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Abstract

This paper addresses the differences in experiences that exist among rural, suburban, and urban children and adults, and the subsequent ramifications these experiences have for standardized testing. Through a nature related experiences report survey, the parents of participating children rated the frequency of their children's science and nature interests and experiences. The survey involved ratings of the children's indirect experiences, structured direct experiences, and unstructured direct experiences. Indirect experiences would be watching television or reading books about nature, structured direct experiences would involve caring for pets, or the going to the zoo, and unstructured direct would involve experiences in nature in areas not changed by man, such as camping, hiking, or exploring. Urban children are having the most indirect, and structured direct experiences with nature, while rural children are having the most unstructured direct experiences. Parents reported on their own activities in nature as well, which determined that urban parents are having the most indirect experiences with nature, through television and literature. However, the rural parents are having the most structured direct experiences, in the form or gardening and pet care, as well as unstructured direct experiences, in the form of camping, hiking, and exploring in the great outdoors. Correlations with the student's scores on the Massachusetts Comprehensive Assessment System (MCAS) in science produced negative correlations for indirect experiences with test scores, and positive correlations for both structured direct, and unstructured direct experiences and test scores. In sum, this data supports the value of the types and frequencies of experiences children are having outside of school, demonstrating that these experiences may be influential in the children's ability to reason and perform on standardized tests.

INTRODUCTION

The goal of this research is to understand the types of activities and experiences children are having when they are out of school, and to determine if there are differences based on the types of communities they live in. Additionally, this research seeks to understand the complex influences on cognitive development. Is there an effect of developmental experiences on the mental process of thinking, reasoning, and problem solving that are utilized each day, often without conscious recognition? To have success as a student or an educator, an understanding of the components which making learning possible is essential. This understanding must involve both the strategies and the experiences that influence thinking and reasoning.

Understanding the ways in which children and adults organize their knowledge has been a subject of psychological research and theory for years. The process of cognitive organization or categorization is directly dependant on the experiences we have had. Therefore, early in life is the optimal time to study the development of cognitive organization. By studying children who have had different experiences, and different types of learning, it is possible to determine what types of experiences have an integral impact on developing cognitive functions.

Contemporary research avenues seek to address the styles and strategies that are used when making inferences; specifically, when extending what we know to what we do not know. Currently, there is a plethora of research to support that the amount of experience one has with a particular subject will influence the ways in which they make

inferences regarding that subject. The research to support this finding will be presented below; however, in order to understand the reason for this research it is essential to understand the previously accepted ideas about induction and the creation of inferences.

Effects of Experience on Adult Inductive Reasoning

Research in cognitive psychology has attempted to explain category-based induction, the process of drawing conclusions that are supported by the premises of a category, but which do not necessarily follow from them. More specifically, this is a process where given some form of stimuli, or premises, a determination is made about what would best come next, or what would best match with the premises. The past attempts to explain this process have relied on similarity between the premise and the conclusion (Osherson et al., 1990). When attempting to draw a conclusion about the strength of an inductive argument, first it is necessary to evaluate the similarity between the premises and the conclusions. For example if the premise were mouse, when asked to project a characteristic, such as a disease to another entity, one is more likely to project to a rat than to a horse, as rat is more similar to mouse than horse is to mouse. Both of the aforementioned conclusions are mammals; however, rats are taxonomically much closer to mice, than horses. The Similarity Coverage Model (SCM) proposed by Osherson et al. in 1990 discusses the use of coverage as a system to use when evaluating for strength in inductive arguments. Specifically, the SCM states that some things are common instances inside of a category, and therefore would lead you to making a generalization. As such, when generalizing to all members of a category, for example, all birds, the premise of sparrow would be more likely to lead to a generalization of ‘all birds’ than geese, as sparrows are more representative of the category birds than geese are.

The above method of making inductive inferences has been studied extensively with the population of college students, and is effective in predicting the conclusions that college students will draw. However, college students are not a representative sample of all people, and it has been shown that studying populations other than college students produces alternative strategies for drawing conclusions. The SCM relies mainly on taxonomic similarity. Taxonomy is the structured relationship that exists between members of a category. The system of the five kingdoms of the biological world is a common example of taxonomic structure. However, with increased experience and knowledge, there is an addition to the strategy, and individuals become reliant on context for further information to aid in induction. The alternative is to rely on specific knowledge about alternative relationships, which is used as a supplement to taxonomic knowledge. As a result of this deep understanding, comes an ability to utilize alternative relations beyond taxonomy and similarity.

Coley, Shafto, Stepanova, & Baraff (2005) discuss four instances in which similarity and taxonomy fail to describe the ways that adult experts are reasoning. The first of these essays describes research done by Lopez, Atran, Coley, Medin and Smith in 1997 comparing the reasoning of Mayans in Guatemala and undergraduate students in Michigan. Although both were reasoning about the mammals in their area, the Itza' have significantly more knowledge about the mammals in their region as they are relevant to life and survival on a daily basis. Thus, the Itza' served as the experts in their set of research, while the undergraduate students served as the novices.

The method used to test these groups involved pairs of either similar or diverse local mammals, which were used to draw a conclusion to 'all mammals in the area.' The

prediction was that the undergraduates would consistently choose the diverse pairs, as they predict more coverage of the category. The Itza' on the other hand would demonstrate a mixture of diverse and similar choices, as they would not use taxonomy as their only guidance when making the inference. The results showed that the undergraduates "picked the more diverse premise 96% of the time… the Maya picked the more diverse pair only 38% of the time," (p. 71). As this task involved only a choice, rather than a detailed explanation there is no way to tell if the Itza' Maya were actually using contextual knowledge. The prediction is that the Maya were using knowledge about habitats, food chains, and other available information to determine their inference, rather than relying on taxonomy, as was the case with the undergraduates.

In order to extend these findings, and determine that it was not strictly a cultural difference, a population of marine experts in Massachusetts was compared to undergraduates (Shafto & Coley, 2003). The two groups were reasoning about marine creatures, where the undergraduates served as the novices and the fisherman functioned as the experts. The format of the experiment involved a pair of marine creatures, whom either shared a novel property, or were affected by a novel disease. The participants were then asked to project which specific creature would share this property or disease. As predicted, the novices made inferences using taxonomic information for both properties and diseases. However, the experts used taxonomic relations only when reasoning about the property. When they formed inferences about the disease, they used specific knowledge about food chains to guide their decisions. Therefore, these results support the premise that with increased experience, and a rich knowledge on a certain subject,

experts will supplement their taxonomic knowledge with context specific knowledge about the premises.

Additional research by the Coley team aimed to determine if their findings could be extended beyond biology. To this end, the team recruited experts in the domain of music, and again compared them with undergraduates (Coley & Baraff, 2003). The task consisted of pairs of musicians that were either taxonomically close or far, with a listed conclusion, either to a specific artist or generally to 'all artists.' The participants were then asked to rate the relative strength of the proposed arguments. The prediction was that the novices would consistently rate the taxonomically far arguments as stronger because they are relying strictly on their taxonomic proximity to determine the strength of the argument. The further away two items are, the better they account for the differences between all possible artists, and thus they make a stronger argument. The experts on the other hand should not follow this pattern, as they are assumed to have additional knowledge that would influence their strength rating. The results showed precisely this, the novices rated the taxonomically strong arguments higher, while the experts showed little difference between their strength ratings for taxonomically strong and weak arguments. Additionally, the experts offered many interesting explanations for their ratings, stating certain characteristics of the premises in their discussions.

These findings demonstrate that for adult experts and novices, there is certainly an influence of experience and knowledge in the field, when reasoning, making strength ratings, and drawing conclusions. The effect can be described as an ability of experts to use multiple strategies when attempting to draw conclusions. Rather than rely on obvious taxonomic similarities and differences, experts will draw from their plethora of

knowledge about the premises before coming to a determination about the strength of the argument. The next step was to determine if the same characteristics would exist in children when reasoning.

Understanding the ways in which children are thinking, reasoning, and decision-making is important from a developmental standpoint, as with this understanding educators could make important decisions about curriculum design. Knowing if the characteristics seen in adults will be seen in children, would allow subsequent research into what experiences lead to expertise in a certain domain.

Effects of Experience on the Development of Inductive Reasoning

In a subsequent study by Coley, Vitkin, Seaton and Yopchick (2005) the team determined that in children there was a similar pattern in reasoning. For children with a higher amount of experience in a certain domain, there was a higher reliance on knowledge beyond strictly taxonomy. Elementary aged children were recruited from schools and after school programs throughout Massachusetts, and classified according to their community type, which distinguished between rural, urban, and suburban, by population density. The tasks included a forced choice triad, where one choice was close taxonomically while the other was close ecologically (either in habitat, or in a predator prey relationship). The children were taught that the premise either had ‘something inside’ of it or a disease, and were then asked to choose which of the targets would be more likely to have the same. The children were given 16 triads with both plants and animals, and their choices were coded as either taxonomic or ecological. The prediction was that the children from the rural communities would choose the ecological match

more frequently when they were reasoning about a disease. This predication came from the notion that the rural children would be acting as experts based on their increased experience with and knowledge about the ecological connections between the base and the targets. However, when reasoning about 'stuff inside' the children would *all* project along taxonomic lines.

As there were many variables interacting in this set of research, the results are complicated but clear. The data showed that all children were using ecological relations at an above chance level when reasoning about diseases. At the same time, when making inferences about 'stuff inside' all children projected at an above chance level to the taxonomic relation (Coley et. al. 2005). Additionally, there was an influence of community type, which demonstrates experience with nature and biology. The children from rural and suburban communities both projected ecologically about disease more than did urban children. Finally, it seems that age also has a effect as the oldest group of students, those in 4th through 6th grade are the most likely to use ecological projections for diseases. These results would suggest that experience is an integral part of the development of inductive reasoning, as those children afforded more experiences with nature, were able to reason with multiple strategies about nature.

Another study by Vitkin, Coley, and Hu (2005) attempts to describe the process in which we reason about what we do not know, when we are allowed an open response to defend our thinking. The same group of children from urban, suburban, and rural communities was used as in the research described above. In this task, the children were given two premises, which were either taxonomically close or far, and were additionally related ecologically by a predation relationship, a habitat relationship, or no relationship.

The purpose of this was to determine if children, like adults are selective when projecting about either 'stuff inside' or a sickness. The children were taught that the two premise items either had the same stuff inside, or were affected by the same disease. They were then asked to make a prediction about what other kinds of creatures would also have the stuff inside, or the disease. It was predicted that the students with increased experiences with ecological environments, would be more likely to project along interaction or ecological line, making projections to predators or prey, or animals known to live in the same habitats as the premises. For the children without significant experiences in nature, their projections would be made and defended along the lines of similarity, or taxonomy.

The results demonstrate support that all children were sensitive to the condition, specifically if it was insides or diseases they were reasoning about. All children demonstrated that similarity (taxonomic) explanations were provided for insides, while interaction (ecological) explanations were given when reasoning about diseases. The results supported that "reasoning about disease seems to make ecological relations relevant to the inference whereas internal substance provides cues for the relevance of taxonomic relations," (Vitkin, p. 5). Finally, the results also supported that rural children were more sensitive to ecological interactions between the premises. The rural children were better able to identify when a predator and prey relationships related the pair of premises, or when they could be found living in the same environment together. It seems that the increased experience with natural environments that comes with a lower population density allowed rural children to reason as experts in their environment.

The research discussed above demonstrates first that there is a clear difference in the ways that adults reason inductively. When an adult is reasoning about something

they have great experience with, they will use their increased knowledge to supplement the simple and straightforward taxonomic organization of the domain. The subsequent research by the Coley team, determined that these same differences, based on increased experience with a certain domain are seen in the reasoning of children. Thus, for children with a great number of experiences with a certain field, they are able to rely on multiple strategies to come to thoughtful conclusions.

What are the experiential differences?

The information provided above demonstrates that differences in thinking based on experiences with the subject matter do effect reasoning, and exist in both adults and children. The next step is to understand how these differences arise during development. For children, parents are supremely important in providing and structuring opportunities and experiences for their children. Parents are in the position to allow their kids to play outside, to sign them up for ballet class, or to buy them a saxophone. Children will learn from the types of activities their parents get them involved in. Those children who learn to play an instrument will undoubtedly develop deeper knowledge about music, than children who never play an instrument. Therefore, the next step is to understand and describe the differences in experiences that are contributing to differences in reasoning. What sorts of activities exactly are the ones that are making some children have differences in the ways they think about science and nature?

Kellert (2002) describes three different ways children can have experiences with nature, the first of which are ‘direct experiences,’ which occur at times when children interact with environments that have not been tampered with by humans. Furthermore,

the direct contact must be with “plants, animals, and habitats that function, for the most part, apart from continuous human input and control,” (Kellert, 119). These must be relatively spontaneous experiences as well, not those planned an executed with purpose. He cites times when children play in the backyard, or nearby brook, or field as direct experiences.

Kellert goes on to describe the next level of experiences, as ‘indirect experiences,’ which still entail physical contact with nature but the context has now been altered and is controlled by humans. He states, that these indirect experiences are “usually the product of deliberate and extensive human mastery and manipulation,” (Kellert, p.119). Children will have these indirect experiences in situation like zoos, aquariums, museums, and nature centers. Additionally, experiences with household plants or gardens would be in this category, situations where human maintenance is essential. Finally, interaction with pets would fall into this category. As pets are animals that are domesticated to be in a home, and a member of a family; however, they still maintain the inherence of being from another species.

The third and final form of natural experience described by Kellert is ‘vicarious or symbolic experience,’ the fundamental difference being there is no actual contact with animals. He describes how when a child has a vicarious experience the interactions are with a “representation or depicted scenes of nature that sometimes are realistic but that also, depending on circumstance, can be highly symbolic, metaphorical, or stylized characterizations,” (Kellert, p.119). Common examples of this type of experience would be television shows, films, computer programs, books, and magazines. While the types of vicarious images children see today are extremely sophisticated in some cases, the idea

of representing nature is certainly not new, and at some point in the past was very simple. Although some of these types of experiences may be seen as superficial and troublesome, there are certainly vicarious experiences that are often extremely educational.

An additional part of the aforementioned research by the Coley team is a time use, experience, and interest questionnaire. For each child tested, there was a take home survey for the parent to complete about their child's interests and activities. This paper will discuss, extend, and analyze the interest and experience information collected from the children. Then it will be possible to determine the types of experiences that lead young children to develop expert like knowledge about their environments.

For the purposes of the survey, the names of the experiences described by Kellert above have been changed, but the content remained the same. The parents were asked first about *indirect experiences* with nature: watching television about nature, reading about nature, or using educational computer programs about nature. They were next asked about *structured direct experiences:* care of a pet, care of a house plant, involvement in gardening, trips to the zoo, picking fruits, feeding animals in a park and others. Finally, the parents were asked about *unstructured direct experience*: camping, hiking, swimming, hunting, or exploring in nature. Parents rated the frequency of each example between occurring everyday, to never occurring, with five additional frequencies in between.

The goal of this paper will be to understand how experiences differ for the children from differing communities: rural, suburban, and urban. Once the differences in interest and experience are known, the extension will be to understand any connection between certain experiences and differences in school performance. Test scores will be

used to measure school performance for comparing between urban, suburban, and rural students. This will further the conclusion found above, that children's thinking is developing differently as a result of the types of biological and ecological experiences they are having.

Testing Differences: Ramifications of Experiential Differences

Testing is presently used in the field of education to assess and monitor the progress of the students as well as the effectiveness of teachers; however, many students are not successful with the current models of testing used to assess them. Educational testing has children demonstrate their ability to make inferences, as the questions are rarely as straightforward as simple fact recall, or even recognition. Instead, tests are designed with intrinsic complexities, with certain answers used merely because they are only slightly incorrect. To be successful on current standardized tests, students must take what is given in the question, interpret what is being asked, and pick the *best* answer available to them. All in all, performing well is a complicated process for even the most seasoned test taker.

The use of testing the in realm of education has grown significantly in the past 10 years as there are now benchmarks and standards that students must show proficiency with. The Federal government has outlined that by the year 2014 all students in the United States will be proficient in both English language arts (ELA) and mathematics. As a result of this statement made in the No Child Left Behind Act, the state of Massachusetts has set up standards for making adequate yearly progress (AYP) towards these proficiency goals. The students are assessed annually between the third and eight

grades and their progress determines if they move on to the next grade level. In the fifth grade, they are tested on Science and Technology, in addition to ELA and math. According to the Massachusetts Department of Education, in 2005 only 51% of the 73,046 students who took the Science and Technology test received passing grades (www.doe.mass.edu).

The following chart provides a breakdown of how the students from the districts used in this study are performing on the Science examination for the past two years.

Table 1: MCAS Science results by district for 2004 and 2005

District Name	Classification	2005 MCAS data		2004 MCAS data	
		# of students	% passing	# of students	% passing
Arlington	Suburban	359	82	352	81
Belchertown	Rural	190	51	222	66
Boston	Urban	4095	17	4462	22
Brookline	Suburban	398	60	435	60
Florida	Rural	12	16	12	58
Lynn	Suburban	1017	29	1091	29
Medford	Suburban	353	55	352	46
Roxbury	Urban	4095	17	4462	22
Petersham	Rural	20	45	13	70
Salem	Suburban	314	36	404	45
Walpole	Suburban	279	71	297	72

The table shows that of the three community types, the suburban school districts are demonstrating the most success with the Science exam. The urban school district, which encompasses six different programs that we surveyed, is demonstrating the least

success with the exam. The rural school districts are demonstrating midline success with the exam, some districts passing and performing while others are not.

The differences demonstrated above could be explained in countless different ways. It could reveal the differences in English language proficiency found in rural and urban districts. It could be a matter of differences in the level of parental involvement. It could reflect differences in socio-economic status. It could demonstrate the effectiveness of teachers in each area. It could be a result of differing experiences for children in urban and rural areas. The ability of children living in rural areas to have direct experiences in nature is far greater than the ability of urban children to have those same experiences. This paper examines whether experiential differences may be one factor contributing to the discrepancy in test performance between suburban, urban, and rural school children.

The information presented in the data has shown two facts thus far. The first is that experiences will affect the ways in which we think and reason about what we know. The second is that there are clear differences in the ways that children from different types of communities are performing on standardized tests. The next step is to see if there is a connection between these two findings, which is the goal of this research. If the parental surveys from the research demonstrate a systematic difference in the experiences of children relative to community type, it may serve as an explanation for the difference in tests scores relative to community type. Moreover, this will explain how children are forming multiple strategies to reason about their environment as a result of how they spend their time. These additional strategies will help to describe how the ways in which they spend their time are influencing their ability to succeed on mandatory tests.

Attempting to determine what is necessary for school success is essential to making education equal. There is no question that students do not come from places of equality, where they are afforded equal experiences. As such, it is of great interest to understand what characteristics of home life and out of school experience are associated with students experiencing success in a school environment. According to Israel, Beaulieu and Hartless (2001) there are certain factors associated with school success. They utilized three measures to describe educational achievement: test scores, grade point average, and length of time spent in school. Their results yielded that, "children whose mother or father attended college scored higher on all three measures (53)." Additionally, in families where parents have conversations with their children about attending college, those students are more likely to attend college. Finally, if parents limited the amount of time children were allowed to watch television, those children were more likely to have these conversation about school and college with their parents.

This paper hopes to determine similar patterns and descriptions of activities as the above research, with a focus more on the activities of children in nature. Based on the parents' descriptions of behavior, it may be possible to find certain patterns in time use, and thus to promote certain experiences to lead to school success and success on standardized tests for more children. For educators, it would be immensely important to understand the types of experiences that lead to success in school. For parents, who ultimately have the most effect on what and how children spend their time, this research is extremely relevant. Parents, who actively seek to promote their children's learning, will be interested in ways they can support and encourage their children.

Investigating how children and adolescents spend their time is nothing new to researchers, who have for years sought to understand what patterns can be seen in how time is spent and what can be correlated with certain usages of time. In a longitudinal study conducted by Wright et. al. in 2001, their three years of study produced intriguing results about the effects of television viewing on the development of early educational skills. The children were followed for three years, during which time they used a diary to describe the amount of time spent watching television, and to document what types of programs were being viewed. An interesting set of results provided strong evidence for benefits to children viewing programs aimed at their age level. These children showed higher performance on reading, math, receptive vocabulary, and school readiness measures than children who were watching programs for general audiences. Programs for general audiences are shows that have no implicit educational messages, and are produced simply for viewing enjoyment. Lastly, their data showed that children who scored higher were more likely to continue to make television choices to encourage their academic development as they grew older (Wright et. al., 2001).

These last two studies support certain activities as effective in encouraging school performance and readiness. The above evidence has been shown that parents who have consciously limited the amount of television their students watched are fostering conversations about school and college for their children. Additionally, research has supported with multiple measures that television shows that are age appropriate can help young children be more prepared for school. Is it possible that other experiences children take part in are also affecting their school success? With an analysis of parental reports

on their children's experiences it will be possible to determine how we can best encourage educational growth.

As the students in suburban populations are having the most success with science standardized tests, could be a result of a high frequency of experiences with their natural environments? The rural populations are also demonstrating moderate success with the science exam, and therefore are they also experiencing a high frequency of experiences? The urban children are demonstrating very little success with the science examination is this a result of their lack of experiences with their natural environment? These predictions do not line up exactly with the induction results that have been determined thus far by the Coley team. Those results state that rural children have developed the most depth in their reasoning strategies, flexibly using more than just taxonomy. The skills being tested on the state examination must be different than the tasks in the inductive reasoning tasks, or else we would see the rural children having the most success on the state exams. To reconcile the differences seen between the Coley results and the state test results, the prediction is that the suburban children will have the most experiences. They will have the most for both structured direct and indirect experiences, which is influencing their ability to perform on the exams. The rural children, who will show the middle amount of indirect, and structured direct, will show the most unstructured direct experiences. It is this combination of experiences that will produce midline success on the exams. Lastly, the urban children have the lowest frequency of all three types of experiences with natural environments, and this is influencing their low amount of success with the test.

These predictions come from theories about life styles in various community types. For rural children, they will demonstrate the most unstructured direct experiences for the obvious reason, that these types of experiences are salient and relevant for them. They live in areas with the lowest population density, and therefore have the most likelihood of being able to walk outside and experience nature in a pure form. Suburban children may live in areas where this is possible, and they may not, which is an explanation for their ranking in the middle of the unstructured direct category. Urban children, unfortunately, are not afforded as many opportunities to walk outside and find rich environments that have not seen the hand of man. As a result, they will have had the least experiences of this type.

Next, the structured direct experiences are the hardest to predict. There are many different types of experiences found in this category, from zoos and aquariums to gardening, and apple picking. As a result, it is hard to predict which group will have the highest frequency of experiences in this category. Some of these experiences are only found in urban areas (zoos and aquariums), but they certainly do not come without a cost. However, other experiences in this category can only be found where there is space for them, such as apple orchards, and horseback riding.

The prediction is that suburban children will most frequently report these experiences. This prediction is a function of proximity and affluence. Suburban families will be in a position to take their children to the zoo, and aquarium, as they close enough to urban areas, and are most financially able. The rural children will be in the middle frequency for these types of experiences, as again the places they live may afford them a greater chance of having these types of experiences. Apple orchards, farms, and nature

centers are likely to be found in rural areas. Finally, the urban children will have the fewest of these experiences, as they are likely to be less financially able to attend the pricey aquariums and zoos, but also live far from orchards and gardens.

The last type of experience in the survey is the indirect experiences. It is predicted that suburban children will also have the most indirect experiences again as a result of financial ability. These parents will be able to provide expensive computer programs and books for their children. The rural children will demonstrate the mid level of frequency with these experiences, and the urban children with the least.

METHOD

Participants

The participants in this study will be the 155 children studied in the research discussed before conducted by Coley through Northeastern University. This number does not reflect all the children who were studied, but in actuality reflects those whose parents returned the survey regarding their activities. The children are all from kindergarten through sixth grade in various communities throughout Massachusetts. For the purposes of the comparison between rural, suburban, and urban, the children have been placed in groups based on the relative population density of the community they live in. The breakdowns of population densities are shown on the chart that follows:

Table 3: Community Classification type by population density

Population Density People/square mile	**Classification**
22-263	Rural

6581-8410	Suburban
13488	Urban

The students who participated were those who had returned a completed waiver signed by their parents, stating the purpose of the research being done. Most of the interviews were conducted in the context of school or after school programs. Therefore, the parental permission and participation in an after school program were the two factors involved in finding subjects for this research. The subjects for this specific research involve those for whom an activities survey was completed and returned, as not all parents returned the survey. The following table demonstrates the breakdown of children in each grade, in each community type.

Table 4: Number of Students in each Community and Grade who Returned a Completed Activities Survey

Grade	Urban	Suburban	Rural	Total
Kind.	11	2	8	21
1st	7	6	16	29
2nd	4	15	9	28
3rd	3	10	15	28
4th	4	11	12	27
5th	5	1	11	17
6th	0	0	5	5
Total	34	45	76	155

Materials

The materials necessary to conduct this research will be the aforementioned parental report surveys collected for each child at the time of research. A full survey can be found attached as Appendix A. An analysis of the way each child spends their time will be done using the categories as presented in the survey: indirect experiences, structured direct experiences, and unstructured direct experiences with nature. The time use will be determined for each child individually, however; the results will discuss the three groups of children as a function of their community type.

The survey completed by the parents had several sections, the first section involved a general list of interests, and the choices very interested, somewhat interested, and not interested. These were scored with 3, 2, and 1 respectively. To analyze the interest section the average interest for each group will be generated by the information about each child's specific interest ratings.

In the next section the parents evaluated the frequency of the child's participation in activities of the three different types of experiences (indirect, structured direct, and unstructured direct). The rating was done on a scale of one to seven, shown below:

1→ never

2→ 1-2 times per year

3→ 3-10 times per year

4→ 1-2 times per month

5→ 1-2 times per week

6→ 3-5 times per week

7→ everyday

As the rating are on a 7 point scale, the analysis will involve taking the mean of how often each activities was participated in by each member of the three differentiated groups. This will produce three scores for each activity, an average score for each of the three community types. Moreover, a higher score for a particular group for a particular type of experience reflects a greater frequency of participation in the experience in question. The last piece of analysis on the survey will be to describe the parents' ratings of their own experiences. This section is a very condensed version of the activities the parents evaluated their children on. It was the same scale, of 1-7 described above and included ten activities, a few of each of the three types.

Additionally, data found on the Department of Education for Massachusetts will also be used, to determine specifics about passing the science examination for all of the school districts the participants came from.

Design

The design of this research will have two parts, the first of which will be using descriptive statistics to compute the average value of interests, and activities for each group: rural, suburban, and urban. This mean will be produced for both the children and the adults for each experience. The second portion of the analysis will use inferential statistics to discuss the effects of experience on test scores. As the survey was designed to address children's experiences with nature, plants, and animals it will be used as a tool to determine if there are experiences that lead to higher levels of success on the state examinations of science knowledge.

RESULTS AND DISCUSSION

Children's Interests

The first portion of the parental report survey involved a ranking of children's interests in twenty seven different activities, on a scale of not interested, somewhat interested, or very interested. The activities are listed in the attached survey. The analysis involves a calculation of means for each activity. Each of the three interest levels was given a numerical ranking, 1 for not interested, 2 for somewhat interested, and 3 for very interested. There were three means determined for each activity, one for each of the three community types. This allowed the interests to be compared with one another, focusing specifically at differences that are existent between the children of each community. The activity ranks for each community are summarized on the table below:

Table 5: Children's Interests by Ranking and Community Type

Interest	Rural Ranking	Suburban Ranking	Urban Ranking
Playing Outdoors	1	1	1
Animals	2	2	--
Movies/DVDs	3	5	2
Art/Drawing	5	--	3
Exploring Outdoors	3	4	--
Music	5	3	4
Sports	--	--	4
Using Computers	--	--	4

The analysis revealed that both rural and suburban children have a narrower set of interests when compared to urban children. When filtering the list for activities with a mean interest level or 2.50 of above, a value that represents the most children in the area are interested in the activity in question. The rural children had 11 interests, and the suburban children had only 9 interests. The urban children on the other hand, had 15 interests that their parents ranked as 2.50 or above. This demonstrates that rural and suburban children have a few concentrated areas of interest, while urban children it seems have a diverse set of interests.

Looking specifically at rural children, their top interest with a value of M=2.80 is playing outdoors. They are also very interested in animals with their interest ranking of M=2.68, this is their second most frequently reported interest. The next two interests, exploring outdoors, and watching DVDs and movies, tied with a value of M=2.66. They are also interested in drawing and music, both interests were rated as M= 2.63. Rural children are also interested in caring for their pets, hiking and camping, and reading.

The picture of suburban children's interests is very similar to that of the rural children. Their highest rated interest is also playing outdoors, with a value of M=2.85. Additionally similar, is their second highest ranked interest, which is in animals, with a value of M=2.75. Suburban children reported music as their next highest interest, with a value of M=2.69. Their fourth highest ranked interest was exploring the outdoors, M= 2.67 and finally, movies and DVDs with a value of M=2.65. Suburban children also reported drawing, reading, using computers, and caring for pets as other interests.

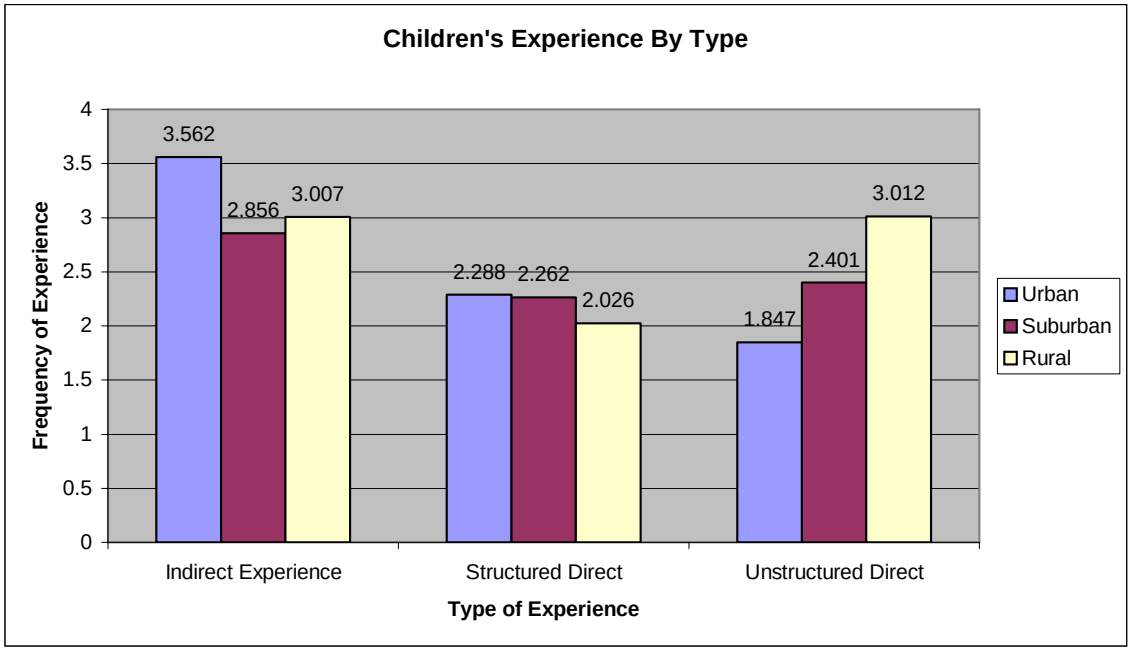
Urban children report far and away the most frequency of interests. This may be because their environment affords them contact with many different opportunities, as well as contact with people who have many interests. Urban children also rated playing outdoors as what they are most interested in, with a high value of M=2.96 respectively. Their parents report that watching movies and DVDs is their next highest interest, with a value of M=2.79. Drawing was the third highest ranked interest for urban children with a value of M=2.75. Finally, there was a three-way tie for the next level of interests between music, sports, and using computers. Urban children have a plethora of other interests including animals, reading, video games, television, caring for pets, exploring outdoors, science, and electronics.

This analysis of interests displays that the children we studied are different, but have a lot of similar interests. Children living in suburban and rural areas seem to have fewer more concentrated interests, while urban children seem to have a broad but equally strong, if not stronger interest in many of the same things. Interesting to highlight is the fact that the top interest for *all* children is playing outside. Furthermore, both rural and suburban children are interested in exploring outside and animals. This is a significant amount of interests that are nature related or biological for the rural and suburban children. The urban children are very interested in playing outdoors, however their other interests do not involve nature to the same extent at their rural and suburban peers. Now that we can see what it is that children are interested in, it is necessary to look at what kinds of experiences they are actually having, and how often they are having them.

Children's Experiences

All of the information in this section has been derived from the parental report survey, which is attached. The data comes from averaging the frequency ratings for each kind of experience for rural, suburban, and urban children. The analysis conducted was a 3 (community: urban, suburban, and rural) by 3 (experience: indirect, structured direct, unstructured direct) ANOVA on the parental reports of frequency. As predicted, the 3 x 3 ANOVA revealed that there is an interaction between community type and type of experience, shown by $F(4, 165)=30.999$ and $p<.0001$. In other words, the types of experiences that children are having, is related to the community they live in. This information can be seen below in Figure 1.

Figure 1: Children's Average Experience Frequency Ratings by Type and Community



Indirect Experiences

To begin, we will look at indirect experiences, which are those that involve plants, animals, and nature, but are not with real items. This type of experience includes watching television about nature, reading books about nature, or playing with animal toys. We examined children's indirect experience using a one way analysis of variance (ANOVA), and found the main effect of community on indirect experience was significant with an $F(2,165)=5.86$, $p=.0035$. The differences in the means for each group can be seen in Figure 1. Urban children are having the most indirect experiences ($M=3.56$), followed by rural children ($M=3.01$), and then suburban children ($M=2.86$). The use of a Fisher's PLSD analysis of the means determined that the frequency of the urban children's indirect experience is higher than the experiences of either rural or suburban children, with significance levels of $p=.0062$ and $p=.0010$ respectively. The frequency of indirect experience for the rural and suburban children did not differ from each other significantly.

In order to understand fully the differences between the three community types, a detailed look at the frequencies of indirect experiences occurs below. The discussion of the frequencies of indirect experiences that children are having is summarized in the table below, and described in the paragraphs that follow.

Table 6: Children's Five Most Frequent Indirect Experiences by Community Type

Indirect Experience	Rural Ranking	Suburban Ranking	Urban Ranking
Animated Movies	1	1	2
Animated Shows about Nature	2	2	1

Playing with Mini Animals	2	4	--
Children's Educational Program	--	3	3
Entertainment Programs w. Animals	4	4	5
Informative Books about Nature	--	--	4
Live Action Movies w. Animals	5	--	--

First, looking at rural children the most common indirect experience was watching animated movies (*M*= 3.79). The next two most frequent activities for rural children both with a value of *M*=3.64, are playing with miniature animals, and watching animated shows about nature. After that rural children are watching entertainment programs about animals (*M*=3.60), and live action movies about animals (*M*=3.53). These results show that the indirect experiences rural children are having with nature almost entirely revolve around the television, either in the form of movies or television programs.

For suburban children the picture of their experiences is very similar to that of the rural children. The most frequent indirect experience is watching animated movies, with a value of *M*=3.65. The second most frequent experience is watching animated shows about nature (*M*=3.51); furthermore, a close third is watching children's educational programs (*M*=3.47). For suburban children the next most frequent indirect experience is a tie between playing with miniature animals, and watching entertainment programs with animals, both with a frequency of *M*=3.41.

The picture for urban children shows a similarity in the types of indirect experiences as suburban and rural children; however, urban kids are having those experiences more frequently. The top indirect experience for urban children is watching animated shows about nature (M=4.66). Animated movies are the second highest indirect experience, with a value of M=4.62. Watching children's educational programs was rated next most frequently with a value of M=4.24, and reading informational books about nature, followed closely with a value of M=4.17. Finally, watching entertainment programs with animals are the fifth most common indirect experience for urban children with a mean value of M=4.07.

This analysis shows that for indirect experiences suburban and rural children are similar not only in the types of activities they are doing, but also in the frequency they are doing them. The means of indirect experience frequency can be seen in Figure 1. This information means that on average, urban parents are giving ratings of 4 or more, meaning 1-2 times per month for each of the top five ranked activities. The mean values for rural and suburban parents are smaller, meaning they show that the most frequent indirect activity on average happened between once and twice a month (a rating of 4) and 3 to 10 times per year (a rating of 3).

In analyzing these results, it is clear that all the children are for the most part getting their indirect experiences from the television, in one form or another. The only exceptions are that urban and suburban children are having experiences reading educational books about nature, and suburban and rural children are playing with miniature animals. That means that 4 of the 5 top rated indirect experiences and activities that all children are having, are occurring in front of the television. Of this television

time, only the children's educational programs that the children are occasionally watching, can truly be classified as furthering education. While the other types of television entertainment contained nature, animals, or plants in one form or another, it was not in an educational form aimed at teaching a lesson, or making a point. This information speaks to the fact that for this generation of youngsters more than any other in the past, the television is a very significant factor in their daily activity.

Structured Direct Experience

Next will be a discussion of structured direct activities, which involve nature but have been contrived for that purpose. Some examples of structured direct experiences would include going to the zoo, walking in public parks, or horseback riding. The first analysis done on the structured direct experiences was a one way ANOVA to determine if the experiences of the students were different, and if the differences were significant. The results found show that there is a main effect of community on structured direct experience, with an $F(2, 165)=5.532$, $p=.0047$. This information can be seen graphically on Figure 1. For structured direct experiences, urban children are having the most ($M=2.29$), followed by suburban ($M=2.26$), and then rural children ($M=2.03$). More specifically, the Fisher's PLSD revealed that the differences in the frequencies of structured direct experiences are significant. Rural children are have a lower frequency of structured direct experiences than the suburban, or urban children, with significance levels of $p=.0052$ and .0093 respectively. The differences between the suburban and urban children were not statistically different.

The discussion of the frequency of structured direct experiences that children are having is summarized in the table below, and described in the paragraphs that follow.

Table 7: Ranking of Children's Structured Direct Experiences by Community Type

Structured Direct Experience	Rural Ranking	Suburban Ranking	Urban Ranking
Exploring a Backyard	1	1	2
Walking in a Public Park	3	2	1
Watching Birds at a Birdfeeder	2	3	--
Going to a Pet Store	--	4	3
Going to a Farm	4	5	--
Going to the Zoo	--	--	4
Going Berry Picking	5	--	--
Going to the Aquarium	--	--	5

Initial analysis of the structured direct experience data shows again that rural and suburban children are having very similar types of experiences. For rural children exploring the backyard was above and beyond the experience most frequently had, with a value of M=5.12. Next rural children are watching a bird feeding at a birdfeeder with a frequency of M=3.85. Rural children are walking in public parks and going to farms with frequencies of M=3.07 and M=3.00 respectively. Finally, children in rural areas are having the opportunity to go berry picking with a frequency of M=2.78, or a few times a year. Combined with the fact that some rural children are on farms about 3-10 times a year, it seems that some rural children live very near to orchards, farms, and fields.

The experiences of suburban children are similar to the experiences of rural children; however, they are not occurring as frequently. Exploring the backyard is the most frequent structured direct experience that suburban children are having, with a frequency of M=4.44, which means on average more than 1-2 times per month. Walking in public parks is the second most frequent experience, with a value of M=4.00. Watching birds and going to pet stores are also common structured direct experiences for suburban children, occurring with values of M=3.29 and M=2.79 respectively. Finally, suburban children are going to farms with a frequency of M=2.50, meaning only a few times per year on average.

Urban children have slightly different experiences than either of the other two groups, and their experiences are occurring a little less frequently. Their most frequent structured direct experience, with a value of M=3.96 is walking in a public park. Exploring in the backyard is their second most frequent experience; with a value of M=3.39, it is occurring on average a little more than 3-10 times per year. Urban children are also visiting pet stores with a frequency of M=2.70, according to the survey returned by their parents. Finally, urban children are visiting the zoo and aquarium with frequencies of M=2.48 and M=2.43 respectively. Meaning that more than twice a year, they benefit from the learning that is possible in these settings, while neither the suburban children nor the rural children are having these experiences in their top five ranked experiences.

To discuss the differences and similarities present in the analysis of structured direct experiences is to speak about the differences in the availability of certain resources as a result of the location where you live. It is clear that rural children are visiting farms,

and orchards, with a frequency that neither of the other groups is able to. This is a direct result of their location. Urban children do not have a farm or an orchard readily available to them in the city and thus are not having these experiences. The same goes for the fact that rural and suburban children are not necessarily visiting the zoo and aquarium in the same frequency as the urban children, because you find those establishments in metropolitan areas. It is surprising that urban children are able to explore the backyard as frequently as they do, as many children do not live in places that have accommodating backyards.

Unstructured Direct Experience

The last discussion will be about unstructured direct experiences, which are real experiences in the natural world. Examples of unstructured direct experiences would be snorkeling, exploring, hiking, camping, and fishing. The one way ANOVA conducted on the unstructured direct experiences determined again, that there is a main effect of community on unstructured direct experience, with an $F(2,165)=33.038$, $p<.0001$. The display of the children's means for each type of experience can be seen in Figure 1. The rural children are having the most unstructured direct experiences ($M=3.01$), followed by the suburban children ($M=2.40$), and then the urban children ($M=1.85$). Furthermore, the differences between the rural children and both the suburban and urban children are significant at the $p<.0001$ level. The differences between the suburban children and the urban children are significant at the $p=.0005$ level.

The discussion of the frequencies of unstructured direct experiences that children are having is summarized in the table below, and described in the paragraphs that follow.

Table 7: Ranking of Children's Unstructured Direct Experiences by Community Type

Unstructured Direct Experience	Rural Ranking	Suburban Ranking	Urban Ranking
Exploring a Field	1	1	3
Exploring a Forest	2	2	--
Exploring a Lake	4	4	1
Visiting a State/National Park	--	--	2
Exploring Tidal Pools at Seashore	--	3	1
Exploring a River, Creek, or Stream	3	--	3
Collecting Bugs	5	5	--

Overall the experiences of the three groups of children are similar in type; however, as seen above when the frequency is examined, the differences become apparent. The urban children are not having these experiences as frequently as the suburban children, and suburban children are not having these experiences as often as rural children. The rural children are exploring a field a frequency of M=3.79, which means on average once a month. There are exploring the forest with almost the same frequency (M=3.78). They are exploring rivers, streams, and creeks with a frequency of M=3.68 and exploring lakes with a frequency of M=3.51. Finally, they are collecting bugs between three and tens times a year on average, as demonstrated by the value of M=2.92.

The suburban children have the same top two experiences, exploring fields, and forests; however, the values are M=2.93 and M=2.80 respectively. The suburban children are geographically closer to the ocean than the rural children, and therefore their third most frequent unstructured direct experience is exploring tidal pools at the seashore, with a value of M=2.72. Suburban children are then exploring lakes with a frequency of M=2.70. Finally, suburban children are collecting bugs a few times a year, with a value of M=2.57. As shown, the experiences are very similar in type to the rural children, but are not happening as frequently.

The top unstructured direct experiences for urban children are exploring tidal pools and lakes. Both are happening with an equal frequency of M=2.16, which means on average it is happening about one to two times per year. Urban children are visiting state parks with the next highest frequency, which is a value of M=2.08, still about one to two times per year. Neither rural nor suburban children had visiting state or national parks in their top five unstructured direct experiences. Finally, the next two experiences, exploring fields, and rivers, streams, or creeks were also a tie for urban children, with a frequency of M=1.92.

Summary of Children's Experiences

In summary of the discussion of children's experiences, these differences in frequency can likely be explained by the large role that geography, and the location one lives can play in dictating and structuring the types of experiences, especially unstructured direct experiences one can have. There are more fields, lakes, streams, forests, and other wide open spaces in rural areas than in either of the other two

community types. It is clear that urban and suburban children are playing near the ocean more than their rural counterparts, because of their proximity to the ocean. Therefore, geography is playing a significant role in dividing the frequency of unstructured direct experiences; furthermore, geography is also interacting and influencing the type of experiences a child can have as well.

These results differ from the predicted breakdown about which groups would be having each experience in the highest frequency, which was made above in the introduction. The prediction above stated that urban children would be having the lowest number of all types of experiences, which turned out to be untrue. In fact, urban children are having *the most* of both indirect experiences and structured direct experience when compared to all the children in the sample. They are however having the least unstructured direct experiences.

For suburban children the prediction was that they would be having the most of both indirect and structured direct experiences. In reality, they are not having the most of any experiences. They are having the middle number of experiences for all three types. The prediction that they would be having the middle amount of unstructured direct experiences was the only correct prediction made.

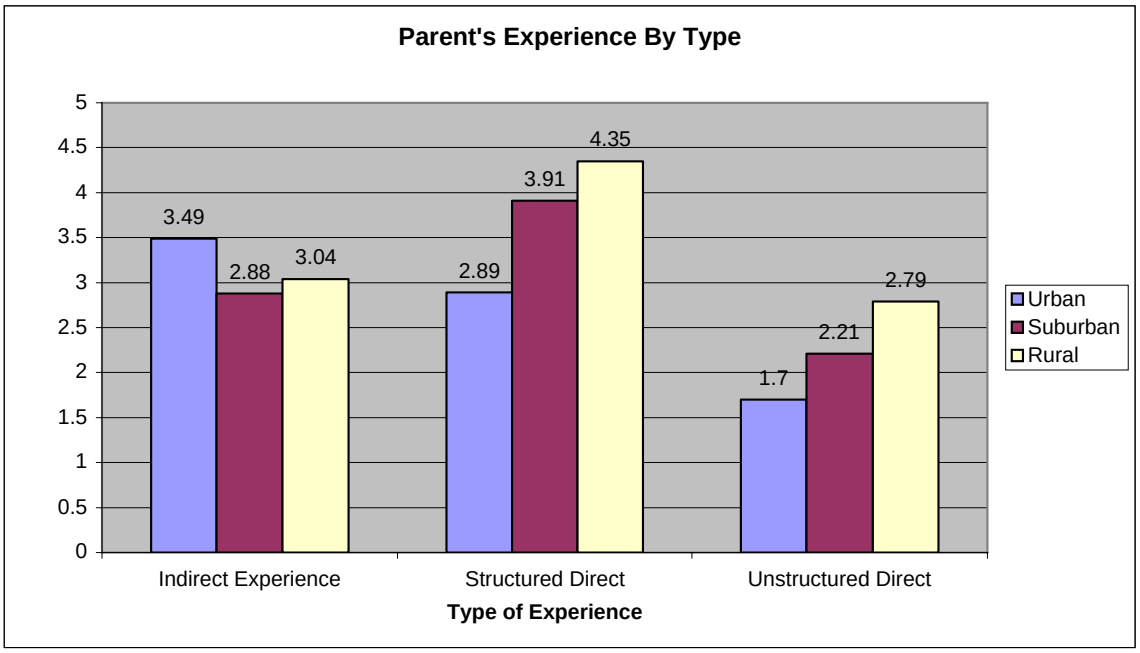
For rural children, the prediction was that they would be in the middle for indirect and structured direct, and would be having the most of unstructured direct. The prediction was correct for indirect experiences; rural children are in fact in the middle of the spectrum. The prediction was also correct for unstructured direct experiences as the rural children are having the most. However, for structured direct experiences, rural children are having the least, which differed from the prediction.

As stated above geography is playing a huge role in the ability of children to have the experiences listed for structured direct, and unstructured direct. Therefore, the location of many of the rural children has allowed them to have a higher number of experiences that require wide open spaces. The result for structured direct and indirect experiences were both considerably different from the predictions made, which comes an unexpected surprise.

Adult's Experiences

The end of the survey had a brief questionnaire for the parents to rank how often *they* were participating in some of the experiences they ranked their children on. This portion was only one short page, and included ranking on four indirect experiences, five structured direct experiences, and four unstructured direct experiences. The same analysis was done for the frequencies with which the parents report their experience. A 3 (community: urban, suburban, and rural) by 3 (experience: indirect experience, structured direct experience, and unstructured direct experience) ANOVA determined an interaction between community type and type of experiences, shown by $F(2,163)=12.090$, $p<.0001$. Figure 2 shows the graphic representation of the frequencies of the means for each community for each experience.

Figure 2: Parent's Average Frequency Ratings by Type and Community



Looking further at each experience individually, the one way ANOVA determined that the difference between the parents' indirect experiences were not significant on a whole, $F(2, 163)=2.721$, $p=.0688$. The urban parents were having the most indirect experiences ($M=3.49$), followed by the rural parents ($M=3.04$), who were followed by the suburban parents ($M=2.88$). However, looking deeper, the differences specifically between the suburban and urban parents was significant, as $p=.0221$ using the Fisher's PLSD. The differences between the rural and suburban as well as the differences between the rural and urban were not statistically significant.

The one-way ANOVA run on the parents' structured direct experiences produced an $F(2, 163)=15.49$, $p<.0001$. This means that there is a significant main effect of community type on the frequency of structured direct experiences for parents. The rural parents are having the most structured direct experiences ($M=4.35$), followed by the suburban parents ($M=3.91$), followed by the urban parents ($M=2.89$). Looking more

closely, the rural parents are statistically different from the suburban parents, with a value of p=.0419. The rural parents are also different from the urban parents with a significance level of p<.0001. Finally, the suburban parents are different from the urban parents with a significance level of p=.0003.

Lastly, the one way ANOVA run on the unstructured direct experiences of the parents again revealed a statistically significant result of $F(2, 163)=27.471$, p<.0001, showing again a main effect of community on experience for parents. Rural parents are having the most unstructured direct experiences ($M=2.79$), followed by suburban parents ($M=2.21$), and then urban parents ($M=1.70$). The difference between the rural and suburban parents demonstrated by the Fisher's PLSD is significant at the p<.0001, as is the difference between the rural and urban parents. The difference between the suburban and urban parents is significant at the p=.0016 level.

Overall, the parents when compared between the community types the rural and suburban parents are participating in nearly all the same experiences, with differing frequencies. The urban parents on the other hand have a slightly different set of experiences from the other two groups of parents. The following table shows the experience frequency information, which is followed by a subsequent discussion of the top five experiences for each group.

Table 8: Parent's Top Experiences by Community Type

Experience	Rural Parents Rank	Suburban Parents Rank	Urban Parents Rank
Caring for Pets	1	1	1
Caring for House	3	2	2

Plants			
Flower Gardening	2	3	--
TV about Nature	5	4	3
Vegetable Gardening	4	5	--
Videos about Nature	--	--	4
Reading Fiction about Nature	--	--	5

Rural Parents

The top five experiences of rural parents fall almost entirely into the category of structured direct experiences, with the exception of the last one, which is indirect. The most common experience is to take care of pets, which rural parents rated as occurring many times a week, with a frequency value of M=5.92. Rural parents are working in flower gardens with a frequency of M=4.81 as well, meaning this is occurring several times each month. Next rural parents are taking care of their houseplants with a value of M=4.51, and working in their vegetable gardens with a value of M=.85. Overall, they are having many structured direct experiences many times each month. Finally, they are watching television programs about nature with a frequency of M=3.76. This final experience is an indirect experience, which rural parents rate as occurring only a once or twice a month on the average.

Suburban Parents

The top five experiences for suburban parents are exactly the same as the top five experiences for the rural parents, they just occur in a different order. The highest rated experience for suburban parents is also taking care of their pets, with a frequency of M=5.19. Next they are taking care of their houseplants, with a value of M=4.87. They are working in their flower gardens with a frequency of M=4.28, which means on average a few times a month. Next suburban parents are watching television programs about nature with a frequency of M=3.35. Finally, their fifth most frequent experience is working in their vegetable gardens, which occurs M=3.04 times a year, or somewhere between 3 and ten times per year.

Urban Parents

The experiences of the urban parents are different from the experiences of the rural and suburban parents, who are very similar to each other. The urban parents are having more indirect experiences than any other type of experience. Their most frequent is the same as the others, taking care of the pets, with a frequency of M=4.25. They are next taking care of their houseplants with a frequency of M=4.21. They are watching television programs about nature with a value of M=3.96. Finally, they are watching videos about nature, and reading nonfiction about nature with the same frequency of M=3.43 respectively. This demonstrates that three of the five top experiences for urban adults are indirect experiences. The difference between the types of experiences for the urban parents from the other parents is likely due to the facts that most urban parents do not have the availability of land to have any type of garden in the city. Furthermore, their

access to places to hike, camp, raft, or explore nature is limited by their geographical location. However, they are having educational indirect experiences regarding nature.

In conclusion of the discussion about the types and frequencies of parental experiences, it seems that they are following a similar pattern to the experiences of their children. Rural parents are having the most of unstructured and structured direct experiences, while urban are having the most of indirect experiences. Thus the difference between the experiences of the parents and the children is in the structured direct experiences. Furthermore, the types of experiences for all the parents are similar; it is the frequency that the experiences are occurring that is different. Overall, this is very similar to the results seen for the experiences of the children as was shown above.

Effects of Experience on Test Scores

To begin the discussion of test scores, it is essential to note that at any time there are countless factors that are interacting to affect the performance of any one single student on any given exam. The data presented below is in no way attempting to simplify the interaction of factors to one single dimension. The analysis below is more to describe the types of experiences that *may* have a positive effect on the performance of children on one measure of their scientific knowledge. The survey used with these children only takes into account their experiences in nature, and therefore would only reflect any impact onto questions regarding ecosystems, plants, animals, etc. It would have little effect on questions regarding the chemical, physical, or molecular aspects of science. Furthermore, this analysis is offered as a means of understanding what some children may be doing to improve their performance. It is in no way drawing far ranging

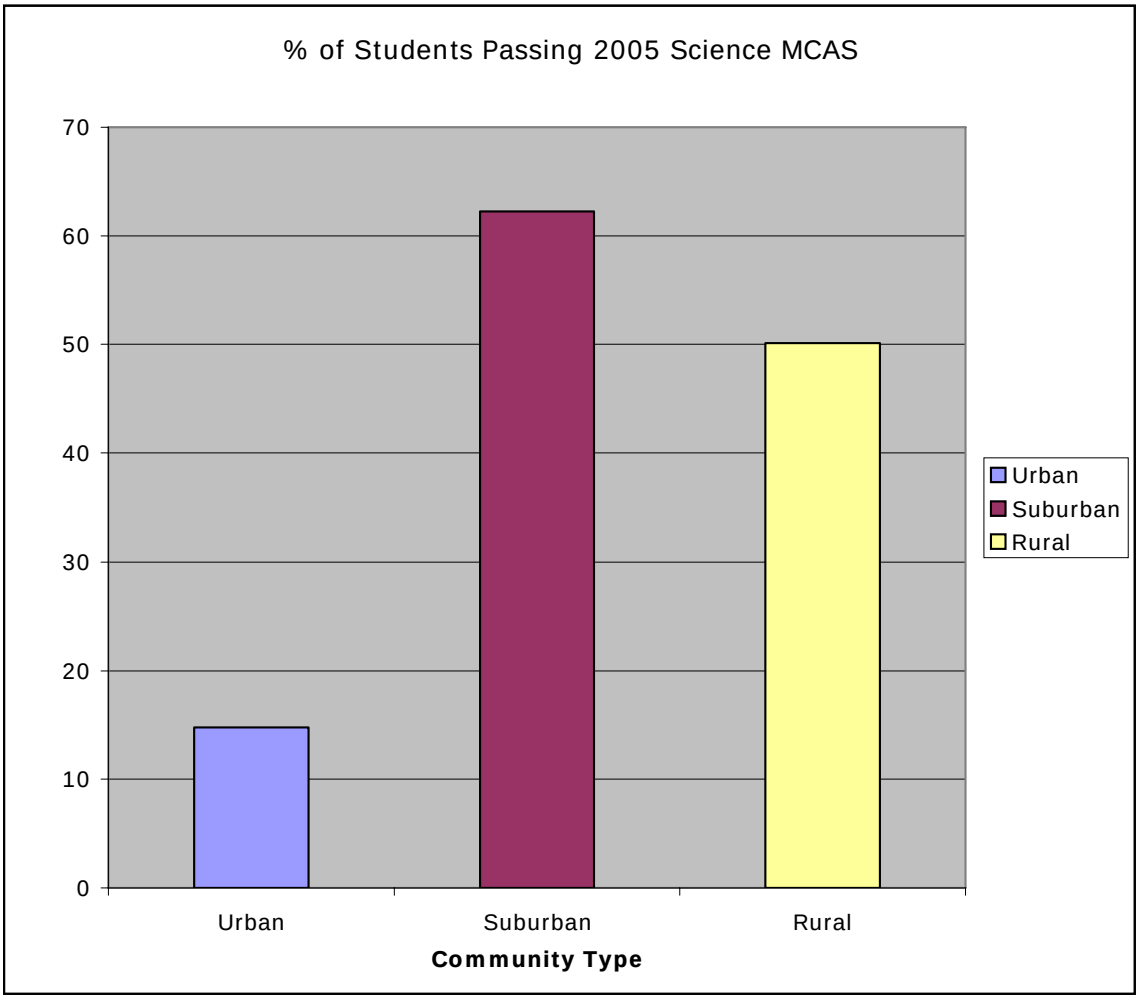
conclusions about test performance generally, as there are *certainly* a plethora of factors interacting at once to impact test scores, as noted above.

The first step in this analysis was to determine if the difference between the three community types scores on the MCAS science exam were significant. The data used for the analysis was based on the number of students passing the science MCAS in the town or district each child was from. For the purposes of determining if a general difference existed between the community types, the scores for all the children for each community were averaged together. Then a one way ANOVA determined that there is an interaction between MCAS scores and the three communities was statistically significant, with an $F(2,164)=55.33$, $p<.0001$.

Further, a Fisher's PLSD was used to determine if the differences between the groups were significant. The suburban children are performing the best on the science MCAS with an average of $M=62.23$ students passing in 2005. The rural children are performing second best, with an average of $M=50.10$ passing the test in 2005. Finally, the urban children are demonstration little success with the science MCAS, with only an average of $M=14.788$ students passing in 2005. The suburban children are doing better than the rural children *significantly* ($p=.0011$), and at the same time, the rural children are performing better than the urban children, *significantly* ($p<.0001$).

The information about the average frequency of students passing the science MCAS test in each community type is summarized in the graph below. The information represented below was obtained from the Massachusetts Department of Education website (www.doe.mass.edu).

Figure 3: Frequency of Children with Passing Scores on the Science MCAS in 2005



After determining that the difference between the groups is in fact significant, the next step was to run correlations to see what the connection between certain experiences and the science test scores could be. To do this, the averages created above for each experience by community type was needed. The average for each type of experience was then correlated with the score that was obtained for the number of students passing the science exam in each town or district, from the department of education website. The purpose of this is to determine if, beyond the different community types, if there is a connection between certain experiences and the scores on the test. This analysis was first

done for indirect experiences, which determined a negative correlation (r =-.178) between indirect experiences and MCAS science test scores for children. This correlation value is significant at the $p<0.05$ level. Thus, the more indirect experiences a child is having, the lower their test scores tend to be.

The next correlation tested for the possible connection between children's structured direct experiences, and their science test scores. The resulting correlation was not significant, with a correlation coefficient of $r=.041$. Therefore, there may be a connection, but the data does not support it.

The final correlation between the children's unstructured direct experiences and their test scores was the strongest of all the correlations produced. The correlation was positive, with strength of $r=.273$; making is significant to the $p<0.01$ level. Moreover, this can be interpreted as the more unstructured direct experiences a child is having, the better they tend to perform on their science MCAS examination.

The impact of parental experiences seems to be the same, as far as the correlations are moving in the same directions. For indirect experiences, there is a negative correlation, with a strength of $r=-.185$, making it significant at the $p<0.05$ level. This correlation supports that the more frequently the parent is having indirect experiences, the lower the test score of the child tend to be.

The correlations between the structured and unstructured direct experiences of adults are the two strongest correlations collected for this data set. Both of the correlations are significant at the $p<0.01$ level, indicating that they are very strong, and tend to be very indicative of performance. The correlation between adults structured direct experiences and test scores has a correlation value of $r=.326$ meaning that as

parents structured direct experiences go up, their children's test scores tend to go up. Similarly, for unstructured direct experiences the correlation value is r=.234. This supports that the more parents are having unstructured direct experiences, the higher the children's science MCAS scores tend to be.

While the data just presented lends strength to the argument that children will do better on their tests if they and their parents are having certain types of experiences, this is not necessarily true. While there is evidence to support that, one limit of using correlations as a statistical tool, is that the relationship determined is not causal. There is no way to say from this data that if children and there parents have more unstructured direct experiences, they *will do better on their tests***.** What can be said, is that one factor that might affect test success is the ability to get out and have real unstructured experiences in nature. The real hope is that with this data in mind, curriculum can be designed to more effectively prepare students for learning.

It is very interesting to note the differences in the correlation for structured direct experiences for the parents and for the children. The correlation between test scores and structured direct experiences for the children is the only correlation produced is the only one which is not significant at either level. However, the correlation produced for the parents' structured direct experiences is the strongest correlation associated with this data. As such, it seems that simply having these experiences as a child is not what is important to learning. A child can go to the zoo, pick fruit, and take care of pets and houseplants on their own and it has relatively little effect on their learning of scientific concepts and knowledge. On the other hand, when parents are doing these things frequently, it seems to have a large effect on the learning of the child. It is logical that a

child may go to the zoo without their parent, with a school trip for example; however, a parent will not go to the zoo without their child. When the two go together, and the parent has an opportunity to share knowledge about nature, plants and animals, it seems that some real learning occurs for the child.

Simultaneously, the correlation between unstructured direct experiences of both adults and children are strong correlations. Thus, it seems that when parents have the opportunity to go hiking, camping, swimming, and exploring *with* their children, it is extremely valuable, and educational. Finally, the experiences that both adults and their children are having indirectly with nature tend to not be extending their education about science knowledge and concepts.

Connections to Research on Biological Reasoning

Research on experience and reasoning, indicates that for all people, taxonomic knowledge is a default choice, when no other knowledge is known about a particular category. However, when there is an increase in experience with a particular topic, there is the addition of contextual, ecological knowledge as a supplement to the strict use of taxonomic knowledge. For example the study with the fishermen, or the musicians, who used their specific knowledge about their area of expertise to make educated inferences as a result of their extensive contextual knowledge.

What Coley et. al. have determined is that the children from rural and suburban communities are more likely to use ecological knowledge as a supplement to their taxonomic knowledge. The team predicts that this difference in reasoning results from the differences in experience. Thus, for children who are having a higher number of

unstructured direct experiences with nature, there is a development of multiple reasoning strategies earlier on. Furthermore, children in urban environments do tend to develop and utilize this ecological knowledge in reasoning; however, it tends to occur later in development.

Implications

The determination that it is possible to encourage the development of alternative reasoning strategies through interactions and experiences with nature has far ranging ramifications. The description above regarding the types of experiences most common to children and adults based on their community type can be used as a guide to encourage a stimulating development. It seems that exploring in the outdoors is a simple unstructured direct experience, which may have a beneficial effect on cognitive development. For structured direct experiences, taking walks in a public park, or watching animals, or exploring the backyard are good choices. Through encouraging children to watch programs that are educational, when they are watching television there may be a significant influence on their development. This is instead of allowing children simply to watch programs that have no educational benefit to them at all.

This research has indicated an effect of experience with one's environment on cognitive development of reasoning skills. How does that transfer and influence the ability of students to pass tests they are required to pass? Curriculum should be designed around knowledge and experiences. This data shows that when children have real experiences in their environment, they are more likely to attach knowledge to realistic

schema. When children have experiences to supplement their classroom learning, the concepts will allow them flexibility in the ways that they reason and problem solve.

The curriculum for science education contains unit such as ecosystems, the earth, astronomy, and technology. It seems obvious that when children are connecting with what a textbook is saying to what they are experiencing with their other senses, the knowledge will be encoded in a multifaceted way and thus more tangible. Children should be learning science with their hands, their eyes, *and* their ears. The lessons should be designed to capture the attention of all students and to help make concepts that are hard to understand in a book or on paper, stand up and touch them.

For units involving ecosystems, children should be building ecosystems, and experiencing the differences between the types in a realistic way. This learning should allow a connection of learning through a sensory structure to what their mind is learning. Astronomy should be seen with their own eyes, studied in a real way. It can be shown that with significant experiences around their environment, that children have a better chance of reasoning with multiple strategies. The key is to apply this knowledge to the classroom, and make it possible for all students to gain the depth of knowledge acquisition that can be possible through hands on, sensory learning.

Plans for Future Research

This research provided a theoretical research foundation that needs to be extended into a more practical educational type of research. It is essential to get into schools and determine what types of curriculum is being used currently to teach science. To know

what types of curriculum are working, would allow an extension to other places where there is a lack of successful curriculum.

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