Utilizing Instructional Games To Improve Students' Conceptualization of Science

Concepts: Comparing K Students Results With Grade 1 Students, Are There

Differences?

©Patrice Juliet Pinder

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ABSTRACT

Education researchers and teachers have long been interested in improving students' conceptual understanding and motivational levels to do academic work. Over the past decade and a half, there has been an increase in the number of studies investigating the effects of instructional games on students' academic performance and motivational levels. Many of the studies documented have been with older students; that is, high school and university level success rates have been documented by education researchers. However, relatively few studies have been documented that assess the effects of instructional games on pre k or k- 5 students. This paper discusses findings of a game activity intervention conducted, reports on prior intervention results obtained a year ago, and also gives practitioners' views and perspectives on the effectiveness of instructional games for pre k and k-5 students (for improve performance and motivational levels). Essentially, this study addresses the following overarching questions: how does the recent results for K students compare with the prior results obtained a year ago with grade 1 students? Are there similarities or significant differences between the two grade level results? And, what light does practitioners' interviews and survey results shed on the differences seen? The study, which was a mix model study (quantitative & qualitative findings), consisted of sixteen urban students and three urban science teachers representing the K-12 schools. Results seem to suggest that instructional games would be beneficial for K-5 students. The paper concludes with suggestions for future research that can fill in the gap in the field, and also gives some implications for practice and suggestions for cross curricular applications of instructional games.

Key words: living, non-living, game board, pre-test, post-test, interviews, survey

{Conference research paper, 7 references}

Education researchers and teachers have long been interested in improving younger students' understanding of scientific concepts and they have also been interested in improving students' motivation levels to do science or to do class work in general (Klein & Freitag, 1991). Over the past decade and a half, there have been studies done that examined the benefits of using instructional games to improve students' motivation and performance levels (Klein & Freitag, 1991).

Gaps / Limitations in Literature

However, despite numerous studies done that examined the benefits of instructional games in improving students' motivation and performance levels (see studies done by Klein & Freitag, 1991), very few studies were done that looked specifically at how young students may benefit from such an innovation tool, particularly, urban students. Additionally, studies are almost non existent that employ both a quantitative study (experimental design) and a qualitative perspective (phenomenological approach).

Procedures followed in the Paper

In this paper, I highlighted some of the key objectives, gave an overview of the methodology employed, compared prior data results that were obtained a year ago with grade 1 students with the new data results obtained this year with pre k students. Basically, how did the two data findings compare to each other? Were there similarities or differences? I also presented survey and interview data of Baltimore City practitioners, who each have more than four years experience (to examine their views / perspectives of this type of innovation tool). The paper concluded with recommendations for future research; this can fill in the gap present in the existing literature.

Theoretical Basis for the Study

According to the National Science Educational Standards, Teaching Standard A, science curriculum and lesson content should originate and be designed from the interests, knowledge, understanding, ability, and experiences of the students (Krantz, 2003). Even though one may feel that younger students are not adept in regards to science, many researchers are proving this theory wrong. It is pointed out that the elementary science classroom is one composed of learners who are engaged in scientific processes. These youngsters often ask real world questions and seek real world answers. So even at very young ages, students are becoming scientific inquirers (Krantz , 2003).

Some pre-schoolers, kindergartners, and first graders have difficulty in classifying concrete objects grouped by a single property. So with this in mind, teachers have to plan a process that actively involves students in their own learning (Wolfinger, 1984). Such a process can generate a variety of perspectives on a topic, provide depth to content and lead to significant understanding of concepts.

Further, according to the socio-cultural and social constructivist theories, effective teaching must be improvisational because if the classroom is scripted and directed by the teacher, the students can not co-construct their own knowledge (Sawyer, 2004). Also, the socio-cultural perspectives imply that in improvisational teaching, learning is a shared social activity, and is collectively managed by all participants, not only the teacher (Sawyer, 2004).

It has been argued that creative teaching is vital to facilitating students' grasping and understanding new concepts. It is often implied that the best teachers are those who can apply immense creativity to their lessons and yet impart profound content in their subject area in a way to enable students to fully grasp understanding of the lesson content.

Moreover, teachers know the importance of cognitive theory in structuring appropriate experiences in science. We try to introduce youngsters to those skills that will grow and carry over to other subject areas and other science experiences. Behaviors such as observing, classifying, predicting, and inferring are important process skills to build in the elementary years or even earlier. Much of the Piagetian research in cognition has underlined the importance of teaching science between the ages of six and eleven from a concrete, demonstrable foundation (Miller, 1989).

Data overwhelmingly support the fact that students in inquiry-oriented, process-approach science classes where they participate in creative exercises (e.g.. game playing) have greater attitudes toward science and scientists when compared to students in textbook oriented science classes (Miller, 1989).

Shayer and his associates argue that students must be well advanced into formal operational stages of thinking before they can understand certain formal science concepts (Rowell and Dawson, 1980). Basically, it is believed that younger children do not have the cognitive (mental) development to understand science concepts at a very young age. However, Piaget's school of thought goes against the findings of Shayer and his associates, as Piaget believed that for a firm science foundation to be developed, students must be exposed to science, especially observation, inference, and classification, at as early as six years of age (age level of grade 1 students).

Purpose & Major Objective

The overarching purposes of the study were to:

(a) To explore and examine the possible effect(s) of game playing on younger students' science learning or academic performance.

(b) To examine and compare the results of instructional game intervention on grade 1 students versus grade K students. Were there major differences?

Major Objective

The overall objective was to use game activities to clear up K (& formerly grade 1) students' prior misconceptions of 'animate versus inanimate objects.'

Research Questions

1. What are the effects of game playing on younger (urban) students' conceptual understanding of science principles?

2. Specifically, is the use of game board activities effective or ineffective in improving the science performance of younger students? What does quantitative and qualitative data findings reveal on the effectiveness of such a tool?

3. Is there a significant difference seen between K and grade 1 students' scores?

4. If there are differences seen between K and grade 1 students' performance levels after utilizing the game activity with them, what may account for the differences between the two grade levels? What does quantitative and qualitative findings reveal in this regard?

Content, Methodology and Materials

Sample Size

<u>For the quantitative experimental part of the study</u>

10 students of an urban elementary school in Atlanta, Georgia; and 6 students of grade K of an urban elementary school located within Baltimore City, Maryland, were selected.
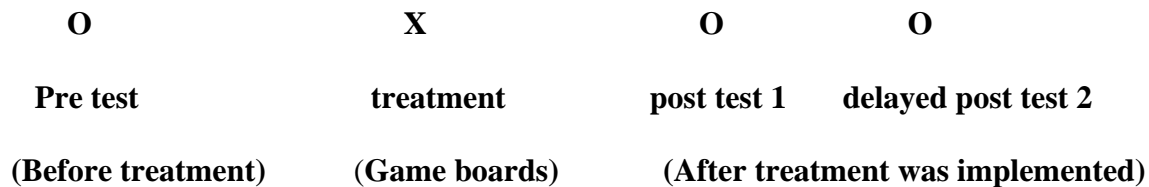
For the qualitative part of the study

    (a) Three Baltimore City science teachers were selected for the interviews

    (b) Five Baltimore City science teachers were selected for the brief questionnaire session

The first study with Atlanta, Georgia students was conducted between February 13, 2006 and May 1, 2006, and the second set of students representing Baltimore City were worked with from October 1 – 31, 2007. Additionally, on November 26, 2007, three Baltimore City teachers were interviewed in order to get their perspectives on the effectiveness or usefulness of game activities as innovative tools for learning.

Research design utilized

    (a) A quantitative research design employing an experimental study that utilized a 'one group, pre test – post test design' that looked accordingly (was utilized):

O   **X**   **O**   **O**

Pre test   **treatment**   **post test 1**   **delayed post test 2**

(Before treatment)   **(Game boards)**   **(After treatment was implemented)**

    (b) A qualitative research design using a phenomenological approach and semi structured interviews were used in order to get a more detail account of the three practitioners' perspectives on the usefulness of instructional games in improving students' understanding of scientific concepts.

Teachers' surveys were also utilized as well to assess the effectiveness of the instructional games**.**

Data Instruments & Materials Utilized:

- Game board activity

- Pre and post tests

- Teachers' survey / questionnaires

- Interview sheets

Evaluation / Discussion

Research question 1 & 2 Revisited

1. What are the effects of game playing on younger (urban) students' conceptual understanding of science principles?

2. Specifically, is the use of game board activities effective or ineffective in improving the science performance of younger students? What does quantitative and /or qualitative data findings reveal on the effectiveness of such a tool?

Findings

In reviewing the common responses or common answers given in the brief questionnaire by Baltimore City (BCPSS) teachers, the following was revealed:

- 60% of the teachers viewed game activities as being <u>highly effective</u> in simplifying scientific concepts for K-5 students.

- 100% of the teachers viewed game board activities as being <u>highly effective</u> in increasing students' motivation levels to do science (this was in line with the findings of Klein & Freitag, 1991).

- 60% of the teachers viewed game board activities as being <u>highly effective</u> in improving K-5 students' conceptualization of scientific concepts.

<u>Research Question 3 Revisited</u>

Is there a significant difference seen between K and grade 1 students' scores?

Findings

Table 1: Pre & Post Tests Results of Grade K students (Baltimore, MD).

Student	Pre test (%)	Post test 1 (%)	Delayed Post test 2 (%)
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0

**Table 2: Pre and Post Test Mean Scores for Grade K Students
(Baltimore, MD.)**

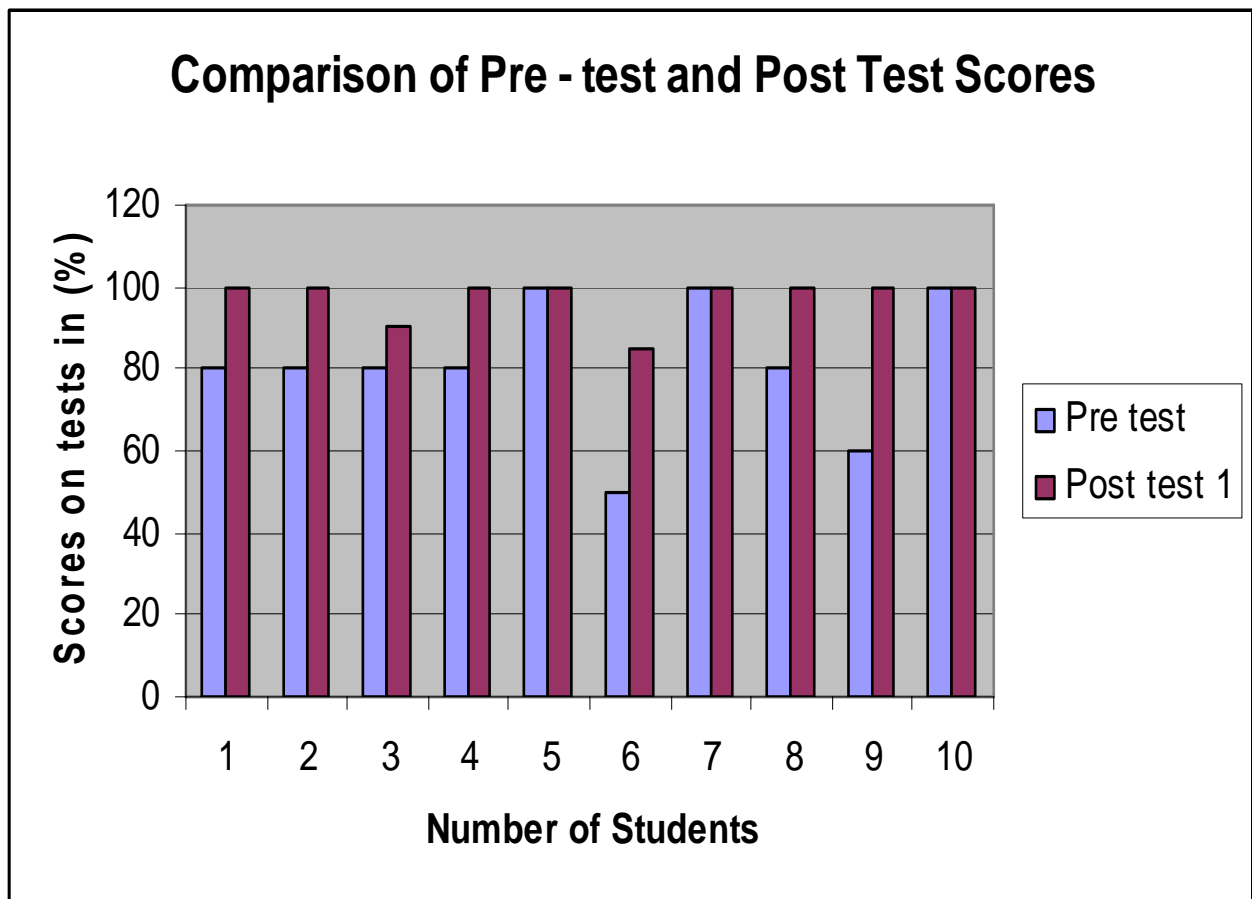| Pre test Mean Score	Post Test 1 Mean Score
0.00	0.00

Table 3: Pre test and Post tests Results for Grade 1 Science Students in Atlanta, Georgia.

Student	Pre test (%)	Post Test 1 (%)	Post Test 2 (delayed)
1	83	100	60
2	83	100	100
3	83	90	70
4	83	100	100
5	100	100	100
6	50	85	55
7	100	100	100
8	83	100	100
9	64	100	100
10	100	100	100

Table 4: Mean Scores for the Pre test and Post test for Grade 1 Atlanta, Ga. Students

PRE – TEST	POST – TEST 1
Mean Score	Mean score
72.9%	97.6%

Figure 1: Comparison of Pre –test and Post –test Scores of grade 1 Atlanta, Georgia Students

Comparison of Pre - test and Post Test Scores

<div align="center">**Findings**</div>

Quantitative data findings as revealed by tables 1 & 2, tables 3 & 4, and figure 1 showed that there were differences seen between grade K and grade 1 students' pre and post test mean scores and individual scores. Tables 1 & 2 recorded no pre and post test individual scores for the six grade K students who participated in the recent game intervention activity, and the resulting pre and post test mean scores were 0.00. Basically, no data was obtained as the students could not move beyond the initial pre assessment stage.

However, with the grade 1 students that I worked with a year prior to working with the Baltimore City students, the results were drastically different. Grade 1 students' post test scores were significantly higher than their pre test scores and their post test mean score was significantly higher than their pre test mean score (97.6% post test mean score > 72.95% pre test mean score).

Research Question 4 Revisited

If there are differences seen between K and grade 1 students' performance levels after utilizing the game activity with them, what may account for the differences between the two grade levels? What does quantitative and qualitative findings reveal in this regard?

<div align="center">Findings</div>

There were significant differences in individual pre and post test scores and in overall pre and post test mean scores for K students compared to grade1 students. Interviews with three BCPSS teachers on November 26, 2007 suggested the following reasons for the differences:

(a) The age factor – the teachers generally felt that because cognitive perceptions and ability levels are drastically different at age 4 or 5 (K level) versus age 6 or 7 (grade 1 level), K students would need more concrete everyday examples of living versus non –living things to be shown to them for them to understand the concept; whereas, with older grade 1 students, this may not be the case.

(b) Wording – was cited as another factor that may have accounted for the differences in results seen between K and grade 1 students as the words living and non living may be unfamiliar to K students, but more familiar to grade 1 students.

Moreover, to improve game activities for grade K students in the future, the following was

highlighted from the interview data:

1. Use appropriate <u>wording </u>for 4 or 5 year olds that they may understand

Teacher 3 Response**:**

"The age factor – the kids were too young for an activity of this kind, it was too difficult a concept and activity for them to grasp. <u>Wording use</u> also seemed difficult for them; <u>choice of wording</u>, e.g. using the term non-living may have been above their little heads."

2. Use <u>concrete everyday examples</u> that they can relate to, maybe comparative examples, e.g. a toy butterfly and a real life butterfly can be shown to them to illustrate visually the images of a living thing versus a non-living thing.

Teacher 1 Response:

"Looking at how they responded to the pictures shown, I would say then show them actual things, actual <u>concrete things</u> that they can see in front of them as <u>concrete examples."</u>

Teacher 2 Response:

"Use different examples in your delivery; you can <u>use concrete examples</u> of living versus non –living things, e.g. an actual plant or a moving worm in a glass jar, or show them a comparative example, like a toy butterfly and a real life butterfly, something of that sort that can clearly illustrate differences between a living thing and a non living thing, rather than still pictures as examples."

Teacher 3 Response:

"Give more <u>concrete examples</u>, and explain terms and expectations before hand to the students before beginning any work with them. Also, utilizing the regular classroom teacher in the actual implementation of your intervention may yield better results for you in the future."

To improve game activities for grade K students in the future, the following was the take away

messages from the interview data:

(1) Use appropriate wording for four year or five year olds that they may understand

(2) Use concrete everyday examples that they can relate to, maybe comparative examples, e.g. a toy butterfly and a real life butterfly can be shown to them to illustrate visually the images of a living thing versus a non-living thing.

Conclusion

Overall, 2006 results obtained with Atlanta, Georgia's first graders, interviews with teachers, and survey / questionnaire results all seemed to concur with the literature findings that game activities would be highly effective for improving students' academic performance and motivation levels, and therefore, these findings seem in line with similar results obtained by Klein & Freitag (1991), except their findings were with university level students and this study's findings were with elementary school children. The positive data findings for grade 1 students in 2006 went against the findings of cognitive psychologists, such as Shayer and his associates, and seemed more in line with Jean Piaget's findings (that some young students do have the mental capability to understand science concepts if made really simple for them); however, the negative data results obtained with the grade K students seemed to concur with the posited beliefs of Shayer and his associates (that some young students do not have the cognitive development to understand science concepts well) (Rowell & Dawson, 1980). Shayer and his associates postulated that students must be well advanced into the formal operational stages of thinking before they can understand certain formal science concepts; so basically, it is believed that younger children do not have the cognitive development to understand science concepts at a very young age (Rowell & Dawson, 1980). The results obtained with the grade K students seemed to be in line with this belief. Moreover, it is inconclusive as to whether or not the negative results

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obtained for the grade K students were correlated with their urban or inner city lived world experiences or cultural experiences, as the grade 1 students from Atlanta, Georgia, were also inner city students and positive results were seen with them. So it is undetermined as to whether or not inner city life styles have any significant impact on some younger students understanding of certain concepts compared to other students of suburban or rural communities.

After reviewing the literature and conducting the instructional game intervention, it is recommended that more studies be conducted that can:

(a) Employ quantitative methods – that is, correlation studies to try to determine if there is a significant relationship between very young urban students' academic performance and their urban (inner) city life worlds.

(b) Employ more qualitative studies—that is, qualitative studies employing phenomenological approaches to explore and understand practitioners' views on the effectiveness of instructional games on pre K or K-5 students' science learning and motivation.

Extension and Cross – Curricular Applications & Implications or Educational Significance

- Using the ideas of game activities could be extended to other topics in biology, general science, or even mathematics.

- Game boards can consist of numbers rather than words for mathematics content delivery and students can be allowed to identify 'even digits' on the game board, or 'odd numbers' on the game board, if teachers wanted to explain and test the concept of 'odd numbers' versus 'even numbers' with younger students.

- Basically, this activity could be a great educational tool for k – 2 students in any subject; it can also be used by science and mathematics practitioners who may need to explore creative ways to engage younger students and to retain their interest in classroom lectures.

- Further, difficult concepts can be broken down or simplified for younger children through game activities (such as the game board activity explored in this study).

- Can facilitate engagement of younger students in their own learning; that is, it may help to cultivate a constructivist teaching and learning environment in which students are 'active learners' as opposed to 'passive recipients' of knowledge (Freire, 2005; Klein & Freitag, 1991; Sawyer, 2004).

- Can serve as both a practice and drill activity to reinforce lecture notes for older students, beyond the grade 5 level.

- Can be a motivational tool for students, especially slower learners (see Klein & Freitag, 1991).

- Can or should improve K-2 students' achievement and overall science performance (refer to tables 3 & 4, figure 1 & interview data of teachers)

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