survey (% Correct)*	*Post-Use Survey (% Correct)*	*Statistical Significance*
Human Organism Zone			
Control of the body's organs by the brain	40.0%	80.0%	≤.0013[1]
Cartilaginous body part that helps you taste food	17.1%	74.3%	=.0001[1]
Space used by brain to control parts of the body	14.3%	57.1%	=.0004[1]
Transport of oxygen from lungs to muscles	28.6%	65.7%	=.0037[1]
Number of bones in the body	5.7%	54.3%	≤.0001[1]
Composition of hair, fingernails, and surface of skin	5.7%	62.9%	≤.0001[1]
Description of how body works	22.9%	68.6%	=.0003[1]
Identifying body parts	35.2%	74.3%	≤.0001[2]
Subtotal	*24.0%*	*68.6%*	
Physical Setting Zone			
Process of wearing away Earth's surface by natural forces	8.6%	74.3%	≤.0001[1]
Origin of Hawaiian Islands	54.3%	74.3%	ns*
Composition and movement of a glacier	62.9%	82.9%	ns*
Description of why riverbanks are good for growing crops	25.7%	60.0%	=.0074[1]
Factors that change the shape of a mountain	25.7%	74.3%	≤.0001[1]
Process of changes in Earth's appearance	22.9%	65.7%	=.0006[1]
Factors that produce big changes in the surface quickly	20.0%	62.9%	≤.0001[2]
Factors that produce big changes in the surface slowly	10.5%	61.0%	≤.0001[2]
Subtotal	*20.8%*	*57.3%*	
Total	***21.1%***	***62.0%***	

[1] Fisher's Exact Test

[2] Chi-Square Test
* Not statistically significant

With regards to specific content areas in which knowledge increased for students who only performed project activities offline, statistically significant improvement between the pre- and post-use Control Group surveys is evidenced for 3 of the 16 content questions. The three items for which this improvement is demonstrated are: (1) "The body's organs are controlled by the brain;"(2) "The nose, which is cartilaginous, helps you taste food;" and (3) "Riverbanks are good for crowing crops because the water mixes up the soil, and the most fertile soil settles on top." Table 12 presents the Control Group's pre- and post-use survey results for each individual item and the level of statistical significance reached when pre- and post-use results are compared.

Table 12. Comparison of ***Control Group*** Pre- and Post-Use Survey Results for Content Questions

Topic of Content Question	*Pre-Use Survey (% Correct)*	*Post-Use Survey (% Correct)*	*Statistical Significance*
Human Organism Zone			
Control of the body's organs by the brain	30.4%	65.2%	=.0377[1]
Cartilaginous body part that helps taste food	8.7%	39.1%	=.0351[1]
Space used by brain to control parts of the body	13.0%	26.1%	ns*
Transport of oxygen from lungs to muscles	30.4%	43.5%	ns*
Number of bones in the body	4.3%	21.7%	ns*
Composition of hair, fingernails, and surface of skin	17.4%	26.1%	ns*
Description of how body works	17.4%	21.7%	ns*
Identifying body parts	49.3%	52.2%	ns*
Subtotal	*27.0%*	*40.0%*	
Physical Setting Zone			
Process of wearing away Earth's surface by natural forces	26.1%	39.1%	ns*
Origin of Hawaiian Islands	43.5%	47.8%	ns*
Composition and movement of a glacier	30.4%	60.9%	ns*
Description of why riverbanks are good for growing crops	17.4%	52.2%	=.00287[1]
Factors that change the shape of a mountain	39.1%	47.8%	ns*
Process of changes in Earth's appearance	26.1%	34.8%	ns*
Factors that produce big changes in the surface quickly	18.8%	33.3%	ns*
Factors that produce big changes in the surface slowly	15.9%	29.0%	ns*
Subtotal	*20.8%*	*33.5%*	
Total	***23.4%***	***36.2%***	

[1] Fisher's Exact Test
[2] Chi-Square Test
* Not statistically significant

Suggestions Offered By Students

Students were asked to offer any suggestions they might have for improving the *Kinetic City* Web site. One student commented: *"Well, it's all good! No changes."* The following are other respondent's written comments (Numbers in parenthesis specify the number of similar responses.):

- *"Add cool music in the background."*
- *"Have more people play on the Web site."*
- *"Faster logon system. More fun activities to attend to. Less places to click on!"*
- *"Make it a little easier to understand."*
- *"Make it easier."*
- *"Make it go faster." (3)*

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- *"If you could be one of the characters in the missions. Design your own character for the mission."*
- *"Less learning."*
- *"More games for the Web site."*
- *"More Games."*
- *"Prizes for winning the game."*

DISCUSSION

Students reportedly found the *Kinetic City* Web site to be educational, interesting, a fun way to learn, and a source of information about science that is both engaging and easy to understand. Students acknowledged that the site's features enhanced their learning experience. They also feel these features are easy to use and the site's activities and text are both comprehensible.

After using the *Kinetic* Web site for an average of approximately 7 hours, students were asked to provide an overall rating of the Web site. On average, respondents gave the Web site a 4.46 rating on a five-point Likert scale ranging from 1 (Very Poor) to 5 (Very Good). A little over 94% of the students rated the site as either "very good" or "Good." None of the Web site users rated it as either "poor" or "very poor."

The three words that they used most often to describe the Web site were "cool," "fun," and "interesting." The game like quality of some Web site activities is what students reportedly liked most. The three other most liked qualities are the site's educational value, the characters associated with the site, and the site's activities/projects. The three things that students reportedly like least about the site are its "slowness," characters that are perceived to talk too fast, and having to answer questions. A couple of students indicated that they initially needed help with the activities.

From an educational perspective, the increase in scores for the students who used the Web site and performed project activities is generally triple the increase in scores of the students who only performed project activities. On average, students who used the *Kinetic City* Web site for an average of seven hours scored significantly higher on fourteen of the sixteen content questions presented at post-use, compared to their answers to the same items on the pre-use survey. These results indicate that Web site users learned the material presented in the site, with the exception of information related to the origin of the Hawaiian Islands and the composition and movement of a glacier.

In contrast, students who performed project designed activities without having had access to the *Kinetic City* Web site, on average, scored significantly higher on

only three of the sixteen content questions presented at post-use, compared to their answers to the same items on the pre-use survey. In addition, while the feeling that science is something they can do increased for members of students who used the Web site, it decreased for students who did not. Similarly, the feeling that science is fun decreased for students who only performed activities offline. This finding suggests that the use of the Web site plays a role in stimulating and maintaining the enjoyment of science activities.

As specified in the Results section, students' suggestions for improving the Web site focused on improving its speed, making the activities easier to understand, adding music, enabling the user to design his or her own character for a mission, providing a reward/prize for completing a game successfully.