

Mapping the SDG 4 Process: Algorithmic Literacy Among Students of the University of Sarajevo

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Volume 47, Number 2, 2024

Bobcatsss 2024 Special Issue
Numéro spécial Bobcatsss 2024

URI: <https://id.erudit.org/iderudit/1115993ar>
DOI: <https://doi.org/10.5206/cjils-rcsib.v47i2.17692>

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Publisher(s)

Canadian Association for Information Science - Association canadienne des sciences de l'information

ISSN

1195-096X (print)
1920-7239 (digital)

[Explore this journal](#)

Cite this article

Adilović, E. (2024). Mapping the SDG 4 Process: Algorithmic Literacy Among Students of the University of Sarajevo. *The Canadian Journal of Information and Library Science / La Revue canadienne des sciences de l'information et de bibliothéconomie*, 47(2), 49–60. <https://doi.org/10.5206/cjils-rcsib.v47i2.17692>

Article abstract

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Mapping the SDG 4 Process: Algorithmic Literacy Among Students of the University of Sarajevo

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Utilizing a mixed-method approach, this research aims to evaluate algorithmic literacy among students at the University of Sarajevo - Faculty of Political Sciences and the Faculty of Philosophy (BIH), and to assess the possibilities for improving existing practices of media and information literacy (MIL) integration. The central research question investigates how current MIL educational strategies influence students' awareness and understanding of the roles algorithms play in the digital transformation of a society striving for sustainable development. Therefore, the study encompasses a descriptive method of holistic approach elements: strategic documents, MIL book edition and MOOC modules. Subsequently, a thematic analysis of ten qualitative interviews with students further explores their experiences, attitudes, and perceptions regarding information, media, and algorithms. The research results offer insights into the potential of MIL education to support algorithmic literacy and its potential contribution to sustainable development, particularly focusing on SDG 4 - Quality Education. By aligning its findings with the objectives of a universally applicable goal, this study not only addresses the context of algorithmic literacy as an integral component of quality education but also serves as a step towards advancing the interconnectedness of open education and artificial intelligence.

Keywords: Bosnia and Herzegovina, media and information literacy, algorithmic literacy, university education, holistic approach

Introduction

Given the relevance of media and information literacy in the context of digital learning, this study explores the state and perceptions of algorithmic literacy among students at the University of Sarajevo. It is a recognized fact that the distinctive implications of algorithms in the post-digital era do not represent a novel conceptual foundation. Therefore, this approach intentionally avoids placing an emphasis on technical skills alone, as they prove inadequate for effective navigation and adaptation within a networked environment. Instead of a unilateral acquisition of skills for participation in automated processes, algorithmic literacy encompasses a more intricate set of knowledge, skills, and values. It involves recognizing processes in the everyday use of artificial intelligence technologies, understanding their applications, and critically evaluating the invisible infrastructure. This evaluation includes assessing the objectivity, fairness, and reliability of machine management and data creation. Also, the investigation of algorithmic literacy among university students contributes to the advancement of Sustainable Development

Goal 4 (SDG4) – Quality Education, by promoting and explaining the acquisition of essential competencies necessary for effective participation in the digital society.

Following an overview of the research topic, structure and selection, the next step is to establish the theoretical framework encompassing relevant literature that addresses the interdependencies within the media, information, and algorithmic literacy. Subsequently, a chapter on the research methodology follows, encompassing the methods employed, sample selection, and data collection instruments. In the section dedicated to analyzing students' perceptions and needs, participants from two organizational units of the University of Sarajevo – the Faculty of Political Sciences (FPN UNSA) and the Faculty of Philosophy (FF UNSA) – were surveyed as a representative sample in the pilot study and interviewed to assess their level of algorithmic literacy. Following this, a comprehensive examination of the challenges, obstacles, and requirements pertaining to algorithmic literacy among students will be conducted. Subsequently, a thorough discussion will be undertaken to analyze the research results, delineating the advantages, drawbacks, and potential avenues for enhancement.

Media, Information, and Algorithmic Literacy

If we revert to the primary reasons for contemplating the unified concept of media and information literacy, we ob-

serve that it has emerged from the necessity to integrate the traditional model of media literacy, developed in response to the growing influence of media in society, with the demands of the digital sphere. Explaining the genesis of individual terms and the emergence of the integrated concept, authors (Carlsson, 2019; Wilson, et al. 2011) highlight the UNESCO initiative of 2007, recommending the use of the term “media and information literacy.” They attribute the introduction of this new terminology to two factors: 1) the expansion of UNESCO’s work in the field of knowledge societies and freedom, and 2) fundamental shifts in the understanding of media due to digitalization. These considerations of digital platform mediation in information exchange reflect characteristics of the “platform society” (Castells, 2000; Van Dijck, Poell, and De Wall, 2018). This society demands the application of media and information literacy in citizen, state, and technological company relations. Despite the new digital environment aiming for the platform-based integration of human activities, there is a need, in the ongoing consideration of media and information, to approach it differently—striving to understand individual terms, various domains, and concepts within a broader framework.

Efforts to discern differences unfold in both directions of convergence, whether media literacy is understood as a broader framework or when information literacy takes center stage in research (Silajdžić, 2021). Alternative distinctions stem from specific research domains (Terra, 2023; Lee and So, 2014), emphasizing information literacy as intrinsic to library and information sciences, while media literacy is seen as integral to communication studies. The authors of the book “Media and Information Literacy: Learning Design for the Digital Age” (2021) also underscore the distinctiveness primarily based on focus: “The difference lies primarily in that information literacy is most often used in the context of education (research, science), while media literacy is directed towards broader civic competencies” (p. 14). Further categorization based on purpose is not an end in itself but serves to identify existing literacies that strategic development needs to incorporate and consolidate. UNESCO (2013) presents various terms: “media literacy, information literacy, literacy for freedom of expression and information, library literacy, journalistic literacy, computer literacy, internet literacy, film literacy, literacy for computer games, television literacy, advertising literacy, digital literacy, and metaliteracy” (p. 13).

Among various forms of related literacy, digital literacy is „erroneously (synonymously) used for media and information literacy“ (Vajzović et al., 2021, p. 115). Efforts to master technical and technological skills and tools, deemed sufficient methods for navigating the digital environment, have been derived from the standpoint of technological solutionism. Presenting itself as a seeming alternative to societal upheavals, the technology operates on two levels – it influences the capacity for deep thinking in each individual (Carr 2010) and

concurrently exerts a mass effect by shaping public opinion in the digital public sphere (Tufekci, 2017), often without generating significant engagement leading to positive outcomes. If the understanding of media and information literacy is excessively centred on digital competencies, it overlooks a broader spectrum of skills and knowledge necessary for understanding, interpretation, and critical thinking. The synonymous use of digital literacy is reductionist when considering that it neglects two dimensions of the media and information literacy concept, which “encompasses three often clearly separated dimensions: information literacy, media literacy, and ICT/digital literacy” (Council of Europe, 2023). The consolidated use of these dimensions centers on critical thinking, ethical dilemmas, navigating media and information systems, and understanding the impact of the platform environment on individuals and society. This approach transcends technical skills, emphasizing the development of critical and analytical abilities. Exploring and explaining specific aspects of media and information literacy can aid in better comprehending and situating the concept of algorithmic literacy.

In other words, it’s inaccurate to equate digital and algorithmic literacy. While digital literacy involves using digital tools, algorithmic literacy explores how algorithms shape information and impact decision-making in society. It goes beyond individual skills, incorporating critical thinking and societal awareness. These competencies are seen as essential, not just for individuals but for creating a better media and social environment (Turčilo, 2020, p. 32).

Distinguishing between digital and algorithmic literacy can have broader implications if applied to creating educational policies that do not overlook the specific impact of algorithms on privacy, data security, and freedom of expression. Such an approach to developing an integrated media and information literacy model appears in the UNESCO curriculum for teachers (2011), which played a significant role in promoting media and information education and its integration into national educational programs (Mansoor, 2023). In this context, when developing educational policies and programs for media, information, and algorithmic literacy, it is crucial to shift the focus from content to learners (Turčilo, 2020). It is essential to place the individual at the center, considering them as unique people with specific needs and a natural inclination towards information that needs recognition and enhancement. Furthermore, viewing them as an active member of the social community whose abilities need strengthening in various aspects of social communication is crucial. This shift in perspective to individual needs and competencies has become pivotal in shaping educational programs for media, information, and algorithmic literacy worldwide.

Research Methods

The central research question investigates how current MIL strategies influence students’ awareness and understanding of

algorithms' roles in the digital transformation of a society striving for sustainable development. Therefore, the study encompasses a descriptive method of holistic approach elements: strategic documents, MIL edition's four books and MIL MOOC modules IX – algorithms, artificial intelligence, literacy for the 21st century, and X – media and information literacy in the context of information security. Analyzing the content of the MIL holistic platform, editions, and MOOC sets the foundation for designing subsequent sections of semi-structured interview questions. Subsequently, a thematic analysis of ten qualitative interviews with students further explores their experiences, attitudes, and perceptions regarding information, media, and artificial intelligence.

Focusing on the specific investigation of algorithmic literacy among students, three research questions were formulated:

1. Analyse how students perceive the relationship between media, information, and algorithmic literacy.
2. Explore students' perceptions and experiences with algorithmic literacy.
3. Identify potential improvements to current practices of algorithmic literacy at the University of Sarajevo.

Semi-structured interviews were conducted to gain deeper insights into algorithmic literacy through students' experiences using a qualitative approach. These interviews aided in collecting data and information for research questions RQ1, RQ2, and RQ3. The interview technique aimed to identify patterns of perception and behaviour among first-, second-, and third-cycle students when engaging in algorithmic processes. In the case of the qualitative analysis of University of Sarajevo students, a non-probabilistic sample was selected based on specific criteria. The sequence of selections initiates purposive sampling, which, for the purpose of this study, is based on three criteria:

1. Students in their first year of the first cycle of study at the Department of Security and Peace Studies at the Faculty of Political Sciences and the Department of Information Sciences at the Faculty of Philosophy, University of Sarajevo, who attended the MIL course;
2. Students from the Faculty of Political Sciences, University of Sarajevo, who did not have direct, continuous, and systematic participation in information, media, and algorithmic literacy;
3. Students from the Faculty of Political Sciences and the Faculty of Philosophy, University of Sarajevo, who actively participated in local, regional, and global research projects promoting media and information literacy.

Out of the total of ten (N=10) participants selected for the study, four (n=4) attended MIL course and a public Massive Open Online Course (MOOC) in the first year of the Department of Security and Peace Studies at the Faculty of Political Sciences and the Department of Comparative Literature and Information Sciences at the Faculty of Philosophy, University of Sarajevo. Two (n=2) participants have been actively engaged in research and project activities related to MIL, while the remaining four (n=4) were not involved in a continuous systematic process. The foundations on the algorithmic era in the literature review and the content analysis of the holistic MIL model served as the starting point for the adapted framework in developing the questionnaire. One of the annexes, the Script of conducted focus groups and interview questions within the integrated text of the Algorithm Study (2020), was utilized to create segments of individual question sets. When submitting documentation for ethical assessment at the University of Sarajevo, standards were set for handling participants and research materials. These standards ensure that interviews align with ethical norms, prioritizing participant safety and well-being and maintaining research integrity.

Interviews were conducted in the Multimedia Hall of the Institute for Social Science Research over three consecutive days, starting on Tuesday, September 12, 2023, and concluding on Thursday, September 14, 2023¹. Initially, the interview transcripts were imported into NVivo, where each transcript was reviewed to ensure accuracy and completeness. NVivo's robust text search and query functions were employed to identify recurring phrases and keywords, providing an initial set of 57 codes. These codes represented a wide range of thematic elements related to students' perceptions and experiences with algorithmic literacy. The subsequent phase involved the filtering and summarizing these codes to refine the dataset. NVivo's hierarchical coding system was particularly beneficial, enabling the consolidation of similar codes into broader categories. This process reduced the initial set of codes to a more manageable number of 25², enhancing the focus on key thematic elements. The final stage of the analysis involved developing a thematic framework based on

¹Semi-structured interviews were conducted based on the following criteria: each interview lasted approximately 45 to 60 minutes in Bosnian/Croatian/Serbian; notes were taken during the sessions, and all interviews were recorded using a mobile voice recorder, with manual transcripts completed after their conclusion.

²25 codes include: 1. media and information; 2. media convergence; 3. algorithmic literacy; 4. perceptions of algorithms; 5. Courses; 6. massive open online course (MOOC); 7. MOOC modules IX and X; 8. resignation; 9. Indignation; 10. need for action; 11. generation gap; 12. digital divide; 13. general impression; 14. public and environmental attitudes; 15. collection of audio data; 16. technocapital; 17. political manipulations; 18. media manipulations; 19. data protection; 20. information confidentiality; 21. information security; 22. protection measures; 23. individual responsibility; 24. state responsibility; 25. standardization.

the refined codes.

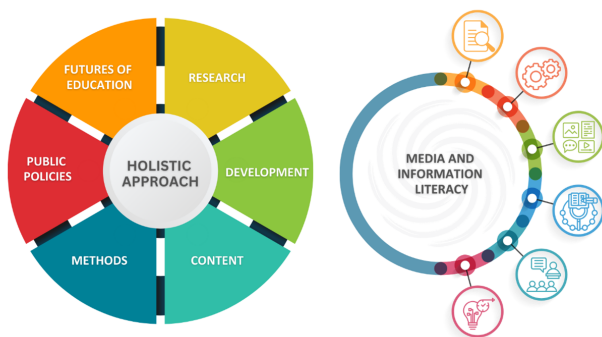
After establishing a thematic framework, a deeper analysis of each theme or category followed. NVivo's matrix coding queries allowed for an in-depth comparison of responses across different participant groups, facilitating a nuanced understanding of variations in perceptions and experiences. Thematic analysis within this qualitative research provided a contextual overview of the interviews, allowing for a more detailed insight into the topics discussed and a better understanding of the complexity of the respondents' experiences and attitudes. This paper presents six overarching themes³, encompassing fourteen focused themes/subthemes and their corresponding codes. Once the analysis was finished, the results were systematically organized and interpreted to address research questions RQ1, RQ2, and RQ3.

Content Analysis of the Holistic MIL Approach

Considering that the initial academic efforts to examine the practice of the integrated concept of media and information literacy at the University of Sarajevo in 2017 revealed a lack of a detailed and coherent research base, a shortage of literature in regional languages, and pedagogical-methodological ambiguities in the field of methods necessary for the application of MIL, the first subsequent step involved devising a holistic approach to establish a scientific research platform. Understood as a PDCA (Plan-Do-Check-Act) cycle, this holistic approach encompasses six key steps that are continuously repeated in the process. Starting with researching the current state, this model further integrates 2. strategic development, 3. creation of relevant content, 4. application of appropriate methods, 5. alignment with public policies, and 6. contemplation on the future of education and media information literacy.

Figure 1

Diagram of the MIL holistic approach, Institute for Social Science Research, University of Sarajevo



The application of MIL multicomponent integration⁴ supporting the implementation of all cycle elements horizontally

and vertically,⁵ is envisioned to conduct a holistic approach reflected in three components: (1) Hybrid model of multi-component MIL integration; (2) Development of public policies and a strategic framework for MIL; (3) Research and development of MIL (Vajzović 2021, 32). This comprehensive approach is designed to execute all essential stages in developing media and information literacy and harmonize and highlight the interplay of its components. The research component has resulted in a series of strategic documents, including two overview and five position studies⁶, as well as the Declaration on the importance of media and information literacy (2019). The content encompasses publications⁷ and training programs for teachers, librarians, and students.

The next element of the holistic approach involves public policies. Based on existing studies and strategic documents, the Working Group developed the Strategy for the Development of Media and Information Literacy in Education in Sarajevo Canton, which was adopted in 2022. Recognizing the specificities of the networked environment, the Strategy considers the “challenge of the application of both digital learning methods and awareness of burning issues related to algorithmic social interactions about which we know little or not enough” (Government of the Sarajevo Canton, 2022,

³Six topics include: 1. algorithmic literacy in the mil context, 2. education and experience, 3. impact of platforms and social media, 4. algorithms and personalization, 5. privacy and data security, 6. critical awareness and (self) regulation.

⁴The unique inclusive model developed by the Institute for Social Science Research, University of Sarajevo, since 2017 (Vajzović, 2020, p. 13)

⁵Vertical integration involves the development of research, science, and lifelong education for teachers, while horizontal integration entails cross-curricular collaboration between teachers and librarians within educational programs and plans, as well as learning outcomes (Vajzović, 2021)

⁶The Overview Study on Media and Information Literacy in Bosnia and Herzegovina (2018); Revised Overview Study on Media and Information Literacy in Bosnia and Herzegovina (2020); Position Study on Policies and Strategies for Media and Information Literacy in Bosnia and Herzegovina: Media and Information Literacy: Time for a Strategic Approach (2018); Revised Position Study on Policies and Strategies for Media and Information Literacy in Bosnia and Herzegovina (2020); Media and Information Literacy: Time for Implementing Adopted Principles (2020); Position Study – The Role of Civil Society Organizations in the Implementation of Media and Information Literacy Strategies in Bosnia and Herzegovina (2020); Position Study Media and Information Literacy in Education Systems in BiH: Hybrid Model of Multicomponent Integration (2021).

⁷The series on Media and Information Literacy consists of four publications: “Media and Information Literacy: Research and Development” (2020), “Media and Information Literacy: Learning Design for the Digital Age” (2021), “Regional Review of the Development and Integration of Media and Information Literacy” (2021), and “Growing Up Learning: Society, Culture, Religion in the Digital Age” (2021).

p. 8). Building upon the previous element in the holistic approach, the sixth element seeks to shed light on what may be overlooked or insufficiently addressed. In other words, the future of education is directed towards critical media and information literacy not only because "data collection happens invisibly and continuously" (Head, Fister, & MacMillan 2020, 5), but also because algorithm-based interactions require the updating of information commons.

The holistic model's elements aim for the common good, facilitating diverse knowledge through shared information (Huskić, Vajzović and Hibert 2022). In line with this, the narrative about the future of education ties into the fourth element – methods or modes of necessary action. One notable method is the Massive Open Online Course (MOOC) on media and information literacy⁸, developed by the Faculty of Political Sciences at the University of Sarajevo with support from UNESCO and the European Union. The twelve MOOC modules were developed based on adapted material from the UNESCO curriculum for teachers (2011) and include the following:

1. Understanding media and information literacy;
2. Information society, human rights, and democratic discourse;
3. Information literacy and ethics;
4. Social role of media;
5. Crafting media messages;
6. User interaction with media;
7. Internet, challenges, and opportunities;
8. Digital ecology and "smart" village;
9. Data, algorithms, and artificial intelligence: literacy for the 21st century;
10. Media and information literacy in the context of security;
11. Critical thinking;
12. Futures literacies.

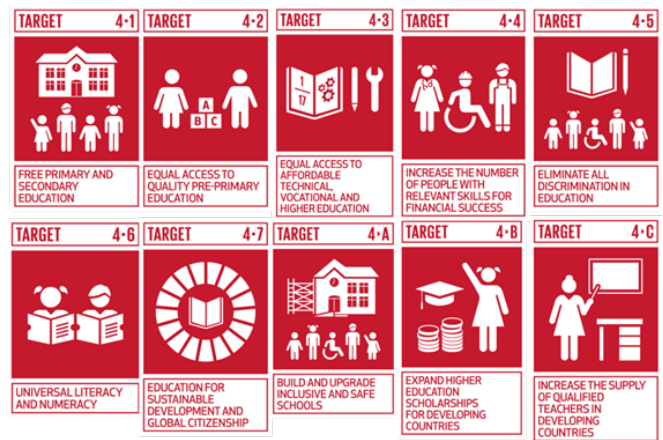
This intertwining involves a gradation of the complexity of topics. For instance, the first modules of the MOOC relate to a general understanding of media and information literacy and its importance in the context of human rights and democracy, gradually moving towards more specific areas such as information ethics, the social role of media, and internet culture. Finally, after gaining insight into digital ecology, and addressing critical thinking and MIL, Module IX delves into the origins of artificial intelligence and the impact and consequences of algorithmic actions, while Module X focuses on the security aspects of information, media, and algorithmic literacy.

The fact that the module Futures Literacies follows algorithmic literacy and information security indicates a reflection of mutually intertwined elements within the macrostructure of the holistic approach in specific methods, in this case, the microstructure of the information commons, the Massive Open Online Course. In doing so, Modules IX and X

call for a focus on exploring a more detailed explanation of monitoring practices in the algorithmic society, which have become increasingly common and advanced. Understanding how these computer programs function and their broad impact has become urgent. By understanding these concepts, learners gain crucial competencies necessary for effective participation in the digital society, aligning with the objectives and targets of SDG4⁹. Figure 2 shows the ten main pillars of SDG4. The research team of the Institute for Social Science Research considered SDG4 while crafting the holistic MIL model. Specifically, they focused on the three pillars and objectives: Target 4.3, Target 4.6, and Target 4.7.

Figure 2

Ten pillars of Sustainable Development Goal 4 – Quality Education



Target 4.3 aims to ensure equal access for all women and men to affordable and quality technical, vocational, and tertiary education, including university. This target underscores the importance of providing equitable and free educational opportunities. Furthermore, Target 4.6 focuses on achieving literacy and numeracy among youth and adults. In the context of algorithmic literacy, this target emphasizes the need to develop critical thinking skills and the ability to evaluate information accurately in a digital environment. Finally, target 4.7 aims to ensure that all learners acquire the knowledge and skills to promote sustainable development. That is why MIL and algorithmic literacy play a crucial role in achieving this target by fostering critical awareness, ethical decision-making, and active engagement in addressing global

⁸Massive Open Online Course in Media and Information Literacy. 2023. University of Sarajevo Faculty of Political Sciences. www.mip.unsa.ba. Accessed on September 12, 2023.

⁹Algorithmic literacy and information security awareness are essential components of education for sustainable development because understanding these concepts enables students to engage critically with digital technologies, promote ethical practices, and contribute to the advancement of a sustainable and inclusive society.

challenges related to sustainability, human rights, and cultural diversity.

As students understand the hidden filters that influence what they see and learn, shaping their thinking and identity (Head, Fister, & MacMillan, p. 13). Therefore, a subsequent analysis of the results will address the possibilities of Modules IX and X in integrating more detailed approaches and reorganizing relevant content.

Qualitative thematic analysis

Thematic analysis was employed for interview analysis. It provided a contextual overview and enabled a better understanding of the discussed topics and the complexity of respondents' experiences and perspectives. The following four basic thematic groups about which students talked during interviews have been identified and analyzed.

Perceptions of MIL and Algorithmic Literacy

Students interpret the relationship between media and information literacy mainly through their fundamental concepts and areas of study – media and information:

"If we have point A where information originates and it needs to reach point B, the media is the path that the information treads." (Student, FPN UNSA, 2nd year)

Analyzing general attitudes and perceptions regarding the reasons why media and information literacy should be considered, developed, and implemented integrally, a similar stance was observed among all participants based on one of two criteria: 1. attitudes based on the interconnectedness of the two areas of study (media and information) and 2. attitudes rooted in previous teaching practices:

"I always combine when I talk about what media and information literacy are because it remained in my head during learning about the use of media and information in terms of literacy of people and society in general." (student, FF UNSA, 1st year, 2nd cycle).

Unlike media and information literacy, which all participants perceived and explained by emphasizing separate media, information, and/or integrated concepts, the participants' understanding of the concept of algorithmic literacy is associated with an integrated concept. In other words, research participants see algorithmic literacy as the last link in the existing MIL sequence:

"Algorithmic literacy goes a step further, exploring what is behind the scenes, how information comes to the screen, and how it is presented in the media." (Student, FPN UNSA, 3rd year)

"Algorithmic literacy is a deeper concept that relates to understanding the algorithms that influence which information I see more and which less." (Student, FPN UNSA, 1st year)

The highlighted emphasis on process automation and work streamlining is noticeable in various reflections, concurrently transitioning into the technical domain of study and practice.

"Algorithmic literacy involves efficiently harnessing all of this, automating certain processes that previously slowed us down during work, and adhering to mathematical principles in all the information that comes our way." (student, FPN UNSA, 1st year, 2nd cycle)

"Algorithmic literacy permeates every profession and facilitates work." (student, FPN UNSA, 3rd year)

Furthermore, there is also a noticeable deviation from the familiarity with the previous concept, which the participants defined without difficulty. In this case, a smaller number of students are unsure about the general understanding of algorithmic literacy:

"I am not fully acquainted with algorithmic literacy, but I know things about Facebook, Instagram." (Student, FPN UNSA, 1st year).

"I must admit that I haven't had many opportunities to acquire that knowledge. On the other hand, media literacy has been frequently addressed in numerous workshops and seminars." (Student, FPN UNSA, 2nd year).

Students feel they don't have enough opportunities to learn about algorithmic literacy through formal or informal education. This highlights the need to examine their educational experience closely and identify specific needs for improving current educational practices.

Education and Experience

Students of the Faculty of Political Sciences did not attend courses specifically focusing on algorithmic literacy, while students of the Department of Information Sciences at the Faculty of Philosophy were indeed instructed as part of their courses. However, they express a desire to delve deeper into specific aspects of the subject.

"As for algorithmic literacy, I must admit that I haven't had many opportunities to acquire that knowledge. On the other hand, media literacy has been frequently addressed in numerous workshops and seminars." (student, FPN UNSA, 2nd year, 2nd cycle)

Given that taking a Massive Open Online Course (MOOC) is an integral part of the course in the first year of the first cycle of studies at the Department of Comparative Literature and Information Science, Faculty of Philosophy, and at the Department of Security and Peace Studies, Faculty of Political Sciences, a smaller number of students confirmed the significance of the MOOC for introducing them to algorithm thinking.

To gain insight into the possibilities of improving the existing resources at the University of Sarajevo, research participants mentioned the option of adapting the MOOC. Due to the frequent mystification of the term “algorithm” and the practices of the “invisible algorithmic hand”, students have expressed interest in understanding how algorithms work through simplified examples:

"I would like to delve deeper into what I have superficially encountered in some courses in the module on algorithms to further build on that part in terms of understanding how an algorithm functions." (Student, FPN UNSA, 1st year)

Recognizing the value of interactivity and gamification for enhanced comprehension, understanding algorithmic operations, and fostering personal strategies to mitigate the impact of personalization while ensuring data security, the majority of students advocated for the incorporation of self-assessment quizzes:

"Perhaps expanding towards a better understanding of our behaviour—a quiz where young people can select specific answers, and in the end, the results show how algorithmically literate they are and whether they critically assess the presented content." (Student FF UNSA, 1st year).

"We need an interaction, a mini-game where someone could develop a greater sense of the digital environment, which is dynamic, while definitions are static, necessary but not sufficient to develop an understanding of its dynamism." (student FF UNSA, 3rd year)

The introduction of new content and approaches to their creation has been proposed to explore algorithmic phenomena from different perspectives. Students with basic knowledge of algorithm functioning would like to supplement their existing knowledge with more complex examples of algorithmic processes: “Their impact on society is quite clear, but more complex, nuanced relationships with algorithms and how they operate are still unclear from an extremely technological perspective.” (Student FF UNSA, 1st year) Diverse perceptions of algorithms among respondents reveal varied educational needs. Commonly, participants express a shared desire for revamped resources catering to both novice and experienced

learners, ensuring a comprehensive acquisition of knowledge and skills. However, a common component in the reflections of all participants remains the need for redefining and supplementing existing resources that will satisfy all categories of participants and offer a specific set for acquiring knowledge, skills, and competencies for those with higher and lower levels of experience.

Personalization and Privacy

Further questions explored students’ recent online searches on platforms like Google, YouTube, Instagram, or Facebook to understand their experiences with algorithms and assess their level of critical awareness. Students shared instances where online content seemed influenced by their identity, activities, interests, or previous interactions, expressing concerns about the implications:

"The first time, I didn’t know what was going on; it was probably about two years ago, in high school, when I started using Facebook and Instagram more. It was surprising to receive information I mentioned out loud to my peers." (Student, FPN UNSA, 1st year)

It is noticeable that the aspect that most concerns students regarding privacy infringement is the collection of audio information:

"My biggest shock was when I realized that my phone was listening to me. It blew my mind the first time I realized it. Now I know what’s going on." (student, FPN UNSA, 1st year, 2nd cycle)

"It was surprising to me that I receive information that I mention out loud to my peers." (student, FF UNSA, 1st year)

However, after accumulating specific experiences over time, respondents usually transition into an apathetic state of awareness:

"This has been happening for years, and there are plenty of examples where the result is that a person becomes indifferent to that information." (Student, FPN UNSA, 2nd year)

When asked whether they had ever felt that what they see online was influenced by who they are, what they were doing, reading, watching, or wanting to buy, and whether it worried them, respondents generally gave affirmative answers, citing examples from their own or their close acquaintances’ experiences, with a slight variation:

"It didn’t concern me; I felt great, I found it interesting. I was talking to a friend about German language courses and then an ad for a course

popped up. It was really funny, we laughed, and I researched how to enroll in a German course. I think it's a great thing in a way that it makes our daily lives easier." (student, FPN UNSA, 3rd year)

Most respondents, regardless of the level of concern, cited similar reasons for content personalization: 1. corporate benefit – increasing engagement, creating a better user experience, and dependence; 2. political benefit – creating filter bubbles and manipulations; and 3. commercial benefit:

"I believe that corporate benefit is happening, but I have never thought about it that way. If it's a corporate game, I'm in." (Student FPN UNSA, 3rd year)

"Creating needs leads to creating dependencies, and capitalism is often the generator of those needs." (Student FPN UNSA, 4th year)

Except for students who see personalization as a time saver, other respondents understand content personalization, whether it involves corporate, political, or commercial interests, as an approach that can have serious implications for user privacy and security. In several instances, students perceive information personalization as beneficial and useful for everyday life, as it can provide relevant information and offers that cater to individual needs and interests. However, personalization evokes fear and concern when they do not view the customization of results based on preferences as a positive effect of artificial intelligence.

Critical Awareness and (Self)Regulation

Considering the observed disparity in respondents' answers, including varying levels of understanding, different experiences, and aspirations regarding algorithmic literacy, information security, and data protection, the subsequent analysis focuses on the practical aspects and steps taken by students to ensure the confidentiality of their own information. Responses from participants regarding their attitudes towards content personalization and data protection have shown diverse perspectives, broadly categorized into three groups: those who perceive time-saving benefits in personalization, those who take basic preventive steps for data protection, and those who see potential threats in personalization but, due to their awareness of the existence and consequences of filter bubbles, believe that a high level of protection is not essential:

"If I want to delve into a topic, I will consciously ask the algorithms to provide me with information related to it. The relationship is symbiotic, but one needs to turn the parasite into mutual benefit." (Student, FF UNSA, 3rd year)

Other respondents cited several examples of using apps or personal measures for prevention. The majority highlighted ad blockers and incognito mode as preventive measures against content personalization:

"I use an ad blocker and clear my browsing history; sometimes you accidentally see something you didn't want to." (Student FPN UNSA, 2nd year)

"Of all, I mostly use an ad blocker, not necessarily for privacy, but it annoys me when pop-ups and ads appear on the screen." (Student FPN UNSA, 3rd year)

When it comes to introducing other additional measures for data protection and information confidentiality, students mentioned using other web browsers, such as DuckDuckGo, Brave, meta-search engines, clearing search history, or VPN (Virtual Private Network).

"I've used VPN, but once, when I needed research for the Demography course, the United States had blocked the data, so we were virtually in the USA." (Student, FPN UNSA, 3rd year)

"I use VPN for accessing content, and it also comes in handy for security reasons." (Student, FPN UNSA, 1st year)

When addressing methods of individual (self)regulation to ensure data protection and information confidentiality, a critical regulatory dimension was observed, emphasizing that it involves not only the responsibility of individuals but also the state's obligations to the community:

"Authorities need to better regulate technology companies to reduce the possibility of data misuse and the spread of false information." (Student FPN UNSA, 1st year) "First, we need to find a mechanism to securely store data, state regulation of the internet." (Student FPN UNSA, 3rd year)

Students feeling secure online often attribute this security to legal measures that penalize privacy violations. Overall, respondents, acknowledging responsibility for their and others' security, expect the state to play a pivotal role in ensuring information confidentiality and data protection.

Discussion

In discussions about their comprehension and engagement in media and information literacy, all participants exhibited a clear and concise understanding of both concepts. Their emphasis and more precise definitions were influenced by their respective educational levels, departments, and faculties.

Students at the Faculty of Political Sciences demonstrated a deeper grasp of media literacy, whereas those at the Faculty of Philosophy directed more attention to the concept of information literacy. These findings align with the results of a 2020 study (Brodsky et al.) where students demonstrated high media literacy, but "this knowledge is inconsistently related to their algorithm awareness" and is mainly content-related (p. 55). In contrast to the MIL model, students articulated algorithmic literacy with less precision, often considering it within existing frameworks or as an extension, background, or behind-the-scenes aspect. Despite the critical role of algorithms in current media, political, sociological, and security issues, there is a noticeable gap in addressing these topics within study groups at the Faculty of Political Sciences. While the Department of Information Science has laid theoretical foundations for critical reflection on the platform environment, the University of Sarajevo lacks adequate training, courses, and programs tailored to students' interests and needs in the ever-evolving digital landscape.

The fear of the unknown and insufficiently analyzed consequences of algorithmic governance have influenced the direction of students' experiential processes. This is manifested through independent research on data collection, surveillance, and distancing from digital devices as an introduction to measures for mitigating attention economy. The authors of the study on algorithmic literacy (Head, Fister, and MacMillan, 2020) emphasize that "students should not have to learn these key information skills on their own. Also, it should not be assumed that all of their strategies are necessarily effective" (p. 28), raising questions about the adaptability of teaching practices and educational policies. This is due to the acknowledgment that "the opacity of platform information services surpasses the ability and responsibility of individuals to control relevance and privacy" (Hibert, 2018, p. 21). Looking towards the future of education in the algorithmic society, all participants have called for re-evaluating existing educational practices, specifically highlighting the potential of Massive Open Online Courses (MOOCs). The algorithms and information security modules within MOOCs provide a solid theoretical foundation for questioning these issues. However, there is a suggestion that they could be better integrated in explaining the relationship between algorithmic literacy and information security.

Most students advocating for enhancements to the existing MOOC highlight the need for practical skills, advice, quizzes on algorithmic literacy, and clear examples of algorithmic functioning. This points to two key aspects: 1. The educational system has yet to meet the complex needs of the digital student population, and 2. A technological solutionist mindset in education assumes that incorporating more tools, applications, gamification, and multimedia content will solve the misalignment of curricula with accelerated algorithmic development. This approach neglects a more complex strat-

egy involving introducing comprehensive research programs and positioning critical theory as a guide in these processes (Hibert, 2018, p. 19).

Nevertheless, it would be counterproductive to dismiss the possibility of game design, as contemplating a critical approach requires concrete solutions where it is possible to construct a whole from the causal sequence of theory and practice. Specifically, to ensure that the introduction of gamification does not merely replicate entertainment models and introduce technological content just to follow digital educational trends or due to claims about new generations' preference for learning with multimedia content, it is necessary to consider solutions that integrate the principles of critical pedagogy with computer and technical skills. Thus, Thumlert et al. (2022) propose introducing a "critical computational literacies" model in the game design approach, which can introduce transparency into algorithmic systems while simultaneously developing and providing students with coding skills not only to resist malicious influences but also to direct coding towards creative, hacktivist, transformative social and democratic purposes (p. 27).

Finally, if we look at similar studies on students' attitudes, information behaviour and privacy over the years, despite individual efforts, there is no observed reduction in feelings of resignation and indignation. A similar trend of feelings of powerlessness and passivity was recorded by researchers in the Algorithm Study (2020), as students' attitudes proved to be ambivalent. On the one hand, there is resignation to the fact that they have to use platforms like Google and YouTube, despite disagreeing with some advertising practices. Although they are aware of the benefits of algorithms for content personalization, they are simultaneously concerned about the potential misuse of their data but often feel that it is too late to protect their privacy. These contradictory feelings show that students value the convenience of these platforms but are aware of the negative consequences. Despite being aware of the problems, many feel powerless to change anything. Haggittai and Marwick (2016), in the study "What Can I Really Do? Explaining the Privacy Paradox with Online Apathy", also found that students feel they are fighting a losing battle. Investigating how young adults understand and experience online privacy, the study reveals that despite understanding the risks associated with sharing information, students often feel they have no control over their personal data once it is shared. These feelings result in apathy, which Draper and Turow described as digital resignation (2019), where individuals feel that their battle for privacy is already lost due to the opaque practices of institutions and the technical limitations of major companies' platforms.

If we do not focus solely on the country-specific case of the University of Sarajevo and the obtained results, other conducted studies (Brodsky et al., 2020; Koenig, 2020) also reveal a continuity in students' attitudes. They recognize

the importance of algorithmic literacy while simultaneously expressing concern about the potential misuse of data, as well as a sense of passivity and a lack of concrete actions to change the situation. This underscores the need for a pedagogical approach in classrooms worldwide that will develop students' abilities to "critique interfaces and produce interfaces in responsible ways" (Gallagher, 2020, p. 70) to encourage a reduction in passive approaches and increase self-regulation models. By introducing both critical theory and basic technological practices regarding algorithmic management, the approach primarily fosters exploration and reflection on social implications. Thus, Archambault (2023) states that "a better understanding of the underlying structures at play when the flow of information is shaped by algorithms is a first step in expanding students' information-seeking habits" (p. 532).

Then, practical action can take various forms. For instance, Koenig (2020) explores the possibilities of student journals for measuring and enhancing algorithmic literacy awareness, while Thumlert et al. (2022) see potential practical forms and practices of this critical approach in the construction of models, microworlds, and systems of stories/simulations where students have the opportunity to understand the basic functioning of algorithms through simple examples and models they build.

In addition to the mentioned recommendations, it is important to consider that during the interviews, students consistently identified peers as sources of information about algorithms, believing that they are better positioned to ask questions and counteract personalized content compared to older family members and teachers. (Head, Fister, and MacMillan, 2020). In other cases, students connected their personal experiences with broader discussions during specific lectures and interviews, applying a critical perspective to complex algorithms-related questions. However, excluding students attending media and information literacy courses, respondents stated that algorithmization was not cross-curricularly problematized.

Therefore, in addition to these universal recommendations, additional recommendations can be made for the integration and enhancement of algorithmic literacy for students, top management of university units, teaching and non-teaching staff, and decision-makers at the University of Sarajevo and other universities.

1. Adapt the public open online courses in media and information literacy to meet the needs of students in the algorithmic environment.
2. Redefine curricula to cross-culturally integrate algorithmic literacy.
3. Implement a system of continuous education and training for the teaching and non-teaching staff in the field of algorithmic literacy.

Therefore, the lack of a systematic approach to algorithmic literacy could be mitigated by converging the understanding of teaching staff on information and society within their discipline, enhancing non-teaching staff competencies for implementing necessary measures and incorporating students' insights and creative practices to develop a curriculum that meets students' needs as participants in educational processes and citizens. This approach should encourage them to consider various forms of action, whether through defensive tactics or advocating for social or legislative changes.

Such an integration of algorithmic literacy, which includes all participants in the educational process, not only empowers students with practical and technical skills (SDG 4.4), but also promotes inclusive and equitable education (SDG 4.3), ensuring equal access to competencies, including a critical understanding of algorithmic processes. This aims to create aware citizens capable of contributing to sustainable development (SDG 4.7), participating in ethical reflections, and engaging in socially responsible actions, creating a fairer, more sustainable, and open information society.

Conclusion

In examining perceptions and experiences of algorithmic processes to address the research questions, this study focused on integrating algorithmic literacy into the University of Sarajevo educational programs. By questioning the impact, conditions, and opinions on algorithmic literacy and information security, the study assumes that due to algorithmic amplifications posing challenges to information security and potential dilemmas in data protection, the current spectrum of methods within a holistic approach needs adaptation and supplementation to align with the ongoing changes in the digital environment. Recommendations include thematic training for staff and integrating AI, algorithms, and data protection into the Massive Open Online Course (MOOC) on media and information literacy, particularly in modules IX and X, which align with SDG 4's emphasis on providing students with the necessary skills and knowledge for facing the challenges of digital, algorithmic environment.

The limitations of the study are based on the relatively small number of participants and the focus on the specific case of the University of Sarajevo. The concentration of media and information literacy (MIL) strategies within a single institution may limit the relevance of the findings for the broader academic community and different educational systems. Furthermore, in addition to students from the Faculty of Political Sciences, only two students from the Department of Information Science at the Faculty of Philosophy were included. A comprehensive overview of the state and perspectives of algorithmic literacy would require involving more organizational units/faculties in the examination process, enabling assumptions for a more relevant representation and action at the University of Sarajevo. Despite the

limitations, certain trends and issues identified in this study are also present in international contexts, suggesting that the integration of algorithmic literacy is a universal challenge that requires systematic and specific approaches in different educational settings.

Just as algorithmic literacy should not be tied to a specific subject within the educational process but developed as a cross-curricular competence within existing practices, universities should utilize their existing capacities. If we say that the university library is the "heart of the university," then the classroom can be called the "brain of the university." Although they occupy different roles, they are part of the same institutional organism. The library, as the heart of the university, provides services and support for the intellectual development of students, researchers, and professors. The classroom, on the other hand, represents the place where the active process of learning and teaching takes place, and ideally, the information gathered in the library is transformed into knowledge through the interaction between professors and students, fostering critical thinking and guided discussion.

Therefore, to create a third space in classrooms that encompasses reflections on the role of algorithms in various sciences, it is necessary to adapt existing curricula, teaching materials, and techniques to address the need to reduce the digital knowledge gap and to supplement active platforms of open educational resources and massive open online courses. Additionally, academic libraries can organize training programs and workshops for students, teaching and non-teaching staff, and public lectures with guest AI experts by supporting the teaching and scientific process. This not only encourages discussion and information sharing but also reaffirms the role of the library and the role of librarians and information professionals as the center of the process of disseminating and managing information in the digital environment, ensuring open access to resources and materials on artificial intelligence, ethical aspects of its use, privacy, and data security.

Although this role of libraries and librarians is not sufficiently and thoroughly addressed in SDG4 – Quality Education, its importance is recognized through the contribution it provides in ensuring access to quality educational resources. Libraries act as key institutions in promoting inclusive and equitable education, allowing all students, regardless of socioeconomic status, access to necessary information and tools. In doing so, they directly support the goal of reducing inequalities in education and strengthening the capacity for lifelong learning by ensuring quality education for sustainable development through the promotion of information, algorithmic, and digital literacy.

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