Lewis Carroll at Play

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Lewis Carroll at Play
Chancellor's Scholars Paper Outline

I. Introduction
A. Popularity of the *Alice* books
B. Lewis Carroll background & summary of *Alice* books
C. Lewis Carroll put *Alice* books together for insight
D. Lewis Carroll incorporated math, logic and games in *Through the Looking Glass* and *Alice's Adventures in Wonderland*, which benefits computer scientists and mathematicians.

II. Mathematics in *Alice* books relates to computer science
A. Properties
1. Identity
2. Inverses
3. No solution problems (nonsense)
4. Rules not absolute–always an exception
B. Symmetry
C. Dimensions
D. Meaning of mathematical phrases
E. Null class
F. Math puzzles
1. Multiplying
2. Alice's running
3. Line puzzle
4. Time
5. Zero-sum game
6. Transformations
G. Mathematical puns

III. Logic in the *Alice* books relates to computer science
A. Concepts being broken down
B. Humpty Dumpty chooses what words mean
C. Need for Order
D. Alice as a logician
E. Logic of a child
F. Don't assume anything
G. Symbols

IV. Games in the *Alice* books relates to computer science
A. Cards
B. Chess
C. Acrostics
D. Doublets
E. Syzgies
F. Magic Tricks

1. Fan
2. Apple
3. Magic Number

G. Mazes
H. Carroll's Games

V. What Lewis Carroll offers to Computer Science and Mathematics today
A. Allows more people to enjoy mathematics
1. Caused more people to be interested in math
2. Origami
3. Teaching Math
4. Tangrams
5. Perspectives

B. New ways to think
–Things should be thought of in a new way–find new ways of doing things
(Alice trying to find the Queen)

C. Inventing
D. Dodgson's Puzzle–Where Does the Day Begin?
E. Datawocky
F. Computer Programs
1. Some programs will blow up with wrong input
2. Quality of a product is better than quantity
3. Limited Resources (time and memory (space) complexity)
a. Bread and Butter Fly
b. So many squares on board with so many who can occupy a square
4. Beware of infinite loops–Red King Dreamed it or Alice?
5. Different rules depending on what the program will be used to accomplish
6. Victorian England's changes–must constantly adapt

G. Ambiguous Languages
H. Boolean Algebra

VII. Conclusion
A. Must constantly update programs so not to become extinct
B. Carroll thought of things differently and open new branch of children's lit
C. Carroll's adventures are played in the mind

Lewis Carroll at Play

I. Introduction

Lewis Carroll, a.k.a. Charles Lutwidge Dodgson, is a person whose books, Alice in Wonderland and Through the Looking Glass, have been quoted frequently in this century and are loved and cherished by many. Almost everyone as a child has listened to or read about Alice and her adventures in Wonderland. Why are they so popular? Florence Becker Lennon said Dodgson was able to "deal with contradictions and horrors and irrationalities, and to convert them into an art form that gives release to children and adults alike." The comedy and attention to "paradoxes of the human condition" is one reason adult readers love Lewis Carroll; because he journeys with them on the "quest for meaning and order" (Rackin 103). Yet another reason could be that he makes math puzzles and the like fun and enjoyable–one doesn't realize they are mathematical puzzles. He unified math, puzzles and games (including chess) and literature, concepts dynamically opposed which most people would not believe could ever go together.

The writer Lewis Carroll may be more interesting than his ordinary human counterpart, Charles Dodgson. Charles Dodgson (1832-1898) was the eldest son of Charles and Francis Jane Lutwidge Dodgson. Growing up, Dodgson's father was a clergyman and so followed in his father's footsteps. Charles often entertained his 10 other siblings by inventing games. He also wrote for the family magazine. In 1850 he entered Christ Church at Oxford and went from a bachelor and master's of arts degrees to being a mathematical lecturer. While he never married, he was the head of his family after both his parents died, since he provided a house for his unwed

sisters. Carroll was also fond of girl children and enjoyed taking their pictures. This is how he met the Liddell children to whom he told the story of Alice's Adventures under Ground; Alice in the book is named after Alice Liddell. Because Alice wanted a written copy, Dodgson obliged and she received a published copy three years after telling his tale. Alice's Adventures under Ground was revised and became Alice's Adventures in Wonderland. Due to the great success of Lewis Carroll's first book, he proceeded and completed the sequel Through the Looking Glass, a book similar to the first but very different.

In Alice's Adventures in Wonderland while Alice is listening to a story, young Alice spots a White Rabbit with a pocket watch and can talk, which she chases down a hole underground. Her decision to follow the White Rabbit introducing Alice to meet a series of confusing characters including: Caterpillar, Mad Hatter and March Hare, Duchess, Gryphon and Mock Turtle, gardeners (who are cards), Cheshire Cat who has a smile without a body and the King and Queen of Hearts (also cards). Following a series of adventures that culminate with the trial of the Knave of Hearts accused by the Queen of Hearts of stealing her tarts, Alice grows wearied and angered at the proceedings and wakes up from her dream.

Through the Looking Glass may contain the same primary character as Alice's Adventures in Wonderland, however Alice is older and more mature in the looking-glass world. In Through the Looking Glass Alice is talking to Dinah's black kitten and pretending she can go through a mirror into a looking glass house. Once inside, she sees a chessboard with the pieces talking. She exits the house into the garden and chats with the flowers, who tell her the Red Queen is in the garden. Alice tries to walk towards the Queen, but only gets farther away. Then she realizes she must walk away from the Red Queen to get to her (looking glass reversal). The

Red Queen allows her to join the chess game they're going to play. Alice will be a white pawn. So Alice moves across the checkerboard and encounters playing pieces located on the squares next to her. She also meets the Gnat, Fawn, Humpty Dumpty, Tweedledum and Tweedledee, White Queen, Red King and White Knight. Alice finally becomes Queen and she has a dinner and tea held in her honor. However, Alice cannot give her speech of being thankful because chaos ensues and thus she cannot stand the anarchy so she picks up the Red Queen and shakes her till she becomes Dinah's black kitten. The Alice of Through the Looking Glass is more mature and more empowered than her counterpart in Alice in Wonderland.

For most people, the *Alice* books were put together to entertain Carroll's friends and readers and to give insights about his society, humans, and himself. One entertaining aspect is the Alice books are popular in part because they are familiar in that Alice's dreams are so very similar to our own. The pattern of one thought fading into a new one can be seen especially in Through the Looking Glass. When Alice and the Queen are finishing their talk, the Queen turns into a sheep. This happens throughout Through the Looking Glass and each time a new scene fades in, it does not seem to make any sense. Dodgson's biographer, Florence Becker Lennon, said, "Both [*Alice* books] use the materials of the universal dream or folk tale; their prime value lies in the articulation of the inarticulate impressions of the childhood and in their multiple use on several planes simultaneously, which make them interesting to all ages and cultural levels" (Lennon 124).

Some critics believe Lewis Carroll (a.k.a. Charles Lutwidge Dodgson) included more in than what readers usually notice. Florence Becker Lennon, Carroll's biographer, writes, "After all, Carroll was a philosopher, which means he transmuted his experiences into something

beyond life" (Lennon 178). Also, Lewis Carroll was an excellent logician while Dodgson was not. If someone wants to see how great of a logician he was, Wonderland is the place to look (Weaver 24). In the math, logic and games Carroll created a series of experiences that challenged Alice and continue to challenge the reader today. Lewis Carroll has intrigued computer scientists and mathematicians–and all people interested in these subjects–by his inclusion of math, logic and games in the *Alice* books.

Math was important to Dodgson since he was a mathematician. Computer science is built upon mathematical concepts and principles and technology during Carroll's age was increasing. Dodgson also enjoyed to reason things out by use of logical deduction. Computer science requires people to logically think about what a program is supposed to do and how to write the code so it will do it. Games are also important to Carroll and provide the basis for much of his humor in the books. These have rules by which players must abide by in order to win. The same holds true for computer scientists who must write code within certain constraints such as time and space. These three major topics of interest to Carroll provide the basis to analyze how they relate to computer science.

II. Mathematics in the Alice books

While being famous as the author of Alice in Wonderland and Through the Looking Glass, most people do not realize Charles Dodgson was a mathematician. He was a mathematical lecturer at Oxford, while he wrote the books. He also wrote several mathematical pamphlets and books. As such, it *is* only natural for him (like so many other authors) to include that which he enjoyed and knew. One of the basic mathematical concepts is the identity property. Many people take these properties for granted. One example of an identity is one

times any number is that same number. This is an important property because it means the number does not change when you multiply by one. Alice has a sense of identity because she remains unchanged throughout her adventures. As William Anderson and Patrick Groff point out in *A New Look at Children's Literature*, "First there is the sense of identity, or the discovery of one's outer meaning gained by looking into a mirror; next, there is the fairy tale journey that provides the fulfillment of one's role; and finally, there is the actual movement of men on a chessboard" (Anderson 75).

Mathematical identities provide a foundation which other rules can be built upon. If these identities are disrupted, many more mathematical concepts would be destroyed. The same applies to human identity. Alice goes through such an identity disruption when the Caterpillar asks her who she is.

> The Caterpillar and Alice looked at each other for some time in silence: at last the Caterpillar took the hookah out of its mouth, and addressed her in a languid sleepy voice.
>
> "Who are *you*?" said the Caterpillar.
>
> This was not an encouraging opening for a conversation. Alice replied, rather shyly, "I–I hardly know, Sir, just at present–at least I know who I *was* when I got up this morning, but I think I must have been changed several time since then."
>
> "What do you mean by that?" said the Caterpillar, sternly. "Explain yourself!"
>
> "I can't explain *myself*, I'm afraid, Sir," said Alice, "because I'm not myself, you see." (Carroll, Alice's 47).

Alice sees her identity resting on arbitrary, constructed systems, which resemble the system of arithmetic. She attempts to re-establish an "in-the-world" identity by reciting her rote-

learned lessons in arithmetic: "Let me see: four times five is twelve, and four times six is thirteen and four times seven is–oh dear! I shall never get to twenty at that rate!" (Carroll's Alice's 23). Alice tries to find a firm footing in the world of chaos she has entered by doing something she has done before–multiplication. But this does not give her peace because she cannot get to twenty the way she is multiplying.

In math,some functions have inverses. An inverse undoes what the function does and vice-versa. For example, addition and subtraction undo each other.
Addition and subtraction and multiplication and division are mathematical inverses. Aaron Bakst, *Mathematics: Its Magic and Mastery*, explains, "A special form of this occurs when numbers are multiplied by themselves, i.e., are squared. The inverse of this is called the extraction of square roots, e.g. $15^2=225$. The inverse of this is square root(225)=square root(15^2)=15" (Eiss 176).

Inversion is manifested in Through the Looking Glass when the Red and White Queens exhort to have Alice do addition and subtraction.

> "Can you do Addition?" the White Queen asked. "What's one and one and one and one and one and one and one and one and one and one?"
>
> "I don't know," said Alice. "I lost count."
>
> "She ca'n't do Addition," the Red Queen interrupted. "Can you do Subtraction? Take nine from eight."
>
> "Nine from eight I ca'n't, you know," Alice replied very readily: "but—"
>
> "She ca'n't do Subtraction," said the White Queen. "Can you do Division? Divide a loaf by a knife–what's the answer to *that*?"

> "I suppose–" Alice was beginning, but the Red Queen answered for her. "Bread-and-butter, of course. Try another Subtraction sum. Take a bone from a dog: what remains?"
>
> Alice considered. "The bone wouldn't remain, of course, if I took it–and the dog wouldn't remain: it would come to bite me–and I'm sure *I* shouldn't remain!"
>
> "Then you think nothing would remain?" said the Red Queen.
>
> "I think that's the answer."
>
> "Wrong, as usual," said the Red Queen: "the dog's temper would remain."
>
> "But I don't see how–"
>
> "Why, look here!" the Red Queen cried. "The dog would lose its temper, wouldn't it?"
>
> "Perhaps it would," Alice replied cautiously.
>
> "Then if the dog went away, its temper would remain!" the Queen exclaimed triumphantly (Carroll, Through, 253-254).

The Queens have Alice doing addition and subtraction (which are inverses) using real-life examples. Nine from eight equals negative one just as eight is nine minus one.

Carroll knew children enjoyed forms of inversion because he amused them by writing letters that used this concept. Martin Gardner tells about one of Carroll's letters that mentions a doll whose right hand becomes "left" when the left hand drops off; another letter tells how he sometimes goes to bed so soon after getting up that he finds himself back in bed *before* he gets up. Many of his letters used mirror writing which could only be read by holding up to a mirror. He wrote letters that had to be read by starting at the last word and reading to the first. He enjoyed playing his music boxes backward. He drew funny pictures which changed pictures when turned upside down (Gardner, Annotated, 142).

Mirrors can also be seen as something that inverses things. Carroll used inversion, which includes logical contradiction.

> "I only wanted to see what the garden was like, your Majesty—"
>
> "That's right," said the Queen, patting her on the head, which Alice didn't like at all:
>
> "though, when you say 'garden'–*I've* seen gardens, compared with which this would be a wilderness."
>
> Alice didn't dare to argue the point, but went on: "–and I though I'd try and find my way to the top of that hill–"
>
> "When you say 'hill,' " the Queen interrupted, "I could show you hills in comparison with which you'd call that a valley." (Carroll, Through, 161-162).

A hill is the opposite of a valley. Basically, the Queen has seen a hill which makes "standard" hills a valley when compared. Calling a hill a valley is contradictory. Harry Eiss comments that "Such logical contradictions are the essence of mathematical paradoxes" (Eiss 181).

"No solution" problems are quite common in working out mathematical problems. Such problems are clearly seen by the "nonsense" found in the *Alice* books. In Alice in Wonderland, before the adventure begins, Rackin explains, Alice being depicted as reaching "that characteristic developmental stage in which the world and its words appear completely explainable, where all questions have answers, where mysteries and paradoxes are simply puzzles awaiting inevitable solutions" (Rackin 38).

In mathematics "no solution" problems are those in which you get "nonsense." An example is when something that is not true is being implied as true (like zero being equal to two).

In Alice in Wonderland on the Mad Hatter, like many other characters, poses a question to Alice, which she can't answer.

> The Hatter opened his eyes very wide on hearing this; but all he *said* was "Why is a raven like a writing-desk?"
>
> "Come, we shall have some fun now!" thought Alice. "I'm glad they've begun asking riddle–I believe I can guess that," she added aloud.
>
> "Do you mean that you think you can find out the answer to it?" said the March Hare.
>
> "Exactly so," said Alice.
>
> "Then you should say what you mean," the March Hare went on (Carroll, Alice's, 70).

As in mathematics, all questions in life do not have a definite answer. Carroll himself had no answer to the Mad Hatter's question (Sale 103). For example, the square root of 2 is not 1.4121356237. That is just an approximation for it. One can keep going to get more and more precise. However, you will not ever get what the square root of two is because you can always find the next decimal place's value (depending on the formula you are using). So, in essence, it can be considered a "no solution" problem because there is not a solution–only an approximation.

Another example of a puzzling question, which has no solution, can be seen when Alice is talking to the Mock Turtle and the Gryphon.

> "And how many hours a day did you do lessons?" said Alice, in a hurry to change the subject.
>
> "Ten hours the first day," said the Mock Turtle: "nine the next, and so on."
>
> "What a curious plan!" exclaimed Alice.

> "That's the reason they're called lessons," the Gryphon remarked: "because they lesson from day to day."
>
> This was quite a new idea to Alice, and she thought it over a little before she made her next remark.
>
> "Then the eleventh day must have been a holiday?"
>
> "Of course it was," said the Mock Turtle.
>
> "And how did you manage on the twelfth?" Alice went on eagerly.
>
> "That's enough about lessons," the Gryphon interrupted in a very decided tone (Carroll, Alice's, 99).

The Gryphon has no answer and wants to change topics. As Carrollian Martin Gardner says in his *Annotated Alice*; The Gryphon is puzzled by Alice's question just as much as early mathematicians. It introduces the notion of negative numbers, which does not seem to apply to lessons in school. Gardner asks, "On the twelfth day and succeeding days did the pupils start teaching their teacher?" (Gardner, Annotated, 99).

Rules are not absolute is another common theme in Carroll's works since mathematics can have unexpected inconsistencies. Mathematics was under attack during the last part of the 19th century. In Compared to What? An Introduction to the Analysis of Algorithms, Gregory Rawlins discusses how mathematicians had not been thinking of inconsistencies in different mathematical branches while they were "madly inventing" the future of their discipline for five thousand years. Some mathematicians mentioned new techniques had not been proven to work. Yet, no one listened that these new techniques are not founded. Georg Cantor, a German mathematician, had just invented set theory and it seemed to create solid ground. However,

Rawlins continues by explaining that serious contradictions were spotted in the "unquestioned mathematical 'truth.'" So in 1900 David Hilbert, the most important mathematician of his time, arguably the most famous German mathematician after Gauss, decided to fix the problem by treating mathematics as a game of manipulating symbols by fixed rules without the symbols meaning anything. This is the *formalist* school of mathematics that is dominant today! (Rawlins 417). The *Alice* books have influenced mathematicians by having them treat mathematics as a game.

Carroll saw mathematics and logic as a game (as can be seen in the *Alice* books) and perhaps this influenced Gauss to treat it as a game. Thus, Carroll saw rules as not being absolute is demonstrated in the two worlds in which Alice encounters. Donald Rackin explains the reverses Alice encounters is almost a total destruction of our logical and orderly approach to the world. Everything except chaos is annihilated. First, ordinary mathematics and logic possess no meaning in Wonderland. So the usual modes of thought are destroyed. Then the basic social and linguistic conventions lose validity. Finally, only Alice retains the concept of time and space (Rackin 36).

Carroll slowly plays a game by eliminating one accepted rule after another, which he does without being concerned of the implications. The world he creates is a very frightening place–since there is no absolute truth, except chaos. Words and numbers come with rules and Alice has accepted the existence of these rules just as the progression of Time. Even in games Victorians realized the rules established boundaries that regulate behavior. Ira Nadel believes "Lewis Carroll most clearly advanced the revised attitude toward play through his inversion of rules and logic. In his various mathematical and language games, he created what Dickens called

a 'region where rules, and figures, and definitions were not quite absolute.'" (20). The whole point of Alice in Wonderland and Through the Looking Glass demonstrated Victorian uncertainty with the stability of rules. Yet, as Anderson explains, "while sanity is valued in the real world, madness is the keynote of Wonderland. But because the types in Wonderland have their obvious counterparts in the real world, a clear statement is made about the apparent aspects of the real world in a setting of nonsense and madness, Carroll points out the absurdities of much conventionally accepted truth" (Anderson 72).

Dodgson was also charmed by symmetries, perhaps because he was handsome and symmetrical. He, Richard Kelly states in Lewis Carroll, "was fascinated by peculiar symmetries and odd reversals, including mirror-writing, looking-glass worlds, and the spelling of words backwards (Bruno and Sylvia exclaims that "evil" spells "live" backwards)" (Kelly 14).

> Tweedledum and Tweedledee are what geometers call "enantiomorphs," mirror-image forms of each other. That Carroll intended this is strongly suggested by Tweedledee's favorite word, "contrariwise," and by the fact that they extend right and left hands for a handshake. Tenniel's picture of the two enantiomorphs arrayed for battle, standing in identical postures, indicates that he looked upon the twins in the same way. Note that the position of the fingers of Tweedledum's right hand (or is it Tweedledee's?–the bolster was put around the neck of Dee, but the saucepan marks him as Dum) exactly matches the position of his brother's left fingers (Gardner, Annotated, 182).

The twins, Tweedledum and Tweedledee, are symmetry personified, since they are mirror-image forms of one another.

Corkscrews, an item constantly referred to in Through the Looking Glass, are asymmetric. They

spiral the "other way" in the mirror as corkscrews are helices (assymmetric, three-dimensional). The toves Humpty Dumpty says look similar to corkscrews. Martin Gardner offers another example of Humpty Dumpty talking of using a corkscrew to wake up a fish in a poem. The White Queen remembers Humpty Dumpty coming to her door with one in his hand looking for a hippopotamus (Gardner, Annotated, 156). Symmetry is found throughout Through the Looking Glass. Many of the pieces in chess come in pairs, but the arrangement of the pieces at the start of the game is a mirror reflection as well (Kelly 100).

Another key idea in math, especially in linear algebra, is the idea of dimensions, also included in the *Alice* books. After all, Carroll had several books such as Charles Hinton's *The Fourth Dimension* and thus he would include it in Through the Looking Glass (Burstein IX). For instance, the mirror reflection concept is about dimensions.

> When you look in a mirror, what you see is a reflection of the entire scene on your side of the mirror, except for bits that disappear from view because the mirror is of finite extent. What is actually happening, of course, is that light rays from real objects on your side of the mirror are hitting the mirror, bouncing off, and entering your eye from an unexpected direction–creating the illusion of objects behind the mirror. It is this illusion that Lewis Carroll alluded to when he contrived to have his heroine climb through the looking-glass to visit the world on its other side (Stewart 110-111).

The light rays bouncing off the mirror and entering the eye, create the illusion of dimension. It looks as if there is something behind the glass when in reality it is a flat surface.

Then there is the game of chess in which one person is playing the other person (similar to positive and negative numbers on the numberline)–the one who wins is the "number" who is

greater. As Mark Burstein, lifelong Carrollian collector and scholar as well as the Vice-President of the *Journal of the Lewis Carroll Society of North America*, says:

> Chess is essentially a game of one dimension (i.e. opposing forces). It is played on a two dimensional surface, the board. The forces (called pieces) are either of one dimension (the pawn, which moves only forward in a straight line); two dimensions (Rooks, Bishops, Kings and Queens, which have two degrees of freedom or directions of movement); and the piece which gives the game its intricacy and life, the three-dimensional Knight. It is three-dimensional in the sense that it can pass over another piece in its move, whereas two-dimensional pieces would be blocked (Burstein IX).

Thus, chess can be seen as a multi-dimensional game because it includes aspects of the first, second and third dimensions. Harry Levin observes that the events in this domain, like most attempts to transform the natural world, are given the dimension of something that will continue to happen over and over. "Tweedledum and Tweedledee will fight; the Lion and the Unicorn will be ridden out of town; and Humpty Dumpty will continue to reenact his disappearing act" (Bloom 29). However, Carroll's chess game is similar to life. Carroll's biographer, Florence Becker Lennon, points out "This chess game, so much-perhaps so consciously–like life (as Carroll would write), is played on several planes, has several interpretations, and no definitive triumph" (174). Carroll shows we are literally living math because of dimensions. Carroll also shows how the meaning of mathematical phrases can be confusing.

> "In mathematics equal amounts of energy have been dissipated in useless argumentation over the "meaning" of such phrases as "imaginery number," "transfinite number," and so on; useless because such words mean precisely what they are defined to mean; no more,

no less" (Gardner, Annotated, 215).

Imaginery number, transfinite number, etc can be seen as oxymorons. While they have definition, they are concepts whose meanings are not meant to be argued. The Cheshire Cat shows how mathematical theorems are abstractions.

> The phrase "grin without a cat" is not a bad description of pure mathematics. Although mathematical theorems often can be usefully applied to the structure of the external world, the theorems themselves are abstractions that belong in another realm "remote from human passions," as Bertrand Russell once put it in a memorable passage," remote even from the pitiful facts of Nature...an ordered cosmos, where pure thought can dwell as in its natural home, and where one, at least, of our nobler impulses can escape form the dreary exile of the actual world" (Gardner, Annotated, 68).

Mathematical theorems are abstractions that are only applied in the human realm.

The null class is another, different mathematical term found in the *Alice* books. A null class is an empty set, it contains no members. Carroll treats the null class as if it were something just like other mathematicians, logicians and some metaphysicians do.

> In the first *Alice* book the Gryphon tells Alice that "they never executes nobody." Here we encounter the unexpected Nobody walking along the road, and later we learn that Nobody walks slower or faster than the Messenger. "If you see Nobody come into the room," Carroll wrote to one of his child-friends, "please give him a kiss for me." In Carroll's book *Euclid and His Modern Rivals*, we meet Herr Niemand, a German professor whose name means "nobody." When did Nobody first enter the *Alice* books? At the Mad Tea Party. "Nobody asked *your* opinion," Alice said to the Mad Hatter. He

> turns up again in the book's last chapter when the White Rabbit produces a letter that he says the Knave of Hearts has written to "somebody." "Unless it was written to nobody," comments the King, "which isn't usual, you know" (Gardner, Annotated, 223).

Once again, Carroll has personified a mathematical term by giving the null class human characteristics (such as sight and walking) disguised in the form of Nobody.

Carroll also includes math puzzles in his books. Alice multiplies numbers in different bases.

> 'I'm sure I'm not Ada,' she said, 'for her hair goes in such long ringlets, and mine doesn't go in ringlets at all, and I'm sure I can't be Mabel, for I know all sorts of things, and she, oh, she knows such a very little! Besides, *she's* she, and I'm I, and–oh dear, how puzzling it all is! I'll try if I know all the things I used to know. Let me see: four times five is twelve, and four times six is thirteen, and four times seven is–oh dear! I shall never get to twenty at that rate! (Carroll Alice's 23).

This mathematical puzzle is explained by Alexander L. Taylor, in his book *The White Knight.* He shows how 4 times 5 is equal to 12 when using a number system based on the scale 18. "On the scale 18, the numbers progress 1, 2, 3, 4, 5, 6, 7, 8, 9, (10) (11) (12) (13) (14) (15) (16) (17) 10, 11, 12 and so on. Similarly 4 times 6 equals 13 on the scale 21, where the numbers progress 1, 2, 3, 4, 5, 6, 7, 8, 9 (10) (11) (12) (13) (14) (15) (16) (17) (18) (19) (20) 10, 11, 12, 13. Increasing the scale by three each time, one arrives at:

4 times 7 equals 14 on the scale 24;

4 times 8 equals 15 on the scale 27

4 times 9 equals 16 on the scale 30

4 times 10 equals 17 on the scale 33

4 times 11 equals 18 on the scale 36

4 times 12 equals 19 on the scale 39

But, and here Taylor finds the answer why Alice will never get to 20, 4 times 13 does not equal 20 on the scale 42, where the numbers go 1, 2, 3, 4, 5, 6, 7, 8, 9 (10, 11, 12....39, 40, 41) 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 1(10), etc., the last notation being 1, in the 42s column, followed by whatever symbol is adopted for ten" (Fisher 34-35). As John Fisher says in The Magic of Lewis Carroll, "It is even more difficult to suppose that he, a mathematical don, inserted the puzzle in the book without realizing it" (Fisher, John 34-35).

Also in Alice Adventures in Wonderland is the zero sum game, seen in the Duchess's words: "And the moral of that is–'The more there is of mine, the less there is of yours.' " (Carroll 92). Martin Gardner says, "Carroll seems to have invented this proverb. It describes what in modern game theory is called a two-person zero-sum game–a game in which the payoff to the winner exactly equals the losses of the loser. Poker is a many-person zero-sum game because the total amount of money won equals the total amount of money lost (Gardner, Annotated, 92).

In Through the Looking Glass, Alice's running faster and faster can be explained by math.

> "Now! Now!" cried the Queen. "Faster! Faster!" And they went so fast that at last they seemed to skim through the air, hardly touching the ground with their feet, till suddenly, just as Alice was getting quite exhausted, they stopped, and she found herself sitting on the ground, breathless and giddy.

> The Queen propped her up against a tree, and said kindly, "You may rest a little now."
>
> Alice looked round her in great surprise. "Why, I do believe we've been under this tree the whole time! Everything's just as it was!"
>
> "Of course it is," said the Queen. "What would you have it?"
>
> "Well, in *our* country," said Alice, still panting a little, "you'd generally get to somewhere else–if you ran very fast for a long time as we've been doing."
>
> "A slow sort of country!" said the Queen. "Now, *here*, you see it takes all the running *you* can do to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!" (Carroll, Through, 165).

Normally the equation for speed is s=d/t. High speeds require distance to be high and time to be small. Yet, here the equation is s=t/d. Now high speeds require time to be high and distance to be small (Kelly 101). Once again, Carroll has played with math and reversed the divisor and the dividend.

Carroll enjoyed puzzles and incorporated some of his favorite ones in the *Alice* books. The poor King looked puzzled and unhappy, and struggled with the pencil for some time without saying anything; but Alice was too strong for him, and at last he panted out 'My dear!" I really *must* get a thinner pencil. I can't manage this one a bit: it writes all manner of things that I don't intend–' (Carroll, Through 125). When Carroll wrote this, he may have been thinking of a puzzle he showed to Isabel Standen. The puzzle requires drawing three interlaced squares in one continuous line without going over any parts of the line twice, without intersecting the line, and without taking the pencil off the paper. Thomas O'Beirne, the Scottish author of *Puzzles and Paradoxes*, gives a method to solve this puzzle. First color areas that the other squares do not

overlap. Then color the sections that all the squares overlap. Then pull apart the appropriate points so the shaded area is one object free of enclosed non-shaded areas. "The edge of this shape approximates topologically to the more precise line required by the solution" (Fisher 58).

Even one of Carroll's favorite word games, doublets, can be seen as transformations. In The Universe in a Handkerchief. Lewis Carroll's Mathematical Recreations, Games, Puzzles, and Word Plays, Gardner tell of Rudy Rucker, a mathematician and science fiction writer, who has likened doublets to a formal system. The first word is the given 'axiom.' The steps obey 'transformation rules,' and the final word is the 'theorem.' One seeks to "prove" the theorem by the shortest set of transformations (Gardner, Universe, 87).

Carroll also has a character, The White Rabbit, who is obsessed with time. The *Alice* books talk so much about time, Carroll had his logical puzzle about two clocks in mind.

> Which is better, a clock that is right only once a year or a clock that is right twice a day?
>
> "The latter," you reply, "unquestionably." Very good, now attend.
>
> I have two clocks: one doesn't go *at all*, and the other loses a minute a day: which would you prefer? "The losing," you answer, "without a doubt." Now observe: the one which loses a minute a day has to lose 12 hours, or seven hundred and twenty minutes before it is right again, consequently it is only right one in two years, whereas the other is evidently right as often as the time it points to comes round, which happens twice a day.
>
> So you've contradicted yourself *once.*
>
> "Ah, but, "you say, "What's the use of its being right twice a day, if I can't tell when the time comes?"
>
> Why, suppose the clock points to eight o'clock, don't you see that the clock is right *at*

> eight o'clock? Consequently, when eight o'clock comes round your clock is right.
>
> "Yes, I see *that*," you reply.
>
> Very good, then you've contradicted yourself *twice*: now get out of the difficulty as best you can, and don't contradict yourself again if you can help it.
>
> You *might* go on to ask, "How am I to know when eight o'clock *does* come? My clock will not tell me." Be patient: you know that when eight o'clock comes your clock is right, very good; then your rule is this: keep your eye fixed on your clock, and *the very moment it is right* it will be eight o'clock. "But–," you say. There, that'll do; the more you argue the farther you get from the point, so it will be as well to stop (Eiss 141).

Lewis Carroll's mind seems preoccupied with puzzles. While the puzzle of two clocks is not directly inserted in the *Alice* books, he indirectly planted it with the White Rabbit. After all, the White Rabbit is always late, which can be attributed to his watch losing a minute a day. Carroll especially enjoyed puns and thus punned on mathematical terms. Some of his other writings include mathematical puns. Richard Kelly says *Dynamics of a parti-cle*, a small pamphlet of political satire published in 1865, has the "distinctive flavor of his nonsense books." This pamphlet contains some interesting puns:

> 1. PLAIN SUPERFICIALITY is the character of a speech in which any two points being taken, the speaker is found to lie wholly with regard to those two points.
> 2. PLAIN ANGER is the inclination of two voters to one another, who meet together, but whose views are not in the same direction.
> 3. When a Proctor meeting another Proctor, makes the votes on one sides equal to those on the other, the feeling entertained by each side is called RIGHT ANGER.
> 4. When two parties, coming together, feel a Right Anger, each is *said* to be COMPLEMENTARY to the other (though, strictly speaking, this is very seldom the case).
> 5. OBTUSE ANGER is that which is greater than Right Anger (Kelly 129).

Since Carroll punned in other writings, it makes sense to conclude he would do the same in the *Alice* books. When the Mock Turtle is talking to Alice about subjects in school, Carroll is punning on them. He puns on arithmetic's basic properties–addition, subtraction, multiplication and division in addition to other subjects taught in school.

> "I couldn't afford to learn it," said the Mock Turtle, with a sigh. "I only took the regular course."
>
> "What was that?" inquired Alice.
>
> "Reeling and Writhing, of course, to begin with," the Mock Turtle replied; "and them the different branches of Arithmetic–Ambition, Distraction, Uglification, and Derision."
>
> "I never heard of 'Uglification,' " Alice ventured to say. "What is it?"
>
> The Gryphon lifted up both its paws in surprise.
>
> "Never heard of uglifying!" it exclaimed. "You know what to beautify is, I suppose?"
>
> "Yes," said Alice doubtfully: "it means–to–make–anything–prettier."
>
> "Well, then," the Gryphon went on, "if you don't know what to uglify is, you *are* a simpleton" (Carroll, Alice's, 98).

As Martin Gardner points out in his *Annotated Alice,* all the subjects the Mock Turtle talks about are puns: Reeling and Writhing (Reading and Writing), Ambition, Distraction, Uglification and Derision (Addition, Subtraction, Multiplication and Division), Mystery (History), Seography (Geography), Drawling (Drawing), Stretching and Fainting in Coils (Sketching and painting in oils), Laughing and Grief (Latin and Greek). "In fact, this chapter [The Mock Turtle's Story] and the one to follow [The Lobster-Quadrille] fairly swarm with puns" (98).

Dodgson did not do anything major when he just attempted to do math. Instead, it took

Carroll to bring out his playful side and show what he could really do. Martin Gardner feels "His strong sense of mathematical beauty became intertwined with a delight in play that found expression in a fondness for mathematical games, puzzles, logic paradoxes, magic tricks, riddles and every variety of word play, especially puns, anagrams, and acrostic verse, published under the name Lewis Carroll" (Gardner, Universe, 1). His interest and love in these games, puzzles and play on words as well as word play have allowed others to enjoy and appreciate math.

Whether people realized it or not, they enjoy math in the *Alice* books without recognizing it as math. Carroll puns on mathematical terms, inserts math related puzzles, but more importantly shows people how math is used in their everyday lives. Math requires people to think just as games do. People enjoy trying to solve puzzles–and Dodgson was no different. He enjoyed a variety of activities of which each one related to his logical and mathematical side of himself.

III. Logic in the Alice books

Mathematics requires a person to think logically or else the problem cannot be solved. Through his games Lewis Carroll utilized humor. Carroll had a new comic subject: people trying to discover the world by thinking about it. Carroll's characters (White Knight, Humpty Dumpty, White Queen, Mad Hatter, March Hare) are considered to be smart in a new way. These were characters who liked coming up with logical reasoning to determine where it will take them (Gopnik 88). The characters are trying to discover the world by thinking about it. One instance of this in Through the Looking Glass is where the March Hare tells Alice to say what she means.

> She replies that "at least I mean what I say–that's the same thing, you know." But the Hatter retaliates with, "Not the same thing a bit! Why you might just as well say that, "I

> see what I eat' is the same thing as 'I eat what I see'!". As Roger W. Holmes points out, Carroll the philosopher-logician is at work here. "We know that if all apples are red, it does not follow that red things are apples: the logician's technical description of this is the non-convertability simplicities of universal propositions." (Kelly 91).

In the *Alice* books, we are allowed to see how far concepts can be broken down without being destroyed. Just like the "simple liar" paradox.

> For example, a card is presented which reads, "On the other side of this card is a true statement," and when the card is turned over, the message on it reads, "On the other side of this card is a false statement." Naturally, Carroll is aware of the pedagogical value of paradoxes for illustrating errors of reasoning to his students. The fundamental "error" of paradoxical propositions resides, of course, in the multiplicity of meanings which are forced to coexist through an overdetermination of predication. When Carroll isn't reversing the order of syntax or causing it to fork into mutually exclusive paths through a double entendre, he produces an interminable sequence of implication which nullifies the message" (Bloom 71-72).

If one message is true, the other must be false–but that is what each statement says the other statement is. So which one is right? This is exactly the world Alice enters into not once but twice. A world in which opposing concepts can both be true.

Another character that Carroll used as a logician in Through the Looking Glass is Humpty Dumpty. Humpty Dumpty said, "when I use a word, it means what I choose it to mean–neither more nor less" (Carroll, Through, 269). When Humpty Dumpty chooses a word, then he determines its meaning. Dodgson got to decide what words meant and he did because he formed

new words from combining different words (example burble is from the b in bleat, the ur in murmur, and the ble in warble), but he only got to decide what they meant when he put them in his book (Gardner, Annotated, 268-269). Humpty Dumpty can be seen as a logician because if he chooses to accept a different meaning that is his choice because the words only mean what a person wants them to mean.

His main character, Alice, is the prime example. Brittanica Online comments, "Alice, the perfect creation of the logical and mathematical mind applied to the pure and unadulterated amusement of children, was struck out of him as if by chance; while making full use of his specialized knowledge, it transcends his weaknesses and remains unique" ("Carroll" 8). Lennon considers Alice as the character that resembles Carroll the most and is his "seeking self, his best-beloved ego to which he assigns all the desirable traits" (Lennon 122). Annette Chang agrees saying Alice is also the one who wants meaning and order and the scene in Alice in Wonderland perhaps "symbolizes the author's hopeless struggle and consequential anxiety in his quest to discern meaning in a world that has reduced itself to the chaos and perhaps the absurdity comparable to that of Wonderland" (Chang 1). Being that Dodgson felt awkward in this world, he might have felt as Alice did trying to play croquet in Wonderland. Annette Chang examined this scene:

> Whereas the game of croquet itself possesses meaning, this absurd way of playing in Wonderland leaves Alice struggling to find order: as she finally "succeeds in getting its (flamingo's) body tucked away, comfortably enough," it would untwist itself. And time after time, after Alice establishes and re-establishes order with one facet of the game, another would break down again into its chaotic state (Chang 1).

Dodgson may have felt he got one thing accomplished and another one would unravel–just like it did when Alice was playing croquet. Lewis Carroll was probably annoyed with this chaos and wanted order to better understand it all–this is the way a logician thinks.

Alice can be seen as the only logical person in Through the Looking Glass. Charles Johnson says in Philosophy in Literature that everything is reversed "what is insane here is sane there; mostly importantly, what is illogical here is logical there." Alice will refuse to be polite when her conversation with some of the characters becomes extremely illogical. Johnson sums it up by saying "She takes the stance of a rational logician" (Johnson 129). Alice wants to feel secure and she tries to reason what is said and how the characters act to understand why something is happening.

Dodgson enjoyed being in the company of children (girl children especially) and would be interested in how they reasoned things out. He got the idea for Through the Looking Glass from Alice Raikes. Dodgson stood her in front of a mirror, and gave her an orange. He then asked her 'which hand the little girl you see there has got it in.' She said her orange was in the right hand but the mirror-girl's orange was held in the left. He asked for an explanation and she answered: 'If I was on the other side of the glass, wouldn't the orange still be in my right hand?' " (Carpenter 527). So Alice Raikes, a child, played a part in the creation of Through the Looking Glass, which was based on her logic.

At the Trial in Alice in Wonderland, readers assume the Knave is the Knave of Hearts. However, Carroll enjoys playing around with the identity of the Knave of Hearts. This is one of the reasons Carroll wanted complete control over John Tenniel's illustrations for the books. John Tufail says, "He [the Knave] is NEVER shown sporting a Heart motif. Indeed, on the

frontispiece the predominent motif shown on the Knave's tunic is the Club" (1-2). In logic you cannot assume things or you will run into problems. Carroll shows as John Tufail points out that when Carroll "plays a semiological game with the key element of 'Alice'–the trial, but what we do not expect is that he would do it in such a subtle manner because most authors like to let the reader in on the secret at some stage. Sadly for the reader, Carroll is not most authors! He is a logician with a fine and personal sense of humour. To Carroll, the longer the joke remains private, the better the joke" (Tufail 2). The nursery rhyme encourages the reader to make the assumption about the trial and misses the point of the trial being nonsense from the evidence given. Instead it is nonsense because the person on trial is not the Knave of Hearts.

Throughout the *Alice* books, Carroll includes symbols and creatures who manipulate those symbols. For instance, the wood in which things have no name is like our real world. Gardner says as Alice wisely remarks, " 'it's useful to the people that name them.' The realization that the world by itself contains no signs–that there is no connection whatever between things and their names except by way of a mind that finds the tags useful–is by no means a trivial philosophic insight. The fawn's delight in recalling its name reminds one of the old joke about Adam naming the tiger because it *looked* like a tiger" (Gardner, Annotated, 178). Logic, just as in math, uses symbols to make it easier to manipulate the objects they represent. However, the symbols may stay the same while the objects they represent may change. The names are only useful to the people who use them. Of course, Carroll using Humpty Dumpty to ask a question about manipulating signs is an example of this.

Carroll's novel shows its modernism (and to a certain extent, its postmodernism) in a number of other ways: if the author's mathematical forays into the realm of symbolic

> logic make his work a natural precursor to Bertrand Russell's and Alfred North Whitehead's *Principia Mathematica* (1910-1913), and his interest in the possibilities of language look forward to Joyce, then his fascination with sign systems in the *Alice* books makes him a forerunner to contemporary approaches to the field of semiotics: Carroll's concerns extend beyond the explication of communication functions to probe the provocative semiotic question argued by Humpty Dumpty: "Who is to be master?" we over the signs we manipulate, or the signs over us Through the Looking Glass subtle pressures exerted by convention and conditioning? In Carroll's universe, the "master" of signification are poets, logicians, and madmen (Downey 2-3).

Symbols are not meant to control humans. Rather, humans should manipulate the symbols. Dodgson was a philosophical mind interested in linguistics and symbolic logic, which is why the *Alice* books are now "frequently interpreted as artistic representatives of abstract philosophical issues" (Rackin 27-28).

IV. Games in the Alice books

Games can easily be seen elsewhere in the Alice books and are also of interest to computer science. After all, some of the secondary characters in the *Alice* books are the King and Queen of Hearts and the White and Red Queen–of which the King and Queen of Hearts are cards and the White and Red Queen are chess pieces. Observing the ways of children and play, Carroll incorporated games in his books. Beverly Lyon Clark notes, "Certainly, as a photographer, he needed to learn what puzzles, games–and especially stories–could mesmorize a wriggling child for the minute or more that it took to record her image" (Clark, Touchstones v1, 47). Dodgson was fascinated by creating and playing games perhaps because they are puzzles in

themselves. To win you have to out-think your opponent. Biographer Edward Guiliano says, "All Carroll's literary works are filled with puzzles, games, anagrams, play parodies and riddles, logical queries, and an overall sense of a game-like contest with his reader. Dodgson loved and invented puzzles and games and was particularly well-acquainted with backgammon and chess. (Chess, of course, figures prominently in the design of Through the Looking Glass)" (Guiliano, Children's Lit vol 4, 189).

Cards are appropriate for the first book since Alice was young. As Donald Rackin says: "Teaching his little-girl friends the moves and rules of chess apparently marked for Dodgson a noteworthy stage in their maturation: even the youngest of his friends could play cards and simple word games, but chess was clearly an adult game that could put his cleverest young protegees on something like an equal footing with their grown-up opponent" (Rackin 76). Playing cards is a game that introduces children to an adult's world of chance. However, chess is an advanced thinking game which requires more skill than cards. Introducing his friends to chess, Dodgson allows them to share something in common with grown-ups, and to mature as Alice has in Through the Looking Glass.

Carroll obviously enjoyed chess because among the books sold from his personal collection after his death were: The Art of Chess-Play: A New Treatise on the Game of Chess (1846), by George Walker; The Chess-Player's Companion: Comprising a New Treatise on Odds, and a Collection of Games (1849) and The Chess Tournament, A Collection of the Games played at this Celebrated Assemblage (namely at the St. George's Club to mark the Great Exhibition)(1852), both by Howard Staunton. These *Alice* books utilize some of the rules used in Victorian society and may explain some of the "discrepancies" in his chess game that his

critics dwell on today.

In a game of chess one is supposed to say "check." However, John Fisher reveals why White ignores the "check" by the Red Queen on her King. On "the arrival of the Queen at King one, the Queen had explained to Alice, now her equal on the final rank, 'Speak when you're spoken to!' Since on her arrival no one had spoken to her, the Red Queen could not break her own stipulation by volunteering 'check' herself'" (Fisher 88-89). In this world the rules are turned upside down–thus ruling out that this rule has to be used.

Stuanton's Companion, entitled On Odds, shows that when chess first started in India, it was based on chance. The moves were determined by throwing the dice. "In a world of pure chance where success is determined by the fall of a dice, the ratio of thirteen wins to three in favour of one player is not so improvable" (Fisher 88-89). This helps to explain the White pieces moving more times than Red. John Fisher continues to say "Certainly, no one can dispute that Carroll well prepared his readers for the extra hazards which this added uncertainty would impart to Alice's adventures. ' "They don't keep this room so tidy as the other," Alice thought to herself, as she noticed several of the chessmen down in the hearth among the cinders; but in another moment, with a little "Oh!" of surprise, she was down on her hands and knees watching them.' " (Fisher 88-89).

Dodgson created many word games, especially when he was a child entertaining his siblings. He included these in Through the Looking Glass. One word "game" Dodgson used in the *Alice* books is acrostics. Acrostics take the first letter of each line and spell a word or phrase. Dodgson used an acrostic of Alice Pleasance Liddell's full name to conclude Through the Looking Glass.

A boat, beneath a sunny sky
Lingering onward dreamily
In an evening of July–
Children three that nestle near,
Eager eye and willing ear
Pleased a simple tale to hear–
Long has paled that sunny sky:
Echoes fade and memories die:
Autumn frosts have slain July.
Still she haunts me, phantomwise,
Alice moving under skies
Never seen by waking eyes.
Children yet, the tale to hear,
Eager eye and willing ear,
*L*ovingly shall nestle near.
*I*n a Wonderland they lie,
*D*reaming as the days go by,
*D*reaming as the summers die:
*E*ver drifting down the stream–
*L*ingering in the golden gleam–
*L*ife, what is it but a dream?

Another such game was doublets. Martin Gardner describes that a doublet is the changing of one word to another by altering single letters at each step to make a different word. The two words at the beginning and end of such a chain are of the same length, and are related to each other in some obvious way. Words in the chain are common English words with proper names excluded. 'Perfect' solutions are those doublets whose number of words in the chain equal the number of letters in the beginning word" (Gardner, Universe, 83). This helps to explain how Carroll let ALICE go Through the Looking Glass the GLASS mirror.

ALICE
Slice
Slide
Glide
GLASS

Gardner speaks of Fred Madden in The Annotated Alice, who wrote on "Orthographic

Transformations in Through the Looking Glass," who explains why a goat was put in the railway carriage next to the gnat. "In Carroll's game of Doublets, the word gnat becomes goat by the change of a single letter. Madden supports this contention by referring to a word ladder that actually appears in Carroll's pamphlet Doublets: A Word Puzzle, in which Carroll changed GNAT to BITE in six steps: GNAT, GOAT, BOAT, BOLT, BOLE, BILE, BITE" (Gardner, Annotated, 173). Dodgson, later on in his life, came up with a new way to create doublets. Only now the two words do not have to be the same length long.

Syzygies is a continuation of doublets. Dodgson created these to have the same group of consecutive letters that he called a syzygy. Martin Gardner in The Universe in a Handkerchief says, "In his 1893 booklet Carroll illustrated this by showing how WALRUS and SWALLOW are "yoked" together by the syzygy WAL. The idea is to link two associated words (which need not be the same length, as in doublets) in a chain such that every pair of adjacent words is joined by a syzygy" (Gardner, Universe, 144). Several examples from the *Alice* books include: Humpty Dumpty, Tweedledum and Tweedledee, etc.

Magic tricks were also quite common in Carroll's day. Indeed, they were amusing tricks that appear in the *Alice* books. For example, Alice trying to cut the cake similar to an old parlour trick Carroll knew about. An apple is inspected by a spectator who peels it and it falls apart in his hand. An instance of 'slice it first, and peel it afterwards'. John Fisher describes how this magic trick is done. "The only preparation necessary is to take a needle and thread and sew round the apple just beneath the skin, inserting the needle each time at the exist of the previous stitch. You start and finish as indicated at the stem, where you then cross the two ends and pull smartly until the polygon loop comes right out. This slices the apple into two halves; repeat at

right angles to slice into quarters. The blemishes left by the needle are hardly distinguishable and merge discretely into the natural texture of the peel" (Fisher 84-85).

Carroll liked to have secrets–such as this apple trick. Carroll would also enjoy the Magic Number trick. " 'Then you keep moving round, I suppose?' said Alice. 'Exactly so,' said the Hatter, 'as the things get used up.' 'But what happens when you come to the beginning again?' Alice ventured to ask." Ethel Rowell, a former pupil of Carroll, explains in her book Time and Time Again how The Mad Hatter's Tea Party exactly illustrates the idea of cyclic order, the idea demonstrated more overtly by Carroll in the other 'numerical curiosity' detailed by Collingwood. This is almost certainly the 'number repeating puzzle' mentioned in his diary on January 26, 1897 as part of a lecture/performance he gave at Guildford High School, and published anonymously in Chatterbox two weeks later.

Another magic trick is ending up with a cyclical number; a number that repeats itself endlessly. By dividing 1 by 7, one obtains 0.142857142857142857 etc. Taking the minimum stretch of digits before repetition begins, Carroll discovers some fascinating characteristics:

> A MAGIC NUMBER 142857
> 285714 twice that number
> 428571 thrice that number
> 571428 four times that number
> 714285 five times that number
> 857142 six times that number
>
> Begin at the '1' in each line and it will be the same order of figures as the magic number up to six times that number, while seven times the magic number results in a row of 9s (Fisher 254).

This is similar to a magician having a person pick a number, doing simple arithmetic to that

number and then being able to guess the number.

Another mathematical game and one of Carroll's earliest is the maze. 'I was thinking,' Alice said very politely, 'which is the best way out of this wood: it's getting so dark. Would you tell me, please?' Through the Looking Glass As a boy the young Dodgson once traced a maze on the Rectory garden at Croft, in Yorkshire. This mathematical puzzle-game is his life's theme. He also drew a maze when he was in his early twenties, for his family magazine Mischmasch. The object is to find a way out of the center of the maze. Crossing over and under paths is allowed but one cannot go outside the single-line border (Fisher 19).

Carroll was constantly thinking up new ideas for games and improving old ones. His own inventions include: a travelling chess set where the pieces stay in and a game where you could move letters on a chess-based board till they form words (Scrabble nowadays) (Fisher 12). Thus, Carroll is thinking ahead of the future–and being very creative by inventing new games to amuse children.

V. Importance to Mathematics and Computer Science

Lewis Carroll has opened the eyes of society upon mathematics and thus computer science. For one thing, more people enjoy mathematics because it is no longer seen as dull and boring but as a fun game. More people are interested in mathematics since they do not realize that tricks such as origami are related to math. Dodgson enjoyed the Japanese art of origami. John Fisher explains how origami related to Dodgson. "It's soothing complexity and geometric overtones both appealed to his mathematical instincts" and this is what made it one of his favorite activities (197). Since Dodgson enjoyed entertaining children, Alice encounters people and things–such as the gentlemen in the train or Alice rides in with the Sheep. "So young a child," said the

gentleman sitting opposite to her, (he was dressed in white paper) "ought to know which way she's going, even if she doesn't know her own name!" (Carroll, Through, 170). Notice the gentlemen is dressed in white paper and in the picture he is wearing a paper hat.

John Fisher says Carroll would have known how to create the paper hat as well as a paper gentlemen: "12...the complete suit. One can easily add a small tube of paper for a face and a miniature hat if required to produce one's own three dimensional facsimile of Carroll's papyrus-clad character" (204). One of Lewis Carroll's child-friends, Freda Bremer, remembers a time when she was playing at the Fort of Margate and Carroll asked them if they could make a paper boat with a seat as each end, and a basket in the middle for fish! (Fisher 199).

Yet, that is not the only paper folding Carroll included. Selwyn Goodacre has observed that the Cheshire Cat, when it reappears, remains in the same tree as before when Alice walks on so Carroll could allow for paper folding. The Annotated Alice by Martin Gardner says, "Tenniel's two pictures were placed on left-hand pages so that (in Carroll's words) 'if you turn up the corner of this leaf, you'll have Alice looking at the Grin: and she doesn't look a bit more frightened than when she was looking at the Cat, *does* she?'" (Gardner, Annotated, 68). Dodgson enjoyed origami because it had geometric shapes, triangles, squares and the such, but it was also an activity that would create something and allow him to share this with children.

The *Alice* books have also allowed math to be a more interesting subject to teach. Carroll's reasoning puzzles are more interesting than a lecture. As Andrea Rothbart, a professor at Webster University, points out, these puzzles show students how mathematics can solve problems and allow for the development of using language and reasoning. If teachers make translating word problems to symbolic sentences fun, students find the puzzles entertaining (6).

A great deal of math and all of computer science deal with word problems and logic. Translating those word problems so they still convey the same meaning as symbols and then solving those problems is the difficult part.

Another mathematical concept Carroll's *Alice* books illuminate are Tangrams, in which you begin with a square of 7 figures. Objects are produced from using the seven different geometric shapes. Dodgson definitely loved this because he had a Tangram book with 373 shapes that could be made. When Dodgson died, the book passed to Henry E. Dudeney, who produced designs for the March Hare and the Mad Hatter. Dudeney also came up with a paradox for a Tangram. He constructed two gentlemen , one having a foot and the other not. Yet, both had the same 7 pieces (Fisher 98-99). Had Dodgson been alive to see this, he definitely would have been impressed because he liked puzzles and paradoxes.

Carroll also shows how each person has their own view of reality. He challenges personal reality by showing a world that rebels against Alice's views and ultimately the reader's.

> "Oh, things that happened the week after next," the Queen replied in a careless tone. "For instance, now," she went on, sticking a large piece of plaster on her finger as she spoke, "there's the King's Messenger. He's in prison, being punished: and the trial doesn't even begin till next Wednesday: and of course the crime comes last of all."
>
> "Suppose he never commits the crime?" said Alice.
>
> "That would be all the better, wouldn't it?" the Queen said, as she bound the plaster round her finger with a bit of ribbon (Carroll, Through, 196-197).

Carroll is questioning who determines reality. Is one's personal reality reality? Does society determine reality?

Reality is constantly changing. Reality means an entirely different thing to each person and to the same person at different points in his life. Just as in a mirror we see our own image, we also see behind us. A mirror does not necessarily show where one is headed, but where one has been. Thus people are affected differently by the *Alice* books because everybody's experiences in life are different. However, because everyone enjoys a good story, the *Alice* books are more likely to give people an interest in math while most people are not going to read a math book.

While computers were not around during Lewis Carroll's time, mathematics (closely related to computer science) was used in his time in making inventions more productive. Carroll saw the new technology being introduced during his time and wanted to give some cautions and things to think about.

Carroll thought of things in a new way and wanted others to do the same. In Lennon's Victoria Through the Looking Glass. The Life of Lewis Carroll, "Dr. Bell says again: 'British mathematicians have often severely gone their own way, doing the things that interested them personally as if they were playing cricket for their own amusement only, with a self-satisfied disregard for what others, shouting at the top of their scientific lungs, have assured the world is of supreme importance.' This criticism was justly aimed at Dodgson more than once." (271). An example of Carroll showing things could be done in more than one way can be seen through the gardeners painting the roses in Alice's Adventures in Wonderland. Fisher states:

> Carroll would have known of an intriguing experiment used to demonstrate the capillary action that carries water up from the soil to the very tips of the leaves and petals of a plant producing a striking visual effect that could have saved the Queen's gardeners the anxiety

> of impending decapitation. Fill two glasses with water, one of which is colored red with dye or food colouring. Take a plain white rose and carefully split the stem, placing half in one glass, half in the other, as in the illustration. Then sit back and watch. After a few hours one side of the bloom will have turned the red the gardeners desired. The two-coloured rose that results is in itself a fascinating curiosity, although it is, of course, possible to change the colour of the whole flower without the need to split the stem (Fisher, John 40).

Sometimes one particular solution to a problem is not always the easiest or the best. Searching for all possible solutions (even ridiculous ones) may lead to the best solution.

Just as physicians, mathematicians had to use other people's work as a foundation to build upon. Stanley Ogilvy comments Lewis Carroll created novels which do not seem to relate to anything else in mathematics or the physical world. Other peer mathematicians feel it is nice but he should work on something more important. So he did. However, a quarter of a century later another person needs it for a more useful and complex project. No one should condemn any piece of mathematics as useless. Ogilvy continues by giving the example of the application of Riemannian geometry to relativity theory.

> During the 1850s Riemann invented his geometry of manifolds and extended of curvature to more than two dimensions. These concepts were then considered by many informed scientists to be nothing but mathematical curios but had they not been ready to hand in 1905, Einstein would have had to develop them before being able to proceed with his relativity theory before being able to proceed with his relativity theory. Again, relativity itself seemed a strange and unacceptable interpretation of the physical world during its

early years" (Ogilvy 8-9).

Thus, Carroll wants mathematicians to think creatively and explore new territories in mathematics no matter what their colleagues may say.

But on the other hand, Carroll also cautions about creating too many inventions. This can be seen in the White Knight's inventions. The Knight's lack of logic in using his inventions is the flaw than the inventions themselves. For example, placing mouse traps on the horse may have been useful if mice approach horses. However, the Knight did not consider that the event was unlikely in the world he lives. Likewise, putting the box upside down may have protected its contents from the rain, whereas if the Knight had thought to close the lid, the outcome would have been the same. The title of the chapter along with the repetition of the word inventions suggests that Carroll is making commentary on the modern idea of inventions.

Perhaps, Carroll cautions against invention getting out of hand and losing its original purpose: inventing for the sake of inventing rather than facilitating life. Serra Ansay argues, "The White Knight's concern with the art rather than the basics and function of riding parallels his craze for inventing; he loses touch with the original purpose of riding, which was a means of transportation. Alice finally says in exasperation: "It's too ridiculous!," as the Knight falls off his horse" (Ansay 2). Inventions are supposed to be useful and make lives easier for mankind. However, Carroll cautions future computer scientists to beware of creating computer programs and hardware products which have no useful purpose or complicate the process they were supposed to simplify.

Different rules apply depending on what the program will be used to accomplish. One such example is linear search, which searches for an object beginning at the front of the list and

finishes once it finds the object or gets to the end of the list. "The White Rabbit put on his spectacles. 'Where shall I begin, please your Majesty?' he asked. 'Begin at the beginning,' the King said, very gravely, 'and go on till you come to the end: then stop.' (Carroll, Alice's, 121).

One of Dodgson's favorite puzzles was "Where Does the Day Begin?" "If a man could travel round the world so fast that the sun would always be directly above his head and he were to start traveling at midday on Tuesday, then in 24 hours he would return to his original point of departure, and would find that the day was now called Wednesday–at what point in his journey would the day change its name?" (Lennon 272). Dodgson posed this question to officials in government offices and telegraph companies and the International Date Line was established in 1884 (Weaver 120). Dodgson wants computer scientists to think about their world and ask questions. Quite likely some questions will be unanswerable, yet there are clarifications to simplify the problem–such as the International Date Line.

While Carroll clearly borrowed on the ideas of other people, so have people tried to duplicate Carroll in new ways. One such way is Datawocky, which is a take off of Jabberwocky.

DATAWOCKY
'Twas global and the megabytes
Did gyre and gimbal on the disk
All mimsy were the prompts and codes
And the software was brisk

Beware the microchip my son
The bits, the bytes and bands and such
Beware the CRT and shun
The qwerty keyboard's clutch

He took his self-pace book in hand
Long time the menu key he sought
Then wrestled he with the toaster drive
And sat a while in thought

Then as he sought the glitchy bug
The microchip, with gates aflame,
Came wiffling, through its I/O plug
And processed as it came

Asynch, Bisynch, all protocols,
His binary went snicker snack,
He felt it crash, and with a dash
He came galumphing back

And dids't thou tame the microchip
Came interface my beamish boy
O frabjous day, Caloo! Callay!
O database, O joy

'Twas global and the megabytes
Did gyre and gimbal on the disk
All mimsy were the prompts and codes
And the software was brisk

(With due apologies to Lewis Carroll and Alice Liddell)

Anonymous (Johnson 207).

People must borrow other people's ideas. In essence, they are using what is borrowed as the foundation to build upon to create something bigger and more useful.

The idea that the pure theory behind mathematics, and thus computer science, will not always work for every situation can be seen as Alice is taken from the "real world" and thrown into a chaotic one. Computers expect certain input. When they do not get that input, it is up to the programmer to determine how that exception will be dealt with. Otherwise, the computer will come crashing down just as Alice gets upset. " 'I ca'n't stand this any longer!' she cried, as she jumped up and seized the tablecloth with both hands: one good pull, and plates, dishes, guests, and candles came crashing down together in a heap on the floor" (Carroll, Through, 266).

Carroll also wanted to show that programs must be flexible and be able to handle any

input. For instance, the number forty-two appears over and over again. One example is in Alice's Adventures in Wonderland, when during the trial of the Knave, Rule forty-two (All persons more than a mile high to leave the court) is produced by the King. This could easily be overlooked had Douglas Adams not written The Hitchhiker's Guide to the Galaxy where earth is an artificial computing device built to find the answer to the question of everything. The answer turns out to be forty-two. Matthew Belmonte believes Adams borrowed this particular answer from Lewis Carroll and continues to explain. "The earth is destroyed for a petty motivation just before the moment of output, and as a result a replacement planet has to be constructed and the entire computation restarted. Dodgson would have loved this idea. So would Charles Babbage, a nineteenth-century pioneer of automatic digital computing. If only the makers of the earth had built in a checkpointing mechanism!" (1,2).

Dodgson can teach a lot of computer scientists about quality being more important than quantity. Cohen cites a letter Dodgson wrote to Macmillan publishing company on December 17, 1871.

> Whatever the *commercial* consequences, we must have no more artistic 'fiascos'–and I...write *at once* about it by your alarming words..."We are going on with another 6000 *as fast as possible.*" My decision is, we must have *no more hurry*...You will think me a lunatic for thus wishing to send any money from the doors; and...that I shall thus lose thousands of would be purchasers, who will...go and buy other Christmas books. I wish I could put into words how entirely such arguments go for nothing with me...The only thing I *do* care for is, that all the copies that *are* sold shall be artistically first-rate (Cohen 133).

Dodgson is more concerned about how durable and presentable the book is than how much money he can make.

The Bread and Butter Fly discussed in Through the Looking Glass shows there are limiting factors.

> 'Crawling at your feet,' said the Gnat (Alice drew her feet back in some alarm), 'You may observe a Bread-and-butter-fly. It's wings are then slices of bread-and-butter, its body, is a crust and its head is a lump of sugar.'
>
> 'And what does *it* live on?'
>
> 'Weak tea with cream in it.'
>
> A new difficulty came into Alice's head. 'Supposing it couldn't find any?' she suggested.
>
> 'Then it would die, of course.
>
> 'But that must happen very often,' Alice remarked thoughtfully.
>
> 'It always happens,' said the Gnat (Carroll, Through, 144).

The chess game also supports the idea since there are only so many squares (64) and only so many people who can occupy a square (1). Not only this but only 48 pieces are on the board. In computers time and space (memory) are limiting factors when it comes to processing things. Carroll warns to beware of getting caught in a cycle or for computer programmers an infinite loop. Martin Gardner, a Carrollian scholar, says "Mathematicians are always losing their way in endless labyrinths. The dozing Red King dreams about Alice, who is asleep and dreaming about the Red King. In both dreams, each dreams of the other, forming a pair of infinite regresses. The book ends with Alice considering the "serious question" of which of them dreamed the other" (Gardner, Universe, 3). Thus who dreamed it can never be determined. One is stuck in this loop,

yet here there is not a "switch" such as Ctrl+Alt+Delete to get one out of it.

The program's purpose also influences what rules should be used to create the program. Linear search is not the only way in which to search something. There is also binary search and jump search. But what should determine which one is used is which one will find the target in the least amount of time. A predictable algorithm will do well in a nice environment. Linear Search does well if the target is always near the front of the list. However, a randomized algorithm does not exploit this advantage. Rawlins agrees by saying, "We could make it adapt to its input, but the better it adapts, the more if exposes itself to worst cases; an algorithmic catch-22. As Lewis Carroll pointed out: jam yesterday and jam tomorrow but never jam today" (Rawlins 128). Thus it is better to choose the algorithm for which the input will be manipulated easily and efficiently.

Victorian England was constantly changing. One example of the Industrial Revolution found in the *Alice* books is the railway carriage in Through the Looking Glass. The railway carriage was familiar to Victorians and time's connection with money and the "getting-and-spending capitalist system" was worrying Victorians as a result of the dominant forces in their lives (expansion of consumerism, cash economy, machinery, and mechanically measured time (Rackin 4). The changes in technology brought more money and led to changes in social class. Thus, people were having to adjust to the newly invented technology and the railway scene "is but one example of the numerous allusions in the *Alices* to the mechanization, commodification, and acceleration that were transforming Victorian life" (Rackin 6). When new programs and computer products are introduced, the transition to these products must be made as easy as possible for people.

Since technology had changed, a great many tasks could be done a lot faster. An effort to do things as fast as possible has always been a plus in business, as long as quality does not suffer too badly. Events being done fast can be seen in the *Alice* books as Donald Rackin explains.

> The rapidity of change occurring almost everywhere during the period, the dizzying pace of life in a multifacious, mechanized mass society is reflected in the *Alices*' fast-paced, crowded, discontinuous dream adventures. So too is the sense of speedy motion, not for the sake of progress toward a definitive goal, but simply for its own sake. Thus, the Red Queen's frequently quoted response to Alice's assertion that "in *our* country...you'd generally get to somewhere else–if you ran very fast for a long time as we've been doing" is especially relevant to the empty bustle of urban existence in Carroll's mid-Victorian England, an England suddenly coming to question its own faith in inevitable progress and the benefits of mechanical invention (Rackin 4-5).

Not only did tasks get done faster, but the rate at which technology and the like was changing too fast. Dodgson's lifetime included technology that increased the spreading of new goods, ideas and techniques for getting work done (Rackin 9). The *Alice* books show the relationships between time and major discoveries in technological advancements. These advancements, and telegraph lines–four of the period's many contributions to commerce, transportation and communications that changed the relations between time and space. (Rackin 4). All of this sounds very familiar to the current time period. The speed at which people must operate can be seen in Through the Looking Glass when Alice and the Red Queen run and don't get anywhere.

> When they stop, Alice leans against a tree, which to her surprise is the tree they had stood under before they started running.

> " 'Well in *our* country,' said Alice, still panting a little, 'you'd generally get to somewhere else–if you can run very fast for a long time as we've been doing.'
>
> " 'A slow sort of country!' said the Queen. 'Now, *here*, you see, it takes all the running *you* can do to keep in the same place. If you want to get somewhere else, you must run twice as fast as that!' " (Carroll, Through 165).

As Florence Becker Lennon says, "Carroll seems to have been anticipating twentieth century New York" (179). People must be able to work fast and are in a hurry to get things done, when it does not seem like they are getting much accomplished.

Computer programmers must constantly adapt their programs to make the programs process faster and more efficiently to meet the world's needs. Programs must constantly be updated to correct errors, but also to be more useful. Martin Gardner learned that Carroll revised the Mouse's Tale poem in his 1866 edition from reading *Under the Quizzing Glass* by R.B. Shaberman and Denis Crutch.

> Fury said to the Mouse,
> That he met in the house,
> "Let us both go to law: I will prosecute you–
>
> Come, I'll take no denial:
> We must have the trial;
> For really this morning I've nothing to do."
>
> Said the mouse to the cur,
> "Such a trial, dear sir,
> With no jury or judge, would be wasting our breath."
>
> "I'll be judge, I'll be jury,"
> Said cunning old Fury:
> "I'll try the whole cause, and condemn you to death" (Gardner, Annotated, 35-36).

His change is interesting because in 1989 Gary Graham and Jeffrey Maiden saw his poem having

the structure of a "tail rhyme." This is a rhyming couplet followed by a short unrhymed line. To quote The Annotated Alice, "By lengthening the last line Carroll turned his tail poem into a pattern which, if printed in traditional form as shown, resembles a mouse with a long tail!" (Gardner, Annotated, 36). Programs also need to be updated or they will become outdated like the dodo bird who could not adapt to the environmental changes.

The English language is ambiguous; meaning it is not clear and concise as to what words mean. Donald Rackin reveals the creatures in Wonderland want language to be consistently logical and self-sufficient. The Mouse says in his tale that Stigland "found it advisable," and is interrupted by the Duck, who wants to know the antecedent noun for "it" before the Mouse continues. Now Wonderland no longer contradicts human constructs by continuing without them, but creates more destruction by using them. The Duck wants language to be consistently unambiguous; an impossible task.

So Wonderland behaves in consistently when the "real world" claims to be strictly consistent (space, size or mathematics). Yet, Wonderland demands complete consistency when the "real world" is admittedly inconsistent (English grammar and syntax). This reminds adults ordinary language is ambigous and is inconsistent and is different from ordinary mathematics. Rackin says "the urgent, rude insistence of Wonderland creatures (like the Eaglet's cry "Speak English!" or later the March Hare's "say what you mean" with its implication that language is not logically reversible like mathematical equations) neatly satirizes the common world's absurd illogicality; and so, in the midst of all the fun, one more conventional prop of above-ground order begins to crumble" (Rackin 43-44).

Some words have more than one meaning, mean something different, and are spelled

differently yet sound the same when spoken. This presents a problem for Alice which Rackin points out in Alice's Adventures in Wonderland and Through the Looking Glass–Nonsense, Sense and Meaning.

> When Alice asks the Dodo what a "Caucus-Race" is (that is, when she asks him to define a word with other words) and thereby puts to the test a fundamental working principle of language, his only answer is "the best way to explain it is to do it." When the Mouse asserts that his "is a long and sad tale," Alice replies, "It is a long tail...but why do you call it sad?" When the Mouse says "not," Alice thinks he refers to a knot. Here, then, another above-ground assumption (and one that perplexed Dodgson all his life)–that ordinary language, whether written or spoken, has at least the potential to be univocal and self-sufficient–dissolved as swiftly and easily as the smiling Cheshire Cat (Rackin 44).

While the English language is allowed to be ambiguous, computer languages cannot be, for then the computer has the same problem as Alice: it does not know which "meaning" to choose.

Dodgson was influenced by the work of George Boole, whose aim according to Jonathan Bowen, was "to identify the rules of reasoning in a rigorous framework and revolutions used formal logic after thousands of years of little progress" (Bowen 1). The logic was transformed into mathematical rules from the philosophical ones, and being known as boolean algebra. All binary computers depend upon this since their electronic gates are logical operations that perform arithmetical operations such as addition.

Alice proves binary cannot be simplified. "It is very inconvenient habit of kittens (Alice had once made the remark) that, whatever you say to them, they *always* purr. 'If they would only purr for 'yes,' and mew for 'no,' or any rule of that sort,' she had said, 'so that one could keep up

a conversation! But how *can* you talk with a person if they *always* say the same thing?' (Carroll 269). Gerald Weinburg says in a letter that in information theory, Alice has a fundamental point. Gardner notes "There is no one-value logic–no way to record or transmit information without a binary distinction between yes and no, or true and false. In computers the distinction is handled by the on-off switches of their circuitry" (Gardner, Annotated, 269).

VII. Conclusion

Carroll's ideas are practical and his ideas have lasted by influencing computer scientists. A scene based on the Mad Tea Party was one of the earliest to be constructed for a rapidly developing new technology called "virtual reality." Gardner explains

> A person puts on a helmet with goggles that provide each eye with a video screen connected to a computer program. The subject also wears headphones, and a special suit and gloves fitted with fiber-optic sensors that tell the computer how one's body and hands are moving, and how these motions alter the visual scene. One is thus able to see and move about in a three-dimensional artificial "space." A person can take the role of Alice, or any of the other characters at the Mad Tea Party, and as the technology improves, should even be able to interact with the characters (Gardner, Annotated, 78).

One person's work and ideas spark new ideas and propel inventing. Why Emil Post, who addressed the American Mathematical Society in 1944 says in Compared to What? An Introduction to the Analysis of Algorithms, "Mathematically thinking is, and must remain, essentially creative. To the writer's mind this conclusion must inevitably result in an at least partial reversal of the entire axiomatic trend of the late 19th and early 20th centuries, with a return to meaning and truth as being the essence of mathematics" (Rawlins 447). Carroll's *Alice* books

have lasted because as Dodgson was a mathematician. G. H. Hardy emphatically states, "A mathematician, like a painter or a poet, is a maker of patterns. If his patterns are more permanent than theirs, it is because they are made with *ideas*." (Rawlins 240).

Carroll also shows how words are more powerful than people think. Wonderland rulers react in the same way adults react to the absurd challenge of a child's imaginery dream. Whenever one of these two worlds is called what it is, it becomes speechless. Donald Rackin says, "Paradoxically, by the power of one of the most artificial constructs of all–the word–these rulers are rendered powerless, that is without words. That the child Alice has had this supreme power all along goes without saying; Alice, however, does not realize the potency of her weapon or, for that matter, that she even possesses a weapon" (Rackin 59).
Computers are powerful too. They too can be used for good or evil. It is up to the user to choose how the computer will be used.

Carroll's use of word-play in the *Alice* books is quite interesting, as is how it corresponds to Alice's. Martin Gardner wonders if Carroll subconsciously includes word-play in his pseudonym name and in his initials or if he purposefully did it.

> Is it coincidence, like the correspondences in the names of Carroll and Alice (noticed by reader Dennis Green) with respect to word lengths, and the positions of the vowels, consonants, and double letters in the last names?
>
> ALICE LIDDELL
>
> LEWIS CARROLL
>
> More letterplay: Consider the initial consonants of "Dear Lewis Carroll." Backwards they are the initials of Charles Lutwidge Dodgson (Gardner, Annotated, 18).

Dodgson and Carroll seem so different, yet, Dodgson used games of logic and math to connect the two, which can be seen in the *Alice* books. Dodgson had clearly said a lot. Yet, Dodgson himself said after the publication of the books: "Words mean more than we mean to express when we use them: so a whole book ought to mean a great deal more than a writer meant. So, whatever good meanings are in the book, I'm very glad to accept as the meaning of the book" (Rackin 18).

Carroll's games, and essentially his books, deal with the mind. Mathematics, logic and games all require a person to use their mind. Carroll enjoys playing games with his mind, but especially the reader's. The mind wants closure; a solution. Mathematicians are constantly searching for a solution, yet a successful conclusion cannot always be found. Computers are modeled after the human brain. They're designed to do meticulous tasks, which they can perform faster than man's brain. Eventually, they reach a conclusion. Alice's Adventures in Wonderland and Through the Looking Glass are reminders that, while computers may be powerful, the human brain is the most powerful: it has the ability to imagine and create.

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