Lesson Plan

Alan Turing

Plaque marking Alan Turing’s former home in Wilmslow, Cheshire

<table>
<thead>
<tr>
<th>Grade Level(s):</th>
<th>9-12</th>
<th>Subject(s):</th>
<th>Physics, History, Computation</th>
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</thead>
<tbody>
<tr>
<td>In-Class Time:</td>
<td>60 min</td>
<td>Prep Time:</td>
<td>10 min</td>
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Materials

• Either computers or printed copies of the CIA’s cypher games
• Prize for the winner of the Code War Game
• Discussion Sheets

Objective

In this lesson students will learn about the life and legacy of Alan Turing, father of the modern-day computer.

Introduction

Alan Turing was born on June 23, 1912 in Maida Vale, London. He went to a boarding school starting the age of 13 called Sherborn School. Here he excelled in math and science, at the expense of his liberal arts classes. Here he met his first love Christopher Morcom, whom inspired him to take his studies more seriously and introduced him to pursuits such as astronomy. Morcom died in 1930, which radically changed Turing life and led him to a deep resolve to pursue his studies for the sake of Morcom. It is believed that Morcom’s death was also the cause for Turing’s successive Atheism, as before in letter to Morcom’s mother he has explicitly talked about his belief of souls. While at King’s college in Cambridge, Turing produced and elegant solution to the Entscheidungsproblem (Decision problem) for

universal machines, which led to the development of the Church-Turing Thesis, and the idea of Turing machines, which by theory can compute anything that is computable [3]. During WWII Turing worked as a cryptanalysis breaking cyphers for the Allies at Bletchley Park. It was here that Turing build his “Bombe”, a machine that could quickly break any German cipher by running through hundreds of options per second [4]. Turing’s machine and team were so quick at breaking these codes the German army was convinced they has a British spy in their ranks. Turing was also responsible for breaking the infamous naval Enigma code, which was used by the Axis power. He went to the United States in 1942 to continue his work in cryptoanalysis and build another bombe machine. He then developed the Turingery technique to use against more complex ciphers. It was a tele printer rotor cipher attachment named TUNNY and lead to the world first digital programmable computer. The information Turing helped the Allies find was imperative in winning the war.

After the war Turing continued working on the Automatic Computing Engine (ACE) at the National Physical Laboratory (NPL) with the goal of being able to create artificial intelligence so complex it could trick a human into thinking it itself was a human. This test is now known as the Turing test [5]. After this Turing became interested in the pervasiveness of the Fibonacci sequence in nature and published work on it. Turing died after committing suicide by poisoning an apple laces with cyanide in the styling of his favorite fairy tale Snow White. It is believed Turing committed suicide due to the chemical castration he was subjected to for being convicted of indecent act, which was being a homosexual at the time. He died at age 43[6].

After decade, Turing was pardoned and received a posthumous apology from the British government in 2009 for his conviction and sentences based on homosexuality. The Turing Law is now what we refer to as the law that pardons men who were convicted under outdated laws that prohibited homosexual acts [7].

Instructions

Engage: 15 Minutes

Here the students will watch a brief video about the life of Alan Turing and his contributions to the world we live in while answering discussion questions

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<tr>
<th>What is the teacher doing?</th>
<th>What are the students doing?</th>
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<tbody>
<tr>
<td>The Teacher will be playing a video for the students in a quiet environment and answering questions as they come up. Make note on whether the students are staying engaged or not.</td>
<td>The students will be watching a video and answering discussion questions to learn about Alan Turing and his life.</td>
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</table>

Explore: 30 Minutes

Here the students will get the chance to try their own hand at working on the enigma code using a coding game form the CIA website (Listed in Required Resources below)

[3] Church 1936
**What is the teacher doing?**
Breaking up the students into equal groups and explaining that they are now representing a country fighting in the second World War. They students will be working against the other teams to break all the codes the quickest, whoever finishes first wins the war!
Supervising the Students as they work through the coding game
Making sure no one is cheating, and each group is working together
Make a special emphasis on the actual enigma code!

**What are the students doing?**
Working together in groups to try and break all the codes provided on the CIA site. No Hints allowed, first to break all the codes wins a prize! (Wins the war)

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**Explain: 10 Minutes**
The students will debrief and discuss with the class what the hardest parts were of the activity/ what made it easier for them. Naturally flow into a deeper discussion of Alan Turing's life

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<td>Mediating an open discussion with the students about what they learned in the cipher activity, what was difficult, what was easy. Did they feel pressure as other students were completing codes? Did they find methods to make decoding go quicker?</td>
<td>Sharing and listening to other students about what they learned and what worked well, or didn't, in the War games activity</td>
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**Elaborate: 5 Minutes**
The teacher will explain how science and the world has changed since Alan Turing's suicide, and show resources available today for LGBT people in STEM, to end on an encouraging note for student.

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<td>Explaining the progress, the world and physics has made by going over the sheet of protections and resources for those in the LGBT community and in STEM, as provided in the resource section below.</td>
<td>Listening to the teacher and taking note that things, while they still have a way to go, have gotten better</td>
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**Evaluate:**
The teacher will be able to evaluate the students understanding by going over the discussion questions provided as well as the students participation in the cipher decoding activity.

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**Required/Recommended Reading and Resources**

**Video on Alan Turing Life by Undefined Behavior on YouTube:** Created by: Cory Chang Produced by: Vivian Liu Script Editor: Justin Chen, Brandon Chen, Elaine Chang, Zachary Greenberg, Kevin Dou
CIA Cypher Breaking Game  

Discussion Questions
In the required reading folder on the main webpage of the teaching guide (Under the link to this pdf)

Discussion Question Answers
In the Required Reading Folder on the main webpage of the teaching guide

LGBT Resources Sheet
In the Required Reading Folder on the main webpage of the teaching guide.

Discussion Questions

Discussion Questions can be found as a Handout with a corresponding Answer Key in the Supplemental Materials to this lesson plan.

1. What was the name of Alan Turing first Love?
   a. Christopher Morcom

2. Where did Turing go to college?
   a. King’s College in Cambridge or Cambridge University

3. What was the first large problem Turing solved while he was still in college?
   a. Entscheidungsproblem (Decision problem), that computers could never universally answer a question on their own

4. What did Turing do during WWII?
   a. Cryptoanalysis (code breaking)

5. Explain what the Bombe machine does.
   a. Break codes by running through thousands of options in a short amount of time

6. What was the goal of Turing after the war while working at NPL?
   a. To build artificial intelligence, and computer brain

7. What is the qualification a computer must meet for it to be considered artificial intelligence?
   a. Convince a human that they are human themselves.

8. How did Turing die (a)? What was he convicted of(b), and what was his sentencing(c)?
   a. Suicide by cyanide poisoning in an apple
   b. Indecent Acts, homosexuality
   c. Either Prison or Chemical Castration, he chose Chemical Castration

9. What is the Turing Law?
   a. A law that states that men convicted of a crime due to outdated laws regarding homosexuality are pardoned

10. Name one resource available to LGBT people in STEM today.
   a. Any of the resources in the resource sheet
### Further Reading and Additional Resources

### Extensions

Related AIP Teacher’s Guides on Women and Minorities in the Physical Sciences:

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### Common Core Standards


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<th>Reading: Literature</th>
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<tr>
<td><strong>CCSS.ELA-LITERACY.RL.9-10.2</strong></td>
<td>Determine a theme or central idea of a text and analyze in detail its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.</td>
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<tr>
<td><strong>CCSS.ELA-LITERACY.RL.11-12.3</strong></td>
<td>Analyze a case in which grasping point of view requires distinguishing what is directly stated in a text from what is really meant (e.g., satire, sarcasm, irony, or understatement).</td>
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<th>Reading: Informational Text</th>
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<tr>
<td><strong>CCSS.ELA-LITERACY.RI.11-12.1</strong></td>
<td>Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.</td>
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<tr>
<td><strong>CCSS.ELA-LITERACY.RI.11-12.7</strong></td>
<td>Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.</td>
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<th>Speaking &amp; Listening</th>
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<td><strong>CCSS.ELA-LITERACY.SL.11-12.1</strong></td>
<td>Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively. a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well reasoned exchange of ideas. b. Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed. c. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives. d. Respond thoughtfully to</td>
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diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

**CCSS.ELA-LITERACY.SL.11-12.2**
Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

**Language**

**CCSS.ELA-LITERACY.L.**

**History/Social Studies**

**CCSS.ELA-LITERACY.RH.9-10.2**
Determine the central ideas or information of a primary or secondary source; provide an accurate summary of how key events or ideas develop over the course of the text.

**CCSS.ELA-LITERACY.RH.9-10.3**
Analyze in detail a series of events described in a text; determine whether earlier events caused later ones or simply preceded them.

**Science & Technical Subjects**

**CCSS.ELA-LITERACY.RST.9-10.2**
Determine the central ideas or conclusions of a text; trace the text’s explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

**CCSS.ELA-LITERACY.RST.9-10.3**
Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

**CCSS.ELA-LITERACY.RST.9-10.4**
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.

**CCSS.ELA-LITERACY.RST.11-12.4**
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

**CCSS.ELA-LITERACY.RST.11-12.9**
Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

**Subject Writing**

**CCSS.ELA-LITERACY.WHST.**

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**Next Generation Science Standards**


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<th>Dimension Two: Crosscutting</th>
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<td><strong>Dimension Three: Disciplinary Core Ideas</strong></td>
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