MATHEMATICS, ELOQUENCE AND POLITICS: the deductive hypothetical model in the political discourses that changed the course of history over the last two centuries

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ABSTRACT

In the present paper we illustrate an interdisciplinary didactic path of mathematics and history developed in the Mathematical High School Project (MHS). The MHS is an experimental research project developed by the research group in didactics of the Department of Mathematics of the University of Salerno (Italy). It aims to build a network of knowledge that is strictly interconnected and goes beyond the individual disciplinary themes; mathematics is "the" substratum and "the" language that creates links between the two cultures, the humanistic and the scientific ones. We analyzed the speeches of various undisputed protagonists of the last two centuries, such as Jefferson, Lincoln, Kennedy, Martin Luther King, through the lens of hypotheticaldeductive logical reasoning, also making references to other areas (literary, political...) with constant links to Euclidean geometry.

1 Introduction

In the National Guidelines issued by the Ministry of Education⁶⁵, i.e. the guidelines for the development of educational paths with reference to the learning outcomes of the scientific high schools, we read "The path of the scientific high school aims at studying the connection between scientific culture and the humanistic tradition. It favors the acquisition of knowledge and methods of mathematics (...). It guides the student to deepen and develop the knowledge and skills necessary to (...) identify the interactions between the different forms of knowledge, ensuring the mastery of the languages, techniques and related methodologies, also through laboratory practice ". Among other objectives, it is emphasized that students need to grasp the relationships

⁶⁵ https://www.gazzettaufficiale.it/eli/id/2010/06/15/010G0111/sg, (D.P.R. 15-03-2010, n. 89, Art. 8 comma 1),

between scientific thought and philosophical reflection and have to understand the supporting structures of the argumentative and demonstrative procedures of mathematics, also through the mastery of the logical-formal language and, specifically, they have to use them in identifying and solving problems of various typologies. In this perspective, mathematics becomes the language for interpreting reality and the tool for building and strengthening critical thinking. The Mathematical High School Research Project adopts the objectives indicated by the Ministry of Education and develops thematic paths and laboratory activities that are developed in an interdisciplinary key and have mathematics as a cognitive substrate and as a universal model and language.

2 Methodologies

The development of educational activities in a laboratory setting in MHS referrers to Vygotsky's constructivist approach to teaching and learning (Vygotsky, 1962). This approach prioritizes the acquisition of new information through experiences of interaction among students, teachers and researchers. Through this teaching-learning activities, teachers play the crucial role of semiotic mediators of knowledge, guiding students towards a deeper understanding of the subject matter.

In order to facilitate this process, educators must follow a research-action path that encourages learning through hands-on experiences, collaboration, and reflection and the suggestion of stimuli that capture students' passion. In the activities of this project the students worked in small groups in a peer collaboration in an action-research strategy and explored the texts of numerous discourses, recognizing the essential scaffolding of the hypothetical deductive approach.

3 The laboratory

In the course of "mathematics and history" for fourth grade students of the MHS we decided to deepen a less evident aspect of the use of the mathematical method, not aimed at implementing the knowledge of technologies but as a theoretical model of the development of critical thinking. The methodological choice adopted in this laboratory is consistent with the approach adopted in the various paths of the MHS, see for example (Bimonte et al., 2021), (Bimonte et al., 2022), (Alfano et al., 2021), (Tortoriello & Veronesi, 2021). The

students were divided into groups and the activities were coordinated by the teachers and researchers who proposed them the speeches of various prominent historical figures, undisputed protagonists of the last two centuries. The articles by Bischi (2013) and Hirsch D., Van Haften (2010) had already analysed Lincoln speeches, from a logical-mathematical point of view; the original contribution by the authors of the present paper is to have created an educational laboratory starting from this idea and expanding it to search for the same protocol in other authors.

The students were provided with the texts of the speeches of Thomas Jefferson (1743-1826), Abraham Lincoln (1809,1865), John F. Kennedy (1917-1963), Martin Luther King (1929-1968), both in English and Italian, and they were asked to analyze them in order to recognize in the model of oratory chosen by the authors the same axiomatic protocol expounded by Euclid in the Elements for the demonstrations of geometry and mathematics i.e. the hypothetical-deductive logical reasoning, also making references to other areas (literary, political...) with constant links to Euclidean geometry.

We chose speeches that characterized and profoundly marked the historicalpolitical path of each author and students had to divide them into the fundamental modules of the demonstration of Euclidean geometry in its completest form, that is composed by six parts: the enunciation, the setting out, specification, construction, proof, conclusion (Heath, T., 1921, pp. 370-373), (Bischi, 2013, p. 34). This form is richer than the most frequent one that is found in many geometrical demonstrations of theorems, composed by hypothesis, thesis and demonstration where some of the parts are omitted. And this greater articulation of the hypothetical deductive process fits well to applications in political discourses in which argumentation is essential for the affirmation of messages.

In the analysis of the texts, other demonstrative techniques also emerge, such as the "reductio ad absurdum", or the use of previously carried out demonstrations as well as rhetorical figures and references to mathematics and logic.

Among other objectives of the laboratory activities, students had to grasp the relationships between scientific thought and philosophical reflection and had to understand the supporting structures of the argumentative and demonstrative procedures of mathematics, also through the mastery of the logicalformal language and, specifically, had to use them in identifying and solving problems of various kinds. In this perspective, mathematics becomes the language for interpreting reality and the tool for building and strengthening critical thinking.

4 Lincoln's Mathematical speeches – some examples

To provide a clear representation of the parallelism between Euclidean demonstration and Lincolnian rhetoric, we show some of the passages that were given to students and were the subject of text analysis.

4.1 An "if-then-else" speech

For example, in the following discourse Fragment on slavery of July 1854 (https://papersofabrahamlincoln.org/documents/D200785), the assumption of the thesis is reached through a demonstrative construction with a hypothetical deductive approach typical of geometric demonstrations: "If A can prove, however conclusively, that he may, of right, enslave B. why may not B snatch the same argument, and prove equally, that he may enslave A? You say A is white, and B is black. It is color, then; the lighter, having the right to enslave the darker? Take care. By this rule, you are to be slave to the first man you meet, with a fairer skin than your own. You do not mean color exactly? You mean the whites are intellectually the superiors of the blacks, and, therefore have the right to enslave them? Take care again. By this rule, you are to be slave to the first man you meet, with an intellect superior to your own. But, say you, it is a question of interest; and, if you can make it your interest, you have the right to enslave another. Very well. And if he can make it his interest, he has the right to enslave you. "

4.2 A "reductio ad absurdum" proof

Another example is found in the 1859 speech in Columbus, Ohio in which Lincoln uses the proof for absurd (Hirsch D., Van Haften D., 2010, p.518): "It is as impudent and absurd as if a prosecuting attorney should stand up before a jury, and ask them to convict A as the murderer of B, while B was walking alive before them."

4.3 A Euclidean proof

The very short Gettysburg speech of 19 November 1863 (Hirsch D., Van Haften D., 2010, p. 396) that sanctioned the success of the Union in the Civil War, has been defined as "the greatest political speech in history". In only 272 words Lincoln shifts the focus from war to freedom, to an egalitarian social

model with a masterful use of Euclidean demonstration. This discourse is built in a systematic and rigorous way on the model of Euclidean proof and the six steps can be observed.

"Four score and seven years ago our fathers brought forth on this continent, a new nation, conceived in Liberty, and dedicated to the proposition that all men are created equal. Now we are engaged in a great civil war, testing whether that nation, or any nation so conceived and so dedicated, can long endure. (enunciation)

We are met on a great battle-field of that war. (setting out)

We have come to dedicate a portion of that field, as a final resting place for those who here gave their lives that that nation might live. It is altogether fitting and proper that we should do this. But, in a larger sense, we can not dedicatee we can not consecrate — we can not hallow — this ground. (specification)

The brave men, living and dead, who struggled here, have consecrated it, far above our poor power to add or detract. The world will little note, nor long remember what we say here, but it can never forget what they did here. (construction)

It is for us the living, rather, to be dedicated here to the unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be here dedicated to the great task remaining before us—that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion—that we here highly resolve that these dead shall not have died in vain— (proof)

that this nation, under God, shall have a new birth of freedom—and that government of the people, by the people, for the people, shall not perish from the earth. (conclusion)".

5 Conclusions

The research path that analyzes with the typical codes of mathematics the speeches of historical protagonists of various historical periods, allows to deepen formal models, that are characteristics for the study of mathematics, with a transdisciplinary vision in which the laws and rules that describe a phenomenon are first recognized heuristically and subsequently demonstrated with the rigor that is proper to the discipline. The request for formalism, decontextualized, allows in the "ars oratoria" to reach assertions that are con-

vincing because they are obtained through hypothetical-deductive reasoning. The exploration in search of other speeches that have the same structure as those of Lincoln allowed us to recognize, in the plots of American history and the defense of civil rights, other speakers closely connected to each other, even if distant in time.

President Jefferson's inauguration speech, for example, is considered one of the reference texts of the American libertarian tradition. Jefferson was Lincoln's predecessor and biographers say that when he retired from politics, he left his copy of Euclid's Elements in the Library of Congress and it was in those rooms that Lincoln approached the study of geometry (Hirsch D., Van Haften D., 2010, p.306).

Another example is President Kennedy's speech in West Berlin on June 26, 1968, "Ich bin ein Berliner," in which the same concepts of "future," "peace," and "freedom" as the Gettysburg Address are invoked.

Martin Luther King Jr.'s speech on August 28, 1963, "I Have a Dream", in which he expressed the hope that one day the African-American population would enjoy the same rights as whites. This speech, which has become a symbol of the fight against racism, was given in front of the Lincoln Memorial in Washington, like a symbolic circle that closes itself.

The speeches of historical figures from different eras and contexts allowed students to verify that what they had explored about Lincoln's oratory art is not a sporadic case, the result of the author's stylistic choices, but is the affirmation that the methods of mathematics in their indisputable demonstrative power, are therefore assertive and effective for consistently carrying out their ideas and positions.

The interdisciplinary path of geometry, history and literature intrigued students from the beginning. They felt involved in an exploratory activity through the reading of historical texts that have characterized topical moments at the international political and institutional level. They discovered the fascination of rereading history from the point of view of the protagonists of the events, understanding the strategic importance that a speech may have for the evolution of a wider context. The laboratory activity has therefore allowed the students to better and actively understand the importance of communication for the conveyance of contents.

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