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THE PEDAGOGICAL SIGNIFICANCE OF MENTAL IMAGES

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THE PEDAGOGICAL SIGNIFICANCE OF MENTAL IMAGES

Thinking goes on in the present, but the process is always largely in terms of past experience. A mind incapable of utilizing past experiences could not think. It would have no "thought stuff". There would be for it no past or future, but only a series of unconnected "nows". Personality, even, would be impossible, for personality implies continuity of experience. All present experience is achieved through a reconstruction of past experience, and each reconstruction makes possible larger future experiences. In thinking, then, the present selects from the past those experiences which will serve in interpreting the present, and makes use of the new experience with reference to future processes.

On the physical side, past experience is recorded in modified structure through the law of habit working in the nervous system. An act is performed: e.g., an object is seen or heard or smelled or tasted in connection with an activity which involves a complex of co-ordinated adjustments related to the functioning of certain cortical centers. This co-ordinated activity leaves the nerve structure modified in such a way that the same activity has a tendency to be repeated a second time, and with each repetition the tendency to be repeated grows stronger. If the activity occurs again through the agency of the original external stimulus, the sensation or perception is again approximately reproduced. If, however, the repetition of the cortical activity is occasioned indirectly, through the agency of a stimulus coming by way of some other cortical center, the activity being modified and adapted to some future end to be served, we get, not the original experience, but an <u>image</u> of the original experience. Thus the image is the mental side of past experience, but is never a mere literal reappearance of the original experience. It always involves a certain amount of adaptation and

adjustment, of selection and reconstruction. In this sence, all of our past experience is available to the present, not as a mere copy of the past, but made over in an infinite variety of recombinations and reconstructions looking toward future activities. All the objects we have seen it is potentially possible for us to see again in the mind's eye without the objects again being present to the senses. All the sounds we have heard, all the tastes and smells and temperatures, etc. we have experienced, may be again in our consciousness without the peripheral excitation. The kinaesthetic effects of all the movements we have performed may again be produced in consciousness without our repeating the movements. It is these facts which enable us to bring our past experience up into the present and utilize it. Professor Dewey says that education is the process of reconstructing experiences. But experience is, on the mental side, as we have said conserved in the form of images. Education then is largely concerned with securing and developing an adequate stock of mental images, not of one type alone, as the visual or the auditory, but images from all the senses. Binet insists that only that man is normal who has images almost equally well developed in all sensory lines, and not in sensory lines alone, but in motor lines as well.

Many writers have shown the relation of mental images to thought and movement, and no lengthy statement is necessary or possible within the limits of this paper. A perception is a complete perception only in that degree in which the actual sensation present calls forth images of other qualities of the object, that all may unite together in one pulse of consciousness. Imagination is conditioned, in so far as its materials are concerned, on the mental images which it has on hand. Memory goes on in terms of mental imagery of one kind or another. A concept could never be formed without the use of mental images. Discrimination, comparison, judgement, reasoning, are all processes

which involve the use of mental images. Movements, in so far as they are not in response to immediately present objects, are conditioned likewise by mental images. Each act that is performed leaves its record on the mental side in the way of kinaesthetic images initated from this movement, and these images serve in turn to make possible the same movement a second time. It would be both tedious and unnecessary to enter into a discussion to show that volitional movements depend for their number and efficiency upon the clearness and effectiveness of the mental imagery at our command. It appears then that the fundamental fact in the utilization of our past is, on the mental side, concerned with the mental image. Mental imagery gives us our fundamental thought stuff. Binet says, "Images, along with sensations, constitute the material for all intellectual operations. Memory, reasoning, imagination, are acts which constitute the ultimate analysis of grouping and co-ordinating images, of apprehending relations already formed between them, and of re-uniting them into new relations". The image is the lowest term to which our mental common denominator can be reduced. We may take an image from our past experience and project it into the future or into the past, using it in a multitude of different ways. It may be used alone or combined with other images to form an ideal or a goal to work to. We may refer the image to the past and call it a memory. We may consider it without reference to time or place at all, and make the process a mere recognition. We may construct a new object which contains the elements of many past experiences, re-combined in new relations, and thereby have a purely imaginative product. We may use the mental image in any of these relations to direct and condition our motor activity. In fact, it is impossible to find any activity, either mental or physical, which does not involve the use of mental images.

The development of the child's mental images thus becomes one of the chief problems in his education. The child deals first with the

real objects of his environment,- his bottle, his toys, his mother, his nurse his bed, etc., soon getting so that he can recognize them when he sees them. Next he will cry for them when they are not at hand. If he knows what it is that he is crying for he has, in that far, an image of the thing desired, and his process of memory has at this point begun. Next, language enters, in which he hears the name of the object spoken in connection with seeing and handling it. The object and the name are thus associated. Either one will now serve to call up the other. Finally written and printed symbols come to stand for images as the child learns to read. With this start images grow and develope rapidly. The sensory and the motor elements in the image become more closely welded tegether. The ball is not something merely to recognize, but something to call b-a-l-l; something to handle and to throw and to catch, and this in connection with some play-mate. The door is not only something to stare at, but something to swing back and forth, and much more than that , something to go in and out of. The image is taking on not only a motor but a social quality as well. The child is socializing his environment and through it himself.

At this stage the image has a decidedly strong motor significance. This is the age of impulse. Each idea is acted upon largely without inhibition. Does the boy think of his ball?--there is an immediate tendency to rush out and start a game. Of the ice pond,--skates are forthwith brought into requisition. Of a game of pull-away,--a mad rush for his play-mates ensues.

Nor is the insatiable desire for motor activity an idle one. The motor activity is no less a necessaty to the image than the image to the movement. Indeed they are but two sides of the same process. It is this fact which gives play its significance in the child's development. The curtailment of motor activity will leave the images incomplete and inefficient. The lack of a socialized environment will leave the images

devoid of their social aspect and their possessor socially inefficient; while the failure to develop and perfect the mental side of the image leaves the motor and social activity without adequate impulse and directin

The great thing then is to provide the child with means and incentive to develop his imagery in all the above aspects. This becomes the problem of the school. On entering school the child already has at command a more or less complete stock of mental images which he has learned to respond to with varying degrees of facility on the motor and social sides. It is the place of the school to see that these impulses are clarified, enlarged and added to, and finally that they are made potent as impulses and inhibitions, so that the child may, on the one hand, be not a mere dreamer of dreams, forever amused by watching the flight of images in his mental stream, but never acting in response to them; nor on the other hand, a creature of impulse, at the mercy of every suggestion to activity which his images give him, without the power of inhibition. In other words, that his images may be of such a type and balance that his will shall be neither of the obstructed nor the over-impulsive type.

In order to prevent or correct wrong images or to induce the formation of a greater number of richer and more complete ones, the first step necessary is to discover from the child the images he already has on hand, or as Pres. Hall would say, to find out the "contents of his mind". Two methods have been employed by students of child psychology to accomplish this result: first, the method which seeks to induce the expression of the mental images involved in any thought process without the intervention of conscious introspection; and second, the methods which require conscious introspection and a report of what is thereby revealed. Any test to be scientifically correct will use both methods in so far as that may be possible, making each serve as a check upon the results of the other, and just here lies the practical difficulty

in testing the images of children. The child does not know what introspection is. The subjective self has but little interest for him. He neither knows what to look for in his mind nor how to look for it. Indeed he hardly knows that he has a mind; nor has he adequate means of expression at his command to describe his images, even if he should succeed in recognizing them. It follows from these facts that efforts to discover the images of children, at least in the earlier stages of life, must be confined to the first method. Beginning with the period of adolescence, however, when the boy or girl directs the attention increasingly for a time to the subjective life, the simpler forms of introspection may very properly be employed in mental tests. Introspection at this period of life, if less critical, is more ingenuous than at a later period when the mind is likely to have a certain psychological or pedagogical bias which can hardly help influencing in some degree the results of introspection.

Following the principles stated in the preceeding paragraph, the writer undertook a study of the mental images of children in connection with their work on certain topics in Geography. The character of the tests employed was determined by suggestions from Professor John Dewey.

Fifth, sixth and seventh grades in the public schools of Chicago and Denver were selected for the test. Replies were received from 386 children of both sexes in Chicago, and from 52 in Denver, making a total of 438. The teachers of these grades were requested to give the following questions as an exercise in English, the children not knowing that it was other than a class exercise:

1. Is an island like a hill? Tell why you think it is or is not. 2. Which is higher a mountain or a tall chimney? How much? (The teacher to mention some tall chimney known to the school). 3. Is an isthmus like a strait? Tell why you think it is or is not. 4. If all

the water in lake Michigan should dry up, what would you see where the lake is now?

In response to the first question, 62% answered negatively, 30% affirmatively and 8% were doubtful, 17% expressed the idea of the island extending below the surface of the water, 16% gave a formal definition of "island", and 14% of "hill". Thirty-one per cent said the difference is that the island has water around it , while the hill has not; 19% thought that the difference lies in the fact that the hill is higher; and 11% thought that the difference is in the greater slope of the hill. The best answers were given by the seventh grade, and the second best by the fifth grade. As an illustration, the idea of the part of the island below the surface of the water was expressed by 23% of the seventh grade, 16% of the fifth grade, and 12% of the sixth grade; resorting to the formal definition of "island", seventh grade 10%; fifth grade,16%; and sixth grade, 33%.

But few indicated a complete misconception of a hill or an island, but many showed that their image of one or both was very incomplete and inadequate. The following are taken from the answers:

A hill is a pile of earth covered with brush and trees. A hill is on the ground but an island is not. An island is not like a hill because it is not round on top. An island is round, and the four sides slant. An island is not hilly, because it is a forest. An island is like a hill, because it is higher in the center. An island is like a hill, because it is fastened to the water, and extends up above the water. An island is round like a ball. An island is not like a hill, because it is a little swamp guarded by rocks. An island is a little bit of dirt piled up. An island has no grass on it. An island is like a hill, because the top comes first. An island is like a hill, because it rests on the water like a hill rests on the ground. An island is land pushed up by the water.

In answering the second question, there were 9% who estimated the chimney higher than the mountain, and 9% who were doubtful, while slightly more than 40% gave answers evidencing an inadequate conception of their relative heights. Of course, judging on the last point is more or less an arbitrary matter, but the child was given the benefit of the doubt where the language left any question. A good many said it depends on the size of the mountain. All these were classad as not having an adequate conception of the difference. It is recognized also that some of the difficulty in expressing the difference in the heights may be from the fact that tha child has not a proper conception of number, instead of being altogether lacking in his images of chimneys and mountains; for even the Colorado children, who are constantly within sight of mountains, will say that a mountain is from fifty to two hundred feet higher than a chimney. But after making due allowance for this fact, it would seem safe to say that very few, if any, children who have never seen a mountain have any real notion of one. Many say that a mountain is higher by two, three, fifteen, or one hundred feet. One says that the mountain is higher, "for it is raised some every year". Others say that if the mountain went straight up like the chimney, it would be higher, but since it slopes, the chimney is the higher. Here again the fifth and seventh grades did better than the sixth.

The replies to the third question showed 51% who thought that an isthmus is not like a strait, and 25% who thought that it is, and 24% who were doubtful. Of those who said they are not alike, 31% volunteered that the difference is that the one is land and the other is water. An average of 27% showed a misconception of one or both, the greatest misconception appearing again in the sixth grade, where it was 32%. The large number of definitions attempted here is also suggestive, an average of 42% for all the grades being 39% in the fifth, 50% in the sixth, and 35% in the seventh grade. That many were relying on the formal defin-

ition instead of their images of the things themselves is shown by their getting the definitions of "isthmus" and "strait" confused, and some even giving the definition of cape instead of isthmus.

In response to the fourth question, 35% said that if the water in the lake should dry up, they would see such things as fish, dead bodies, lost ships, shells, plants, rubbish, etc., etc. Forty-nine per cent mentioned the broad expanse of the lake bed which would be left exposed, and 32 the deep hollow or depression which would be left. Here again the sixth grade fell behind the others in the fullness of their answers.

It is manifestly impossible in this question to measure the amount of misconception where any occurs. The following extracts are suggestive however, some of defective images, and some of very vivid ones:

It would be shallow. Cannot get this one. Hole so deep would be left that you could not get out. One could then see Michigan. There would be left the shape of a great pan. Hills would be where the islands now are. The sand would smell very funny. We would see millions of fish gasping. Would see a large hole with sand and rocks at the bottom. We would see in the distance a dark body, which, on approaching, would turn out to be a wreck in which would be found dead bodies. We would see broken pieces of ships, provisions decayed, fishes of all kinds lying around, a great many men and women and children, hills and valleys, long and narrow basins looking like little rivers, basins looking like lakes, and what looks like large plains. It would look like a bath tub. We could see all the banks and the piers caved in. Would see a field with cattle grazing, or a minting town. There would be a sandy, hot, dry place. You would see -----, but it is not likely to dry up. You would see the boats way down below, and the tunnels and cribs that make and pump the water to the big water stations. There would be great piles of rock left by the glaciers, and cliffs hundreds of feet high. A basin

as deep as the tallest chimney in the world, and fishes flattering around.

Some of these answers were repeated in different ways many times, and an especially large number spoke of the desert which would be left.

While the number of papers examined was not as large as could be desired, yet it seems safe to draw a few conclusions, especially on the points where the evidence seems to agree quite completely.

1. Too much is taken for granted by the teacher in the matter of childrens' images. More attention should be given to developing a method of teaching which will lead the child constantly to clarify and enrich his images by reconstructing his past experiences in the light of his present. He should utilize the images he already has in the formation of new and more perfect ones.

2. The individual differences of children in the matter of their mental images should be taken more into account in teaching. The difference of mental content between the rich and varied stock of mental images on the part of one child and the limited and meager supply of another makes a fundamental difference, not only in the subject-matter suitable for them, but in the method of its presentation as well.

3. Perfect images cannot be built on imperfect perceptions. The child who has never perceived that an island really extends below the surface of the water will hardly have a clear image of that part which is out of sight. Nor is it enough to have the clear perception; there must be clear and frequent recalls of the object by means of the memory image, and the image must also be applied in some definite way in the acquisition of new knowledge; else it becomes so much lumber in the mind.

4. Children at this age are slow in generalizing the particular illustrations which are presented to them. A number defined "hill" as a pile of dirt with trees around it , or with brush over it. These were the ones who had had their experiences of hills from the molding in the schoolroom or from the little artificial hills in the city parks.

They were not able to construct a real, big hill from so small a model. Many gave the difference between a hill and an island as being in the fact that an island is level or flat and a hill is not level or flat. The islands of their experience had probably all been flat, and they had never pictured one of any other kind.

5. The use of formal definitions by the child seems to go along with faulty imaging, and teaching him formal definitions of objects before he has clear images of these objects leads him to faulty imaging. When he fails to get or does not choose to get, an image of the object, he falls back on his verbal image of the definition to take its place, even though the definition does not have the shadow of a meaning to him. In proo f of this, by far the largest number of definitions in these papers were given in the case of "isthmus" and "strait", where there had been the least opportunity for perceiving the real objects, and where the misconceptions were manifestly the most numerous. 42% attempted book definitions, and 27% evinced a complete misconception of either isthmus or strait, or both, and besides this it is probable that many of those who gave correct definitions had no real notion of the objects they were defining. On the other hand, but 16% gave definitions of island, and 9% of hills, and here it could not be determined that there were any complete misconceptions of either. Also, the oldest pupils, those of the seventh grades, gave the fewest definitions, and their papers showed them possessed of the bset images, as would be expected. The sixth grades gave the largest per cent of definitions, which may be accounted for by the fact that they had recently come into the use of the text-book, while most of the fifth grades were still having their instruction orally, and the seventh grades were becoming a little more independent in their thinking.

6. Even granting clear perceptions and vivid images, the imagination may still be faulty through a failure to utilize the images already at hand in the construction of new ones. The fact that we have shown the

child a two-by-four mudpuddle with an isthmus doing duty in the middle of it is not a safe warrant that he has a clear notion of an isthmus; it is not a safe warrant even when our device is supplemented by calling attention to the fact of the striking analogy to be found in the case of the human body, where the neck connects the head and trunk! Neither can we assume either the child has molded a relief map showing the plains, hills, and mountains, or even after he has seen hills of some two hundred to three hundred feet --- which is about the limit in the Mississippi valley ---, that he has more than the faintest and most inadequate idea of a mountain. Likewise, the black streaks on the map which are meant to represent rivers may still be but black streaks and nothing more to the boy, although he has fished, waded and swum in the real river. He may fail to make use of his past experiences in the formation of new images.

In order to pursue this line of study still further, the writer undertook an investigation of the early mental imagery of children as related to natural phenomena. The plan taken was to secure reminiscences from boys and girls of secondary school age in response to a questionary as given below. It is fully recognized that lapse of time may have dimmed the recollection of some, and colored that of others so that the results are not as trustworthy as if the time element did not necessarily enter in. Yet the data secured are not without their value, and are at least suggestive. The questionary is given here in an abbreviated form, the original having been very full and explicit.[1]

THE QUESTIONARY.

After full directions as to reading the questions over several times and

[1] Printed by the University of Chicago Press.

taking time to think about them, etc., the pupils were asked to answer the following:

What were your earliest notions about

1. The earth, as to size, shape, interior, support, etc?
2. The ocean, as to depth, saltiness, bed, tide and waves?
3. The north and south poles, location, region about?
4. The horizon, where it is, reaching it what would you find?
5. Rivers, where the water comes from and goes, real, or only map?
6. Mountains, height, how formed, sharp peaks or sloping, etc?
7. Islands, support, height above water, level or the opposite?
8. Straights and Isthmuses, whether confused with each other, etc?
9. Deserts, level or rough, soil, cause, temperature?
10. Lines of latitude and longitude, real, what zones are,etc?
11. Rain, where it comes from, what holds it up, thunder and lightning?
12. When you first studied geography, did continents, lakes, rivers, islands, etc., seem to you to belong to the real earth on which you lived, or only to the map or the globe from which you were studying?

There were 325 responses to the questionary -- seventy-five boys and two hundred and fifty girls. These were from widely separated schools, and are probably as nearly representative as so small a number could be. Iowa, Dakota, Minnesota, Wisconsin, Chicago and New York are represented in the replies, which are all from secondary schools and normal schools.

The first question. Fifty per cent thought of the earth as much too small, many saying that to them it was only as large as their town, or that it reached to the apparent horizon, or that it was as large as their state is to them now. On the other hand, 17% thought of it as larger than it is. To them it was "immeasurably large", or it was large "beyond comprehension". As to its shape, 50% thought it was flat, while

19% always thought of it as a ball. Of these last, however, a surprisingly large number thought of the earth as hollow and themselves living on the inside of the ball. Of those who looked upon the earth as flat several thought of it as a large table on four legs. Four thought of as a square box. As to its interior, not so many had any notion definite enough to be remembered. Twenty-six per cent thought the earth was the same all the way through as on the outside. Twenty-two per cent pictured the interior as a raging fire, or a boiling mass. Of these many located Hell in this region. Six per cent believed China to be either in the interior of the earth or to be easily reached on the opposite side by digging through, and several spent much time trying to dig through. About three per cent thought of the interior as water, since water was obtained by digging down. Thirteen per cent looked upon the poles as the means of support for the earth. Three per cent supposed the earth must rest on other ground. Six per cent had either seen the picture of Atlas with the earth on his shoulders, or had heard such a story and accepted it as true. Five per cent thought of it as resting on a platform as a ball would rest on a table. Only two per cent report that they had any conception that the earth really stands out in space without tangible support.-

Second question. Twenty per cent thought of the ocean as altogether too deep, some thinking that it had no bottom, and others thinking of it as extending down as far as the earth itself extends. About twenty-nine per cent thought of it as too shallow, some thinking it the same in depth as their little brook at home, or as the river or the pond which they knew. Eight per cent speak of not knowing until they had begun to study geography that the ocean is salty, or if salty at all, not enough to spoil it as drinking water. Seventeen per cent thought of it as very salty, several imagining that the salt was thick enough to be scooped up with the hand, or skimmed off the top "like cream off of

milk". Five per cent credited the story of the salt-mill which keeps on manufacturing salt. Thirteen per cent thought of the ocean bed as perfectly level and without any elevations and depressions. Seventeen mentioned the mud, shells, salt, etc. which would be found on the bottom. Of those who recalled their notions of tides and waves, many thought of them as just the same thing. Six per cent accounted for them by the wind. Two per cent thought the ships caused them. Four per cent thought they were caused by the animals to be found in the ocean. Some thought that the tide was a solid wall of water about as high as a table, moving across the ocean. Others thought the waves were about like those they were used to seeing on the river or the pond at home. A few thought of the size of the ocean as far larger than the whole earth, indeed, forming its boundary, while others thought of it as very small compared with its real size.

The third question. The most general response received on any question was on that of the real pole. 285 out of the 325 reported they imaged a real pole for one or both of the poles. Many descibed the pole which they saw; with some it was a barbers pole, with others, a telephone pole, with others a clothes-line pole. Some had the American flag on the top, and several had it labeled "north-pole", so that it would be known on arriving at it. While a large number imagined the region around the south pole, very few spoke of the definite pole in as clear terms as the north pole. Only two per cent said they had no recollection of a real pole. Fifth-one per cent imaged the region around one or both of the poles as a field of ice or snow. Many had the foot of the pole imbedded in a large field of ice. There were twenty-three per cent, however, who had the region around the south pole either very hot, or else a warm and pleasant region abounding in vegetation. As to where the poles were located, the favorite answer was "at the ends of the

earth". A number thought of the north pole as above their heads, and the south pole as beneath their feet.

The fourth question. Quite a general response was given to the question about the horizon. Fifty-two per cent regarded the horizon as the end of the earth, and many expressed a recollection of the childish dread with which they contemplated how easy it would be to fall off the earth if they should by any mischance reach the horizon line. Fifty-four per cent believed that the horizon could be reached by traveling to it, and not a few spoke of the times when they had in good faith set out to walk to it. Only 5% thought the horizon was beyond our reach. Many of those who expected to be able to reach the horizon thought it to be but a very little distance away, "just beyond the edge of the village", or "out beyond the row of willows where I used to watch the sun set". Some who imagined the earth as meeting the sky expected to find the earth rise up a little to meet the sky and then see them riveted together. Those who expected to find the earth really ending, described the abyss into which they would probably fall if they slipped over. Twenty per cent had pictured space or an abyss at the horizon. Two per cent expected to find gold or treasure. Three per cent had pictured clouds or fog beyond the edge. Three per cent saw the edge of the earth surrounded by water. One per cent expected to see fire. Two per cent had imaged a wall "to keep people from falling off". Only a very few said they always thought of the horizon as shifting with their own position, and not touching the earth at all.

The fifth question. Not so many had answers as to their early imagery concerning rivers. Several said the just accepted the rivers as always there and did not enquire where they came from. Others said they never thought of a current in the river which would deplenish the stream until they were well along in the study of geography. Four per cent said their earliest conception of the rise of a river was that it

came up from the ground. Some explained in this connection that they had lived near the origin of some small stream where they had a chance to inspect its origin. Seventeen per cent had accounted for the supply of water from the rain and snow. Seven per cent thought that rivers have their rise in the ocean. As to why the ~~rivers do~~ ocean does not run over, some say it is because the water soaks in. Others wondered why, but never solved the question. A few thought the banks were so high that it never got full. Others said that animals and people drank so much that it never got full. Thirty-six per cent said that they never thought of the rivers on the map as real, but only as black streaks on the map. Nine per cent thought of them as real water. Some of these last, however, said they had no idea of the size of a river even then, but thought of it as a narrow little rivulet, not seeing how so small a streak as that on the map could stand for a large stream.

The sixth question. Comparatively few answers were given to this question. Seventeen per cent said they compared mountains in their imagination to hills, usually mentioning some hill near their home with which they made the comparison. Most of these indicated that they had no notion of the height of the mountain. Nine per cent said their first notion of a mountain was that it was exceedingly high-- that it extended to, or up through the sky. Nine per cent compared mountains with some building, thinking it to be twice or three times as high as their home or church. Very few had any notions as to the origin of mountains, three per cent ascribing them directly to God, while two per cent accredited them to giants. A few imagined them as having been built up by men with shovels or road graders. Forty per cent imagined a mountain as running up to a very sharp peak, many wondered as children how those who climbed the mountains could find place enough to stand on top. Others used to wonder how several found room to be on top of a mountain at the same time. Eight per cent always thought of a mountain as a gradual

slope.

Seventh question. A surprisingly large number thought in their childhood that islands float on the top of the water, thirty-two per cent giving this response, as against ten per cent who always thought of the island as resting on the bed of the ocean. Thirty-three per cent always thought of an island as perfectly level-- like a pancake. Others volunteered that they always thought an island was at most a few rods across-- hardly big enough for a man to live on. Two per cent only had any notion of the surface being rough in any instance. Thirty-five per cent thought that an island was level with the top of the water or at most, a few inches higher. None expressed the idea of its extending for any considerable distance above the surface of the water.

Eighth question. Not many responses were received to this question. Twenty-three per cent always had trouble to keep from confusing isthmus and strait in the study of geography. A few state that they did not for some time see any diffenence between them. Nine per cent report that they always thought of the resemblance in form between the two, while two per cent never thought of the resemblance. Eleven per cent imaged the water in a strait as flowing like the water in a river, two per cent say they had the correct idea. Several reported that they supposed a strait was so named because it was perfectly straight,and a few supposed that it had a wall that was straight up and down, hence the name.

Ninth question. Fifty-five imaged the surface of deserts as perfectly level, while two per cent thought of it as being irregular. Forty-six per cent thought of the soil as pure sand, while only one per cent reported that they had any conception of any other nature. Eleven per cent ascribed the cause of deserts to lack of rain, and one per cent laid it to the sun. Fifty-one thought of deserts as too hot

for people to live in-- one unrelieved glare of heat.

Tenth question. Fivty per cent had imaged lines of latitude and longitude as real lines drawn on the surface of the earth. Some thought the lines were rope or wire, others that they were furrows thrown up, others that they were ditches, and others that there were stakes set. One thought that the equator was a serious hindrance to navigation, but that the tropic lines were not so because they were dotted instead of sold on the map. Only one per cent report that they had a correction notion of the lines from the first. Eleven per cent thought of zones as marking off sharp distinctions in temperature between different regions of territory. Some thought that zones marked off regions which had distinctly different animal life.

Eleventh question. Seventeen per cent thought in childhood that the rain comes from the sky-- nine per cent first thought that it comes from the clouds. Twelve per cent thought God had direct control of it and made rain when he pleased. A s to what holds the rain up, two per cent said the sky, five per cent said it was held up by heaven, and eight per cent accredited it to the clouds. Some thought the clouds act as some big dish, and when it became full it ran over. Others looked upon the clouds as a large spunge. Five per cent thought it rained when the clouds collided. Thirteen per cent thought that this colliding, or else something falling in heaven caused thunder, while two per cent accounted for thunder by vehicles of some kind running over the clouds or over the streets of heaven. Only a few attempted to account for lightning. Three per cent thought it was caused by cracks in the clouds showing the brightness through. Some thought lightning was "golden chariots" running across the sky. All the others thought that God was speaking in anger when it thundered and lightened. It is a striking point that those who speak of God in this connection always see him as a God of anger.

Twelfth question. Thirty-five per cent report that the geographical

forms belonged only to the map and not in any considerable degree to the real earth, while seven per cent report that they were real from the first.

A FEW QUOTATIONS.

(Girls.)

It was only just a little way to the poles from my home.
The horizon was just a little distance west of our town.
Islands were only about large enough for one man to stand on them.
I thought one would find a white fence of tin at the horizon.
People poured out water into the rivers to produce them.
Children digging in the ground and throwing up sand made deserts.
Lines of lat. and Lon. were of rope stretched around the earth.
Thunder was from potatoes rolling out of a wagon on a bridge.
The earth was a flat disc-- could easily dig through.
Though that all rivers flowed in a circle.
At the poles the earth came to a sharp point enough to stand on.
Islands as big as the top of the teachers desk.
Surface of islands just specks above the water.
Rivers were streaks put on the map to make it look better.
Islands were resting places for the nymphs.
Servants of God held the rain up in a big umbrella.
When the umbrella was closed God was displeased and scolded.
Could hear the earth rotate on its axis like a merry-go-round.
Lightning caused by the clouds striking sparks as they rubbed together.
Islands just floated and no one knew just where to find them.
Aside from my own town everything belonged to the map.
Never knew that water in rivers flowed.
Didn't discov er the flow of water in rivers until past twenty.
Hardly dared to think of the earth lest I should drop off into space.
Never thought of the ground on which we walked as the "earth" of geog.

The zones were separated by fences.

The mountains no higher than a room in school.

Could not think of a mountain higher than a telephone pole.

Forests were paved like the streets.

Could not see how a little line could represent a big river.

Mountains were very small-- like thimbles.

I spent much time looking for the lines of lat. and long.

Rain was the angels' tears.

Hell in the interior of the earth.

The earth rested on the sky on the other side.

Sun an electric light with yellow globe--moon the same with white globe.

Lakes, rivers etc. were real for we went out and studied them in nature.

The ocean was just the blue portion of the map.

The earth was just a shell or crust-- we were living on the inside.

The ocean much larger than the earth ,the earth floated on water.

Threw clods at God when I was angry.

Impossible to realize people or places south of me--had never been south.

The only people in the world were those I knew.

Evil spirits lived inside the earth--held ear down to ground to hear them.

When God thought the earth needed rain he "turned on the water".

The earth was hooped together by lines of lat. and Lon.

The earth a flat disc four or five feet thick.

Stars were where the earth had worn holes in the sky resting on it.

We lived on the inside of a hemisphere.

Zones were shut off from each other by curtains.

Lightning was flashes from hell.

The equator was a ball of fire.

(Boys.)

It rained sand in the desert.

The earth was surrounded by large rivers.
Didn't know that rivers were wet--just streaks on the map.
Did not know that the earth of the geog. was the one we lived on.
The islands rested on piling like grain elevators.

The following points seem to come out clearly from the responses to the questionary.

1. Children possess a large stock of images relative to natural phenomena, but by far the larger part of these images, are either wholly incorrect, or are else very incomplete and inadequate, and are of comparatively little use as "pedagogical" material. By this last is meant that many of the images are not of a nature to be amplified and enriched, but must be eradicated and correct ones given in their places.

2. Wrong images are often induced by pictures in text books, by chance words of teacher or parent which are misunderstood or only partly understood by the child, or the child thinking for himself from wrong premises may often form incorrect images. The child takes things implicitly for what they seem to be. If the book shows the north pole as a real pole with a bear climbing it, that henceforth is the child's image of the north pole. If the horizon looks to the child as if the earth ends there, to him it does end there unless he is disabused of the idea.

3. The mistake is often made of giving the child the symbol and then expecting him to image the real from this when he is unable to do so, or is not led to do so. Map lines of latitude and longitude are carried over and applied to the real earth in the form of ropes, or furrows or ridges of dirt. The river on the map is not finally a real stream of flowing water, but remains a "black streak" still. A small round, flat island is shown the child as the type of all islands, and a floating pancake becomes his image henceforth of an island.

4. It should be the teacher's first concern to discover the nature of the child's conceptions of natural phenomena before attempting to teach him about nature and natural forms. Otherwise the instruction given by the teacher is almost certain to be vitiated and distorted by preconceptions on the part of the child, which are for the most part at variance with the teacher's instruction. It is never safe to assume that the child has a correct notion or an adequate notion of natural phenomena without making a skillful investigation of his stock of images.

In order to discover the relation existing between the power of ready visualizing of mathematical forms and general ability in branches of mathematics involving these forms the writer also gave a test on what is called the Hall cube, and also one upon the visualization of the triangle. The first tests are as follows:

The First: Imagine a 3-inch cube, and paint it on all faces. Now saw it up into inch cubes. How many inch cubes will have paint on three faces?

2. How many on two faces?

3. How many on one face?

4. How many will have no paint on them at all?

The Second: Imagine an equilateral triangle. Connect the mid-points of its sides.

1. How many different classes of figures will result?

2. Give the number of figures of each class.

The test was given to 247 pupils in secondary schools in Chicago, Des Moines and Waterloo. In each case the teacher was requested to make sure that the pupils had no drawing or other suggestion before them but that each performed the operations wholly mentally. Of the 247 who took the cube test, 184 had had geometry or were at the time studying it, and 63 had never studied geometry. The triangle test was

not given to any who had not studied geometry. This left 184 who took the triangle test. The results are given in the percentage of correct answers, and not of the individuals who got all points correct. That is, in the case of the cube, there is a possibility of four correct answers from each pupil,one for each separate question asked. The ratio of correct answers given to correct answers possible is used in obtaining the per cents.

The teachers were requested to mark their judgment of the ability of each pupil on his manuscript, using the letters E, G, F, and P. The results from the answers of boys and girls were computed separately, but practically no difference showing between the results from the work of the two sexes, only the combined results are given in this report.

Ressults by grades of effiency.

THE CUBE.

Percentage of correct answers for those marked E, 73%
" " " " " " " G, 60%
" " " " " " " F, 54%
" " " " " " " P, 40%

THE TRIANGLE.

Percentage of correct answers for those marked, E, 30%
" " " " " " " G, 30%
" " " " " " " F, 23%
" " " " " " " P, 10%

Of course this investigation has not gone far enough to draw other than tentative conclusions. In order to reach any final conclusions it would be necessary to investigate a far larger number of cases, and also correlate with ability in mathematics ability in other lines

which do not require visual images to any considerable degree, such as algebra and grammar. Here we are not entirely sure that ability to visualize mathematical forms and ability in geometry are not largely correlatives, and not cause and effect.

It will be seen, however, that the correspondence between power to visualize, and mathematical ability in lines where visualizing is required is quite regular. And this in itself is sufficient to encourage further investigation in this line.

The fact that the percentage of correct answers for the cube is more than double that for the triangle suggests that the ability to form images is directly condidioned on clear perceptions. Every one has more or less experience with a cube, or at least with similar forms, from his earliest childhood, while very few have had occasion to observe closely an equilateral triangle, much less to connect the mid-points of its sides, or if this were done, to select out all the different kinds of figures resulting.

On the pedagogical side, the danger points in the development and use of mental images are connected with two processes; (1) in passing from the perception of the real object to the use of the image which stands for the perception, and (2) in learning the language symbols and employing them in mental processes. This paper has dealt mainly with the first of these points and has touched only a very few of its phases. Some of the further problems which lie ready at hand are the relation of the mental images to (a) motor activity in general, and, from the pedagogical standpoint, particularly to manual training, drawing and writing, modeling, etc., and music; (b) moral development, the growth of sympathy, the sense of justice, etc; (c) enjoyment, the cultivation of the aesthetic, etc.

Comparatively little has been done by students of psychology and education on the second of the problems mentioned, the relation of the language symbols to mental images. Any careful investigation, or, indeed, casual observation cannot fail to convince one that children introduce (or have introduced for them) into their vocabulary many words and sentences which have little or no significance or content. The only images connected with them are purely verbal,- the visual, auditory or motor images connected with the words themselves. True words may come to stand for images to some extent, but unless the words have at some time called up their appropriate images or been themselves called up by the images, and unless the words retain an image halo, or setting, or fringe, language has lost the greater part of its vitality and words are but troops of dry skeletons instead of living things.

The writer has undertaken a reminiscence study of the common definitions usually learned in school. This study is not completed, but it has gone far enough to discover that the testimony is overwhelmingly to the effect that most of the definitions learned in school (and particularly in the lower grades) were nothing but a jingle of words with no content whatever. Much of the "dictionary work" is of the same character. The terms used in the definition are as devoid of meaning and content as the word defined.

Recently the writer listened to a high school class read The Lady of the Lake. The lesson for the day was the hunting scene. When they had finished the teacher invited his criticisms or comments. He asked the class to tell him in which direction the stag was fleeing, what was the color of the horse, the hounds and the stag, whether the pupils got the odor of the woods and could hear the breaking of the twigs; the character of the trees, where the lake lay, etc. Most of the pupils frankly said in reply that they had not thought of these things and did not know. It requires no argument to show that such reading is

largely without value, and yet much of the reading done in the schools is of this type. A number of the class mentioned above could recite whole pages of the beautiful poem, but the imagery involved was chiefly if not altogether verbal.

It would seem that the pedagogical significance of the mental image has not been recognized by teachers, or if realized, most of the problems connected with it yet await solution. One of the most fruitful fields of scientific study along educational lines unquestionably lies in this direction.

Cornell College, April, 1904.