Facing the Appeal of Social Networks: Methodologies and Tools to Support Students towards a Critical Use of the Web

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Abstract: In the present contribution, we introduce an integrated approach, grounded both on cognitive and computer science, to strengthen the capacity of adolescent students in discerning information on the Web and on social networks. The proposed approach includes methodologies and tools aimed at promoting critical thinking in students. It has been structured in four main operational phases to facilitate implementation and replication, and it is currently tested with 77 high-school students ($14-16$ years old). Preliminary insights from this pilot study are also presented in this paper. We argue that the integrated approach can be comprised in a more general framework designed to boost competences of reasoning of students, which are crucial in promoting fake news detection and, consequently, in preventing the spreading of on line false information.

1 INTRODUCTION

The Internet is a global phenomenon, affecting private and public life immensely. It has evolved into a ubiquitous digital environment in which people access content (e.g. Web), communicate (e.g. social networks), and seek information (e.g. search engines). The Internet search engines are more and more often used as a source of information on the Web, and also in educational contexts they are widely used by pupils in the acquisition of new knowledge on a specific topic (Taibi et al., 2017; Taibi et al., 2020). For example, Search As Learning is a recent research topic aimed at investigating the learning activity as an outcome of the information seeking process (Ghosh et al., 2018). However, search engines are optimized for acquiring factual knowledge and they are effective for specific types of search, but they do not support searching as learning tasks (Krathwohl and Anderson, 2009; Marchionini, 2006). In fact, search engines are not purposely designed to facilitate learning activities such as understanding or synthesis, given that they do not offer mechanisms to support iteration, reflection and analysis of results by the searcher.

Social networks play a predominant role in the communication between individuals, and their use in the educational settings have been widely investigated. In particular, social networks have been used by teachers to share information and communicate with pupils, they have been also used to support self-regulated learning to connect informal and formal learning. The structure of the most used social networks such as Facebook, Twitter and Instagram has been also investigated in terms of their ability to foster interactions and contents sharing (Thompson, 1995; Chelmis and Prasanna, 2011), feelings (Kaplan and Haenlein, 2010), opinions, and sentiments expressions (Pang et al., 2008). However, if from one hand the Internet and its tools support new communication dynamics able to reach a wider number of persons, on the other hand these characteristics have generated issues that cannot be ignored. Indeed, Internet has also introduced challenges that imperil the well-being of individuals and the functioning of democratic societies, such as the rapid spread of false information and online manipulation of public opinion (e.g., (Bradshaw and Howard, 2019; Kelly et al., 2017), as well as new forms of social malpractice such as cyberbullying (Kowalski et al., 2014) and online incivility (Anderson et al., 2014).

The negative effects of these challenges are even more exacerbated when it comes to young adolescents, specially when they use the Web to shape their understanding and acquire knowledge on a new topic. Moreover, the Internet is no longer an unconstrained

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and independent cyberspace but a highly controlled environment. Online, whether people are accessing information through search engines or social media, their access is regulated by algorithms and recommender systems with little transparency or public oversight. We argued that one way to address this imbalance is with interventions that empower adolescents, as Internet users, to gain some control over their digital environments, in part by boosting their information literacy and their cognitive resistance to manipulation. As a consequence, adolescents need to be equipped with a more informed use of social media and the Internet.

In this contribution we present an integrated approach that includes methodologies and tools aimed at promoting critical thinking in adolescent students. This approach will help students in perceiving and elaborating on line information in a more critical way, in order to face the challenges posed by the digital environments in which they are imbued.

2 RECOMMENDER SYSTEMS, ALGORITHMS AND OTHER DIGITAL TRAPS

One of the main challenging aspects of online environments is represented by the way in which they shape information search. Indeed, information is filtered and mediated by personalized recommender systems and algorithmic filtering. Algorithmic filtering and personalization are not inherently malicious technologies. On the contrary, they are helpful mechanisms that support people in navigating the overwhelming amount of information on the Internet. In a similar vein, news feeds on social media strive to show news that is interesting to users. So, filtering information on the Internet is indispensable and helpful. All in all, these mechanisms act as filters between the abundance of information and the scarcity of human attention. However, they are not without some notable problems. One general problem is that the decision on such personalized content is being delegated to a variety of algorithms without a clear understanding of the mechanisms underlying the resulting decisions.

Delegating decisions results in a people's gradual loss of control over their personal information and a related decline in human agency and autonomy (Anderson et al., 2018; Mittelstadt et al., 2016; Zarsky, 2016).

Another closely related concern is the impact of AI-driven algorithms. For example, on what information should be presented and in what order (Tufekci, 2015). Another challenging consequence of algorithmic filtering is the algorithmic bias (Bozdag, 2013; Corbett-Davies et al., 2017; Fry, 2018), which introduces biases in data processing and consequences at a societal level, such as discrimination (e.g., gender or racial biases).

However, at a closer look, algorithms are designed by human beings, and they rely on existing data generated by human beings. They are therefore likely not only to generate biases due to technical limitations, but also reinforce existing biases and beliefs. Relatedly, it has been argued that personalized filtering on social media platforms may be instrumental in creating "filter bubbles" (Pariser, 2011) or "echo chambers" (Sunstein, 2018). Both filter bubbles and echo chambers are environments in which individuals are exposed to information selected by algorithms according to a viewer's previous behaviours (Bakshy et al., 2015), amplifying as a result the confirmation bias – a way to search for and interpret information that reinforces pre-existing beliefs.

Concerning social networks, a wide variety of artificial intelligence algorithms is adopted to target the purposed audience on social media. The fundamental idea of the use of these algorithms on social networks is to optimize the content for the users. There is a wide literature on the application of AI in social media to capture the trends and the moods of users (Salloum et al., 2017; Ching et al., 2015; van Dam and Van De Velden, 2015; Del Vicario et al., 2017). Previous studies have shown that young adolescents are not aware of the presence of AI algorithms during their experiences in social networks and the contents that are shown to them are considered as *spontaneous*. As an interdisciplinary science of thinking, psychological science can inform interventions to counteract the challenges that digital environments pose (Kozyreva et al., 2019). Indeed, cognitive science has developed some very general insights into how we perceive and elaborate on line information that can be critical in understanding general cognitive preferences.

It has been proposed that one of the factors that could explain the success of online misinformation is that it appeals to general cognitive preferences, in that it fits with our cognitive predispositions (Acerbi, 2019). While we acknowledge that several boosts could be implemented, we decided to elaborate an integrated approach grounded both on cognitive science and technological tools to strengthen the capacity of students in discerning information on the Internet. In the next section a general overview of the integrated approach is provided. Afterwards, a more detailed description of the four main phases of this approach will be presented.

3 INTEGRATED APPROACH

In the present contribution, an integrated approach that leverages cognitive and technological tools will be introduced and discussed. We argued that these integrated tools can be comprised in a more general framework designed to boost competences of reasoning of adolescent students to prevent the spread of false information. Among the possible human cognitive factors, our approach is focused on cognitive style of thinking. A crucial individual difference that emerges from human cognitive architecture is the propensity to think analytically (Pennycook et al., 2015).

Analytic thinking can be acknowledged as a tendency to solve problems through understanding of logical principals and the evaluation of evidence compared to a more intuitive, emotional and/or imaginative way. We argue that understanding individual differences in the cognitive processing mechanisms of novel information - such as in the domain of fake news – can be crucial in promoting fake news detection and in turn preventing fake news spreading. Analytic thinking has been proved to be the strongest predictor (among several) of a reduction in conspiracy theory (Swami et al., 2014), religious (Gervais and Norenzayan, 2012), and paranormal beliefs (Pennycook et al., 2012). Most relevant in the present context, previous work has shown a negative association between a tendency to think analytically and fake news susceptibility (Bronstein et al., 2019; Pennycook and Rand, 2018). The integrated approach, consequently consists of the following four main phases:

- Phase 1: Assessment of students' cognitive style and Internet habits.
- Phase 2: Fostering students' analytic thinking mindset.
- Phase 3: Assessment of students' abilities to detect fake news.
- Phase 4: Promoting knowledge of social network algorithms.

From the technological point of view, the tasks related to the phases 1 to 3 have been conducted by using the Lime Survey open source software. The tasks of the final phase have been carried out on the PixelFed platform, an Instagram like platform based upon the ActivityPub federated network. The ActivityPub is a W3C recommendation and allows server-server and client-server communication through *inboxes* and *outboxes* mechanism. It is a decentralized social networking protocol that makes possible for a user to interact with many different Internet applications. In the ActivityPub context each user plays as an actor who is represented as an account on the server. Each actor has an inbox where he receives his messages and an outbox where he can send messages. Anyone can listen to someone's outbox to get messages they post, and people can post messages to someone's inbox for them. Most of the federated projects are open-source and besides Pixelfed, many services such as PeerTube (a YouTube open-source alternative) or Mastodon (a Twitter open-source alternative) are integrated over the ActivityPub protocol and form what is known as *the Fediverse*: an universe of open-source and interconnected Internet applications. It is possible to post a video to PeerTube and to get a notification on Mastodon, respond to the video post on Mastodon, and the message shows up as a comment on the video.

3.1 Assessment of Students' Cognitive Style and Internet Habits

The proposed integrated approach was tested with a sample of seventy-seven secondary school students. Students' age ranged from 14 to 16 years old (M = 15.07; SD = .442). A majority of students (80.5%) were male. In order to evaluate pre-experimental individual stable differences in cognitive style, students completed the Rational/Experiential Multimodal Inventory (REIm) (Norris and Epstein, 2011). The REIm contains 42 items,12 of which in the Rational scale, and 30 in the Experiential scale. The 12 items that compose the Rational scale measure an analytic thinking style (e.g., 'I enjoy problems that require hard thinking'). The 30 items that compose the Experiential scale measure an experiential thinking style. It consists of three 10-item subscales, namely Intuition (a tendency to solve problems intuitively and based on effect), Emotionality (a preference for intense and frequent string effect), and Imagination (a tendency to engage in, and appreciate, imagination, aesthetic productions, and imagery). Examples of the items are: 'I often go by my instincts when deciding on a course of action'; 'I like to rely on my intuitive impressions', and 'I tend to describe things by using images or metaphors, or creative comparisons', respectively. All items are rated on 5 points scale (1 = Strongly disagree, 5 = Strongly agree) and subscale scores are computed as the mean of associated items. From a principal component factorial analysis two factors were extracted: Rational and Experiential. The overall scale (Cronbach's α = .75) as well as both subscales (Cronbach's α = .68 and α = . 77 for the rational and experiential subscales, respectively) showed a good internal consistency. Finally, students' Internet habits were assessed in order to evaluate whether the quality of students' habits, in terms of the con-

tents they are exposed to mostly, can affect their ability to detect online fake news. Students reported to be Instagram (89.6%), Facebook (51.9%), and WhatsApp (24.7%) users. Most of them reported to use their smartphone (98.7%) to connect to Internet. Table 1 reports the top ten contents students mostly research on line. No correlations emerged between the quality of students' Internet habits and their ability to discern between true and false on line information (r's $>.05$). However, given the exploratory nature of the present investigation, this result has to be carefully interpreted.

Table 1: Top ten online contents searched by students.

Content	%
School	32.5
Football	23.4
Music	18.2
News	18.2
Sport	15.6
Video	13.0
Engines	10.4
Sports	10.4
Games	9.1
Memes	9.1

The full set of contents is summarized in the word cloud displayed in Figure1.

Figure 1: What students search online.

3.2 Fostering Students' Analytic Thinking Mindset

In the second phase, students completed a priming task used to activate analytic thinking without explicit awareness (Gervais and Norenzayan, 2012). In this task, students received 10 different sets of five randomly arranged words (e.g., *man away postcard the walked*). For each set of five words, students dropped one word and rearranged the others to form a meaningful phrase (e.g., *the man walked away*). The analytic condition included five-word sets containing a target prime word related to analytic or rational reasoning (*analyse*, *reason*, *ponder*, *think*, *rational*). In the control condition, the scrambled sentences contained neutral words (e.g., chair, shop). Alternatively, an even more subtle experimental manipulation can be used to elicit analytic thinking in which students are randomly assigned to view four images of either artwork depicting a reflective thinking pose (*Rodin's The Thinker*) or control artwork matched for surface characteristics like color, posture, and dimensions (e.g., *Discobolous of Myron*). All students receive instructions to look at each picture for 30 seconds before moving on to the next portion of the experiment. This novel visual prime measure has been proven to successfully trigger analytic thinking (Gervais and Norenzayan, 2012). In order to make sure that the manipulation was successful, students were asked to complete the one item Moses Illusion Task (Erickson and Mattson, 1981): *'How many of each kind of animal did Moses take on the Ark?'*, a measure used to assess analytic versus experiential processing (Song and Schwarz, 2008). Results of this preliminary study showed that students were significantly more likely to respond with the correct answer (e.g., 'Moses did not have an ark' or 'Cannot say') in the analytic condition (31%) compared with the control condition (8%).

3.3 Assessment of Students' Abilities to Detect Fake News

After being exposed to either analytical or experiential processing, students, in the third phase, were required to detect the accuracy of news headlines. Those students who have been exposed to an analytic mindset are expected to be more effective in fake news detection compare to those who did not receive such input. Specifically, three factually accurate stories (real news) and three subtly untrue stories (fake news) were presented. After the reading of each news headline, students were required to indicate if a) they have seen or heard about the story before, b) evaluate how accurate (namely, detailed, true in their understanding and real) the headlines was, and c) evaluate their willingness to share the story on line (for example, through Facebook or Twitter).

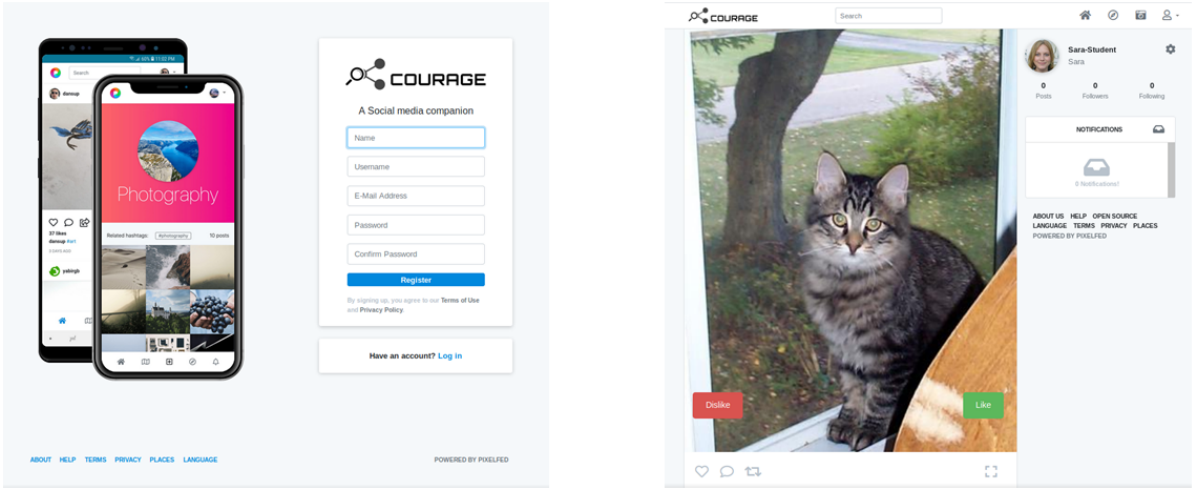

Figure 2: In this figure is shown our customized version of Pixelfed. It is possible to run different use cases in order to collect user data for future analysis.

3.4 Promoting Knowledge of Social Network Algorithms

The aim of this phase is to analyse how the social networks work in order to make students more aware of the hidden mechanisms that are implemented. As we stated above, in this phase we took advantage of Pixelfed, an open-source alternative to Instagram, to design use cases to make young adolescents aware of the presence of artificial intelligence algorithms in social networks. Pixelfed is an ethical photo sharing platform software based on the federated open web protocol named ActivityPub. The *federated* term is referred to a distributed network of multiple social websites, where users of each site communicate with users of any of the involved sites of the network.

Thanks to Pixelfed we are able, on the one hand, to show to young adolescents how the response of a system changes by changing the parameters provided by the designer and, on the other hand, what are the implications in a social network architecture by pursuing certain actions instead of others. Pixelfed is equipped with the most mainstream features of a social network. Users are able to create personal profiles and friend lists, post status updates, follow activity streams, and subscribe to be notified of other users' actions within the environment. Thanks to Pixelfed we are able to provide the users with posts containing specific images or texts and collect their reactions in real-time by adopting different types of interactions such as like/dislike buttons. Fig.2 gives a shot of the Pixelfed social network design.

We decided to adopt and to customize our experiments on Pixelfed, due to the fact that the new technological trend has led adolescents (especially in the age range under investigation in our piloting) to prefer the use of applications such as Instagram or TikTok, instead of the old fashioned social networks like Facebook. Providing adolescents with an environment they are familiar with and that is equipped with the newest features allow us to record interactions that more closely resemble those, that adolescents perform every day.

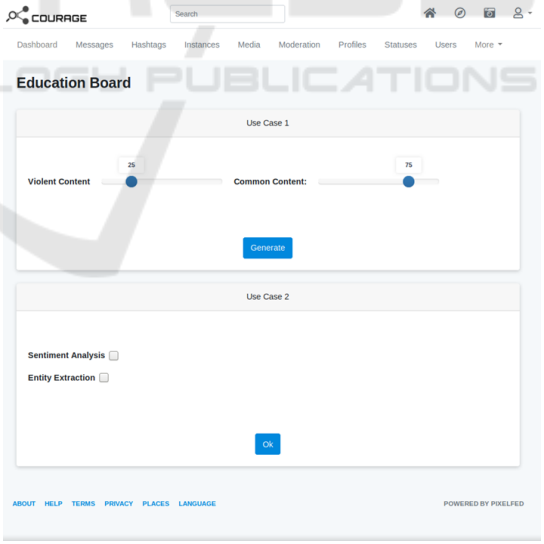

Figure 3: The dashboard teacher should use to tune the publishing content algorithms.

The use of PixelFed will ensure to have control over an open source social network to analyze the user behavior. We also develop a teacher dashboard (see Fig.3) through which it is possible to tune the algorithms used to publish the content, so that students

can observe how their interactions could modify the behaviour of the algorithms in the social network.

4 CONCLUSIONS

The main objective of the integrated approach presented in this paper is to provide school students with opportunities to reflect upon effective strategies for using the Web and social networks. To this aim, in addition to the project phases reported in the paper, further opportunities to unveil concerns that are central to understanding these strategies have been given to the students participating to the pilot study. Specifically, during each session the debate methodology has been adopted in order to discuss the most relevant issues emerged during the class activities and stimulate comparison of points of view amongst students.

Furthermore, even though we are aware about the fact that critical thinking is a complex activity, we argue that lower-level skills on which analytical thinking is built up can be acquired and ultimately taught. An effective way to promote such skills is diagramming arguments, namely, argument mapping (Gelder, 2005) in which students are invited to visually represent arguments through diagrams. Students can see the reasoning and they can more easily identify important issues, such as whether and assumption has been articulated, whether a premise needs further support, or whether an objection has been addressed. In short, the use of diagrams makes the core operations of critical thinking more straightforward, resulting in faster growth in critical-thinking skills. The experimental phase is still at a very preliminary stage; nevertheless, some initial results can be reported: firstly, it has been confirmed that students' knowledge on the algorithms governing social networks and Web search engines is scarce; similarly, students' awareness on the negative consequences arising from uncritical acceptance of Internet news is limited to specific and well-known circumstances; finally, a correlation between the boost of analytical thinking and the ability to discriminate true information from false information has emerged, even if further analysis is necessary to confirm our hypotheses. The expected results will shed light on important individual factors that may predict the ability to better discern between real (true) and fake (false) news in adolescent students.

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