

Artificial intelligence and critical thinking in secondary schools

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### **Abstract**

This article analyses attitudes towards the use of artificial intelligence and the need to develop critical thinking in secondary schools in Croatia. The results of a quantitative survey conducted in August and September 2024 on a sample of 503 educational staff and secondary school students show that the majority of respondents recognize the potential of digital technologies and artificial intelligence in improving learning outcomes. However, there is a difference in the perception of students, who see the technology as easy to use, and school staff, who indicate the need for additional training. While educational staff express strong support for project-based learning and the development of data literacy, students express a need to develop critical thinking, which is crucial for quality interaction with artificial intelligence and recognition of reliable information in the digital environment. The survey was conducted by the Digital Literacy Network within the project "Digital Literacy in the Age of AI".

*Keywords:* secondary schools, digital competences, data literacy, artificial intelligence, teacher education, critical thinking

### **Artificial intelligence and critical thinking in secondary schools**

The Digital Literacy Network was formed in 2020 with the aim of strengthening intersectoral cooperation and building the capacity of stakeholders from the civil, public and private sectors for research and development of the digital society in Croatia. The Network conducts scientific research and based on the results, has so far created eight guidelines for the development of digital literacy as part of digital inclusion, digital education and digital transformation of work and professions.

In 2021, the Network conducted a Survey on the Digital Inclusion Needs of Vulnerable Social Groups and a Public Opinion Survey on Digital Literacy in Rural Areas. Guidelines for the digital inclusion of vulnerable social groups have been drawn up, which include raising public and political awareness of the needs of digital inclusion, developing a network of digital inclusion centres and training e-facilitators who will assist in the digital inclusion of the elderly and people with disabilities (Digital Literacy Network, 2021).

The guidelines also included a recommendation for the development of a volunteer programme as part of civic education in secondary schools. In informatics classes, students could acquire skills in using digital public services, in civic education classes they would become aware of the problems of the digital divide, and as part of extracurricular activities they would help in the digital inclusion of vulnerable groups in their local community.

The Network has developed amendments for the Croatian Digital Strategy for the period until 2032 (Digital Literacy Network, 2022b) and submitted them to the Central State Office for the Development of Digital Society as part of the e-Consultation held in 2022. Part of the guidelines related to the transformation and strengthening of the competitiveness of cultural and creative industries industry is included in the state strategic document (Central State Office for the Development of Digital Society, 2022).

In the e-Consultation on the National Education System Development Plan for the period until 2027, the Network developed amendments, which were also partially adopted (Digital Literacy Network, 2022a). The proposal to add the outcome indicator OI.02.2.75, which reads “Number of secondary school students who participate in informatics classes annually”, was adopted.

Since informatics in Croatia is an elective subject from the second to the fourth grade of general grammar schools, and for vocational schools the new informatics curriculum is still not adopted, this indicator will measure the increase in the number of secondary school students participating in the structured development of digital competences. At the same time, the ratio of this number to the total number of students will provide insight into the number of students who had to acquire these competences informally or perhaps did not acquire them at all. The Network proposed introducing informatics as a compulsory subject in all four years of secondary education with a unified curriculum for grammar schools and vocational schools. The proposal was rejected with the explanation that students would acquire the necessary knowledge as part of the cross-curricular topic Use of Information and Communication Technology.

At the same consultation, the proposal of the Network on teacher education was also adopted. Digital teacher education programmes will include the development of team project learning competencies, critical analysis of information, digital storytelling, programming and design, processing and distribution of multimedia content on the Internet (Ministry of Science and Education of the Republic of Croatia, 2023).

This research is a continuation of the qualitative study on data literacy and artificial intelligence literacy, conducted within the same project "Digital literacy in the Age of AI". As part of the study, a review analysis of 53 scientific and expert papers, corporate reports and

international public policies focused on the development of digital education related to the research topic was carried out.

### **Purpose of the research**

The purpose of the research was to examine the attitudes of secondary school students and school employees in Croatia about the needs for developing data and artificial intelligence literacy in secondary school education.

### **Objectives**

- Gain insight into the attitudes of secondary school students and school employees on the needs for developing critical thinking competencies
- Gain insight into the attitudes of secondary school students and school employees on the use of AI in learning, teaching, assessment and school management.

### **Target beneficiaries**

- Teachers, professional associates and secondary school principals
- School boards
- Creators of public education policies
- Managers of human resources development projects and programmes

The research results will be used to plan strategies, curricula and annual plans and programmes aimed at human resource development. Needs analyses will provide guidance to project managers, enabling them to face the challenges of the digital transformation in education. Insight into the attitudes of key stakeholders in secondary education can help in designing promotional campaigns to strengthen their digital competences.

### **Research questions**

1. What are the needs for developing data literacy and AI literacy in secondary schools?
2. What are the views of key secondary school stakeholders on AI in education?

### **Methodology**

After reviewing the literature, a questionnaire was created for quantitative survey research that was conducted during September and October 2024. We tried to capture the broadest possible picture of the respondents' attitudes, relying on the ABC (Affective - Behavioural - Cognitive) model from the field of social psychology, which deals with understanding the formation, expression and change of attitudes. In this context, we examined the affective, behavioural and cognitive elements of the respondents' attitudes. Affective elements refer to the emotions and feelings that an individual has towards an object or topic. Behavioural elements refer to doing or acting, while cognitive elements include knowledge and understanding. Emotional reactions, behavioural intentions and cognitive judgment are interconnected and contribute to the formation of an attitude, which becomes stronger when all three elements are aligned (Niosi, 2021).

The affective element is considered the most important in the advertising industry, so by gaining partial insight into the emotions and feelings of key stakeholders in the educational process, we have provided the prerequisites for planning promotional campaigns that aim to raise awareness of the importance of continuous development of digital competences of educational staff and students.

In the first part of the survey, we collected demographic data on gender, age, occupation, and the type and location of the school where the respondents work or study. In the second part, we asked thirty questions about the affective, behavioural, and cognitive elements of the respondents' attitudes. The questions were closed-ended with answers offered on a five-point Likert scale (from 1 = Strongly agree to 5 = Strongly disagree). The third part consisted of three open-ended questions in which the respondents could express their interest in additional education.

The comprehensibility of the survey questions was validated by three members of the ODRAZ association, after which the survey was published on the Survey Monkey online survey platform. The survey was distributed to respondents with the help of the Association of Croatian High School Principals and Varaždin County.

### **Results**

The survey was started by 572 respondents, and 88% completed it (N=503). Of the total number of respondents, 72% were women, while 28% were men. By occupation, the largest share was made up of teachers (42%), followed by students (35%), principals (12%) and professional associates (10%), while 1% belonged to other professions. 42% of respondents belong to the age group of 30 to 54, 39% are younger than 30, and 19% are older than 54. In answers to questions about the type of school in which they work or study, 64% of respondents stated that they come from vocational schools, 29% from general, science-mathematical, science, classical or language grammar schools, and 7% from art schools. The research covered the whole of Croatia with responses from all 21 counties. The highest number of respondents completed the survey in Varaždin County (37%) and the City of Zagreb (25%).

In four questions on affective attitudes, respondents answered to what extent they agreed with statements about how much they like to learn, read, write and follow video posts on social networks. In the graphs illustrating their answers, we used shades of green for agreement with the statement, grey when respondents could not decide and shades of red for disagreement with the statement in question. At first glance, a statistically significant difference is noticeable in the responses of students and school employees about learning, reading and writing.

While slightly more than 31% of students agree with the statement that they like to learn, this percentage among school employees exceeds 94%. This significant contrast can be



interpreted as an indicator of differences in motivation towards learning. Employees, as adults who have chosen education as their profession, probably have a greater affinity towards learning, while students perceive learning as an obligation that comes with a burden and increased stress.

Figure 1. I love learning

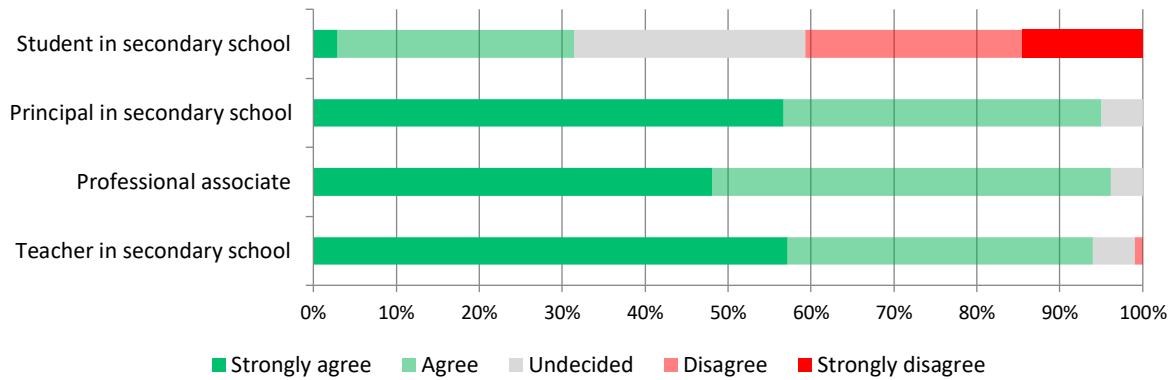


Figure 2. I love to read

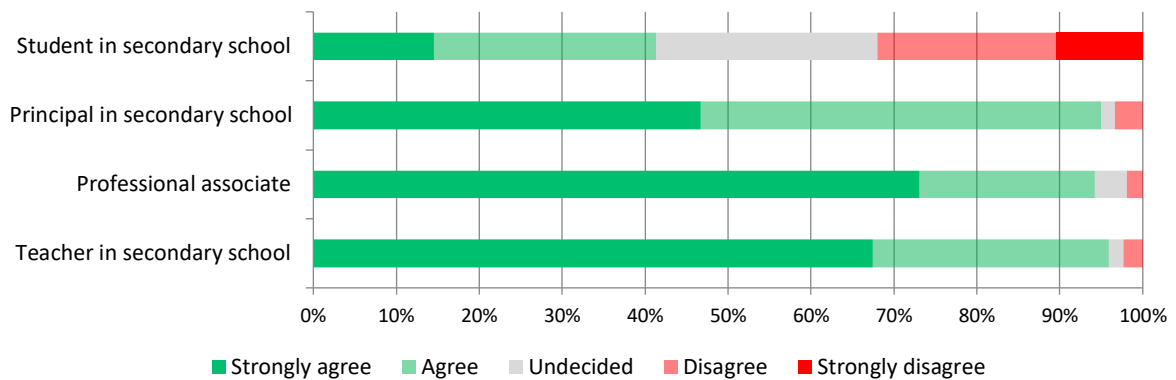
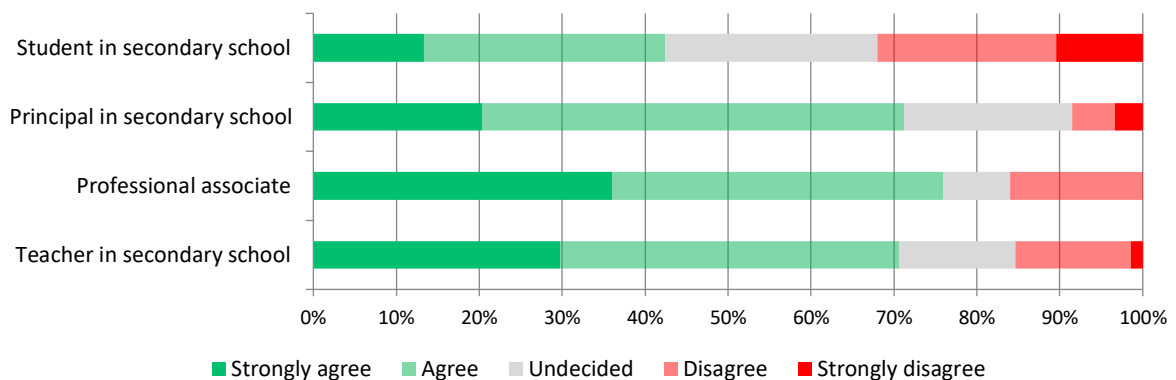


Figure 3. I love to write



Among students, interest in reading (41%) and writing (42%) is slightly higher than in learning. This increase may indicate that students see reading and writing as activities that are less burdensome than learning, although formal education methods in schools still rely heavily on reading and writing. The answers to the question about following video posts on social networks show a different picture. The fact that 89% of the students surveyed like to follow such content probably indicates a trend of increasing preference of young people towards short visual content compared to text-based content.

It is interesting to note that, although around 95% of employees like to read, this percentage drops significantly when it comes to writing. Namely, only 71% of teachers and principals and 76% of professional associates state that they like to write, which may suggest that employees perceive writing as a task that requires more time and effort than reading. It may also point to the conclusion that they prefer to consume information rather than create it themselves.

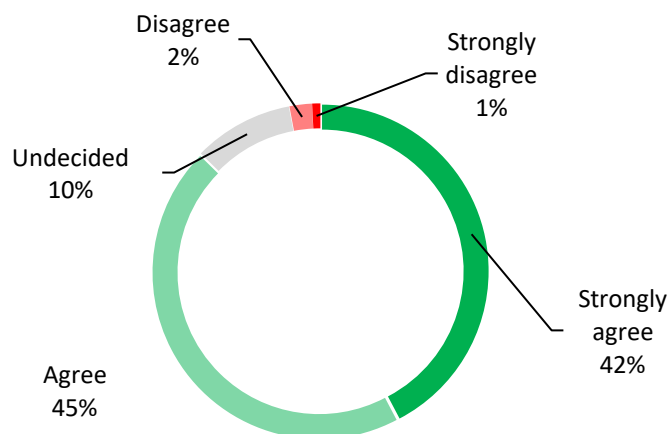
These survey results can also be interpreted in the context of the growing need to develop language skills needed to design instructions for generative artificial intelligence (AI). Given that creating AI instructions requires clear text formatting to generate the desired answers, developing writing skills becomes crucial. On the other hand, critical interpretation of generated answers is based on reading comprehension. Students could therefore be motivated to improve their language skills through communication with large language models such as ChatGPT, which would also make formal education more relevant to the modern social environment.

Students' low interest in learning points to one of the key challenges of modern education, which is how to make learning more interesting while achieving the desired outcomes. In response to this methodological question, scientific and professional literature often emphasizes the method of project-based learning, which connects theory with practical

life experiences in various fields. In our survey, we investigated how interesting project-based learning really is.

The results show strong support from respondents for project-based learning that includes real-world data. As many as 87% of them agree that such an approach makes learning more interesting, which indicates a high level of interest when theory is connected to practice. Only 10% of respondents remained neutral, which may mean that they need a better understanding of the method or that their previous experiences with project-based learning have been ambivalent. On the other hand, only 3% of respondents do not see value in project-based learning based on real data, which suggests that the reasons for their lack of interest are likely individual.

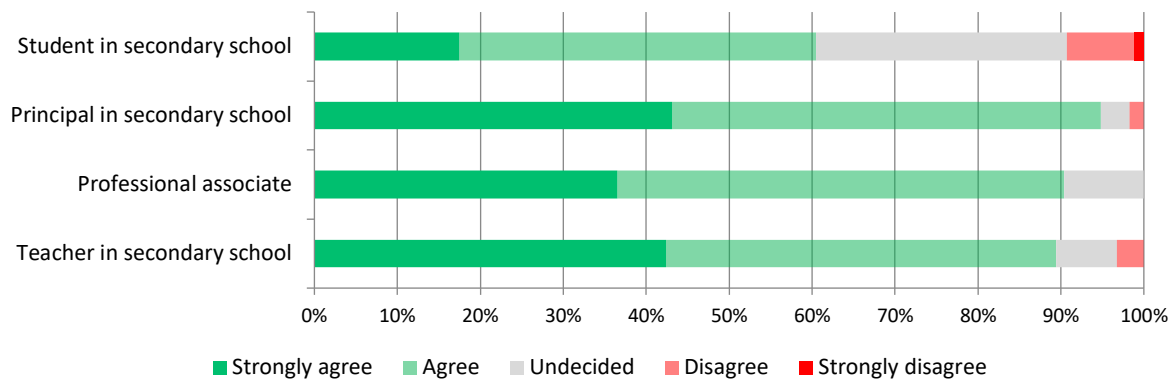
*Figure 4. Project-based learning that uses real-world data makes learning more interesting.*



Project-based learning is most often used to help students develop practical skills through working on real-world problems. When students work on solving concrete problems, they gain a deeper understanding of the material because they connect theoretical knowledge with real-world application. Project-based learning thus helps students develop critical thinking, creativity, and problem-solving skills, which are key competencies needed for

active living in the 21st century. We therefore investigated how much our respondents enjoy solving problems.

Figure 5. *I love solving problems.*



There is still a visible difference in the answers of students and school employees, but it is smaller compared to the answers to questions about learning, reading and writing. The survey results show that 60% of students like to solve problems, which is significantly more than the 31% who say they like to learn. This difference suggests that students perceive problem solving as a more active and interesting activity, while learning is often perceived as passive and boring. We can conclude that practical teaching, such as project-based learning or working on real problem tasks, could increase student engagement and make the learning process more attractive and relevant.

This interest in problem solving can be further supported through interdisciplinary learning, which offers students the opportunity to connect knowledge from different subjects. Such an approach corresponds to their natural inclination towards research and allows them to learn in a dynamic way through real projects. Data literacy is essential for interdisciplinary and project-based learning because it enables students to collect, analyse and interpret data from different sources, thereby making informed conclusions and solving complex problems by connecting knowledge from different disciplines.

Over 87% of teachers, professional associates and principals believe that data literacy should be developed across all subjects, while this view is shared by 59% of students. This data shows that educators recognize the importance of data literacy and interdisciplinary learning, while students' views on the need for development data literacy aligned with their interest in problem solving.

Critical analysis of information, which is the foundation of data literacy, enables students to distinguish reliable from unreliable sources and to understand and interpret data in a social context. We asked our respondents whether they agreed with the statement that most students their schools are able to critically analyse media content and form opinions based on collected information with opposing views.

Figure 6. Most students at our school are able to critically analyse media content

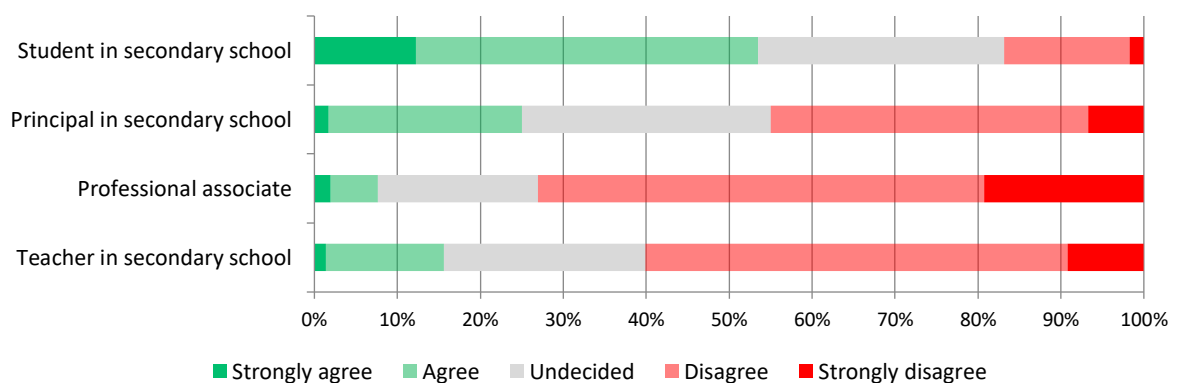
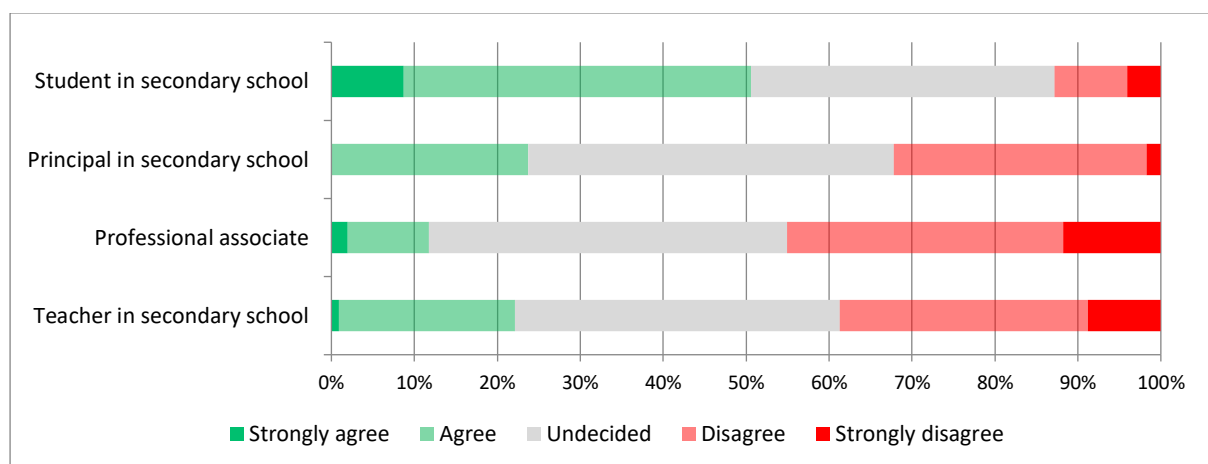


Figure 7. Most students at our school are able to form an opinion based on the information collected with opposing views.



These questions referred to key media literacy competencies, necessary for navigating an information-saturated world full of disinformation and propaganda. Media literacy competencies should help students gain a deeper understanding of the topics they are studying, encouraging independent thinking and making informed conclusions throughout the learning process. Again, differences are noticeable in the responses of students and staff, but with a different sign.

Analysis of the responses to the question about media content analysis shows a clear difference in the perception of critical skills among students and school staff. While slightly more than half of students believe that most of their peers can critically analyse media content, educational staff, especially professional associates (8%) and teachers (16%), are much more sceptical. Principals believe somewhat more in students' analytical abilities (25%), but still significantly less than students themselves, which suggests a possible overestimation of their own skills among students.

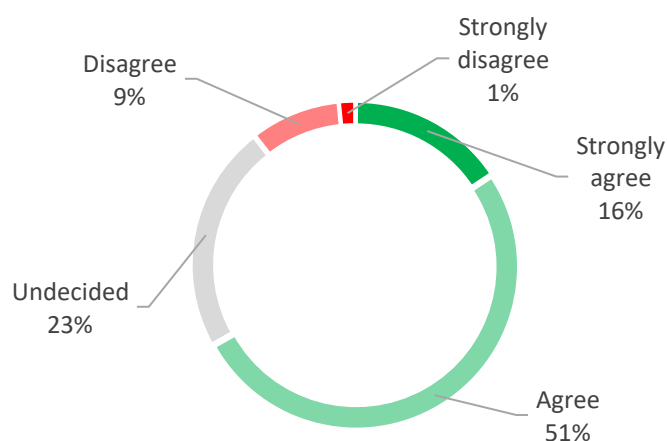
The responses to the question about forming an opinion based on conflicting information show a similar pattern of perceptions among respondents. Teachers, professional associates and principals express a low level of confidence in both questions, with the lowest percentage among professional associates (12% for forming an opinion). The question arises as to why this discrepancy in perception exists, given that 87% of teachers agree that they regularly discuss different views on a topic during class.

A possible interpretation of this discrepancy is that although teachers encourage discussion of different views during class, students may not be sufficiently engaged or have sufficiently developed critical thinking skills to take full advantage of these opportunities. Teachers may provide space for discussion, but this does not necessarily mean that this space is sufficient and will result in the ability to form critical thinking among students.

By introducing more activities aimed at critical analysis and reflection, such as case studies and debates, students would be more likely to develop a more realistic assessment of their thinking skills. By linking these activities through interdisciplinary projects, they could more easily understand the applicability of critical thinking in different contexts and more effectively develop this important competence.

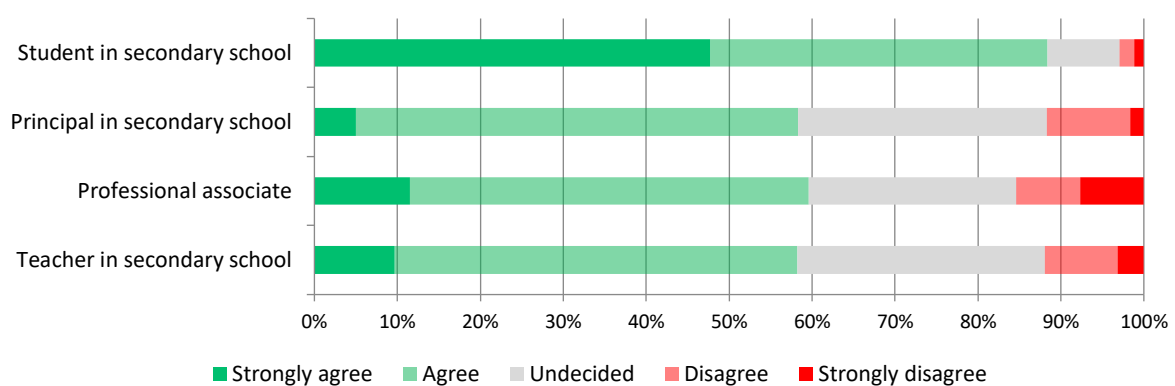
The views of the surveyed respondents converged in their responses to the question about the ease of recognizing disinformation. Most respondents, including professional associates (59%), teachers (61%), principals (63%) and students (52%), agree that they are easy to recognize, with students being somewhat less confident in their ability. Given the increasingly sophisticated methods of digital marketing based on artificial intelligence algorithms, it is possible that most respondents are wrong in this assessment. The Unified Theory of Acceptance and Use of Technology (UTAUT) is the model we used to assess the intention to use artificial intelligence in schools. The authors of the model identified four factors that play a key role as predictors of user acceptance and use of technology. These are expected work performance, i.e. improved efficiency, the effort required to use the technology, social influence or attitudes of colleagues and superiors, and supportive external conditions, such as technical and professional support (Venkatesh et al., 2003).

*Figure 8. The digital technologies we use at school significantly contribute to the quality of teaching and learning outcomes*



Our survey participants expressed satisfaction with their experience with digital technologies in education so far. 67% of respondents believe that digital technologies improve the quality and outcomes of learning, while 64% believe that artificial intelligence can contribute to adapting learning to the abilities of students. In the answers to the question about the ease of use of artificial intelligence, significant differences in the attitudes of students and school staff again emerged.

*Figure 9. Artificial intelligence is easy to use*



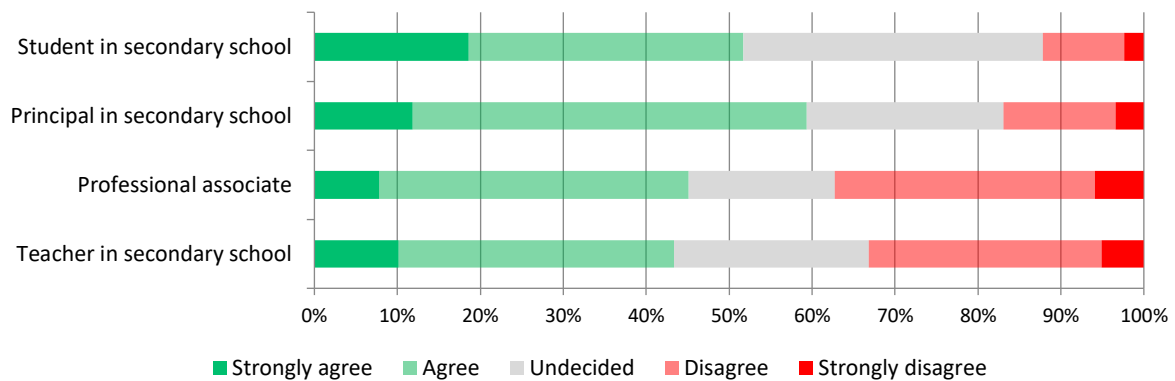
About 59% of teachers, professional associates and principals rate the use of artificial intelligence as simple, while 88% of students have the same assessment. This difference may indicate greater technological adaptability and confidence of students in working with new technologies, while school staff may encounter more challenges due to less experience and the need for training in the use of artificial intelligence in education. This difference in the perception of the ease of use of artificial intelligence may also indicate the possibility that students approach technology more superficially, relying on the first generated solution without a critical approach in analysing the answers received.

The majority of 62% of teachers express satisfaction with the level of professional IT support available at school, while 60% of teachers positively assess the quality of the IT equipment they use in teaching. 71% of teachers recognize the strong support that principals provide for the informatization of teaching, which indicates an administrative commitment to



technological progress in education. However, only 43% of teachers believe that knowledge in their environment is highly valued, which points to potential dissatisfaction with the culture of valuing professional competences at school and perhaps reduces motivation for further professional development and innovations in teaching.

Figure 10. Knowledge is highly valued in my environment

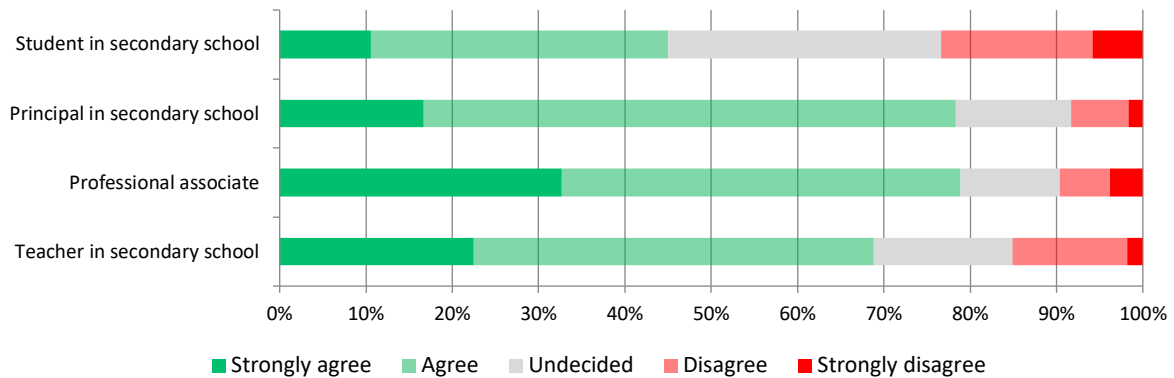


In the context of UTAUT theory, these results show that the majority of respondents recognize the usefulness of technology for improving learning outcomes and adapting to student needs, which encourages its acceptance. High satisfaction of students with the ease of use of AI compared to teachers indicates the need for additional training of school staff, but also for the development of critical thinking in students. Satisfaction with professional IT support and support from principals among teachers supports the construct of facilitating conditions, while the perception of low knowledge valuation may negatively affect their motivation to use AI.

We then explored the need for additional education in research design, for which 69% of teachers and about 79% of principals and professional associates showed interest. By developing research competencies, teachers and educators could design research to assess the effectiveness of different teaching methods, such as interdisciplinary and project-based learning, and analyse how these methods affect student engagement and learning outcomes. School psychologists could use research to collect data on students' emotional state and key

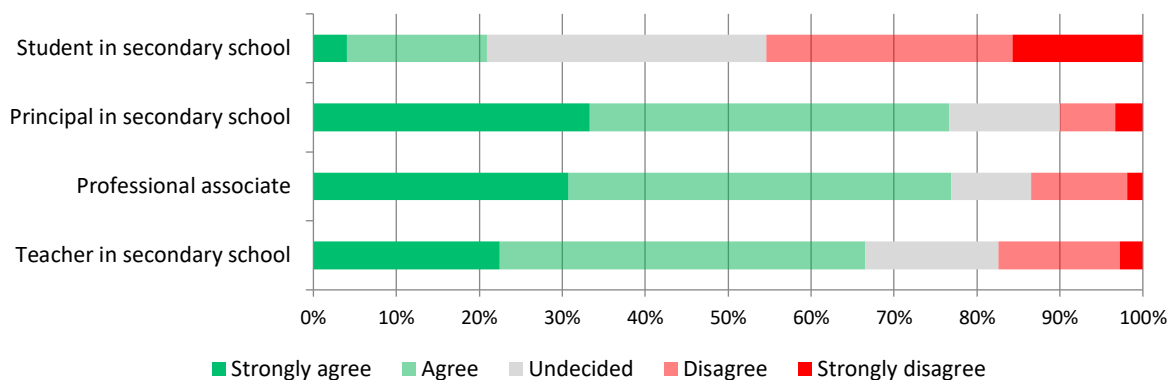
stress factors, while principals could use research competencies to gather feedback on teachers' professional development needs.

*Figure 11. I need additional knowledge and skills in research design*



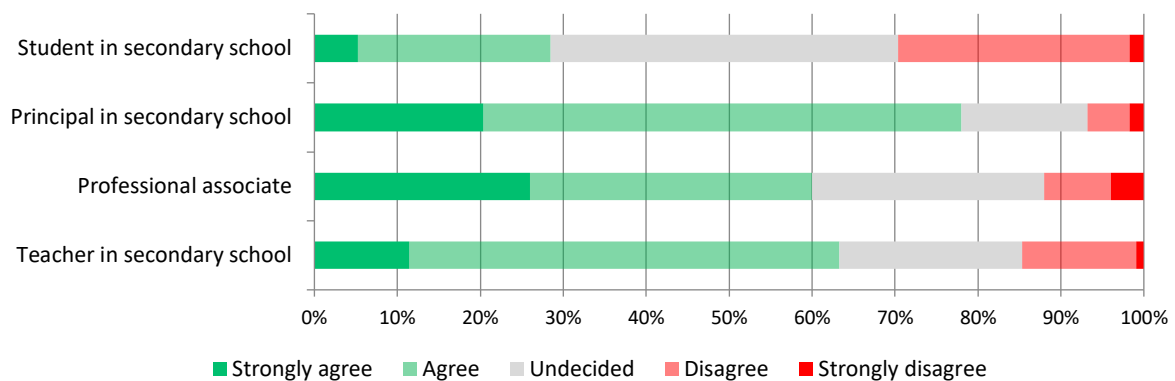
We then asked them to assess the need for additional training in designing questions and instructions for artificial intelligence, and critical data analysis.

*Figure 12. I need additional knowledge and skills in designing instructions for artificial intelligence*



67% of teachers and 77% of professional associates and principals express a need for additional training in communication with artificial intelligence. Teachers could use these skills to create project and problem-solving tasks, while professional associates could design queries that help analyse the emotional and social development of students. Principals could apply these competencies to optimize administrative processes.

Figure 13. I need additional knowledge and skills in critical data analysis



The need for additional competencies in critical data analysis is expressed by 78% of principals, which is significantly higher than 63% of teachers and 60% of professional associates. These results suggest that principals, who are often responsible for making strategic decisions, recognize the importance of critical data analysis for quality school management. The need for this education among teachers and professional associates probably also reflects the recognition of the necessity of developing these skills in students.

Responses to the open-ended question about additional education that participants would like to attend show a dominant interest in learning about the application of artificial intelligence in education and teaching, with an emphasis on specific aspects such as the use of artificial intelligence in assessment, evaluation, content adaptation, and recognition of inaccurate information. Topics such as media and data literacy, critical thinking, and the use of various digital tools that would enable teachers to make teaching more interactive and tailored to the needs of students are also highlighted.

### Discussion

Although it is relatively simple to design and conduct a survey, a more complex challenge is to encourage change based on the guidelines from the analysis of the data obtained. In the discussion, we consider an example of a development project that could arise from the results of this research, with the aim of applying to international tenders of the

European Union for human resources development. We used a kind of "open source" concept of project planning, where the project draft is open for free use and adaptation.

We chose low student motivation for learning in secondary school as the project problem, which is based on the results of our research. As the goal of the project, we set the increase of student motivation through the application of interdisciplinary and project-based learning. We integrated mandatory elements of the Croatian language curriculum, focused on the development of media literacy, and optional elements of computer science in the implementation of multimedia projects. Based on the high interest of the respondents in project-based learning, the project will include teacher education and piloting of these methods, with the aim of determining their impact on student motivation and improved learning outcomes.

The project team will include, in addition to language and IT teachers, school pedagogues and psychologists, with the pedagogues helping to set realistic and developmentally oriented learning outcomes, as well as in the selection of evaluation tools, while the psychologists will analyse the effects of new methods on students' affective attitudes. The project envisages cooperation with European schools through an international hybrid event, such as a conference or a broadcast of a cultural event, for students to develop communication, organizational, creative multimedia creation and digital literacy skills.

This proposal illustrates just one example of how research results can be applied to projects that do not necessarily require significant funding but encourage the important development of digital and interdisciplinary competences in education.

### **Conclusion**

Research on the role of artificial intelligence and the development of critical thinking in secondary schools points to significant challenges and opportunities for the development of formal education. The results show that students and school staff recognize the potential of

artificial intelligence in improving the teaching process, but also the need for additional training focused on critical data analysis, designing instructions for artificial intelligence and the application of project-based teaching methods.

Key challenges, such as low student motivation and differences in the perception of their own critical competencies between students and teachers, require innovative approaches that connect theory and practice. The application of interdisciplinary and project-based methods, as well as the targeted development of data and media literacy, are promising tools for increasing student engagement. Involving teachers, pedagogues and psychologists in the development and evaluation of these approaches would ensure a focus on the holistic development of students.

This research provides the foundation for international educational projects that can significantly improve the quality of teaching. Principals, as key strategic leaders, have an important role in creating a supportive environment for the implementation of innovative learning methods and providing the resources and professional support necessary for the successful digital transformation of education.

### Bibliography

- Ministarstvo znanosti i obrazovanja RH. (2023). *Nacionalni plan razvoja sustava obrazovanja za razdoblje do 2027. Godine*.  
<https://mzom.gov.hr/UserDocsImages//dokumenti/Obrazovanje/AkcijskiNacionalniPlan//Nacionalni-plan-razvoja-sustava-obrazovanja-za-razdoblje-do-2027.pdf>
- Mreža za razvoj digitalne pismenosti. (2021). *Smjernice za digitalnu inkluziju ranjivih društvenih skupina*. <https://digitalnapismenost.com.hr/wp-content/uploads/2023/04/Smjernice-za-digitalnu-inkluziju-ranjivih-drustvenih-skupina.pdf>
- Mreža za razvoj digitalne pismenosti. (2022a). *Smjernice za dopunu Nacionalnog plana razvoja sustava obrazovanja za razdoblje do 2027. Godine*.  
<https://digitalnapismenost.com.hr/wp-content/uploads/2023/04/SMJERNICE-ZA-DOPUNU-NACIONALNOG-PLANA-RAZVOJA-SUSTAVA-OBRAZOVANJA-ZA-RAZDOBLJE-DO-2027.pdf>
- Mreža za razvoj digitalne pismenosti. (2022b). *Smjernice za dopunu Strategije digitalne Hrvatske za razdoblje do 2032. Godine*. <https://digitalnapismenost.com.hr/wp-content/uploads/2023/04/SMJERNICE-ZA-DOPUNU-STRATEGIJE-DIGITALNE-HRVATSKE-ZA-RAZDOBLJE-DO-2032.pdf>
- Niosi, A. (2021). *Introduction to consumer behaviour*. BCcampus.  
<https://opentextbc.ca/introconsumerbehaviour/>
- Središnji državni ured za razvoj digitalnog društva. (2022). *Strategija digitalne Hrvatske za razdoblje do 2032. Godine*. [https://rdd.gov.hr/UserDocsImages/SDURDD-dokumenti/Strategija\\_Digitalne\\_Hrvatske\\_final\\_v4.pdf](https://rdd.gov.hr/UserDocsImages/SDURDD-dokumenti/Strategija_Digitalne_Hrvatske_final_v4.pdf)
- Venkatesh, Morris, Davis, & Davis. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, 27(3), 425. <https://doi.org/10.2307/30036540>

