Artificial Intelligence: Creative Problem Solving At Its Best!

by Lisa Clark Ashworth, 2014 CTI Fellow
Barringer Academic Center

This curriculum unit is recommended for:
Mathematics, Language Arts, and Social Studies in Grades 6-8

Keywords: artificial intelligence, creative problem solving, probability, statistics, algorithms, computer science and programming, robots, computer codes, Alan Turing

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: This artificial intelligence curriculum unit is designed to be taught over a quarter or nine weeks of a school year. The classroom activities are not conducted consecutively, but they are dispersed amongst four subject areas over the quarter. This unit will be taught during the first half of the school year, and it is used as a complement to middle school mathematics, language arts, and social studies courses that are taught in sixth, seventh and eighth grade classrooms in North Carolina. Many schools have access to a variety of technology devices from laptops to tablets to desktop computers. This unit will utilize technology to examine aspects of machine learning through experimenting with computer programs, researching the history of artificial intelligence and encountering class discussions concerning artificial intelligence. By combining math, social studies, and language arts instruction with activities computer science, students will have a better opportunity for grasping complex concepts involved in artificial intelligence and how it is used in the real world. By showing students how math and linguistic concepts such as probability, language translation, and algorithms are used in computer programming, students will have fun learning about artificial intelligence while gaining a better understanding of math and language arts are connected to computer programming. The curriculum in my classroom is closely tied to sixth, seventh, and eighth grade common core standards.

I plan to teach this unit during the coming year to 15 students in Horizons 4th and 5th grade, Mathematics, Language Arts, Science, and Social Studies 6-8th grade curriculum

Artificial Intelligence: Creative Problem Solving At Its Best!

Lisa Clark Ashworth

Rationale

Our current technology provides us with artificial intelligence in everything we do within our everyday lives from buying groceries to choosing restaurants to ordering clothes, furniture, etc. on the internet. With the invention of the iPhone, iPad, and other technology devices, our every move and buying choices can be tracked and analyzed. Technological research using artificial intelligence is also being implemented today in many scientific fields from psychology and computerized games to robotics and international warfare. People are very attracted to using the latest type of technology. As a 5th grade teacher of highly gifted students, I observe my students using these technology devices, and I also observe that they are very interested in how these devices work. We often have class discussions on how the systems used in these devices were created and how they work in many different facets of today's society. For my classroom, a unit designed around the concept of artificial intelligence would involve connections to the four main common core curriculum areas of math, science, social studies/history, and language arts/reading and writing.

The curriculum in my classroom is closely tied to the seventh grade common core standards. In the area of math, we would investigate the mathematical concepts that are used in computer science, especially in regards to artificial intelligence. In the area of science, we would look at the engineering and design behind how these computer systems are developed. My history instruction and novel studies are closely tied to the period of time in world history from 1900 to present; therefore, the history of the development of artificial intelligence could be easily woven into our study. We also study the art of argumentative writing and students would enjoy writing argumentatively about whether artificial intelligence has moral and ethical implications within our society. The underlying skill used in developing artificial intelligence is problem solving. Creative problem solving is an essential skill for students to develop in order to equip themselves to be successful in both the workplace and in their personal lives. By introducing students to the problem solving used in artificial intelligence, they will strengthen their own critical thinking skills.

Introduction

Barringer Academic Center is an elementary school in Charlotte, N.C., that contains students in kindergarten through fifth grade. The school contains students that have a wide range of abilities. There are students who perform at a basic academic level all the

way up to those who perform at a high academic level. There are two levels of gifted education curriculum at Barringer. There is a talent development program containing six gifted inclusion classes that are comprised of third through fifth graders. The other gifted program is called the Horizons program. The Horizons program is a kindergarten through fifth grade academic program within Barringer for students who are classified as highly gifted. The curriculum for the Horizon students is accelerated two to three years above their current grade level. The students who will be participating in this artificial intelligence curriculum unit are in the third through fifth grade of the Horizons program and the talent development program. These students use advanced math curriculum which includes pre-algebra, algebra, and geometry concepts. The language arts curriculum is also advanced, and the oldest students in fifth grade read middle school level novels and write persuasive essays and other middle school level compositions. These students study and master many advanced concepts in fifth through ninth grade math and science curriculum.

While they learn academic concepts that are several years above their grade level peers, they are still ten and eleven year olds who like to play games both outside the school building at recess time and on the computer inside the school building. Students also like to make up many new games and activities while they are at school recess time. Many of these students are fascinated by how computer games work, and how they could possibly design one of their own. These students learn many of their math and science concepts through inquiry-based problem solving activities in the classroom. They often enjoy discovering new ideas or designing new games or activities that correlate with their math, history and literature curriculum.

Classroom Background

As one of five Horizons teachers at Barringer, I am responsible for twelve to fifteen students who are working in three different math textbooks with pre-algebra and geometry concepts that range in sixth through eighth grade level. These students are from third through fifth grade classrooms in the Horizons program. They received pre-assessments at the beginning of the school year in order to group them with similar students in their ability range. I am responsible for individualizing and differentiating each student's curriculum to fit the abilities of each student. Some of the students are operating at two years above their current grade level, while others are four to five years above grade level. Essentially, my goal is to help students achieve a personalized learning situation within the classroom that best fits their needs.

Within my Horizons math classroom, I often have to plan for individual or paired math instruction for my students. I introduce new concepts in groups of two, three, or four students with oral instruction using a textbook, Smart Board, and manipulatives. Following this introduction to new concepts, students are "set free" to work at their own pace through the investigations of the Pearson Connected Mathematics textbooks. Students demonstrate their understanding through classwork investigations, peer tutoring,

verbal observations, as well as formal assessments. Because students are working at their own pace, they need time and experiences with hands-on activities in order to explore the new concepts that they are learning. It is also important that they have opportunities to create new ideas and applications using these math concepts. They also need the opportunity to share and present these new ideas and applications within the classroom.

By incorporating artificial intelligence activities and analysis into my math and science curriculum, students will have the opportunity to explore fun, creative ways to learn and apply these middle school math and science concepts. Students will have the opportunity to see how math concepts such as algorithms, statistics, data, probability, combinations, tables, and graphs have an important role to play in the execution of many applications of artificial intelligence.

By incorporating artificial intelligence activities into my language arts and social studies curriculum, students will have the opportunity to learn about the historical development of artificial intelligence as well as where the future of artificial intelligence is going in a modern technological society. Students will develop critical thinking skills in their written analysis of moral and ethical implications of artificial intelligence.

Content Background

What is artificial intelligence?

Marvin Minsky, a computer science pioneer from the early 1960s, stated that "artificial intelligence is the science of making machines do things that would require intelligence if done by men"[i] (David Moursund, p. 3 of 75). Artificial intelligence is often portrayed as human-like. For example, artificial intelligence is portrayed in our society today through the image of a small robot called *C3PO* from the movie *Star Wars* who is programmed to roam around the spaceship and complete simple tasks. Machines are simply programmed to complete specific tasks that are designed by a human mind. However, the reality is that modern A.I. has little in common with human intelligence. In practice, what we have are "intelligent" programs and robots that excel at specific, narrowly defined tasks. For example, the Roomba vacuum cleaner is programmed to vacuum by itself without a human operator. An example of how artificial intelligence is used in marketing is through the company Netflix. Netflix employs a computer program which stores our choices for purchasing movies by assigning numbers to likes and dislikes of movies. Netflix then analyzes statistics of movie likes and dislikes and then recommends to customers more movie rentals that other customers have in common with their movie preferences. This is a good example of machine learning. Netflix uses its knowledge of your past viewing history and preferences to make predictions about what you may enjoy in the future. A few other examples of current artificial intelligence are *Google's self-driving car,* unmanned drones, robots that can be programmed to build other machines and products, and automated spam filtering.

Who Was Alan Turing?

Alan Turing is a famous mathematician and scientist who is considered the father of artificial intelligence. He was part of a team who was able to decipher the German WWII code known as the Enigma.

The following information describes his early career in the field of computer science:

> "In his seminal 1936 paper, he proved that there cannot exist any universal algorithmic method of determining truth in mathematics, and that mathematics will always contain undecidable propositions. That paper also introduced the "Turing machine". His papers on the subject are widely acknowledged as the foundation of research in computer science. The central concept of the modern computer was based on Turing's paper. Over the next two years, Turing studied mathematics and cryptology at the Institute for Advanced Study in Princeton, New Jersey. After receiving his Ph.D. from Princeton University in 1938, he returned to Cambridge, and then took a part-time position with the Government Code and Cypher School, a British code-breaking organization."[ii]

After WWII, Turing published a paper that discussed a central dilemma of artificial intelligence. This dilemma was whether humans could ever replace themselves with a thinking machine. The "Imitation Game" was developed to address the question of whether machines could think. The following passage describes this issue:

> "Turing went on to hold high-ranking positions in the mathematics department and later the computing laboratory at the University of Manchester in the late 1940s. He first addressed the issue of artificial intelligence in his 1950 paper, "Computing machinery and intelligence," and proposed an experiment known today as the "Turing Test"—an effort to create an intelligence design standard for the tech industry. Over the past several decades, the test has significantly influenced debates over artificial intelligence."[iii]

The Turing test is a method of making a determination of whether or not a computer is capable of thinking like a human. It is a test of measuring a machine's ability to exhibit intelligent behavior similar to that of a human.

Mathematical Content Objectives

Numbers and Operational Standards for Grades 6-8

One of the main mathematical objectives is to design and compute algebraic equations that utilize one or more variables. This mathematical skill is closely related to computer programming algorithms. Students will design basic mathematical algorithms and implement them in a visual programming language called *Scratch.* Students will use pattern and sequencing skills to design a "perfect tic-tac-toe playing algorithm" by ordering the "turns" needed to have a winning game. Students will develop stronger problem solving skills using a "guess and check" method as they design their own "perfect tic-tac-toe playing algorithm". They will also enhance their probability skills as they observe combinations and patterns as they play the game of *Hexapawn*. *Hexapawn* is a good setting for students to see machine learning in action. *Hexapawn* is a game where computers can "learn" from their own "mistakes" and eliminate those possibilities as choices to win the game. These mathematical objectives will reinforce strong problem solving skills as they are implemented in exploring artificial intelligence activities

Science Content Objectives

One of the main science objectives includes the understanding and implementation of the scientific process. Essential standards in learning the scientific method include exploring and investigating a problem, designing and implementing an experiment, as well as analyzing data and results to come to a resolution of a problem. The process of trial and error or guess and check is heavily utilized in the scientific process. Students will have the opportunity to explore this as they problem solve situations and activities that deal with artificial intelligence.

History/Social Studies Objectives

This unit will include a historical examination of the history of artificial intelligence so that students can better understand where artificial intelligence is used in our present day society. Social studies objectives in middle school encourage students to reflect on the past in order to help students understand and predict what will happen in the future. Students will study Turing, the founder of artificial intelligence, and the present day implications of artificial intelligence on our society. Students will also examine significant events in artificial intelligence such as the memorable chess match of man vs. computer (Kasparov vs. Deep Blue) in order to understand the difficulties of man trying to program a computer to reason with a human brain.

Writing and Speech Content Objectives

This unit will also help students improve their argumentative writing skills as they analyze and formulate their own opinions of the moral and ethical implications of some uses of artificial intelligence. Students will be asked to clearly compose a written argument based on their analysis of the pros and cons of programming machines to

complete tasks that may result in harm or destruction of people or things. Students will use their written arguments in class discussions and debates as they participate in a Socratic seminar that examines these issues.

Classroom Strategies

This artificial intelligence curriculum unit should take approximately four to six weeks to teach. It is important for students to have lots of hands on activities in order to adequately grasp the concepts associated with problem solving, algorithms, statistics, probability, and number sense. In addition to class discussions, videos, games and tricks, as well as exploring the math, science, and language concepts in the classroom that connect to artificial intelligence, students will examine a variety of real world applications of artificial intelligence.

The first strategy in the teaching of this unit will be instruction of background knowledge and history. Students will begin the unit with background knowledge of computer programming and its origin. The classroom discussions will include how programming and artificial intelligence include many concepts connected with math, science, and language. The second major strategy in the teaching of this unit will offering hands-on instruction opportunities. Students will conduct and participate in projects, games, cooperative learning, think-pair-share activities, as well as inquiry based instruction using data analysis and research. By utilizing background knowledge and multiple hands-on experiences, students will be able to connect the applicable concepts of math, science, and language with their own experiences with artificial intelligence.

I will begin this unit of study first with whole group instruction on the basic math concepts of numbers and operations, statistics, probability, tables and graphs. I will also give some background information on how their Latin roots in their Caesar's English study relates to the translation of other romance languages. In addition, the science whole group instruction will consist of explaining the scientific method. After the whole group instruction, the class will be divided up into small groups/partners to explore tools such as *Scratch.* Scratch is a programming language that can be used to implement an algorithm. In both whole group instruction and small groups/partners, students will analyze the mathematical, scientific, and linguistic aspects that apply to different artificial intelligence activities.

All of the concepts learned throughout this unit will be used to make connections, as the students are given opportunities to apply crucial math, science and language concepts dealing with problem solving in artificial intelligence activities.

Students will develop stronger critical thinking and problem solving skills as they progress through this unit. A critical aspect of problem solving is being able to give clear directions and steps involved in utilizing algorithms in artificial intelligence activities.

Another important strategy that I will use in this unit is the development of research and writing skills. I want students to increase their ability to conduct research and succinctly summarize and analyze the information that they find. Students will become more proficient in their written analysis of ethical and moral issues involved in the implementation of artificial intelligence. They will also use their research skills to help design a new game or activity that utilizes algorithms and problem solving concepts.

Classroom Activities

Background and History of Artificial Intelligence

Students will receive background information on Alan Turing who is considered to be the father of artificial intelligence. Teachers can access links in the appendix of this curriculum unit to get more information on Alan Turing and his development of artificial intelligence. In an article, published in October of 1950 by *Mind: A Quarterly Review of Psychology and Philosophy,* Turing discusses the question of "Can machines think?" In other words, Turing explores in the article whether or not a machine can be programmed to think intelligently or introspectively like a human being. This article is a good resource for teachers to read in order to understand the beginning elements of artificial intelligence: http://www.jstor.org/stable/2251299.

In order to commemorate Alan Turing's 100th birthday, there was an exhibition match between Turing's chess playing computer program and Kasparov. Although Kasparov beat Turing's program, he was expected to so because Turing's program was over 50 years old. Kasparov merely played the program in order to honor Turing because the program was the first of its kind when it was written. Students will be shown this commemorative YouTube video on a chess match between Turing's machine program and Kasparov so that they can watch how a machine can be programmed to compete with a "human-like" mind. This video is an excellent example of how creative problem solving is used in teaching a machine to "learn and react" through artificial intelligence.

http://www.youtube.com/watch?v=wrxdWkjmhKg&feature=youtu.be

After an introduction to Alan Turing and artificial intelligence, students will be asked to write a reflection as to whether they believe that computers can be programmed to think and operate like a human being. This will prepare students for the creative problem solving unit and prepare for the Socratic Seminar/Debate at the end of this curriculum unit.

Alan Turing and the Enigma *Code* of WWII

In my fifth and seventh grade social studies curriculum, there is a strong focus on American history. Within the seventh grade history objectives, students examine America's involvement in WWII and its impact on our present day society. Students

spend half of the school year studying the technological, sociological, economical, and historical impacts of WWII on our current society. One of the most significant accomplishments during WWII was Alan Turing's deciphering of the German *Enigma Code*. The *Enigma code* was developed by Nazi Germans who were following Hitler's orders during the war. Alan Turing worked as part of a team using clever mathematics and statistics in order to decipher the code. Students will be asked to research the *Enigma Code* and the work that Turing did to decipher the code. Students will then be asked to organize their research in partners using a technology based presentation such as Microsoft Power point or Prezi. Students will also have a discussion comparison about any differences in the information that they found during their research.

Math and Science Activities

Warm-up/Ice-breaker STEM Activity

Students will need to follow directions as well as be very clear in their directions as they carry out the math and science activities in this AI curriculum unit. One activity to help students sharpen their direction skills is known as "Describe it/Build it". This activity comes from a North Carolina website for Science Olympiad. Students will be divided into groups of three, and each group will be given paper, pencil, and a specific number and type of materials. These materials can be anything that can be combined together to build a structure. An example of materials could be a paper plate, a paper cup, plastic straws, and masking tape. Two of the students will stay with the materials and the other student will stand where they can't see or hear what the other two students are doing. One of the pair of students will build a structure with the materials while the other students will write down clear, concise directions for building the structure. This pair of students is given ten minutes to complete this activity. Next, the third student returns to the pair of students where he/she attempts to build the structure according to the directions that were written for them. The original structure is hidden and it is not revealed to the "building" student until that student has ten minutes to construct the structure. This activity is helpful for having students give clear directions as well as follow directions as closely as possible. Students will be giving directions in these subsequent math and science activities, so this will be helpful to emphasize the importance of giving clear directions in order to get an expected acceptable outcome.

Scratch

The first unit in seventh grade *Connected Mathematics* is entitled *Variables and Patterns.* Students explore different problem solving concepts involving patterns, sequencing, and algebraic algorithms. This unit also involves the study and use of variables, coordinate pairs, and graphing. Another applicable unit is during the fourth quarter study of genetics in fifth grade scientific concepts. Students examine patterns in inherited genetic traits using patterns, variables, and sequencing. One example of patterns is using a Punnett Square which helps predict what type of inherited traits such as eye color or handedness

that a human offspring will have. Here is a Khan Academy link to genetics and Punnett Squares that demonstrate probability in inherited traits:

http://www.khanacademy.org/science/biology/heredity-and-genetics/v/punnett-square-fun

There are several activities that can show students a connection of these math and science concepts to computer science. The first activity is using the computer programming language tool known as *Scratch.* Students can access the *Scratch* website at http://scratch.mit.edu/. This tool is designed to teach students the basics of computer programming. There are numerous activities and projects that have been developed by other people and shared on the website. Some of these activities include "Escape", "Capture the Flag", and "Dragon Maker". *Scratch* can demonstrate to students how to program algorithms into a computer in order to get the computer to do what you want it to do. This activity is related to the warm-up activity of "Describe it/Build it" where students have to give accurate step-by-step instructions in order to have an activity or model exactly replicated. The teacher will model how to use this free website program; assign students to complete an activity on the website, and then have the students show the teacher what they were able to accomplish using *Scratch*. After students have explored some activities on Scratch, then the teacher will ask the students to design a mini-project/activity that can be shared on the interactive website. This is a link to the *Scratch* website: http://scratch.mit.edu/ where students can complete this activity.

The next set of activities will involve using another computer programming language tool that is an extension of *Scratch* known as the SNAP! These activities will demonstrate a connection between seventh grade linguistic concepts and math concepts. Students will be asked to complete two introductory activities using the SNAP! In the first activity, students will design a short script between two literary characters in *The Hobbit*, Bilbo and Gandalf. Students will use this programming language tool to create a simple script between these two characters. Students will use patterns to program the script, as well as literary recognition to design the appropriate words for the conversations in the script. In the second activity, students will create an electric keyboard that will go along with one of the poems/songs from The Hobbit. The instructions for completing these two activities and several more in computer science are found in the following link from UC Berkeley:

http://bjc.berkeley.edu/website/curriculum.html

SNAP! Loops and Variables Activity

The next activity using the SNAP! connects to using x and y coordinates and graphing, as well as identifying and drawing geometric shapes using a computer programming language. In the first activity, students will write programming language scripts to devise

a simple game of tag. In the second activity, students will draw five geometric shapes using programming constructs like loops and variables. The programming language uses terms such as x position, y position, turn, move, and repeat. Geometric shapes are studied in several mathematical units in the seventh grade Connected Mathematics course. Students will be asked to draw the following shapes in this activity: equilateral triangle, circle, pentagon, octagon, and hexagon. The following link from UC Berkeley gives teachers students step by step instructions on completing this activity:

http://bjc.berkeley.edu/website/curriculum.html

Tic Tac Toe

Students will use pattern and sequencing skills to design their "perfect" strategy for tic-tac-toe by ordering the "moves" needed to create a winning player. Students will develop stronger problem solving skills using a "guess and check" method as they design their own "perfect" game. Students will be divided up into groups of four in which they write step by step instructions for playing a perfect winning game of tic tac toe. Students will write five sentence instructions for player one and four sentence instructions for player two. After they have written their instructions, two students will square off with the other two students and play each other with their algorithms. This activity shows how students can use programming language to design a perfect tic tac toe game. There is a link to more detailed instructions for carrying out this activity in the classroom under resources at the end of this unit.

Hexapawn

The last unit in the seventh grade *Connected Mathematics* book is called "What do you Expect?" This unit deals with the study of probability. Students are asked to develop a probability model and use it to estimate a probability of events. This unit combines the concepts of probability with chance. They will deepen their understanding of probability as they observe combinations and patterns as they play the game of *Hexapawn*. *Hexapawn* is a game where computers can learn from their own "mistakes" and eliminate those possibilities as choices to win the game. Students will watch machine learning in action in the game of *Hexapawn*. *Hexapawn* is played like a mini game of chess with only pawns and colored jelly beans which students will love! Players move "X's" and "O's" on a 3 X 3 board in order to win the game. There are three ways that they can win the game and they involve making it impossible for their opponent to move, being the last player on the bottom row, or taking all the pieces of the opponent. The website, www.cs4fn.org , contains this *Hexapawn* activity, The Sweet Computer: machines that learn, and it is listed in the resources section of this unit.

Exploring the Scientific Process: *Eureqa*

During the first and second quarters of the school year, the students will be involved in conducting a science fair experiment. Students will be introduced to the scientific process through *Discovery Education* videos along with classroom instruction of the vocabulary that corresponds with the process. The main vocabulary terms include problem, research, question, hypothesis, experiment, data collection, analysis, results, and conclusion. To go along with this introduction to the scientific process, students will be asked to investigate a website called *Eureqa Desktop/Nutonian, Inc.* Eureqa uses a machine learning technique that analyzes relationships in data and interprets these relationships using mathematical concepts. This technique models the scientific process by analyzing data in order to formulate a mathematical hypothesis that explains the observations. Students will be asked to work in pairs to investigate one of the scientific research problems that used the Eureqa technique. The research problems cover a variety of scientific topics from astronomy to biology to computer science. Students will be asked to present a 3-5 minute report on how the scientific process was carried out in the project.

Writing and Speech Activities

Argumentative Writing

The first activity will be where students are asked to research robots and the ethical treatment of robots in our society. There are a number of ethical/moral questions that students can examine for their argumentative essay. Students should be given the links below to learn about two issues of ethics and morality with the use of robots. The following link to an article written by the BBC on "killer robots" examines some of the ethical/moral dilemmas involved in allowing robots to make decisions in warfare:

http://www.bbc.com/news/business-27332130

Another article examines the legal ramifications of robots operating Google cars, especially if they end up in an accident and harm another human. Here is the link to that article:

http://www.theatlantic.com/technology/archive/2014/05/googles-self-driving-cars-have-never-gotten-a-ticket/371172/

Here are a few questions that pose some of the concerns of artificial intelligence/robots in warfare and in driving a car operated by a robot:

- How do killer/soldier robots know that they are shooting at the enemy?
- Who is at fault if a Google Car is in an accident?
- How do robots determine who is in charge on the battlefield or on the road?
- Is it ethical to allow robots to destroy each other?
- Should robots be armed with weapons that can destroy or harm both people and/or the environment?

- How can a robot distinguish between firing towards a “war target” and a “civilian target”?
- If robots have a malfunction in the system while programmed to fire weapons, will it result in more loss of lives?

Students will be asked to probe an ethical/moral issue concerning robots by constructing an argumentative essay on the issue that he/she chooses.

Socratic Seminar Debate

The culminating activity for this unit will be a classroom Socratic Seminar/Debate. The students in the class will use their argumentative essays as a basis for conducting a Socratic Seminar/Debate in the class and discuss the ethical and moral implications of having robots in control of human lives in certain situations. This activity will provide for a conclusion to this unit related to artificial intelligence that encourages students to use their critical thinking and problem solving skills.

Notes

[i] "No Cost Access to Many of Dr. Dave Moursund's Writing about Computers in Education." *No Cost Access to Many of Dr. Dave Moursund's Writing about Computers in Education.* Web. 12 Nov. 2014 <http://darkwing.uoregon.edu/~moursund/dave/index.htm>.
[ii] "Alan Turing Biography"*Bio.com*. accessed Web. 12 Nov. 2014. <http://www.biography.com/people/alan-turing-9512017#!
[iii] "Alan Turing Biography"*Bio.com*. accessed Web. 12 Nov. 2014. <http://www.biography.com/people/alan-turing-9512017#!

Bibliography, Resources, and Reading List

http://scratch.mit.edu/. This website is where students can complete computer science activities that demonstrate machine learning.

"Alan Turing Biography"Bio.com. Accessed November 12, 2014. http://www.biography.com/people/alan-turing-9512017#! This website gives pertinent details about Alan Turing's life as it relates to computer science and artificial intelligence.

"Curriculum What We Offer: SNAP: Loops and Variables." Curriculum. Accessed December 2, 2014. http://bjc.berkeley.edu/website/curriculum.html. This is a university curriculum website that contains computer science activities that demonstrate machine learning.

"Kasparov vs Turing." YouTube. Accessed November 12, 2014. http://www.youtube.com/watch?v=wrxdWkjmhKg&feature=youtu.be. This video shows a chess match between a world famous chess professional (Kasparov) and Turing's machine programmed chess player.

"'Killer Robots': Are They Inevitable?" BBC News. Accessed November 12, 2014. http://www.bbc.com/news/business-27332130. This news story examines how robots are being used in combat.

Madrigal, Alexis. "Google's Self-Driving Cars Have Never Gotten a Ticket." The Atlantic. May 19, 2014. Accessed November 23, 2014. http://www.theatlantic.com/technology/archive/2014/05/googles-self-driving-cars-have-never-gotten-a-ticket/371172/. This online magazine article focuses on how "Google Cars" operate and how they are a perfect example of machine learning.

McOwan, Peter, and Paul Curzon. "Winning Games: The Perfect Tic-Tac-Toe Player." *Computer Science for Fun*. Accessed November 23, 2014. http://www.cs4fn.org. This website contains computer science activities.

McOwan, Peter, and Paul Curzon. "The Sweet Computer: Machines That Learn." *Computer Science for Fun*. Accessed November 23, 2014. http://www.cs4fn.org. This website contains computer science activities.

"No Cost Access to Many of Dr. Dave Moursund's Writing about Computers in Education." No Cost Access to Many of Dr. Dave Moursund's Writing about Computers in Education. Accessed November 12, 2014. http://darkwing.uoregon.edu/~moursund/dave/index.htm. This internet computer science article defines and explains how machine learning and artificial intelligence operate in today's society.

"Nutonian, Inc." Eureqa Desktop. Accessed November 23, 2014. http://www.nutonian.com/products/eureqa/. This website uses the scientific process to analyze data of a science topics and interpret this data through mathematical reasoning.

"Punnett Square Fun." Khan Academy. Accessed November 12, 2014. http://www.khanacademy.org/.../heredity-and-genetics/v/punnett-square-fun. This educational website contains mini-lessons on various types of curriculum. This section of the website demonstrates how Punnett squares work in predicted genetic probability.

Turing, A. M. "I.—Computing Machinery And Intelligence." *Mind*: 433-60. This article was written by Alan Turing to examine the connections between machine learning and intelligence.

Appendix1: Implementing Common Core Standards

The following standards are used in connection with this artificial intelligence curriculum unit:

The following math objectives are addressed as students complete the multiple computer science activities in this artificial intelligence curriculum unit. Students will demonstrate mastery of critical thinking skills as they complete the complete these multiple computer science activities that use probability objectives. Some of these activities include tic-tac-toe, Hexapawn, SNAP loops and variables. The mathematical objectives below are key components in carrying out creative problem solving in this curriculum unit.

- CCSS.Math.Content.7.SP.C.5 Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.
- CCSS.Math.Content.7.SP.C.6 Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability. *For example, when rolling a number cube 600 times, predict that a 3 or 6 would be rolled roughly 200 times, but probably not exactly 200 times*.
- CCSS.Math.Content.7.SP.C.7a Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events. *For example, if a student is selected at random from a class, find the probability that Jane will be selected and the probability that a girl will be selected*.
- CCSS.Math.Content.7.SP.C.8 Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.
- CCSS.Math.Content.7.SP.C.8a Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.
- CCSS.Math.Content.7.G.A.1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

These literacy objectives are used when students write argumentative essays and participate in a Socratic Seminar. Students will also demonstrate these literacy

objectives as they write directions in several of the computer science activities. Conducting and analyzing research is also an important literacy objective in this artificial intelligence curriculum unit. Finally, students will use some of these literacy objectives as they participate in class discussions and play computer science games with one another in class.

- CCSS.ELA-Literacy.W.6.1.a
  Introduce claim(s) and organize the reasons and evidence clearly.

- CCSS.ELA-Literacy.W.6.1.b
  Support claim(s) with clear reasons and relevant evidence, using credible sources and demonstrating an understanding of the topic or text.

- CCSS.ELA-Literacy.RI.7.1 Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
- CCSS.ELA-Literacy.RI.7.2 Determine two or more central ideas in a text and analyze their development over the course of the text; provide an objective summary of the text.
- CCSS.ELA-Literacy.RI.7.3 Analyze the interactions between individuals, events, and ideas in a text (e.g., how ideas influence individuals or events, or how individuals influence ideas or events).

- CCSS.ELA-Literacy.SL.8.1.c
  Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
- CCSS.ELA-Literacy.SL.8.1.d
  Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented
- CCSS.ELA-Literacy.RH.6-8.1
  Cite specific textual evidence to support analysis of primary and secondary sources.
- CCSS.ELA-Literacy.RH.6-8.2
  Determine the central ideas or information of a primary or secondary source; provide an accurate summary of the source distinct from prior knowledge or opinions.
- CCSS.ELA-Literacy.RH.6-8.3
  Identify key steps in a text's description of a process related to history/social studies (e.g., how a bill becomes law, how interest rates are raised or lowered).

- CCSS.ELA-Literacy.RST.6-8.3
  Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks
- CCSS.ELA-Literacy.RST.6-8.7
  Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
- CCSS.ELA-Literacy.RST.6-8.8
  Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.
- CCSS.ELA-Literacy.RST.6-8.9
  Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.