The perspective of complexity to futurize STEM education: an interdisciplinary module on Artificial Intelligence

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Abstract. The EU-project I SEE aims at facing young's difficulties in imagining their future from the perspective of STEM education, assuming that STEM disciplines provide both epistemological and technical tools to deal with cross-cutting and societally relevant topics and to scaffold students' approaches to the future. Within the project, the Italian community designed and implemented an interdisciplinary module on Artificial Intelligence for high school students. The data analysis revealed that the students were intellectually and emotionally engaged by the richness and the interdisciplinarity of this module, which encouraged them to become agents in the present in order to face future challenges.

1 The I SEE project

Global crises, digital revolution and social acceleration are transforming the relation of the young people with time: future is no longer a promise but a threat and present is experienced as a frenetic standstill dominated by an alarming sense of fear and anxiety [1]. Within this situation, a challenging task for education is to foster the development of students' skills to analyse the present not only through the lenses of the past, but also of the future. This challenge is at the basis of the EU-project I SEE (https://iseeproject.eu) that aims to turn STEM learning into an opportunity to make students develop "future-scaffolding skills", that is abilities to construct visions of the future that support possible ways of acting in the present with one's eye on the horizon [2]. How to do it? The core idea is to exploit science of complex systems key-concepts, like *sensitive dependence on initial conditions*, *feedback* and *circular causality*, to problematize and overcome the deterministic Newtonian view of future (one, predictable, depending strictly on initial conditions) and to encourage students to think in terms a plurality of possible future scenarios. Starting from this point of view, we designed teaching modules on cross-cutting and societally relevant topics (e.g. climate change, artificial intelligence), where the perspective of the science of complex systems is introduced and the scientific contents are enriched with societal issues and values, borrowing some prototypical activities from Futures Studies strategies of imagination of the futures, like *forecast, foresight, anticipation, building desirable scenarios, back-castings* [3]. The module on climate change was tested in 2017, during an international summer school in Bologna targeted to 24 high school students [2]. The present work focuses on the module, designed by us (the Italian community), concerning Artificial Intelligence (AI).

2 The module on Artificial Intelligence: design and implementation

The module on AI is articulated in three main phases. In the first, students are introduced to the state of art and contexts of application of the AI *now, in the present,* through a lecture and a group activity. In the second phase, through experts' lectures and interactive activities, students are guided throughout an *historical and critical perspective on AI*. Firstly, AI is framed within the story of the metaphor of "machine" (nature as a machine or mind as a machine). Then, the three radically different approaches to AI, developed during the XX century, are compared: the two symbolic approaches (imperative or logic programming) and the sub-symbolic (neural networks) [4]. The approaches (imperative/procedural, logic/inferential and example-based/machine learning) are compared by applying all of them to the same problem: implementing a winning algorithm for the Tic-Tac-Toe game. Special attention is paid to stress the epistemological difference between the classical deterministic scientific perspective, underlying the symbolic approaches, and the perspective of complexity, underlying the sub-symbolic one. In the third phase, future-oriented activities are proposed, with the aim of turning the addressed STEM concepts into future-scaffolding skills. The students are required to project themselves into a desirable future in 2040, to identify in this scenario a problem solved through AI and to propose an action that, in 2018, contributed to address it. We implemented the module in February 2018 in two contexts (50 students in total) and collected data through audio- and video-recording, interviews, questionnaires, written essays and focus groups. We are now analysing them through qualitative methods.

3 Preliminary results

Although the process of data analysis is on-going, evidences and trends are already visible.

- The students initially declared their anxiety toward future while, in the end, they expressed a positive feeling of being agents in the present, able to shape their future.
- The application of complexity science to AI and social systems analysis was helpful to change students' approach towards the future.
- The students initially were disappointed with some novelties introduced by the neural networks approach, like the possibility of making errors and the unavoidable presence of uncertainty. They started accepting such aspects and adapting their mindsets when they grasped how a neural network works from a technical point of view, and recognized that uncertainty is what makes a decision-making process interesting.
- The students were fascinated by the richness and interdisciplinarity of the topic, as well as by the philosophical, social and ethical questions that it arises. This helped some of them to reflect deeply on the criteria that could be used to choose their future university path.

References

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