European Commission

JRC SCIENCE FOR POLICY REPORT

# Artificial Intelligence and the Rights of the Child

## Towards an Integrated Agenda for Research and Policy

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* For a detailed description of the youth workshops, please refer to Chaudron, S. and Di Gioia, R., *Artificial Intelligence and the Rights of the Child - Young people's views and perspectives*, EUR 31094 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-53101-2, doi:10.2760/272950, JRC129099.
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# ABSTRACT

Artificial Intelligence undoubtedly offers children many opportunities, but it also raises the risk of compromising their rights. While an increasing number of policy initiatives and corresponding research seek to better understand and provide solutions to mitigate the risks and augment the benefits of AI-based technologies for children, there is often a lack of interaction among stakeholders.

This report provides elements for an integrated agenda for research and policy regarding children's rights and Artificial Intelligence. It aims to connect scientific evidence with policymaking, to gain insights of the interplay between different stakeholders, and to go beyond the identification of ethical guidelines towards methods for practical future implementations.

A review of relevant policy initiatives is presented. This is followed by an overview of research on three selected AI applications for children, namely conversational agents, recommender systems and robotic systems, under the lens of children's rights. Then, the results of two workshops with children and young people, and three workshops with stakeholders from policy and research in the field of AI and child's rights are presented. A thematic analysis of the discussions revealed different sets of topics proposed by the stakeholders, which have then been triangulated to identify priorities from the different perspectives.

Based on the above-mentioned input, a set of recommendations for an integrated agenda and future directions in research and policy are provided. Lastly, this report includes reflections from invited experts in the field, who participated and contributed to this study.

# EXECUTIVE SUMMARY


### Children's fundamental rights when using AI-based technology

Artificial Intelligence-based technology is increasingly present in our children's lives. Governments and global organisations are developing initiatives and establishing frameworks to create trustworthy and child-centred AI technology. Significant steps in policy and research have already been taken to identify the core elements needed for trustworthy AI for children.

However, stakeholders from the worlds of academia, policymaking institutions, and industry mostly follow their own agendas, with little awareness of the needs and values of others. These communities do not always have the opportunity to work together towards integrated and harmonised actions. In addition, while children's participation has been considered as a core element for the development of trustworthy AI for children, there is still a lack of children's meaningful participation in many initiatives.

### Reaching conclusions through analysis and workshops

To address these issues, three approaches were used. The current policy initiatives for AI and Children's Rights of major international organisations were reviewed. In addition, the scientific evidence of the impact of a selection of three AI-based applications on children was analysed. To complement these reviews and analyses, a series of workshops with children, researchers and policymakers were held. These three communities were deemed to be key stakeholders when considering AI and children's rights. The findings from these three approaches led to the identification of key requirements, methods and knowledge gaps that need to be comprehensively addressed in research and policy agendas, to ensure that children's fundamental rights are respected when they are interacting with AI-based technology.

### Requirements, methods and knowledge-gaps

The main requirements identified are in line with the seven requirements for trustworthy AI, as detailed by the High-Level Expert Group for AI of the European Commission.[1] Moreover, methods that are considered of use for researchers and policy-makers for engagement were highlighted. Finally, knowledge gaps that need to be addressed as priority in the short- and medium-term are listed (see page 6).

### Topic priorities of experts, policymakers and children

It is pertinent to understand how these requirements, methods and knowledge gaps are prioritised by different stakeholders, specifically children, academia and policymakers. A content analysis of the corresponding workshops indicated that the different groups emphasised and prioritised different topics. While children and policymakers placed emphasis on the impact of AI in education, researchers emphasised its impact on children's cognition, behaviour and development. In addition, inclusion and the fight against discrimination appeared to be a topic of priority only for policymakers and researchers. Interestingly, transparency and explainability of AI technology seems to be important for researchers and children, while policymakers gave this the lowest priority of all.

### Future steps

A harmonised and coordinated action towards trustworthy AI for children would benefit from transparent communication among stakeholders regarding the differences in the respective agendas and priorities. This report details the main outcome of the AI and Rights of the Child (AIRoC) research activity. It provides the above-mentioned requirements and methodological tools and the identified knowledge gaps to pilot specific applications in real-world situations with children in Europe.


## NOTES

[1] https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai

## Requirements

**AI minimisation, valuable purpose and sustainability**: The use of AI technology should be considered as a limited resource. Strategic and systemic choices should be made to develop AI-based services for children, both at a public and private level.

**Transparency, explainability, communication and accountability**: These elements should be developed to inform and empower young citizens and all users of AI technology, preventing mistrust or over-trust in AI systems.

**Inclusion and non-discrimination**: AI technology should be child-friendly when appropriate and not reflect discriminatory biases.

**Privacy, data protection and safety**: Children and their carers should be facilitated and empowered to control how their personal data are exploited by AI technology.

**Integration and respect of children's agency**: Children should be integrated further in conscious interactions with AI technology and research should support the construct of children's agency in this context.

## Methods

**Anticipation, evaluation and monitoring**: Frameworks and toolkits that can enable/guide the design and evaluation of child-friendly AI systems in the short- and long-term should be created and developed. These frameworks should incorporate aspects such as personal data protection and risk assessment.

**Multi-stakeholder collaboration**: Communication and collaboration between stakeholders should be supported to seek balance in the use of AI technology by children and resolve the conflicts between their provision, protection and participation rights. Communication and collaboration are key to define common goals and to build around a child-friendly AI by design.

**Children's participation**: The cognitive and socio-emotional stage of each child should be taken into account while ensuring their fundamental rights (Participation, Provision and Protection) in the design, development and use of AI technology.

**Balancing conflicting rights**: Regulation and policies on AI technology should consider the full range of children's rights (Participation, Provision and Protection) and should define the correct degree of compromise between different, sometimes conflicting rights.

## Knowledge gaps

**Children's cognition, development and play**: Designers and researchers should systematically study the impact of the use of AI technology on children's cognitive and socio-emotional capacities in different contexts and in an inclusive way.

**Empowerment through education**: Schools should prepare children for a world transformed by AI technology and develop adequately their competences and literacy, also supported by AI technology itself that can develop competences supporting children's well-being.

**Developmentally appropriate systems and age verification**: AI-based systems targeting children should be developed to fit appropriately children's cognition stage. Age recognition tools should consider the large variety of skills, capacities and agency level of children sharing the same age. AI systems should adapt to different children needs as well as children's views on how to safeguard their privacy.

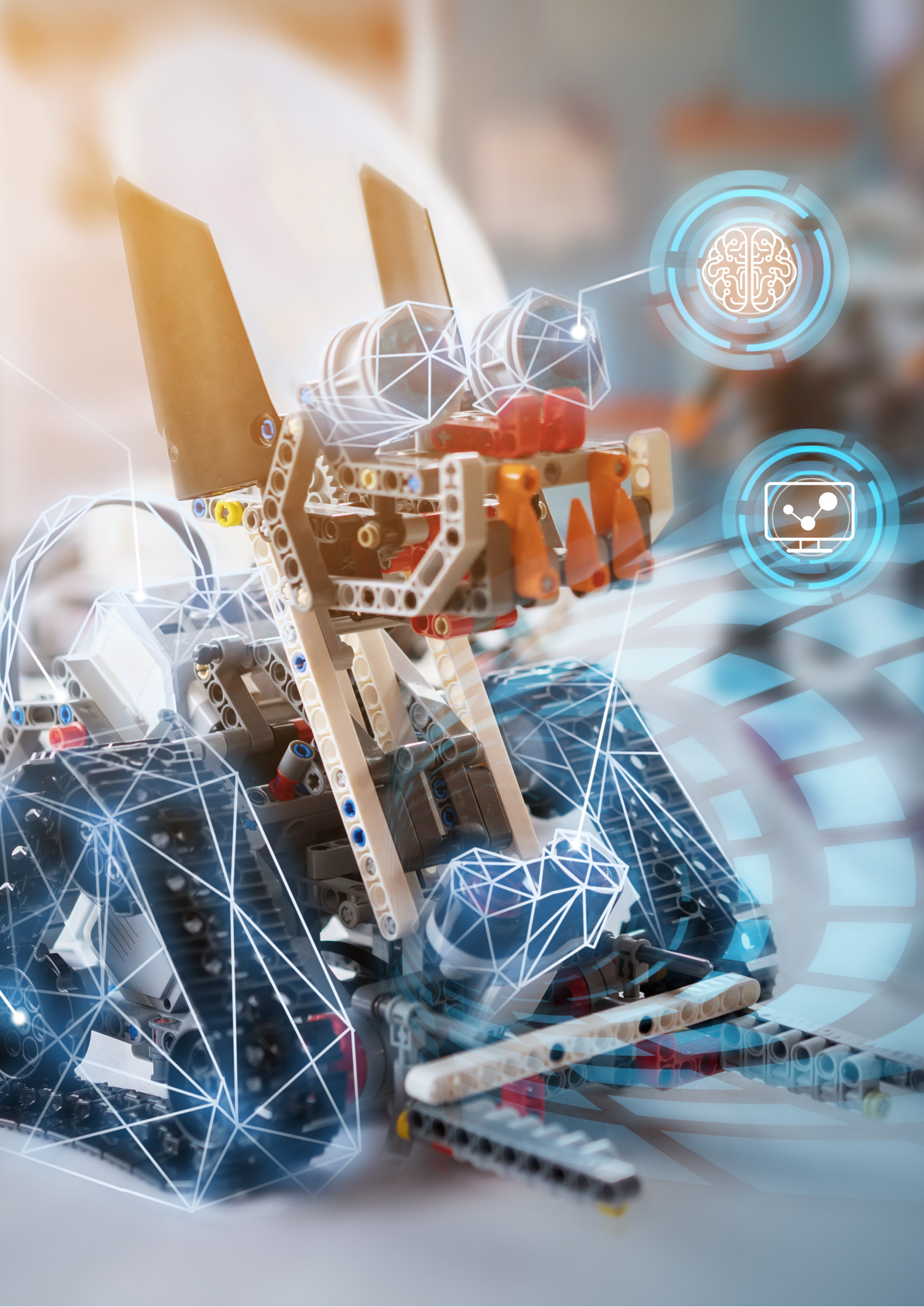

**FIGURE 1 – Structure of the report**
Source: EC

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UN General Comment 25
UNICEF
OECD
UNESCO
IEEE
Council of Europe
European Commission

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Transparency, explainability, communication and accountability
Inclusion and non-discrimination
Privacy, data protection and safety
Integration and respect of children's agency

**Methods**
Anticipations, evaluation, monitoring
Multi-stakeholder collaboration
Children's participation
Balancing conflicting rights

**Knowledge gaps**
Children's cognitions, development & play
Empowering through education
Developmentally appropriate systems and age verification
Other research questions to be addressed

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Chapter 7
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Chapter 8
**Conclusions**

Chapter 9
**For deeper consideration: reflections of invited experts**

# 1. INTRODUCTION

With Artificial Intelligence (AI) and Robotic technology on the rise, an increasing number of novel applications are currently affecting – and have the potential to impact further – children's well-being and development in terms of formal learning and informal play.[2] The use of AI-based technology for children provides unique opportunities in ways that are novel and have great potential to support children's well-being and their development. However, there is a general concern that AI-based applications carry certain risks that might not sufficiently support – or might even violate – children's fundamental rights. For example, AI-based systems that record children's individual preferences and provide personalised content, might present privacy and data protection risks.

Similarly, systems with face recognition modules might discriminate against specific groups of children. These concerns have created the need for the introduction of specific policies by governmental and non-governmental institutions, with the aim of mitigating the emerging risks, as well as supporting and enlarging the potential opportunities of AI-based technology for children.

The protection, upholding and promotion of children's rights, as they appear in the United Nations' Convention on the Rights of the Child[3] have a profound effect on children's wellbeing and their physical, cognitive, and socio-emotional development. For the purposes of this report, UNICEF's definition for children's well-being is used, being defined as "children's health and safety, their material security, their education and socialisation, and their sense of being loved, valued, and included in the families and societies in which they are born".[4]

The term 'child development' refers to the growth and development: i.e. to the physical, cognitive, emotional, and social changes an individual experiences from infancy through to adolescence (Levin, 2011), which has a dynamic nature over time. Indeed, 'children's' knowledge of information technology and AI may vary substantially over the course of a few years as they pass from infancy to adolescence.

As adolescents, they may have a more advanced and intuitive understanding of some of the challenges raised by AI than their parents, or even than researchers and policymakers. However, with the current advances in AI-based technology, the causal relationship between children's rights and well-being is increasingly being mediated by AI-based applications which may be catalytic for the improvement of all children's lives or be a tool that might put children at risk. The way that the AI-based applications are designed, developed, and deployed requires special attention in order for us to ensure the best interests of all children.

While there are already several initiatives from governmental and non-governmental institutions that propose policy directions towards the upholding of children's rights in the digital world some national and international policy actions have only recently started to show that AI brings specific risks and opportunities in relation to children's rights, and which should be considered with special attention. These initiatives indicate the importance of understanding the impact of AI-based systems on children's development and well-being, and identify ways in which AI can contribute to all children's empowerment, while taking the necessary actions to mitigate possible emerging risks.

Scientific evidence about the impact of AI-based technologies on children is growing quickly, and it has already shaped some initial understanding.

## NOTES

[2] For the purposes of this report, any human being below the age of 18 is termed as 'a child' https://www.unicef.org/child-rights-convention/convention-text

[3] https://www.ohchr.org/en/professionalinterest/pages/crc.aspx

[4] https://www.unicef-irc.org/publications/pdf/rc7_eng.pdf

However, the complexity of these systems on the one hand, and children's rapid development and adaptive behaviour on the other hand, render this endeavour particularly challenging. While there is a consensus regarding the need for an expansion of such initiatives, further work should be done towards formulating concrete plans and guidelines, as well as directions for their realisation.

## Scope

This Science for Policy report is published in the context of a cross-cutting research activity of the Joint Research Centre (JRC), European Commission, on the topic of Artificial Intelligence and the Rights of the Child (AIRoC).

The JRC is the European Commission's science and knowledge service, providing scientific evidence throughout the whole policy cycle. Among the current priorities of the Commission, AI has become an area of strategic relevance, as the European approach to AI is based on ensuring excellence and trust, while aiming to boost research and industrial capacity, and at the same time guaranteeing fundamental rights.

Considering that AI is an integral part of children's everyday life, it is essential to adopt a children-centric approach to understand which are the specific challenges and means to protect children's rights, while seizing the opportunities AI offers.

Within the overall recognition regarding the need for concrete, evidence-based actions on AI and children's rights, the JRC AIRoC research activity is framed under the Cybersecurity Education, Awareness and Societal aspects (CEAS) project. It aims to explore, and contribute to the current knowledge regarding AI and the implications of its development and use in relation to children and their rights.

This project is linked to the Human behaviour and Machine Intelligence (HUMAINT) project of the JRC, which researches the impact of AI on human behaviour, with a focus on decision-making, as well as cognitive and socio-emotional development (Gómez et al., 2021).

The AIRoC research activity falls within the wider activities of the European Commission to promote the transformation of Europe into the global hub for trustworthy Artificial Intelligence (AI).[5]

The AIRoC research activity takes a research-oriented perspective and seeks to identify how the current state-of-the-art of scientific evidence can inform policy directions. Even though AI-based applications have only recently started to be widely used by children, research in various areas of AI in relation to children has already some evidence to exhibit.

With this research activity, we build upon the existing scientific results concerning the impact of AI-based applications; we seek to examine these issues from the perspective of children's rights; and we propose future research and policy directions. The expected outcome of the research activity is to draw recommendations for researchers, industry practitioners and policymakers on how to protect and uphold children's rights in an AI context.

The goal of this report is to review the existing initiatives on children's rights in the context of AI and discuss the current state-of the-art on specific AI-based applications for children, in order to formulate specific research and policy-related challenges to be addressed by academia, industry and policymakers. Directions that go beyond the identification of ethical guidelines concerning the development of methods for their practical implementation are also considered.

It is outside the scope of this report to provide an exhaustive review of policy initiatives and AI applications for children. For this reason, certain criteria for the selection of a subset of these have been applied (as indicated in Chapters 2 and 3).

## Technical definitions

For the purposes of this report, a set of technical definitions to facilitate the narrative are provided. These working definitions are addressed to non-specialist audiences.

### NOTES

[5] https://ec.europa.eu/commission/presscorner/detail/en/IP_21_1682

**AI system**: the definition of an AI system as put forward in the AI Act proposal[6] has been adopted. This considers an artificial intelligence system (AI system) as software that is developed with one or more of the techniques and approaches listed in Annex I of the AI Act proposal. For a given set of human-defined objectives, such software can generate outputs such as content, predictions, recommendations, or decisions influencing the environments they interact with. Annex I of the AI Act contains a list of artificial intelligence techniques and approaches including machine learning, knowledge-based approaches and statistical models. In this report, AI systems that are embodied in robots are also considered, as explained below.

**AI actors**: AI actors are those who play an active role in the AI system lifecycle, including organisations and individuals that produce or use AI systems.

**AI stakeholders**: stakeholders encompass all organisations and individuals involved in, or affected by, AI systems, directly or indirectly. AI actors are a subset of stakeholders.

**AI system adaptation**: the process by which an AI system learns to change its behaviour by analysing the current state of the environment and how the environment is affected by its previous actions. For example, adaptive learning platforms have the potential to provide adaptive personalised learning experiences to address each user's needs.

**AI system lifecycle**: this definition is adopted from the OECD's Recommendation of the Council on Artificial Intelligence.[7] AI system lifecycle phases involve: (i) 'design, data and models', which are a context-dependent sequence encompassing planning and design, data collection and processing, as well as model building; (ii) 'verification and validation'; (iii) 'deployment'; and (iv) 'operation and monitoring'. These phases often take place in an iterative manner and are not necessarily sequential.

**Trustworthy AI**: concept proposed by the High-Level Expert Group[8] of the EC, which consists of seven key requirements: human agency and oversight; technical robustness and safety; privacy and data governance; transparency; diversity, non-discrimination and fairness; societal and environmental well-being; and accountability.

**Children's rights**: children are entitled to all human rights – as anyone else. In addition, they are granted particular rights taking into account specificities, vulnerabilities and age-appropriate needs.[9] Children's rights consider the necessity of the development of the child, and they imply the need to protect children and grant assistance to them, adapted to their age and degree of maturity. These particular rights are enshrined in the United Nations Convention on the Rights of the Child (UNCRC): children's rights are thus human rights specifically adapted to the child. Children's rights are duly reflected in the Charter of Fundamental Rights of the EU and EU secondary law.

Definitions of additional terms will be given, where necessary, throughout the document.

## NOTES

[6] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0206

[7] https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449

[8] https://digital-strategy.ec.europa.eu/en/policies/expert-group-ai

[9] https://www.ohchr.org/en/professionalinterest/pages/crc.aspx

# 2. EXISTING POLICY INITIATIVES ON AI AND CHILDREN

This section presents and discusses a selection of existing international policy initiatives on AI and children's rights. The analysis of initiatives at a national level, and policy initiatives from industry and NGOs is beyond the scope of this report. Some of the initiatives have not been developed specifically for children, but they have been used as a basis for further consideration of children's rights.

Overall, the initiatives examined are aligned to a certain extent regarding the risks and the opportunities of AI for children, but they differ in terms of goals and priorities. For instance, OECD initiatives focus mainly on education; UNICEF takes a more generic approach to children's rights; and the EC policy initiatives address mainly AI in education while taking a risk-based approach with the AI Act. The IEEE takes a more practical perspective and actively includes best practices from industry to draw conclusions about the methodologies and techniques that are used for the upholding of children's rights in the design, development, and deployment of specific AI-based products for children.

In all initiatives, we observe that children's participation is recognised as a fundamental requirement. However, some organisations, such as UNICEF, consider children's participation as a priority. In addition, all initiatives recognise the need for practical, actionable methodologies that would pilot policy guidance for AI and children's rights and eventually support AI development and use.

While all initiatives recognise the importance of scientific evidence in policy decision making, they do not explicitly discuss how science has informed their policy decisions or the methodological challenges involved in the implementation of research in policy related to AI for children.

This connection between policymaking and scientific research on AI and child's rights is the focus of this report.

## 2.1 The UN Convention on the Rights of the Child

We take as a starting point the United Nations Convention on the Rights of the Child (UNCRC), which is a legally-binding international agreement setting out the civil, political, economic, social and cultural rights of every child, regardless of their race, religion or abilities.[10] The convention has 54 articles, and it has become the most widely ratified human rights treaty in history, helping transform children's lives around the world. The UNCRC has been ratified by all EU Member States and neighbouring countries.

Technological advances have radically changed the world in which children develop, play and learn. Even though the rights and principles established in the CRC are also applicable to the digital world, and UN CRC General Comment 25 provides concrete guidance on this, governments, businesses and communities systematically take specific actions to ensure that every child has every right in the technologically changing environment children face.

## 2.2 The UN General Comment 25

Given the evolving and expanding digital environment and the opportunities and the risks that the digital world brings for children, the UN adopted the Comment 25 of the rights of the child in the digital environment after a large consultation with children and all interested parties.[11]

This comment considers children's possible interactions within digital networks, content, services and applications, connected devices and environments, virtual and augmented reality, artificial intelligence, robotics, automated systems, algorithms and data analytics, biometrics and implant technology and invites governments to take the appropriate actions in order to mitigate the possible risks and ensure that the new opportunities for the realisation of children's rights are accessible to all children in the digital world.

This Comment elaborates on the four basic principles of the Rights of the child namely

- Non-discrimination;
- Best interest of the child;
- Right to life survival and development; and
- Respect for the views of the child.

It proposes a set of general measures of implementation by States parties, such as the review and possible adoptions, amendments and updates in the national legislation in line with the international human rights standards and the implementation of national policies relating to children's rights to specifically address the evolving digital environments.

The Comment 25 invites governments to implement regulation, industry codes, standards and plans to provide children with beneficial opportunities from engaging with the digital environment in a safe manner. After a detailed consideration of how the rights of the child should be viewed in the digital environment, the document indicates that the cross-border and transnational nature of the digital environment requires strong international and regional cooperation to ensure that all stakeholders, including businesses and other actors, effectively respect, protect and fulfil children's rights in relation to the digital environment.

This General Comment 25 acknowledges that in developed countries, navigating the digital world is part of children's everyday life, and the global community has started to understand the challenges and the opportunities digital environments bring to children. However, it indicates that special attention should be paid to AI-based technologies that have been shown to change fundamentally children's interaction with the digital and physical world.

**NOTES**

[10] https://www.ohchr.org/en/professionalinterest/pages/crc.aspx

[11] https://www.ohchr.org/EN/HRBodies/CRC/Pages/GCChildrensRightsRelationDigitalEnvironment.aspx

The current scientific evidence about the impact of AI-based applications on a child's development and the kind of opportunities and risks they bring is still limited. Even less explored is **how the rights of the child, as defined in the UNCRC and the General Comment 25, can be realised in the AI context**.

## 2.3 The UNICEF initiative on AI and children's rights

In 2019, UNICEF and the Government of Finland launched a two-year project to focus specifically on children's rights in the context of artificial intelligence.[12]

This project aimed to understand better how AI-based systems will affect children and their rights, and what kind of actions are needed to protect, provide for, and empower children worldwide. UNICEF considered that children have difficulties understanding AI-based systems while having no opportunities to express their opinion in decision-making processes.

For this reason, the inclusion of children in the process of the development of the relevant Policy Guidelines was a priority. In this context, UNICEF invited a wide range of stakeholders, including children, governmental and non-governmental organisations, businesses and experts from the field of AI and child's rights to contribute to the development of a set of Policy Guidelines for AI and children's rights.

The organisation of a series of global and regional, workshops with experts and children was instrumental to the development of those guidelines.[13] **UNICEF involved 245 adolescents** from Brazil, Chile, South Africa, Sweden and the United States, in a global consultation.

The children had the opportunity to discuss their experiences with AI and how they understand the risks and the opportunities it presents in their lives. One of the most prevalent outcomes of this consultation was the observation that there is an **adult-based bias** in the current AI-based technologies.

In addition, a review of 20 National Strategies on AI revealed that most make only a cursory mention of children and their specific needs.[14]

Moreover, little attention is explicitly being given to safeguarding the rights of children in an algorithmic-oriented economy and society; while measures for the preparation of children to live in an AI world and develop basic AI literacy skills need to be significantly expanded. This report invites policymakers to consider the re-prioritisation of children's rights in the National AI policies to be of critical importance. Based on the above-mentioned activities, UNICEF published a report on **Policy Guidance for AI and Children** in November 2021.[15] It proposed nine requirements and corresponding recommendations for the development and deployment of child-centred AI, namely:

1. Support children's development and well-be ing;
2. Ensure inclusion of and for children;
3. Prioritise fairness and non-discrimination for children;
4. Protect children's data and privacy;
5. Ensure safety for children;
6. Provide transparency, explainability and ac countability for children;
7. Empower governments and businesses with knowledge of AI and children's rights;
8. Prepare children for present and future de velopments in AI;
9. Create an enabling environment for child-cen tred AI;

### NOTES

[12] https://www.unicef.org/globalinsight/featured-projects/ai-children

[13] https://www.unicef.org/globalinsight/stories/adolescent-perspectives-artificial-intelligence

[14] https://www.unicef.org/globalinsight/media/1156/file

[15] https://www.unicef.org/globalinsight/media/2356/file/UNICEF-Global-Insight-policy-guidance-AI-children-2.0-2021.pdf

The report indicates that a foundational framework for the implications of the above-mentioned requirements prioritises:

- Protection = do no harm;
- Provision = do good;
- Participation = include all children.

The report underlines that when applying this foundation to AI policies, systems design, development and deployment, regardless of regulatory frameworks, children are always entitled to their rights. Finally, this guidance indicates specific opportunities and risks that have been correlated with specific AI-based technologies, such as chatbots, recommendation systems, robots and automated decision-making systems and different AI techniques, such as natural language processing, computer vision, and reinforcement learning.

For the development of this report, UNICEF invited a group of governmental and non-governmental organisations and businesses to pilot the proposed guidelines with real applications and policies,[16] and share their findings (the JRC participated as one of the pilot partners in collaboration with the HONDA Research Institute, Japan).[17]

The piloting of the Policy Guidance for AI and Children's Rights contributed to the improvement of the guidelines and entailed implementation examples for the design, development and deployment of child-centred AI.

## 2.4 OECD related initiatives

In May 2021, the OECD published a revision of the "Recommendation on the Protection of Children Online" in view of the technological, legal and policy advances, which was renamed as "Recommendation on Children in the Digital Environment".[18] The goal of this recommendation is to find a balance between protecting children from risk and promoting the opportunities and benefits that the digital environment can provide.

These recommendations are based on the OECD's five principles for responsible stewardship of trustworthy AI, as referred to in the OECD's Legal Instrument of the Council on Artificial Intelligence,[19] and call on all the Members and Non-members, as well as on all the actors involved to engage proactively in responsible stewardship of trustworthy AI by integrating the following principles for the development of AI systems:

- Inclusive growth, sustainable development and well-being;
- Human-centred values and fairness;
- Transparency and explainability;
- Robustness, security and safety;
- Accountability.

The above-mentioned principles for the development of trustworthy AI should be taken into consideration with the overarching child-specific framework as it appears in the Recommendations on Children in the Digital Environment, and which emphasises to the following points:

- Review, develop, and amend as appropriate, laws that directly or indirectly affect children in the digital environment;
- Promote digital literacy as an essential tool for meeting the needs of children;
- Adopt evidence-based policies;
- Promote the adoption of measures that provide for age-appropriate child safety by design.

### NOTES

[16] https://www.unicef.org/globalinsight/policy-guidance-ai-children-pilot-testing-and-case-studies

[17] https://www.unicef.org/globalinsight/media/2206/file

[18] https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0389

[19] https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449

The OECD has formulated clear recommendations for the development of trustworthy AI and for actionable points for the best interests of children regarding their navigation of the Digital Environment. Still, it draws special attention to the role of children's AI literacy and the role of AI in education with the "Trustworthy AI in education: promises and challenges" report.[20]

One of the current challenges, though, is the limited evidence about the effectiveness of many AI solutions in education, and the need for new forms of innovative school networks since the traditional ways of assessing the effectiveness of educational interventions (e.g. randomised control trials) may be too slow in a rapidly evolving technological context. Another important policy consideration is questioning how governments can work with stakeholders to shape AI in education, in order to help prepare for the transformation of the world of work and society, and to define what appropriate data sharing means.

With an extensive analysis of various AI-based applications, the OECD proceeded with the exploration of the current state-of-the-art and recommendations for AI in education in its "OECD Digital Education Outlook 2021: Pushing the Frontiers with AI, Blockchain and Robots".[21]

One of the main conclusions of this report is that effective use of robots, classware, predictive analytics and similar technology will require reinventing the role of teachers and will require international and cross-sectoral collaborations.

Finally, the OECD recognises children's AI literacy as an essential part of their education and their socio-emotional development,[22] as indicated in the first AI principle of inclusive growth, sustainable development and well-being.[23]

## 2.5 UNESCO related initiatives

The United Nations Educational, Scientific and Cultural Organisation (UNESCO) recognises that AI can be a powerful tool to address current global challenges and to advance human capabilities. However, it also recognises that, along with multiple advantages, these technologies generate downside risks and challenges, derived from the malicious use of technology or deepening inequalities and divides. Moreover, it highlights the need for international and national policies, as well as regulatory frameworks to ensure that these emerging technologies benefit humanity as a whole.[24]

To this end, UNESCO published drafted recommendations on the ethics of AI in 2019, to provide a basis to make AI systems work for the good of humanity, individuals, societies, environment and ecosystems, and to prevent harm.[25] In November 2021, all 193 member states of UNESCO unanimously adopted the recommendations on the ethics of AI, which aim to realise the advantages of technology while reducing the risks to human rights associated with its use.

Regarding the AI-related activities for education, UNESCO adopted the UN General Comment 25 on Children's Rights in Relation to the Digital Environment,[26] and following a similar approach to OECD, UNESCO categorised AI-based applications for education into two large categories that contribute to the improvement of learning and equity for all children, namely:

1. AI to promote personalisation and better learning outcomes; and

2. Data analytics in Education Management Information Systems (EMIS) and the evolution to Learning Management Systems (LMS)

### NOTES

[20] https://www.oecd-ilibrary.org/docserver/a6c90fa9-en.pdf?expires=1633947478&id=id&accname=guest&checksum=F2EFBB42D1F4EC64A20E7B827FC3DF26

[21] https://www.oecd-ilibrary.org/education/oecd-digital-education-outlook-2021_589b283f-en

[22] https://www.oecd.org/education/ceri/social-emotional-skills-study/beyond-academic-learning-92a11084-en.htm

[23] https://oecd.ai/en/ai-principles

[24] https://en.unesco.org/artificial-intelligence/ethics

[25] https://unesdoc.unesco.org/ark:/48223/pf0000377897

[26] https://en.unesco.org/news/unesco-welcomes-new-international-instrument-childrens-rights-relation-digital-environment

In its report "Artificial Intelligence in Education: Challenges and Opportunities for Sustainable Development",[27] UNESCO identified a number of recommendations that can support relevant stakeholders to promote the following actions:

- Develop a comprehensive view of public policy on AI for sustainable development;
- Ensure inclusion and equity for AI in education;
- Prepare teachers for AI-powered education;
- Develop quality and inclusive data systems;
- Enhance research on AI in education;
- Deal with ethics and transparency in data collection, use and dissemination.

To facilitate the design of concrete actionable points by policymakers, UNESCO published the "AI and education: Guidance for policymakers" report, which identifies specific areas for action.[28] In parallel, since the children's participation has been considered essential in this process, UNESCO in collaboration with Ericson, which functions as a repository for educators and curriculum developers, aim to prepare and exchange learning resources.[29]

## 2.6 IEEE related initiatives

The Institute of Electrical and Electronics Engineers (IEEE) is the largest association of technical professionals, aiming to advance electrical and electronic engineering, computer engineering and similar fields. It has been particularly active in prioritising the emerging ethical considerations in the creation of AI and autonomous systems.[30]

In 2016, it launched the IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems to ensure every stakeholder involved in the design and development of autonomous and intelligent systems is educated, trained, and empowered to prioritise ethical considerations, so that these technologies are advanced for the benefit of humanity.[31]

Since then, IEEE has developed a set of guidelines for Ethically Aligned Design by prioritising human well-being,[32] as well as practices for assessing the impact of autonomous and intelligent systems on human well-being.[33]

In this context, the IEEE has showed a special interest in better understanding the impact of AI on children's lives, by first considering parents' perceptions regarding the use of AI by their children with the "Generation AI: A Study of Millennial Parents of Generation Alpha Kids". This study reports on the results of 600 parents who were surveyed; the survey illuminated how millennial parents with Generation Alpha children (seven years-old or younger) think growing up interacting with AI technology will impact the lives of their children.[34] The results indicate that millennial parents have a tendency to accept AI as an integral part of their children's lives including their education and their social life.

Since then and taking a practical perspective, the IEEE has initiated a series of projects on AI in relation to children in the context of its Standards Association.[35] The global initiative on the Ethics of Autonomous and Intelligent Systems was integrated into the IEEE Standards Association and seeks to identify methodologies

### NOTES

[27] https://en.unesco.org/artificial-intelligence/education

[28] https://unesdoc.unesco.org/ark:/48223/pf0000376709

[29] https://en.unesco.org/news/unesco-and-ericsson-launch-new-portal-teaching-ai-students

[30] https://standards.ieee.org/content/ieee-standards/en/news/2016/ethically_aligned_design.html

[31] https://standards.ieee.org/content/ieee-standards/en/industry-connections/ec/autonomous-systems.html

[32] https://exploreaiethics.com/guidelines/ethically-aligned-design-v2/

[33] https://doi.org/10.1109/IEEESTD.2020.9084219

[34] https://www.ieee.org/about/news/2017/ieee-unveils-generation-ai.html

[35] https://standards.ieee.org

to proceed from ethical principles to practical developments.[36]

Further initiatives of the IEEE Standard Association focus on the collection of industry best practices that uphold children's rights from the design stage of their products onwards. For example, the initiative of "Children's Data Governance Applied Case Studies" presents a collection of case studies that demonstrate the connection of ethical principles in relations to children's rights to best practices to ensure trustworthy and positive online/offline experiences for children.[37]

In September 2021, the IEEE Standards Association published the "Draft Standard for Age-Appropriate Digital Services Framework – Based on the 5Rights Principles for Children" (P2089/D4).[38] Following the growing desire of companies to develop digital and AI-based products for children, this standard establishes a set of processes by which organisations seek to make their services Age Appropriate. This standard reflects children's existing rights as they appear under the UNCRC by setting processes through the life cycle of development, delivery and distribution of the product.

## 2.7 Council of Europe related initiatives

The Council of Europe questioned and led policymaking initiatives on the impact of AI technology on human rights, early in the last decade. Moreover, since launching the Program "Building a Europe for and with Children" in 2006, the Council of Europe has implemented strategies over a series of policy cycles to guide its work on strengthening the protection of children's rights in Europe. In 2016, it published the Strategy for the Rights of the Child (2016-2021), adopted by the Committee of Ministers of the Council of Europe.

The strategy covers priority areas to guarantee all children's rights, namely in the areas of equal opportunities, participation, a violence-free life, child-friendly justice and children's rights in the digital environment. An ad hoc Committee for the Rights of the Child (CAHENF) was created in the same period and tasked by the Committee of Ministers to oversee the implementation of the strategy.

Specifically, on the theme of AI technology and children's rights, we can highlight the "Guidelines to respect, protect and fulfil the rights of the child in the digital environment - Recommendation CM/Rec(2018)7 of the Committee of Ministers". Its purpose and scope are to provide assistance to relevant stakeholders in the implementation of the rights enshrined in international and European human rights conventions and standards, in the light of the case law of the European Court of Human Rights. The guidelines rely on five fundamental principles and rights:

1. Best interests of the child;

2. Evolving capacities of the child;

3. Right to non-discrimination;

4. Right to be heard;

5. Duty to engage other stakeholders.

The guidelines developed seven operational principles and measures to respect, protect and fulfil the rights of the child in the digital environment, namely:

1. Access to the digital environment;

2. Right to freedom of expression and information;

3. Participation, right to engage in play and right to assembly and association;

4. Privacy and data protection;

5. Right to education;

6. The right to protection and safety;

### NOTES

[36] https://standards.ieee.org/industry-connections/ec/autonomous-systems.html

[37] https://standards.ieee.org/initiatives/artificial-intelligence-systems/childrens-data-governance.html

[38] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A237%3AFIN

7. Remedies.

The document concludes by insisting on the need for cooperation and coordination at the national and international level. To support the implementation of the recommendations CM/Rec(2018)7, the Council of Europe published a "Handbook for policymakers on the rights of the child in the digital environment".

Regarding the participation of young people in the policymaking process, the Council of Europe published the "Declaration on Youth Participation in AI Governance" at the end of 2020, presenting the outcome of the work done by the young people participating in the seminar on *Artificial Intelligence: How Can Youth Take Part?* organised by the Youth Department of the Council of Europe, between 23 and 27 November 2020.

This is positioned within the wider framework of the Council of Europe's youth policy and initiatives that link AI and democratic citizenship. The declaration explores issues, challenges and roles that stakeholders can play to secure and enable the participation of young people in AI governance processes at all levels. It highlights five important considerations:

1. **The exclusionary consequences of the fast-paced development of AI technologies** driven by the private sector that leave many stakeholders, especially youth actors and human rights activists, but also policymakers, behind, and result in normatively questionable and ineffective self-regulation in the private sector.

2. **The need to develop and ensure legal safeguards**, both by international organisations (through existing or new legal instruments) and by national governments responsible for securing and implementing them at national level.

3. **The absence of youth in the emerging AI governance processes** as a denial of the right to participate in democratic processes which impedes a whole sector from co-shaping the discourse about development, assessment, implementation and regulation of AI technologies.

4. **The imperative to respect ethical principles** which must be at the core of all AI developments and deployment (transparency, justice and fairness, responsibility, safety and security, privacy).

5. **The need to assess the value of AI technologies** on the impact of their consequences and benefits on individuals and society. Not all social and economic problems need to be anchored in technological solutions.

Finally, we can point to the activities of the Ad Hoc Committee on Artificial Intelligence (CAHAI). From September 2019 to December 2021, and on the basis of broad multi-stakeholder consultations, it examined the feasibility and potential elements of a legal framework for the development, design and application of artificial intelligence, based on Council of Europe's standards on human rights, democracy and the rule of law.

Among the outcomes of this initiative, we can highlight the data visualisation of AI initiatives tool, which brings together more than 500 documents related to artificial intelligence, coming from national authorities, the private sector, international organisations or multi-stakeholder initiatives. However, we also note that the words, 'child', 'children' or 'youth' are not among the concepts listed as frequent.

## 2.8 European Commission related initiatives

### 2.8.1 The European strategy on the rights of the child

The Charter of Fundamental Rights of the European Union, in particular Art.24, guarantees the protection of the rights of the child by the EU institutions and by EU countries when they implement EU law.[39] Regarding the intersection of human fundamental rights and AI, the European Union Agency for Fundamental Rights

**NOTES**

[39] https://www.europarl.europa.eu/charter/pdf/text_en.pdf

**TABLE 1**
Key actions proposed by the "EU strategy on the rights of the child" regarding the support of children's rights in the digital and information society [adopted by the EU Strategy on the Rights of the Child]
Source: EC

| Actor | Key actions |
|---|---|
| **By the European Commission:** | Adopt an updated Better Internet for Kids Strategy in 2022;<br><br>Create and facilitate a child-led process aimed at developing a set of principles to be promoted and adhered to by the industry;<br><br>Promote the development and use of accessible ICT and assistive technologies for children with disabilities, such as speech recognition, closed captioning and others, including in Commission's conferences and events;<br><br>Ensure the full implementation of the European Accessibility Act;<br><br>Step up the fight against all forms of online child sexual abuse, such as by proposing the necessary legislation, including obligations for relevant online service providers to detect and report known child sexual abuse material online. |
| **The European Commission invites the Member States to:** | Ensure effective equal access to digital tools and high-speed Internet connection, digital literacy, accessible online educational material and education tools etc. for all children;<br><br>Support the development of children's basic digital competences, through the Digital Competence Framework for citizens;<br><br>Support media literacy actions as part of education, to develop children's ability to evaluate critically online content, and detect disinformation and abusive material;<br><br>Support and promote the work of the EU co-funded Safer Internet Centres, and support child helplines and hotlines in developing online avenues for communication;<br><br>Encourage children's and especially girls' participation in science, technology, engineering and mathematics (STEM) studies and dismantle gender stereotypes in this field to ensure equal opportunities in the digital labour market. |
| **The European Commission invites ICT companies to:** | Ensure that children's rights, including privacy, personal data protection, and access to age-appropriate content, are included in digital products and services by design and by default, including for children with disabilities;<br><br>Equip children and parents with adequate tools to control their screen time and behaviour, and protect them from the effects of overuse and addiction to online products;<br><br>Strengthen measures to help tackle harmful content and inappropriate commercial communication, such as through easy-to-use reporting and blocking channels or effective age-verification tools;<br><br>Continue their efforts to detect, report and remove illegal online content, including child sexual abuse from their platforms and services, to the extent that these practices are lawful. |

(FRA) analysed different risks in the use of AI from a fundamental rights perspective, and acknowledges the lack of awareness of stakeholders regarding the rights of the child in the context of AI.[40]

With the same report, FRA emphasises the need for mainstreaming children's rights in AI policies. Guided by the principles set out in the UN Convention on the Rights of the Child,[41] the Commission published the European Strategy for the Rights of the Child[42] to address persisting and emerging challenges around six thematic areas, and to propose concrete actions to protect, promote and fulfil children's rights in today's context.

The proposed thematic areas, which are based on the EU priorities for the coming years, relate to action points that should be taken into consideration by the European Commission and by the Member States. Among the thematic areas that the Strategy proposes is the "Digital and information society: an EU where children can safely navigate the digital environment and harness its opportunities".

To this end, the Strategy identifies a set of initiatives by the EU that have already been adopted, mainly towards children's online safety and protection, as well as the new Digital Education Action Plan (2021-2027) which promotes digital literacy and puts education and training at the heart of this effort.[43] Lastly, it highlights the impact that AI has and will have on children and their rights, such as in the fields of education, leisure, healthcare provision. It also calls for a more effective fight against Child Sexual Abuse.[44]

Based on the above-mentioned thematic areas, and going one step further, the European Commission has proposed certain key actions that should be considered in the future for upholding children's rights in the digital and information society.

Table 1 shows the invitation of the European Commission of certain actors (the European Commission, the Member States, and the ICT companies) to consider a set of key actions (see Table 1).

### 2.8.2 Artificial intelligence policies at the European Commission

The **General Data Protection Regulation (GDPR)** consists of a harmonised set of data protection rules across the EU to protect citizens' fundamental rights in today's digital society.[45] One of the main goals of the regulation is for citizens to be in control of their personal data and to ensure the protection of their fundamental rights.

The GDPR applies to AI systems that process personal data. It contains specific provisions that refer to profiling and to automated decision systems, many of which are based on AI. The GDPR recognises that children need special protection regarding their personal data, and it contains provisions aimed at securing the processing of their data and to ensure that children understand and can exercise their data protection rights.

In the context of the European strategy for data,[46] the European Commission has proposed the Regulation on European data governance[47] and the **Data Act**[48] that aim to unlock the re-use potential of different types of data, and to create common European data spaces.

## NOTES

[39] https://www.europarl.europa.eu/charter/pdf/text_en.pdf

[40] https://fra.europa.eu/en/publication/2020/artificial-intelligence-and-fundamental-rights

[41] https://www.unicef.org.au/upload/unicef/media/unicef-simplified-convention-child-rights.pdf

[42] https://eur-lex.europa.eu/resource.html?uri=cellar:e769a102-8d88-11eb-b85c-01aa75ed71a1.0002.02/DOC_1&format=PDF

[43] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0624

[44] https://ec.europa.eu/home-affairs/system/files/2020-07/20200724_com-2020-607-commission-communication_en.pdf

[45] https://gdpr.eu/what-is-gdpr/

[46] https://digital-strategy.ec.europa.eu/en/policies/strategy-data

In relation specifically to AI, the European Commission has launched a set of initiatives related to Artificial Intelligence since 2018, that we summarise as follows:

The launch of the **European AI Strategy in 2018**, with a Communication on Artificial Intelligence for Europe and the Coordinated Plan on AI,[49] prepared with Member States to foster the development and use of AI in Europe. This plan proposes joint actions for a strategic cooperation between Member States, Norway, Switzerland and the Commission on three main pillars: to ensure technological developments and uptake, to prepare for the socio-economic changes brought by AI, and to lay out an appropriate ethical and legal framework.

The work of the **High-Level Expert Group** on AI (AI HLEG),[50] a group of 52 experts bringing together representatives from academia, civil society, and industry, has been appointed by the Commission. Their work includes the elaboration of the ethical guidelines for trustworthy AI and a set of recommendations on future-related policy development.

The **White Paper on Artificial Intelligence**,[51] published in 2020, aimed to foster a European ecosystem of excellence and trust in AI. This initiative incorporated a public consultation that received over 1,200 individual responses from EU and non-EU citizens, Member States and relevant stakeholders, including representatives from the civil society, industry and academia. Finally, in 2021, the EC published a Communication on Fostering a European approach to AI, combining one of the world's first attempts at regulating AI and the revision of the Coordinated Plan on AI.[52]

The Proposal for a **Regulation (AI Act)** laying down harmonised rules on artificial intelligence contains new rules to make sure that AI systems used in the EU are safe, transparent, ethical, unbiased and under human control, categorising them by risk.[53] The legal text considers children as a vulnerable population in several parts. For instance, according to Article 9 (Risk Management System) point 8, "when implementing the risk management system, specific consideration shall be given to whether the high-risk AI system is likely to be accessed by or have an impact on children".

In parallel, the review of the **Coordinated Plan on AI** builds on the strong collaboration between the Commission and Member States established in 2018, in order to achieve EU global leadership in trustworthy AI.[54] No specific mention of children is found in the plan, even if AI education is mentioned as a key component of the EU AI ecosystem, connected to the Digital education action plan mentioned as follows.

### 2.8.3 The Digital Education Action Plan and audio-visual media services directive

Through actions related to education and training, the EU supports citizens in acquiring a basic understanding of digital and emerging technologies which include systems driven by artificial intelligence (AI).

The Digital Education Action Plan (DEAP) (2021-2027) is a renewed European Union (EU) policy initiative that has various actions towards this aim.

As part of fostering the development of a high-performing digital education system, DEAP foresees the development of ethical guidelines

## NOTES

[47] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020PC0767&from=EN

[48] https://digital-strategy.ec.europa.eu/en/policies/data-act

[49] https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence

[50] https://digital-strategy.ec.europa.eu/en/policies/expert-group-ai

[51] https://ec.europa.eu/info/publications/white-paper-artificial-intelligence-european-approach-excellence-and-trust_en

[52] https://digital-strategy.ec.europa.eu/en/library/communication-fostering-european-approach-artificial-intelligence

[53] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1623335154975&uri=CELEX%3A52021PC0206

[54] https://digital-strategy.ec.europa.eu/en/library/coordinated-plan-artificial-intelligence-2021-review

on AI, and data usage in teaching and learning to be ready by the beginning of the 2022 school year. The overall aim is to help understand the potential that AI-based applications could have in education, and to raise awareness of the possible risks.[55]

On the other hand, to enhance citizens' digital skills to cope better with the digital transformation of today's society and the economy, the DEAP foresees action to include AI and data-related skills[56] to the update of the European Digital Competence Framework (DigComp).[57] The aim is to improve citizens' sensitivity towards potential issues related to data protection and e-privacy, rights, and discrimination and bias – including gender bias and disabilities, ethnic and racial discrimination.

A related action to empower citizens, and especially children, through media literacy skills comes from the Audiovisual Media Services Directive as the availability of harmful content (including disinformation) in audiovisual media services and new platforms has become a challenge.[58]

It outlines that "measures taken to protect the physical, mental and moral development of minors and human dignity should be carefully balanced with the fundamental right to freedom of expression as laid down in the Charter on Fundamental Rights of the European Union". One of the concrete actions is that video-sharing platforms will need to include media literacy education for young audiences which will be implemented in collaboration with European Regulators Group for Audiovisual Media Services.

## NOTES

[55] https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan/action-6_en

[56] https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan/action-8_en

[57] https://ec.europa.eu/jrc/digcomp

[58] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32010L0013&from=EN

# 3. ANALYSIS OF THE IMPACT OF SELECTED AI APPLICATIONS ON CHILDREN'S RIGHTS

This section sets out the existing state-of-the-art research and the scientific evidence for three AI-based applications that have already been applied in contexts related to children: (i) recommender systems, (ii) conversational agents, and (iii) social robots. We summarise the main findings that are relevant to children's rights. The main criterion for the selection of the specific AI technologies, as examples for this report, was their current integration and use by children, the current empirical evidence of their impact on child development and their diverse technical features. While conversational agents rely mainly on language-based communication, recommender systems might take text-based forms, and social robots for their part make use of the physical components of the system for communication based in multiple modalities. Research in the three cases highlights certain directions that are common, such as the development of systems that adapt to children's individual characteristics and needs. The research challenges that are indicated in all the cases focus on the lack of effective methodologies for scientific research to address the urgent need for evidence-based policymaking, as well as the need for longitudinal studies to examine the long-term effects of the use of those technologies on children's development.

Regarding the emerging opportunities, evidence in all the three use-cases indicates that with an appropriate approach in the design, development and deployment of those technologies, their use could create opportunities for the expansion and the support of children's development in various ways, with a special focus on personalised learning.

However, research indicates that the use of these applications is correlated with risks that need to be addressed, such as children's privacy, possible algorithmic discrimination and lack of fairness which is often connected to the lack of transparency and equity in accessibility.

The different characteristics of applications require a fine-tuned approach indicating that we cannot have one solution that fits all applications within the various contexts; rather we need principles and best practices that provide directions for the multiple characteristics of AI-based applications for children and their different uses.

Lastly, the relevant literature indicates that often research and policymaking on AI for children are minimally connected, and so there is a need for multistakeholder collaboration, including the participation of children in a meaningful way.

Further research for the development of evidence-based policy directions requires a bi-directional understanding of the impact of these applications on children, in terms of the scientific evidence relating to AI technical developments and policy structures.

**Child-users as one of the target human populations that are being and will be affected by AI require special attention which might be different from AI for adults, and separate research sub-fields have been developed especially for children**.

First, children's cognitive and socio-emotional skills manifest rapid growth and they lack fully-mature abilities which mean that children are a category among vulnerable populations.

Second, while AI-based applications are increasingly affecting children's everyday lives, as in the case of personalised learning applications, or face recognition applications for entertainment, children are rarely invited to be part of the decision-making process for the development and deployment of those applications.

Third, children need to be prepared in the most appropriate and effective way, not only as current and future users of AI-enabled systems, but also for the possibility of being involved in the design and development of such systems. This means that children and young people need to be given the opportunities to start develop a mindset for human-centred ethical designs and certain sets of skills that will allow them to reflect critically on the design, development and use of robotic technology in every setting.

In this chapter, we present scientific findings at the intersection of the rights of the child with three AI-based applications: recommender systems (RSs), conversational agents (CAs),) and social robots for children.

While these systems come with specific common characteristics and are overlapping, there are several characteristics that render them distinct from each other. A recommender system is a type of information retrieval system whose goal is to suggest items from an ample collection of activities that meet the preferences of a user. These can be text-based, visual-based or speech-based systems and might have various kinds of interfaces.

Conversational agents rely on language-based dialogue systems and might take various forms of embodiment, such as screen-based chatbots or voice-enabled embodied devices. Social robots are embodied systems that typically use multiple modalities for verbal and non-verbal communication with the user. In addition to language, they use modules such as expressive non-verbal behaviours, navigation and action to interact with the surrounding environment.

**For the selection of the case studies that are included in this report, we formulated the following criteria**.

First, we sought to include case-studies or applications that are diverse in terms of their technical characteristics. As shown in Fig.6, an application might involve modules that are based on various techniques, such as natural language processing, computer vision or learning from examples. Some of the modules involved by the different applications may also (or may not) require or record novel data during the interaction with children (e.g. reinforcement learning), increasing the risk of privacy leakage.

Second, the case-studies included had to involve different types of interactions with the end-users, such as embodied or non-embodied interaction and verbal or non-verbal interaction.

Lastly, since this report draws on a science for policy orientation, we decided to include applications for which there is already scientific evidence about their impact on children's development. As a result, three case-studies were included, namely conversational AI, recommender systems and robotic artefacts.

We acknowledge that with the selection of the above-mentioned case studies, we excluded others that are equally important, such as applications of learning analytics, AI tools used to detect CSA (child sexual abuse) online (i.e. new CSAM and grooming), smart toys and other applications, which increasingly affect children's development and well-being.

The selected case-studies are set out in the following subsections. For each case study, we first give an overview of the application, definitions and a technical description which is followed by the opportunities and the emerging risks that are connected to the specific application, with a connection to children's rights. In the end, we discuss emerging future directions.

Tables 2 and 3 provide a summary of the existing work of the selected AI-applications regarding the emerging opportunities and risks.

**TABLES 2 AND 3**
Emerging opportunities and risks in relation to children's rights, in the context of recommender systems, conversational agents and social robots for children, as found in the relevant literature
Source: EC

| | AI-based applications | | |
|---|---|---|---|
| **Opportunities** | Recommender systems | Conversational Agents | Social robots |
| **Accessibility** | ✓ | ✓ | ✓ |
| **Engagement for learning** | ✓ | ✓ | ✓ |
| **Adaptation** | ✓ | ✓ | ✓ |
| **Social interaction** | ✓ | ✓ | ✓ |
| **Health** | ✓ | ✓ | ✓ |
| **Transparency** | ✓ | | ✓ |
| **Inclusivity/Diversification** | ✓ | | ✓ |
| **Acceptance** | | ✓ | ✓ |
| **Physical interaction** | | | ✓ |

| | AI-based applications | | |
|---|---|---|---|
| **Risks** | Recommender systems | Conversational Agents | Social robots |
| **Limited accuracy** | | ✓ | ✓ |
| **Augmentation of inequities** | | ✓ | |
| **Data disclosure / Privacy violation** | ✓ | ✓ | ✓ |
| **Overtrust** | | ✓ | ✓ |
| **Bias / discrimination** | ✓ | ✓ | ✓ |
| **Over-exposure to similar content** | ✓ | | |
| **Inappropriate content** | ✓ | ✓ | |
| **Reduction of child autonomy in relation to the system** | ✓ | ✓ | ✓ |

## 3.1 Recommender systems

A recommender system (RS) is a type of information retrieval system whose goal is to suggest items from a large collection that meet the preferences of a user. RSs are complex systems with different components that contribute to their outcome and impact, such as data, algorithms or graphical user interfaces. State-of-the-art recommendation algorithms are hybrid as they combine different approaches, such as collaborative filtering techniques (i.e. recommending to a user the items that a similar user liked in the past), content-based methods (i.e. recommending to a user items similar to those she/he likes), demographic systems (e.g. targeting specific languages or countries) or knowledge-based approaches (e.g. case-based reasoning systems) (Ricci et al., 2011).

RSs are used in a variety of domains, with well-known applications such as video services, product recommenders in online shopping, content recommenders in social media and web content recommenders in different areas such as restaurants, wines, dating, news, language teachers or financial services.

Children are common users of recommender systems. Watching videos is one of the most common digital activities of children reported in the literature (Radesky et al., 2020), where tablets seem to be their favourite devices according to studies carried out in Europe and USA (Chaudron et al., 2018; Izci et al., 2019). Although general RSs are widely used by children, some research studies have addressed specific children's needs, challenges and risks of this kind of technology (Fails et al. 2017), and companies have also adapted their products to children (e.g. YouTube Kids or Spotify Kids).

In this section, we briefly reflect on the opportunities, challenges and risks of RSs for children. We refer to Gómez et al. (2021) for a more detailed description of the use case in the extensive scientific literature.

### Opportunities

The literature identifies several domains where recommender systems can bring value and support children's autonomy in numerous tasks, by facilitating access to different information sources and modalities. These domains include information search, media recommendation, learning, smart toys, story and book recommendations and social media. RSs offer children different opportunities for learning, play and entertainment, and their functions can be summarised as follows:

- Provide **access** to large sets of material, such as in the context of school-based activities or entertainment.
- Support the analysis of data to mitigate **misinformation**, especially in learning contexts. Children may have the perception of being able to judge the credibility of information sources. However, it may not be the case, even for adults. RS can account for mechanisms to support children's interaction with digital resources addressing misinformation (Spezzano, 2021).
- Support children's **diversification** by allowing each child to control their own learning, play and entertainment trajectories, by selecting from a large set of recommended material. This own control is related to children **trusting** into RS, which is a relevant topic to note, as children may not always rely on RSs (Pera et al., 2019).
- Facilitate **peer-to-peer recommendations** (Picton, 2014).
- RSs used in educational setting can **support cognitive self-regulated learning skills** (Tsiakas et al., 2020).
- RSs can provide **personalised scaffolding and adaptation** for children's learning through recommendations (Ashlee et al., 2019; Aisha Yaquob et al, 2019).
- **Monitor and report** the child's progress and **predict** future performance (Ueno and Miyazawa, 2017), which might prove beneficial for the teaching process.

### Challenges

Ekstrand (2017) summarises the challenges of evaluating RSs with children, confirmed by other authors, and consisting of these three main aspects:

- **Data availability**: the lack of data (i.e. the so called "cold-start problem") is one of the limitations of children-centric studies, compounded by restrictions due to rights of data protection (Milton, 2017). Together, these lim-

it the availability of benchmarking datasets including for child users, yet which are crucial for algorithm evaluation and development and to ensure the reproducibility of studies.

- **Limited survey abilities** when dealing with children. Surveys provide a common strategy and practical way for large-scale evaluation of RSs. However, some studies have signalled the limitations of this methodology for children (Borders et al., 2000; Chaudron et al., 2018; Ekstrand, 2017). Other methodologies such as user studies, usability exercises and participatory design processes are then required for children, which are costly to be carried out on a large scale.

- **Multi-stakeholder evaluation**: RS evaluation has been traditionally centred on metrics and protocols that measure how the different system components impact the "user". In child-centred recommendations, we need to consider different stakeholders, e.g. children, parents, educators, RS providers.

Motivated by these limitations, Gómez et al., (2021) propose a multi-perspective evaluation framework for children-centred RSs, which cover four different dimensions: system component, stakeholder, methodology and temporal scale. This framework is designed as a means for the classification and mapping of reproducible and incremental evaluation practices allowing for the scientific understanding of the impact, potential bias and needed adaptations of RSs for children.

## Risks

While the use of RSs by children brings certain opportunities for children, recent research literature, policy reports and press articles have identified several risks that children may encounter when using recommender systems (Chaudron et al., 2018; Izci et al., 2019). These risks include:

- **Personal data processing**. One of the risks that recommender systems entail concerns the violation of children's privacy due to personal data processing. It is important to comply with the regulatory framework of data protection, following data protection principles (e.g. considering which data are appropriate to collect considering needs), and adopting data protection by a design approach, when designing and developing RSs for children. Considering that the target audience is children, particular care should be added to protecting the personal data processed and ensuring that children (or their legal tutors depending on age) understand and can exercise their data protection rights (e.g. provide child-friendly informed consent).

- **Over-exposure**: several studies mention the risk of children being exposed to the same or similar content repeatedly, because recommender systems are driven by the notion of similarity. This includes so-called information bubbles, understood as the risk for children to encounter a certain type of content, based on their previous choices, reinforcing these and so giving children less opportunity and room for discovering something different.

- **Exposure to undesirable content**, given that entertaining contents (e.g. videos) are not always adequate for children and may for instance contain sexual content, include physical violence or refer to unhealthy food or habits. It is important to note that the detection and filtering of undesirable content is not a trivial task. Although some search engines have already incorporated such functionalities (e.g. "safe-search"), some limitations have been identified. First, they depend heavily on curation, which is not always possible to implement in a proper way. Second, they may suffer from over-filtering: i.e. preventing resources that are suitable but contain (out of context) misleading terms. Finally, they mostly focus on sexual content, overlooking other important undesirable content such as hate speech, bullying or violence (Anuyah et al., 2019). Beyond undesirable content, the trade-off between what children **want** versus what they **need** is a challenge that must be considered in the design and evaluation of RSs. In the educational context, for instance, this trade-off has to be considered together with others: e.g. curriculum limitations, commercial expectations, classroom requirements, parents' beliefs in the case of educational context (Murgia et al., 2019).

- **Online advertising**, as platforms may treat children as "young consumers", linked to the concept of the "commodification of childhood".

- Addictions or **dependency** on screen, derived from the fact that RS algorithms maximise user engagement with the content.

- Social media platforms or apps such as Messenger Kids allow children to post and message friends through a federation mechanism monitored by parents. Some voices have signalled the risk of these applications to be used to familiarise children with **commercial** products that will be used when they become teenagers.

- **Difficulty** for parents to monitor children's behaviour, as recommender systems are consumed by children mostly on personal devices such as tablets or phones.

- **Propagation of existing gender stereotypes** present in search and recommendation systems. Recent research works address gender stereotypes in RS (ALRossais and Kidenko, 2018; Wang et al., 2021), and a position paper by Raj et al. (2021) exemplifies some potential issues related to gender stereotypes concerning children. However, research is needed to see if these stereotypes are indeed present and propagated in RSs for children, and to define proper methodologies for their evaluation and mitigation.

Although some of these risks also appear in the adult population, children need special protection, given their vulnerability and potential impact in their cognitive and socio-emotional development. In addition, the tendency of children to use trial-and-error methods to learn how to use a tool increases several risks such as straying from suitable to non-suitable content, the accidental disclosure of personal information, and the unintended contact with people.

### Future directions

This use case summarises existing research related to the evaluation, opportunities, risks, and challenges of children using recommender systems. An analysis of the literature reveals the importance of children-centred design to minimise the risks that recommender systems pose, without sacrificing the opportunities such systems can bring to children.

This review also shows the need to include different perspectives for the evaluation of such systems as whether the tools scaffold children's well-being and development by prioritising their innate characteristics such as curiosity, exploration and creativity.

We think that only by evaluating RSs from a wide range of perspectives (i.e. from single to longitudinal studies, combining quantitative and qualitative methodologies), will we understand the effect that their designs may have on individual stakeholders (e.g. children, parents and businesses), as well as the ways that in which these communities exercise their agency and shape these technologies.

## 3.2 Conversational agents

In the context of this report, we consider the definition of a conversational agent (CA) as a language-based computer program that supports conversational interactions with humans. This system is traditionally composed of different modules (Fig.2): automatic speech recognition (ASR), transforming audio inputs into text; natural language understanding (NLU), understanding the input text; dialogue manager (DM), managing the conversational agent actions; natural language generation (NLG), translating the computer intent to a text; and text to speech (TTS), transforming a text into an audio output.

Nowadays many systems use Neural Networks as a particular module or even for unifying some of them (McTear, 2020).

CAs are accessible and popular among children. Studies about the use of conversational agents, particularly in home environments have identified the relevance of these devices for children (Sciuto et al., 2018; Garg & Sengupta, 2020 and Lovato, Piper & Wartella, 2019).

### Opportunities

The literature identifies several opportunities regarding the use of CAs by children:

- Improvement of accessibility: for children too young to write, with dyslexia or physical disabilities (Pradhan et al., 2018) (Catania et al., 2021).

- Engagement of learning: information search (Downs et al., 2019) (Landoni et al., 2020) teaching languages (Kanda et al. 2004) (Nasihati et al., 2018) or teaching school material (Xu and Warschauer, 2020) (Law et al., 2020).

- Promotion of social behaviour: improving persuasion (Fraser, Papaioannou & Lemon,

2018) (Keizer et al., 2017), and helping autistic children (Ali et al., 2020) (Zhang et al., 2020)

- Support of health at home: helping to record treatments and track disease (Sezgin et al., 2020), as well as reducing depression and anxiety (Fitzpatrick, Darcy & Vierhile, 2017).

## Risks

Because of all the previous challenges, CAs can show **poor accuracy** when conversing with some children, depending on their demographics (age, socioeconomic background, or language). This fact affects **their participation rights** and **magnifies inequities** in our society.

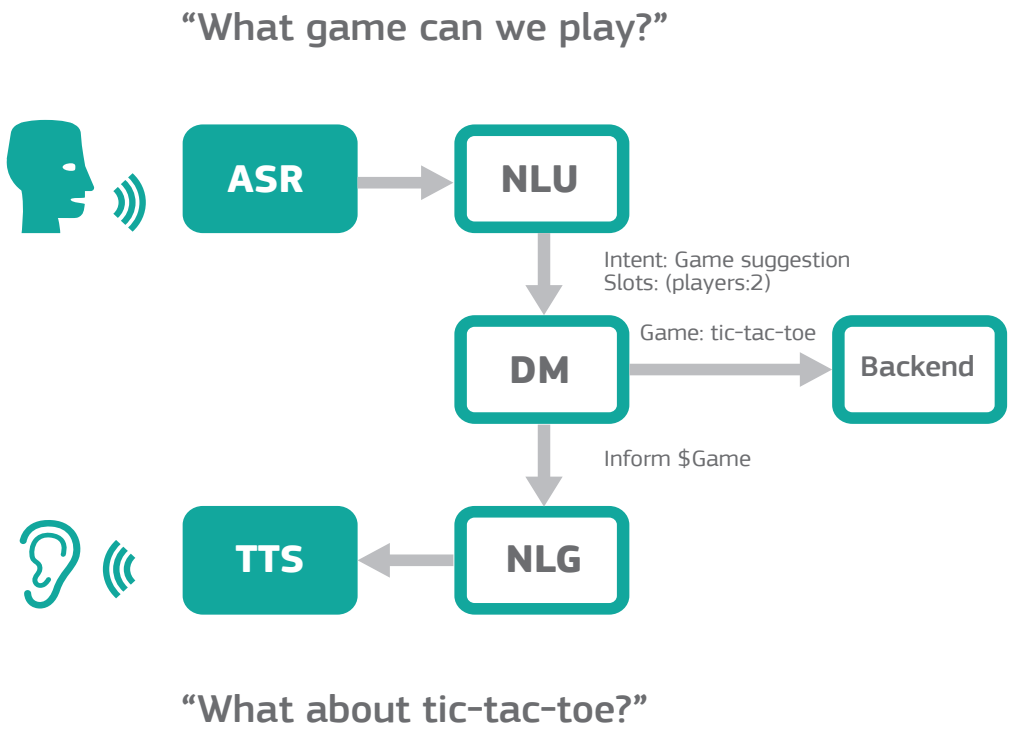
That is why a lot of work has been done on improving child-computer interaction: Lavechin et al. (2020) have developed speech identification for babies; while Røyneland (2020) and Cheng et al. (2018) have identified good strategies to follow when a system does not understand a child.

Other risks that have been identified due to misinformation about what a conversational agent is, and how it works, generating over-trust: i.e. children tend to perceive conversational agents as friends when embodied in a social robot (Kahn et al., 2012) or an intelligent speaker (Druga et al., 2020). These have high influence on children, risking data disclosure. In a study also involving an intelligent speaker, Straten & Caroline, et al. (2020) sought to deal with over trust through transparency in the programming of their systems.

Gender-specific cues are commonly used in the design of chatbots and most chatbots are – explicitly or implicitly – designed to convey a specific gender with most of them being identified with female names, female-looking avatars, and are described as female chatbots (Feine, 2020).

One of the challenges of preventing the risks of these devices is that CAs are new and different from what we have experienced before.

**FIGURE 2**
**Block diagram of conversational agents (Adapted from Mansfield et al., 2019)**
Source: EC



Our inexperience with them makes it difficult to prevent future problems.

An example of an unexpected problem is when parents asked Amazon to change the wake-up word "Alexa" in their CA product, as their daughters suffered bullying when they had the same name (Johns, 2021).

### Challenges

CAs are mainly designed for adults, and this generates some challenges when conversational agents interact with children (Narayanan & Potamianos, 2002) (Kennedy et al., 2017). Different issues have been identified here:

- Children's speech features differ from adults, as they may have a higher pitch range and a different prosody. This impacts the ASR module (which transforms audio inputs into text).
- Children's expressions may also differ from adults, as they may make grammar or vocabulary mistakes, as well as making up words. This affects the NLU module performance (which understands input text).
- Children's rights differ from adults as well, as small children should have a different response than an adult when they try to access a particular service, e.g. buy something online or access some specific websites. The right of purchase or the right of protection is different. This should influence the DM module, which is the one driving the conversational agent actions.

Children's understanding diverges from adults, as they may need simpler words or explanations. This impacts the NLG module performance (which translates computer intent into text output).

### Future directions

We give a short technical description of conversational agents and identify the relevance of these systems with children. We follow with an analysis of opportunities these devices can bring to kids and follow with some challenges as CAs may face when talking to a child. Finally, we discuss some risks conversational agents may cause children.

As with every technology, conversational agents can benefit people, but they also cause potential harm. We need to pay special attention to children, as they are frequent users, and they have special needs.

The development of trustworthy CAs seems indispensable to pushing the balance between technology and society in favour of users.

## 3.3 Robotic systems

A robotic system is an autonomous or semi-autonomous machine, capable of sensing its environment, carrying out computations to make decisions, and performing actions in the real world with the use of multiple modalities. With developments in AI, sensing, visual processing and mobility robots appear in spaces that are occupied by humans, including children, affecting the ways humans behave and develop.

Robots for children fall under two general paradigms: (i) robots that function as a physical interface for children's programming skills and computational thinking which has a relatively long history in the area of STEAM education (e.g. Pappert, 1970); and (ii) robots that are designed to interact with children in a socially-meaningful way. Although in some cases the line between these two paradigms is blurred, this section mainly focuses on the second category which is known as social robotics.

For the purposes of this report, we use the term "social robots" to refer to embodied, AI-enabled systems with embedded sensors and actuators, capable of perceiving and processing human social signals, such as human intention communication, and complex social structures, and responding to them in a socially meaningful way (Dauntenhahn et al., 2007).

Recently, there has been a special interest in the impact of the design and deployment of robots on child-users. However, the field of child-robot interaction is still highly diverse, changing and with a scattered set of empirical results. While it shares similar gains and concerns with other implications of AI, the embodied nature of robotic systems allows for a set of additional or different forms of interaction with humans in terms of perception and action.

The embodiment of the systems supports the integration of AI into human physical rather than virtual environments, which has the potential to be embedded in human everyday activities and social fabric.

## Opportunities

Scientific evidence from empirical studies about the impact of robots on children's behaviour demonstrates several examples of applications where robots may have an added value. Despite several technological and methodological limitations, the field demonstrates: a rich representation of different age groups; methods such as experimental, participatory design and ethnographic approaches; and the presence of various robotic platforms in formal and informal settings.

An overview of the empirical studies demonstrates a consensus regarding the potential beneficial use of robots in creating novel opportunities for children's development regarding the following areas:

- **Social learning**. Pedagogical theories indicate the importance of children's social interaction for learning. Due to the effectiveness in engaging children's social cognition, robots can be used to successfully scaffold children's learning and entertainment. Social robots can effectively facilitate children's language learning (e.g. Neumann et al., 2020; Johal et al., 2020, Vincent-Lancrin et al., 2021), problem solving (Charisi et al., 2020a; Charisi et al., 2021a).

- **Children's perceptions and acceptance of robots**. Children's perceptions of their acceptance of robotic artefacts have been widely researched, especially in post-intervention sessions with various methodologies. Research shows children's perception of robots to be relatively positive, curious and exploratory, while there are some differences in relation to the embodiment of the robot (Søraa et al., 2021).

- **Personalisation and adaptation**. Children's individual differences in terms of cognitive and socio-emotional development, as well as their personal needs and preferences can be addressed with autonomous robots that adapt to individual behaviour and appearance (Fitter et al., 2018).

- **Embodied cognition and physical interaction**. The embodied nature of robotic artefacts facilitates children's interaction with the physical world, including the physical social interaction with robots and with peers. The potential of multimodal, verbal, and non-verbal communication of robots provides the means for a powerful interaction, which can elicit communicational properties that respect children's holistic development. The variety of robots' morphological characteristics and the degree of a robot's anthropomorphic features in terms of appearance and behaviour provide a large palette of possibilities.

- **Inclusivity**. Extensive research on the use of robots for diagnostic or therapeutic purposes with autistic children has shown that the robots' socio-technical nature and their predictability are effective for the scaffolding of interventions that help autistic children develop social skills (Ghiglino, 2021).

## Challenges

While research in the field of child-robot interaction has already yielded evidence to demonstrate the effectiveness and the potential benefits of the use of robots in formal and informal settings with children, there are several challenges that require special attention when researching and deploying robots to interact with children.

- From a research perspective, the current empirical work lacks **large scale and longitudinal** studies that span more than several months, such as the one presented in Davison et al. (2020).

- Due to current technical limitations in the deployment of fully autonomous robotic systems, most of the empirical studies are being held in **controlled settings with close-ended tasks**.

- The vast majority of activities and studies in child-robot interaction are being conducted in **developed countries** with a relatively small representation from developing countries, especially from Africa (e.g. Mondana et al., 2016; Charisi et al., 2021b).

- **Novelty effect**: Children's behaviour and perceptions of robots are still under the effect of novelty. That means that children who

participate in the research might contribute to results that are biased by the novelty.

In addition to the above-mentioned challenges, current evidence in research of robots for children has highlighted the following concerns:

- The **complexity** of a robotic system which relates to various modules (e.g. computer vision, decision-making, planning, control etc.) which are integrated into one system, makes it more difficult to address emerging issues for **transparency and explainability**.

## Risks

While robotic applications bring certain unique and novel opportunities for children's development and well-being, their design, development and deployment entail certain risks. These risks can be connected with multiple aspects, one of which concerns the characteristics of a robotic application regarding its connectivity, autonomy, embodiment and social embeddedness (Charisi et al., 2021c). We summarise some of the emerging risks as follows:

- **Privacy and data protection**. A connected embodied agent may collect and share personal data from and about the child-user. The user might not always be completely aware of such collection of processing, which raises concerns in terms of transparency (Articles 12, 23 and 14 of the GDPR) and the informed consent that might be required from the data subject (Art. 6 of the GDPR). In addition, the physical and embodied nature of robots allows the combination of various modalities that create a more accurate representation of the surrounding social and physical environment. This might result in the perception of aspects of human activity that put children's privacy at risk. A social robot might be able to navigate the personal space of the child perceiving personal information of child's private environment. This might become even more complex in the case of a telepresence robot which is manipulated by third users (e.g. social robots for elderly care).

- **The (child's) right to be forgotten** and other **data protection** rights. In the case of connected robots there are emerging, considerations regarding how the data subject (in this case the child) can effectively exercise their data protection rights need to be taken into account. Personal data can be collected and stored in cloud services, where it could be kept for longer than necessary and be subject to data breaches. In this context, a personal data breach might have a serious impact on a child's future.

- **Freedom of expression**. Children's interaction with cloud-based robots raises issues of their freedom of expression. In the case of a child's interaction with a cloud-based robotic device, it might be advisable for a child not to share sensitive information with a connected robot. Yet this imposes limitations of children's freedom of expression.

- **Cyber-security**. A connected robotic system can be hacked by threating actors, potentially impacting the safety and fundamental rights of the children interacting with it.

- **Reduction of children autonomy and oversight**. One of the main goals of social autonomous robotic systems is to support humans in a complementary way and to facilitate humans' well-being. However, in the case of over-reliance on robotic support, this might raise considerations about human autonomy. Especially in the case of child's over-reliance on robotic interventions. **Bias amplification and discrimination** system training processes are often based on the data of humans with a specific cognitive, social and cultural background. This results in discrimination and bias in terms of perception and interaction.

- **Overtrust**. The use of embodied social agents has the potential to effectively communicate, present and deliver abstract information regarding the system's decision-making process to children in a developmentally appropriate manner. Yet, embodied social agents might be used as tools for misguidance. A robotic agent might trigger children's trust based on design decisions regarding its appearance and behaviours, which in some cases might lead to over-trust.

- **Propagation of existing gender stereotypes**. Robots may reinforce or counteract gender stereotypes (Song-Nichols & Young, 2020; Wang et al., 2021) which has an effect on human behaviour towards robots (Kraus et al., 2018) and eventually towards other humans.

- **Stimulation of children's agency attribution to machines**. The human brain has the tendency to attribute anthropomorphic characteristics and agency to inanimate objects and artefacts. Children attribute agency to things that look, move, act and interact like agents, by exhibiting goal-directed actions or being responsive to changes of their environments (Piaget, 1929; Leslie, 2006). Agency attribution depends on many variables and how this capability develops from early infancy, and may depend on different factors. For example, agency attribution may be biased by the negative or positive outcomes of the machine (Hamlin et al., 2014), by agency cues and by the affective valence of actions' differing between cultures (Bart et al., 2019; Goya et al. 2019). For this reason, special attention should be given to how robots (and they behaviours) are designed.

## Future directions

The identification of the potential opportunities and of the current challenges and risks for robots for child-users is only one first step towards the design and deployment of robots, which could be used to expand children's potential in novel and safe directions.

One of the unique characteristics of robotic technology is its embodiment and the potential embeddedness in children's everyday physical activities. For this reason, further research is needed on how the embodied nature of robots might have a distinct impact on children's rights and how robots can be used as a tool for the best interest of all children.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# 4. YOUTH'S PERSPECTIVE: FROM THE WORKSHOPS WITH CHILDREN AND YOUNG PEOPLE

To study the impact of AI technology on children's rights, it seemed to us essential to include the voices and views of children in the research process, thus we adopted participatory research method. We invited young people aged between 14 and 20 years old from across Europe. Ten young participants coordinated by the European Schoolnet/ INSAFE network joined. Additionally, as the Spanish ambassador of the Spanish Plataforma de Infancia could not be present at the workshop, they provided us with a written contribution describing the outputs of two other workshops organised with eight teenagers on the same topic.

During the workshop young participants could:

- express their views, perceptions and preconceptions of artificial intelligence (AI) and discuss them with experts to explore them deeper;
- determine in what way AI could positively influence children's rights or, on the contrary, how it could challenge them;
- formulate important questions to ask before implementing AI further in our everyday lives, so as to protect and guarantee children's rights.

Participants recognised the presence and usage of AI technology in usual tools of everyday life. They provided several examples in various fields of application such as entertainment, gaming, e-commerce, education, transport. Surprisingly, apart from the example already provided by Fitbit, they did not report cases of AI applications used in the healthcare system.

Youth panellists wished that AI could contribute to get the new generations to a better and safer world. This wish took form with some examples that covered different fields of application. In some cases, they recognised both opportunities and risks (e.g. online safety and security, knowledge and learning). They showed concerns about the amount of personal data collected to let AI operate, and acknowledged the tensions in completely trusting AI.

Looking to the future, young participants asked for transparency and explicability (e.g the use a child-friendly language) and ex-ante evaluation, involving end-users when conceiving and developing AI-based tools. They underlined the need for law and regulation of AI and children's rights to balance protection and participation, and finally they expressed their wish to be ready for AI that will surely impact their educational and professional-life paths.

They called for more knowledge and more (digital) skills for all ages (e.g. children, parents, educators) to be accompanied by ethical and philosophical questions when conceiving, developing and using AI.

In this section, we present the youth workshop which provided insights about children's perspectives on AI and their rights.

To study the impact of AI technology on children's rights, it seemed essential to include the means to collect and study the voices and views of children and young people themselves. For this, we chose to rely on the methods of participatory research (PR) (Vaughn & Jacquez, 2020). We invited children and young people aged between 14 and 20 years old from across Europe to discuss with researchers and policymakers AI and children's rights in an online workshop.

Ten young participants joined JRC experts (AI technology, privacy, online safety) in the workshop on the 15 to 16 April 2021: 6 girls and 4 boys; aged 14 (1), 16 (3), 17 (2), 18 (2) and 20 (1); coming from Austria (1), Czech Republic (1), Greece (1), Iceland (1), Ireland (2), Italy (2), Lithuania (2), Malta (1).

European Schoolnet coordinated their participation, on the margins of the INSAFE network. Participants have all been BIK Youth ambassadors and participated in the Safer Internet Forum in November 2020. This prior experience certainly raised awareness among the young panellists of the issue of children's safety in the digital world.

The workshop was designed to allow young participants:

- to express their views, perceptions and pre-conceptions of artificial intelligence (AI) and to discuss them with experts and explore them deeper;
- to determine in what way AI could positively influence children's rights or, on the contrary, how it could challenge them;
- to formulate questions important to ask before implementing AI further in our everyday lives, so as to protect and guarantee children's rights.

As a first step in participatory research, this methodology allowed us to collect children and young people's voices and views and to consider them as an important input to shape the outcomes of the study.

We provide here an outcome summary of the JRC youth workshop, and of two online workshops gathering eight teenagers in Spain and coordinated by the Spanish Children's Rights Coalition (known as Plataforma de Infancia).

We acknowledge that given the relatively small number of participants, the findings of this workshop provide only some indications for further exploration, and we invite researchers to expand on children's perceptions about the use of AI in various contexts.

## 4.1 Participants' preconceptions of AI

Workshop participants recognised the presence and usage of AI technology in the usual tools of everyday life. They provided several examples in various fields of application (Figs.3 and 4). These examples can be summarised as follows, based on a categorisation by sector of application of AI technology, and starting with ones closer to the everyday life of the participants:

**Entertainment**. The use of recommendations systems based on previous choices powered by AI in popular applications like Spotify, TikTok, YouTube, search engines and social media in general. Items of news or articles written using AI powered tools. Machine drawing and/or enhancing pictures.

**Gaming**. BOT and Virtual Non-playing characters in video games were mentioned particularly by gamers among the participants. Interestingly, speaking assistants, such as Google assistant, Siri, Alexa, were also reported in this field of application. Lego robot, even though robot applications were not discussed extensively as participants still consider them as science-fiction and non-realistic.

**E-Commerce**. AI powered tools allowing targeted advertising, adjustment of prices according to users' behaviours and interconnections with other services such as Facebook and Google. A direct experience of AI drone grocery delivery services was reported as one of those presenting failure.

**Education**. When thinking about education, panellists' thoughts went to the Covid-19 pandemic and their experiences of remote learning and online schooling. First, they made some considerations on how the entire

educational system has been and will, most probably, be impacted. They see the opportunity to develop new ways of learning online and that AI could be part of this. Then, they also mentioned that AI systems were already in place when using platforms such as Microsoft Teams, Zoom and others during the lockdown. Some of the participants have had some experience with self-learning tools (e.g. Duolingo), auto-correct keyboards (i.e. Gboard), applications that evaluate the users' level of knowledge of a certain language (i.e. Duolingo) and accommodate the supply of learning materials to the level of user's needs. Linked to this, the use of AI within automatic translation services from one language to another (i.e. Google translator). To conclude, smart toys were also named among AI-powered tools that could support informal learning.

**Transport**. Auto driven cars were immediately mentioned by our participants. Along with this example, Google maps using predictive traffic was also reported. With a glance to the future, participants mentioned the possibility of using AI for auto-piloting planes.

**Healthcare**. Workshop panellists reported that it would be beneficial if Artificial Intelligence could support future generations to live in a better world. AI could serve as a tool to assist doctors, either in prevention of diseases and in forecasting future diagnosis, or in care during surgery. Fitbit was also among the practical tools given as an example. Only one of the two workshop groups provided an example of AI in the field of healthcare.

**Astronomy**. Apart from the use of AI with satellites, no other example was provided for this specific field of application.

**Agriculture**. Panellists identified the use of AI for weather forecasting, data analytics from data collected by drones and for water and crop management.

**Finance**. Market analysis powered by AI to make predictions of the evolution of the stock market was an example.

**Personal data protection**. Participants showed concern about their sharing of personal data with digital platforms and services in exchange for free access and use. They are aware of the trading of personal data that they are subject to, and they link this to the need for vast quantities of data to develop AI systems.

## 4.2 Participants' perceptions on the impact of AI on children's rights

The young panellists provided a large spectrum of examples and could link them to various challenges and opportunities, bringing either clearly positive outcomes or fears of negative consequences. Most were described challenging and holding both positive and negative view, depending on the context of an application and its use. 'Who', 'when', 'why', 'what for' were essential dimensions of the discussion.

In the following sections, we present a summary of the benefits/opportunities and risks/challenges that AI can bring to children according to our young panellists.

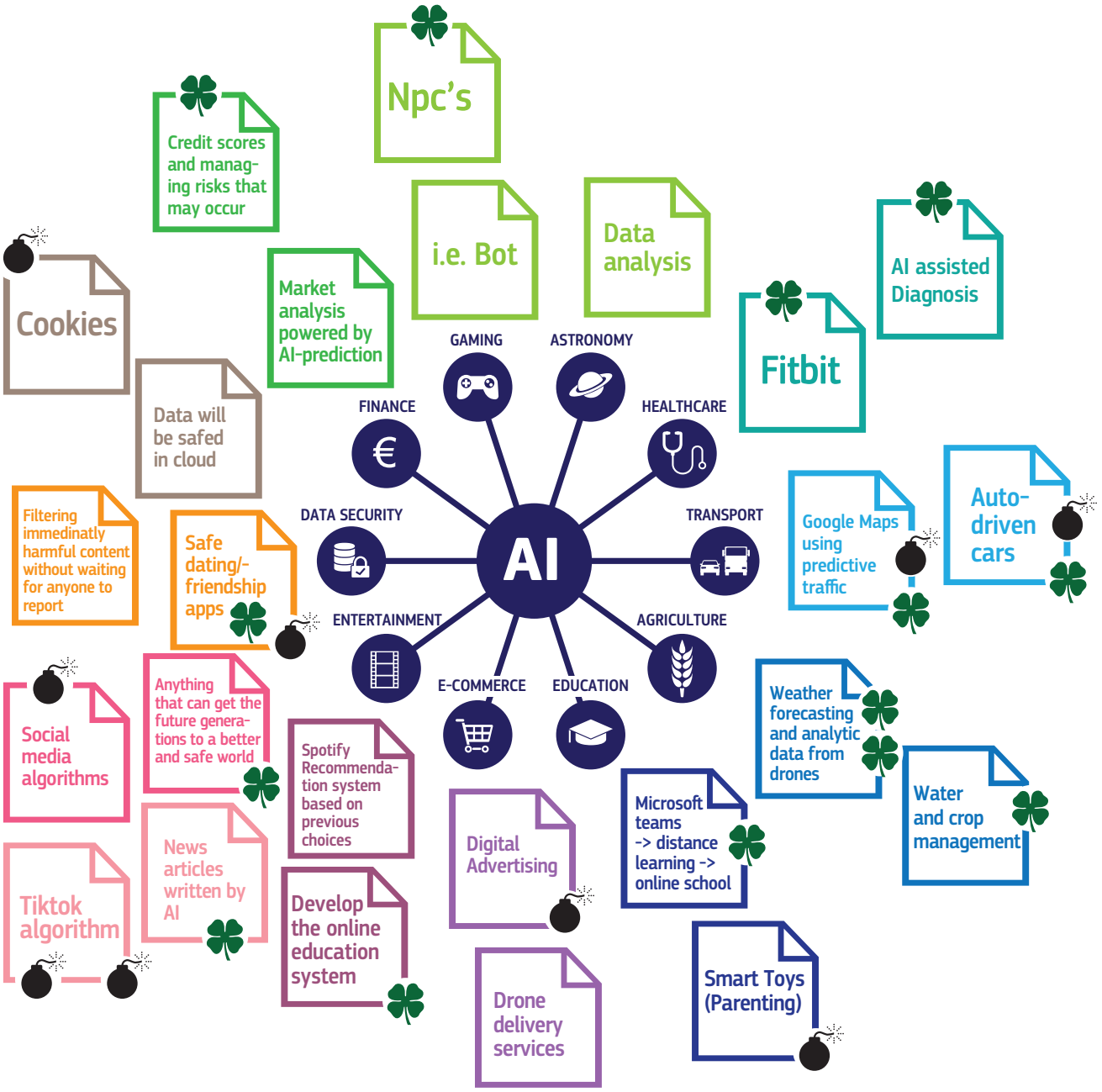
### *Benefits and opportunities - "What AI can bring to me?"*

As general comment, participants wished that AI could contribute to bring the new generations a better and safer world. This wish took shape with some examples that covered different fields of application:

**Information and entertainment**. Bearing in mind that recommendations systems (RS) are based on personal data collection, and particularly the previous choices of the users, participants showed appreciation for the opportunities that these mechanisms could bring to them, notably by easing, personalising and reducing search time. In the case of social networks and media, RS support was seen positively in nurturing social life and opening up opportunities for meeting new people, as well as getting to know new interesting content, tools or products.

AI assisted by drawing, picture or video-enhancing software is part of the common toolset present on smartphones nowadays: this is fun and boosts creativity. Personal and speaking assistants like Alexa, Siri or hey Google were also seen as fun, easy and practical to use. Moreover, they offer efficient compensation technology for non or poor writer-readers, including young children. In the video-gaming world, the use of NPC characters – AI technology driven – renders the game more real, enjoyable and attractive.

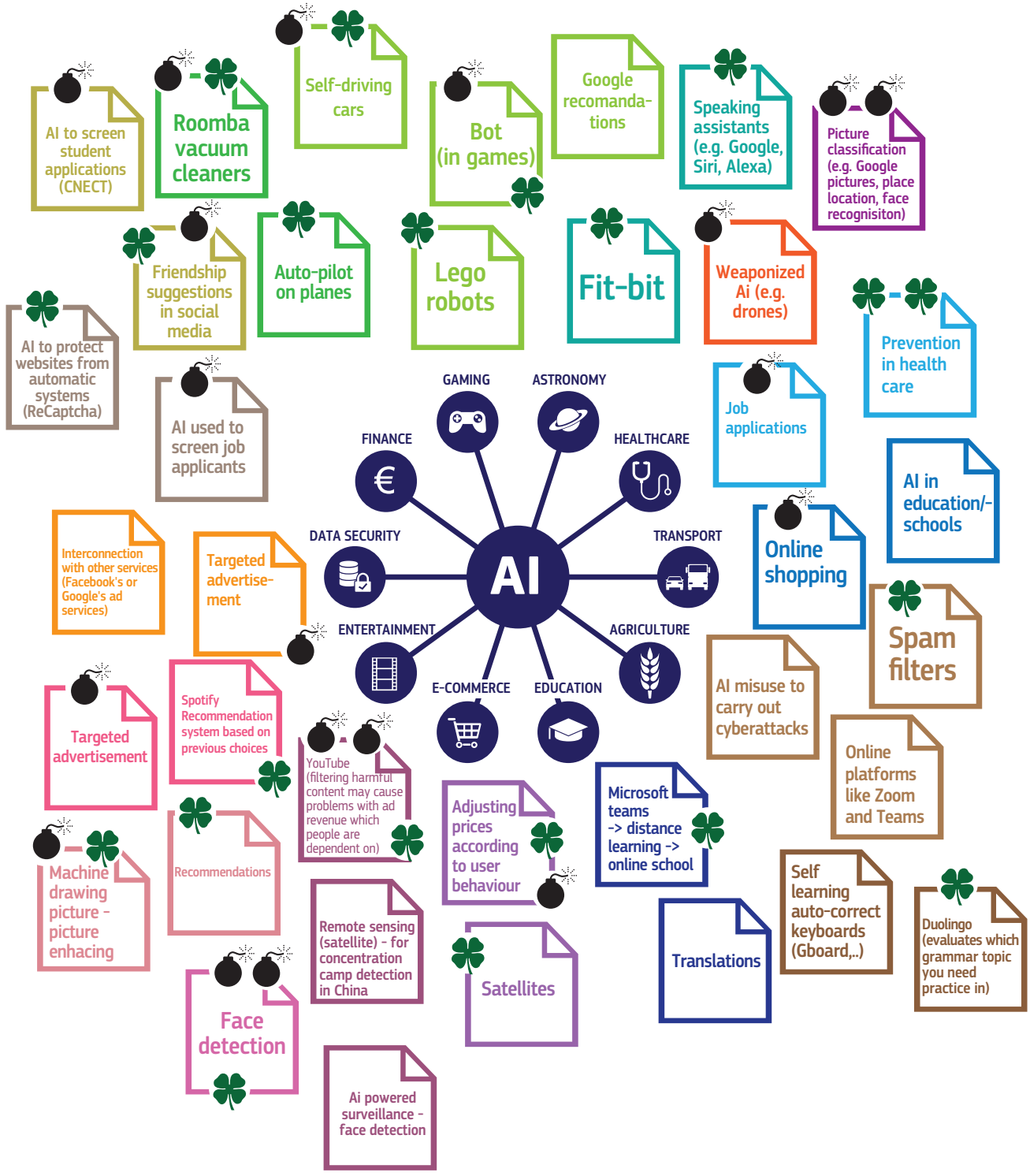
**FIGURE 3**
**Young participants' preconceptions and perceptions of AI technology applications (blue team)**
Source: EC




Possible risks as perceived by young panelists

Possible opportunities as perceived by young panelists

**FIGURE 4**
**Young participants' preconceptions and perceptions of AI technology applications (green team)**
Source: EC




Possible risks as perceived by young panelists

Possible opportunities as perceived by young panelists

**Knowledge and learning**. AI could simplify knowledge discovery thanks to RS and voice recognition applied to search engines. The common use of applications includes: AI for language translation (Google translator) as practical and easy tools, language learning app (Duolingo) that allows more tailored learning;, AI-based learning tools such as editing and auto-corrector tools and self-learning; and predictive keyboards. Participants underlined the promising opportunities that such tools open to students that suffer from difficulties in using traditional tools and learning strategies (dyslexia, visual impaired students, blindness).

**Health and care**. AI could simplify the lives of patients and doctors by enhancing prevention and assisted diagnosis. This dimension of AI technology seemed still far off from the preoccupations of young participants, although they recognised the use of apps and tools such as Fitbit as having great potential for preventive health care. Surprisingly, apart from the Fitbit example already provided, young panellists did not report examples of AI applications used in the healthcare system, though the healthcare sector should be especially at the forefront of adoption in the EU Strategy for AI. This could be explained by the age of participants, but also by the way AI is presented to the public: "Maybe our generation is more into fantasy about AI and the negative consequences, so the opportunity does not come up immediately."

**Online safety and security**. Participants realised the importance of AI in cybersecurity, and spontaneously provided examples (e.g. protection spam filters, AI supporting the launch of cyberattacks). The dual nature of technology was underlined especially in this part of the discussion.

Based on the same model that allows RS tailoring content to be closer to the user thanks to profiling, AI could support prevention by automatically filtering harmful content upstream, rather than leaving the users reporting negative content. For example, in areas close to their concerns, participants also saw the advantage of AI in providing secure dating/friendship apps and online educational systems.

Safety and security were also discussed for transport by self-driven cars and planes, and when talking about finances (credit scores and risk management).

### *Risks and Challenges - "What should we pay attention to with AI?"*

The discussion dedicated to this question turned around AI usage and potential risks to privacy, data protection and fundamental rights. Practices allowing profiling were perceived sometimes to be close to surveillance. Participants also mentioned the risk of failure of the AI technology or errors in its outcome, the difficulty detecting these errors, and the issue of accountability when such errors occur.

**Personal data collection**. The young participants showed concerns about the personal data they exchange for free access to platforms and online services. They are aware that the development of AI systems needs vast quantities of personal data. Participants aired their concerns as well regarding lack of awareness in: the sharing of personal data (e.g. automatic tagging and geo-localisaion); the negative impact of AI applications in terms of data protection (e.g. targeted advertisement, screening of job applicants); and about the mandatory collection of personal data (e.g. cookie walls), as well as complicated and long privacy statements not understood by children.

**Trust**. The trust that users can invest in AI technology remained at the level of philosophical questioning for most, having difficulties anchoring them with concrete examples. Still, and close enough to this subject, one panellist recognised business opportunities, but questioned the trust and the fairness of the business model: "Also, the financial side. Lots of people that make money from YouTube. If something is changed in YouTube through AI, that may affect the finance of those people".

**Surveillance and profiling**. They also expressed concerns about weaponisation of AI in military applications and surveillance, abuse of AI for marketing purposes, but also the possibility of AI being used by the State to induce behaviour in people and reduce their freedom, by "civilising" them. Possible "positive" applications of AI include avoiding the unintended disclosure of personal data from kids (e.g. in massively multiplayer online games (MMOs); filtering email addresses).

**AI Failures**. Unexpected AI failures (e.g. AI powered content filter that excludes the wrong content) and their consequences.

## 4.3 What do young people tell us, what are their concerns?

Participants showed a balanced approach towards Artificial Intelligence. They see AI as an opportunity with potential benefits and at the same time, they expressed concerns about challenges, dangers, risks, and harms that the use of AI technology can lead to. The young participants recognised the increasing complexity of the digital world as an interlinked world based on data and information, but also as technically challenging.

**AI – An "unavoidable and 'mind blowing' technology": Lots of talk, little knowledge**. Panellists judged AI technology as "mind-blowing" technology, considering its capacities. Still their primary concern was that they perceive AI as progressing a lot, while they consider that people lack knowledge of what AI is and what its implications are. Participants themselves declared knowing little about AI: "I don't know about AI intelligence a lot and I would like to learn and maybe talk about AI with my friends and classmates at school. I want to know like the whole situation". They also recognised that AI technology is set to become an essential feature of their lives, yet they questioned how fast its adoption will be.

**Concerns on privacy, data protection and trust**. The discussion on AI technology and data collection generated initial considerations on the rights to privacy and data protection. Participants were aware of the trading of their personal data that they are subject to when using online services, and they link it to the need for vast quantities of data to develop AI systems.

They showed concern about their sharing personal data with digital platforms and services in exchange for free access and use. Furthermore, they mentioned the risk of attacks on people's privacy by companies or governments (e.g. the use of AI to control where any given citizen goes, and who they relate with; the perverse use of facial recognition, GPS or data shared by users while on the Internet, especially on social media).

The participants linked these privacy and data protection risks to the difficulty for young people in accessing information on data collection and data storage in the legal terms and conditions for the common online service they access (privacy policies), due to a lack of use of child-friendly language. One participant also underlined the coercive nature of online services ("Who cannot be on Instagram or TicToc nowadays, if they want to connect with friends?"), and the inherent data collections system at that underpin such services ("Can you really say no to data collection if you want to use the app?").

Additionally, the young participants questioned the true capacities of AI, and the impacts technology can have on their lives. Regarding safety, they questioned the risk of "AI rebelling against humans and weaponised AI", as well as the risk of manipulating people's thinking/opinions, of children's behaviours.

**Getting ready for AI – education and the job market**. Participants showed concerns regarding the future of their work and pictured a scenario where AI could replace humans. In this context, they questioned how the school and society can prepare them for a world transformed by the AI revolution in motion: "What to learn, how to learn?". On the technical and skills side, but also on the ethical and emotional side, it was noted that: "It is not because a technology allows to do things that it is good to use it".

## 4.4 What do young people propose?

To balance protection and participation in a digital world driven by AI-technology, young panellists proposed:

- More knowledge, more skills - protective rules and ex-ante risk assessment. Awareness raising and empowerment through education among users of all ages using age adapted materials and groups (e.g. disabled and vulnerable), on: (i) the nature of AI; (ii) its ways of functioning, what it needs, what it provides; (iii) if something goes wrong who can help to solve it; (iv) on improvements process; and finally (v) on the legislative framework within which AI systems can be used. Young panellists requested children-friendly risks assessment of the technology from designers before the market release of applications, based on their ethical questioning of AI.

- Transparency and explicability - Finally, the young panellists demanded transparency regarding AI: how and where it is used, for what

aims, and based on what. They also asked for a simple and child-friendly explanation of the use of AI technology as a way of raising knowledge and awareness. They drew a parallel with the imposition of cookie-technology alerts, which according to them raise awareness about data collection and sharing. Drawing on this model, the participants suggested the creation of AI alert messages and clear and simple information regarding its use, when the technology is used in online services.

## 4.5 Participants' questions about future directions

We report in Fig.5 the questions that the participants of the youth workshop found important to ask, at this stage of their analysis and understanding of AI technology, its applications, its benefits/opportunities, risks, and challenges.

**FIGURE 5**

**Young workshop participants' questions on future directions**

Source: EC

### Safety and risks

Would AI be trained very well to not turn on their owner?

Since AI can have the capability of learning, how can we be sure that it is respecting children's rights?

Will AI be able to make the situation better or worse?
Will AI be able to manipulate people's thinking/opinions?

(Assuming we want it to do so as little as possible) - How can we prevent it from doing so?

Where should the line be between marketing and children's psychological well-being?

Is AI manipulating children? What dangers does unmonitored AI bring to humans using it?

### Future prospect

All users need to know more about AI – information that they can understand should be provided.

What may be the timespan till AI becomes an essential part of everyday life?

Will AI become more smarter, more capable etc. in the future?

What is the presumed interaction between humans and AI is going to look like?

Do people get (grasp) the definition of AI?

Do people get (understand) the benefits of using AI?

Do people get (understand) the risks of using AI?

Are users aware in which parts of their life AI is already present?

### Educational needs to prepare the new generations to AI

What will be needed by our generation to be able to know exactly how it will affect us and how students are going to be educated about AI?

Regarding education, will AI be able to instruct young children about empathy and other important emotions?

### Employement

How exactly will it affect people, especially their jobs?

### Trust

Do people trust AI?

In which tasks do they trust AI and in which they do not?

Will AI be able to make the situation better or worse?

How reliable can AI really be in comparison to humans doing the same job?

### Future prospect

What is the chance of recently developed AI may compromise children's privacy?

### Provision: Increasing awareness and feedback to users

Are users aware of the presence of AI technology on the online platform they decide to visit

When we feed the AI with data, are the users well informed about which data it is and for what purpose will it be used?

Are children (potentially all users) informed about it in a clear and easy-to-understand way?

### Protection and Participation

Where is the line between protection and participation of children in AI?

Protection is the "base" which we should think about first and then build upon it further. Making children "comfortable" in a way that they trust the AI system, this also goes hand-in-hand with protection of children.

Will further regulations be put in place? Which ones?

Will they ensure the advantages of the free market but also respect people's privacy?

Where's the middle ground between these two

# 5. EXPERTS' PERSPECTIVE: FROM THE WORKSHOPS WITH SCIENTISTS AND POLICYMAKERS

This chapter proposes a set of directions for the implementation of future research and policy on AI and children's rights. It summarises the outcome of a series of three online workshops at the end of 2021, that gathered eight JRC researchers, eight external experts with varied backgrounds and seven EU policymakers (see the acknowledgement section). After being introduced to the outcomes of the reviews on policy initiatives and on the scientific evidence regarding the three selected AI systems as well as to the outcomes of the youth workshops, the participants explored the needs and gaps in research and policy regarding AI and children's rights. They identified and articulated requirements and methods that need to be considered, as well as knowledge gaps and directions that need to be prioritised for future research and policy.

Five requirements were identified: (i) AI minimisation, valuable purpose and sustainability, (ii) transparency, explainability and accountability, (iii) inclusion and non-discrimination, (iv) privacy, data protection and safety, and (v) integration and respect of children's agency.

Four methods were highlighted as necessary to develop successfully and frame child-friendly AI technology: (i) anticipation, evaluation and monitoring, (ii) multi-stakeholder collaboration, (iii) children's participation, and (iv) balancing conflicting rights.

Pressing knowledge-gaps and three priority directions for research were also underlined: (i) children's cognition, development, and play, (ii) empowering through education, and (iii) age verification systems.

Here again, we acknowledge that given the small number of participants in the experts' workshop, the findings presented provide only some indications which merit further exploration, and we invite researchers to further explore AI and children's rights in greater detail..

We invited specialists from various scientific fields and sectors to participate together with EU policymakers in a series of three workshops, which took place in November and December 2021, and to reflect on future directions for implementation of AI in relation to children.[59]

The first workshop focused on the introduction of the scope of the workshop series, the presentation of the core elements of the current report, as well as on generating ideas about the topics of the report.

The second workshop considered the written feedback by the experts on the first draft of this report, and considered a series of policy-related questions that we received from the invited policy experts. Based on these questions, the participants were asked to formulate a project which would prioritise certain topics and would propose corresponding methodologies.

The third workshop elaborated on the conclusions of the activities, as well as on the reflections regarding the methodologies that could facilitate research to support decision-making.

Below we present and elaborate on the topics that emerged during the interaction of experts and policymakers in the three workshops, and the questions that were proposed for an integrated policy and research agenda.

## 5.1 Requirements for AI policy supporting children's rights

Five requirements were identified:

I. AI minimisation, valuable purpose and sustainability,

II. transparency, explainability and accountability,

III. inclusion and non-discrimination,

IV. privacy, data protection and safety, and

V. integration and respect of children's agency.

### 5.1.1 AI Minimisation, valuable purposes and sustainability

An important dimension of children's lives that was only briefly tackled during the workshop relates to the quality of the environment in which children are growing. In its Art. 27, the UNCRC especially takes into consideration the risks of environmental pollution.[60] AI technology shows potential to address some environmental challenges in several fields, according to some publications (Vinuesa et al 2020; Liu et al. 2019).

Smart energy grids, smart farming, smart transport are a few examples of fields in which AI is already showing promising positive environmental impacts around the world. Still, data centres, critical for storing the substantial amounts of data needed to power AI systems, demand huge amounts of energy, and have already pointed out as important contributors to increased CO2 emissions.[61]

Recently, Vinuesa et. al (2020) concluded their study on the role of AI in achieving the 17 UN Sustainable Development goals (Strubell et al., 2019) by calling for actions to achieve sustainable AI that go beyond environmental considerations, to include systemic and ethical evaluations.[62] Similarly, a recent European report on the Impacts of the digital transformation on the environment and sustainability (Liu et al. 2019) already recommended measures to minimise the footprint of digital products and services. This echoes the above-mentioned need for more transparent handling and protection of personal data.

Furthermore, an approach rooted in the concept of 'data minimisation' and 'AI minimisation'

**NOTES**

[59] We invited 8 experts with backgrounds in engineering, developmental psychology, law, child-computer interaction, and robotics as well as policymakers from the relevant Directorates of the European Commission (DG.HOME, DG.JUST and DG.CNECT), as well as other policy organisations and agencies, such as the European Union Agency for Fundamental Rights. The experts came from diverse geographical areas: Belgium, Chile, Italy, Netherlands, Spain, the UK and the USA.

[60] https://www.unicef.org/child-rights-convention/convention-text

[61] https://ec.europa.eu/environment/enveco/resource_efficiency/pdf/studies/issue_paper_digital_transformation_20191220_final.pdf

[62] THE 17 GOALS | Sustainable Development (un.org) https://sdgs.un.org/goals

would limit the use of AI to complete tasks that are considered essential, and having valuable purposes. Yet, this opens up the crucial question of what 'valuable purposes' are. Despite relevant research in the field, more evidence is needed to determine what 'valuable purposes' are for children.

Experts participating in this work stress that society must not consider the use of AI technology as an unlimited resource. Strategic and systemic choices will be needed to develop the AI services at public and private levels. Considering the negative environmental impact and the positive implications of AI on climate change will be crucial in moving forward to better children's lives.

### 5.1.2 Transparency, explainability and accountability

The literature review and the interdisciplinary discussions with researchers, policymakers and teenagers confirm the importance of transparency and information provision as a key consideration for AI and children. Transparency and explainability are related to the right to the information but also linked to education and literacy.

**Transparency and explainability**

As a conclusion of our analysis, transparency so that children can become informed, empowered citizens and users of AI is seen as a means to promote critical thinking and fight misinformation and preventing over-trust, or mistrust in AI systems.

What are the most suitable ways to explain AI systems in child-friendly language remains an area to be researched, while being a topic that is partially being addressed now by various non-profit educational organisations. This also includes an analysis of how to adapt these explanations to children at different developmental stages.

Aware of the increasing presence of AI in their daily lives, teenagers taking part in our youth workshop mentioned their wish to learn more about AI, and the need to create awareness and knowledge about the nature of AI, how it works, what it needs, what it offers, the legal requirements for AI, how to behave in a responsible way with AI.

Performance and accuracy of models are no longer the only criteria for evaluating algorithms. Their transparency and explainability has become an additional criterion and a priority that cannot be ignored, especially for end-users (Weitz et al., 2021).

**Accountability**

It is widely accepted that all AI actors should be accountable for the proper functioning of AI systems, based on their roles, as well as on the context in which they are applied, in prioritising children's fundamental rights. The involved organisations and individuals are expected to ensure the proper functioning of the AI systems, throughout their lifecycle, that they design, develop, operate or deploy, in accordance with their roles and the applicable regulatory frameworks.

Their accountability is expected to be demonstrated through their actions and decision-making process and it involves: (i) the data used to develop and operate an AI model; (ii) the governance at an organisational and system level; (iii) monitoring of the system over time; and (iv) the performance of the system or of the components of the system.

This is highly connected with transparency at an organisational and system level of procedures that can be audited. However, AI systems pose unique challenges because their input and operations are not always visible, especially to the end-users. An AI system might be opaque because the implemented algorithms are inherently difficult to understand or because of proprietary reasons. As such, especially for AI systems that are designed for children, there is an emerging need for the identification of the minimum requirements that would ensure and monitor the accountability of the involved AI actors.

### 5.1.3 Inclusion and non-discrimination

The challenges and risks of exclusion and discrimination due to the use of 'biased data' have been the subject of extensive debates worldwide, and the case of children's data has raised special attention in this context. The discussions with experts and youth, preparatory to this work, suggest that a unique approach will not be sufficient to tackle the theme comprehensively. Instead, a socio-ecological approach seems promising to enhance children's

rights to inclusion and non-discrimination by developing capacity-building and knowledge sharing. Based on Bronfenbrenner's Ecological Systems Theory (1979), we identified four levels of interactions (individual/child, community, societal and policy levels) emphasising the importance of the interplay and relationships between them (Fig.6).

**Child**

Drawing on the first interactions during the Youth Workshop, participants pointed out the need for more knowledge, and rules to balance protection and participation in a digital world driven by AI-technology. They underlined the concept of diversity and the need to tackle users of all ages (very young children, children, adolescents, but also adults) and particular groups (e.g. disability, special needs, cultural, socio-economic and gender).

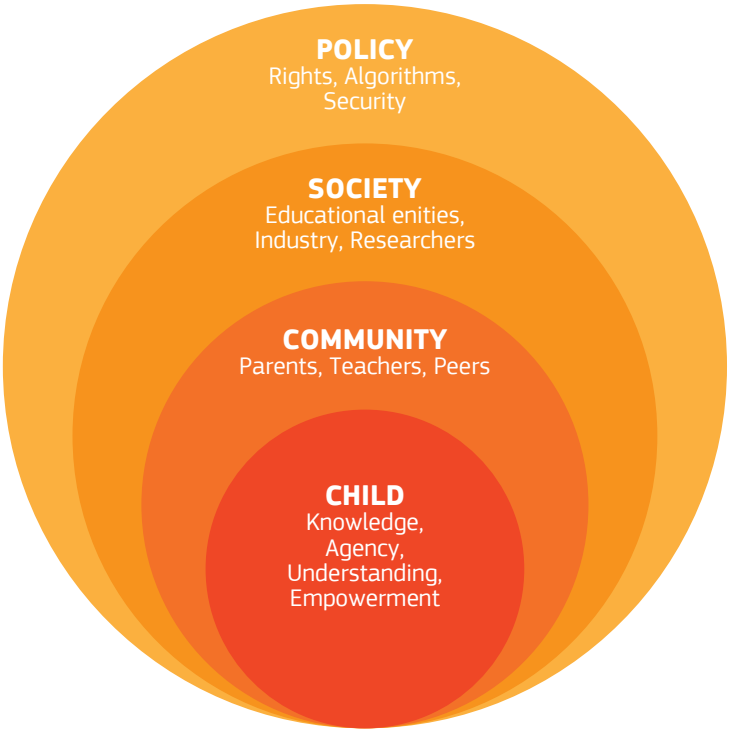
Interestingly, they already suggested the need for interactions with the other levels of the model. More precisely, they highlighted the need to build AI knowledge for their adults of reference such educators and care givers. As the literature suggests (ZOPED-Vygotsky) these "more knowledgeable others", like parents and teachers, may enhance the children's learning slightly above a child's ability level or provide support to avoid exclusion and discrimination "in case something goes wrong" (cit. Panellist). The role of education will be dealt with more extensively in the next paragraph: however experts suggested emphasising the relevance of formal education to build paths to minimise inequalities and foster inclusion.

Indeed, not only do others matter to empower children about AI technology and their rights: individuals, including children, should develop their human agency by acquiring new skills and knowledge, but also by being curious and questioning AI technology and how these systems work. This goes beyond merely teaching, and requires the internalisation of certain concepts.

**Community**

The significance of the role that carers can play within the inclusion and non-discrimination of children in their interaction with AI-based tools was already anticipated in the first section. However, it is important to note that parents

**FIGURE 6**
**Brofenbrenner's Ecological System**
Source: EC



are often addressed either to blame them (e.g. for being responsible of risks and consequently possible harm) or they are patronised (e.g. considered as the ones who allow the use of a digital technology or not). Together with parents, teachers are frequently asked to take over the burden to teach children in recognising risks while using digital technology.

Relying on parents and teachers does not imply any reduction in other actors' responsibilities. Developers, industry, data controllers, regulatory bodies, policymakers and finally researchers play also a crucial role.

**Society**

The need for further research was underlined several times among experts. There is a lack of interdisciplinary research, longitudinal studies and non-experimental approaches. Suggestions for participatory research where children encounter these technologies was made. It is by observing their direct interactions, the setting (at home or in simulated environment), that it is possible to understand how digital inequalities come into play and how children's experiences are different based on their age, socio-economic context, digital skills, and kind of access they have to technologies.

The cautious involvement of industry within research could also be considered in obtaining a full picture of the data processing. There are also limitations related to the unavailability of developers to share data. Linked to this, the use of Big Data and the personal data of children for the purposes of Machine Learning, Communication with Machines and Automation deserve particular attention.

There is a need to understand the impact of: i) more automation, ii) more data, and iii) machine communication.

**Policy**

The right to participation, inclusion and non-discrimination was addressed by all policymakers attending the workshop in different fields of application; starting from education, personal data and privacy issues, cognition and development, and children's abuse and exploitation.

The common understanding is that there is a need for a community-driven exercise to design those policies that could guarantee the respect of children's rights in AI systems. This could be achieved by simulating intervention of the foreseen solutions and addressing ethical challenges.

The recommendation is to develop concrete guidelines and an evaluation framework to assess the impact of AI technology on children's rights. As previously pointed out by the youth panel, considering the child-friendly risks assessment of technology from designers is also a key challenge.

**Algorithmic Bias**

Research and development of AI systems for children are often carried out in the context of WEIRD (Western, Educated, Industrialised, Rich and Democratic) societies, and we need to make sure that technologies, methodologies, conclusions and recommendations can be extended to other populations. Diversity in terms of gender, age, socio-economic status and cultural context should be our target goal in the development of AI systems.

Another important aspect is the consideration of children with disabilities, as AI tools are already being used to help persons with disabilities. AI systems have a strong potential to support people with vision, hearing, mobility and learning disabilities. The use of AI by persons with disabilities can lead to living a more independent life. However, certain AI outputs can reflect discriminatory biases due to the algorithms they rely upon, or due to the underlying data used to develop algorithms. One of the main questions regarding children with disabilities is how to ensure that the use of AI systems do not systematically discriminate against children with disabilities?

There is a need to ensure that AI systems do not systematically reflect discriminatory biases due to the algorithms they rely on. It is of utmost importance to develop concrete guidelines and an evaluation framework to assess the impact of AI technology on every child's right, considering the child-friendly risks assessment of technology from designers and developers.

### 5.1.4 Privacy, data protection and safety

AI breakthroughs observed in the last decade are recognised to be largely supported by advances in computational capabilities, a new generation of machine learning algorithms,

and the processing of huge quantities of data. Nowadays, personal data is much used to both train AI systems and as part of their input in making decisions, predictions or recommendations, or for generating content.

In this context, AI is closely entangled with data protection, as it heavily involves the processing of personal data during its lifecycle. AI technologies enable new levels of automation and new functionalities, allowing for new types of practices, many of which take place in the context of interactions with children. This has become the core business of many digital companies and platforms.

The young participants in our preparatory work linked privacy and data protection risks to the difficulty for young people of accessing information on data collection and data storage, given the complex language in which legal terms and conditions of the common online services they access (privacy policies) are provided. Young participants also underlined the coercive nature of online services and of the inherent data collection systems on which they are based, questioning whether one can really avoid data collection in using certain online applications.

The specific nature of AI, considering its opaqueness and complexity, poses additional risks on top of those that already relate to privacy and data protection, connected to the principles of fairness and transparency, accuracy, purpose limitation, data minimisation and the storage limitation of the GDPR.[63]

The GDPR is an important pillar to support and manage this new AI powered revolution, in preventing negative impacts on fundamental rights. In this context, cybersecurity is also equally important to ensure that the uptake of AI-enabled products and services do not result in further risks to children, including safety.

The GDPR recognises that children deserve special protection when it comes to the processing of their personal data. In the context of AI technologies, this has become especially relevant. Children need to be empowered to control how their personal data is used and what the implications are. There has to be an effort, as it is mandated by the GDPR, to make privacy statements understandable by children, and support them in exercising their data protection rights. More generally, data protection principles, such as privacy-by-design, should take children into consideration and translate into effective mechanisms to ensure their protection.

**Integration and respect of children's right for agency**

Children's right of agency is one of the fundamental requirements to be met when designing and using AI for children. Respecting children's right for agency means that the option for the no-use of AI should be given to the children, while at the same time we ensure that the children choosing off-line and non-AI-based activities have equal opportunities for development.

Adding to this challenge, research usually considers children's perceived agency as a proxy for their actual agency. However, agency is a complex phenomenon which consists of at least a three-levels process:

- the child's sense of agency,
- the opportunities provided to a child for the exercise of agency; and
- the transformation of opportunities into affordances, by designing systems that facilitate children to recognise consciously the opportunities – it is affordances, not just opportunities, that are crucial prerequisites for the exercise of agency by children.

During the workshops, the experts indicated the need for further research on how the construct of agency is developed in children, when they interact with AI-based systems.

## NOTES

[63] https://www.europarl.europa.eu/RegData/etudes/STUD/2020/641530/EPRS_STU(2020)641530_EN.pdf

## 5.2. Methods to develop AI policy supporting children's rights

Four methods were highlighted as necessary to develop successfully and frame child-friendly AI technology:

I. Anticipation, evaluation and monitoring,

II. Multi-stakeholder collaboration,

III. Children's participation, and

IV. Balancing conflicting rights.

### 5.2.1 Anticipation, evaluation and monitoring

Research dedicated to the evaluation and monitoring AI technology used by/designed for children are most of the time limited in terms of case-studies, stakeholders and the period considered. The importance of multi-stakeholder and multi-perspective evaluation methods was mentioned in the literature and by the experts consulted. Children-centric evaluation should combine different methodologies, including participatory methods, interdisciplinary research, collaborative consultation of stakeholders and large-scale studies.

It should also consider different temporal scales and stakeholders. Evaluation also needs real-world scenarios, where the role of industry was considered as involving key participatory actors, in collaboration with academia, civil society actors, policymakers and children. Identified research questions include the creation of frameworks and toolkits that can enable/guide the design and evaluation in the short and long-term of AI systems having children as their users. These frameworks should incorporate aspects such as data protection and risk assessment.

### 5.2.2 Multistakeholder collaboration

During the workshop, it was highlighted that the collaboration among stakeholders from different sectors, and the inclusion of children as actors are important for the democratic development of AI-based technology for children. However, multistakeholder collaboration presents major challenges. For instance, different stakeholders might have different, sometimes conflicting, goals, aims and strategies. Also, they might consider key concepts differently in creating interferences in communication and interactions. The experts consulted proposed that the future AI research agenda should include the outline of a simple framework (or guiding questions) and that would facilitate communication among stakeholders. Lastly, it was suggested platforms should be developed that would facilitate the interaction of different stakeholders based on common projects, but also a common conceptualisation (a lingua franca). Children should be actively involved in such work.

### 5.2.3 Children's participation

Some of the above-mentioned topics for future research and policy have already been extensively researched with the use of well-established methodologies from neighbouring fields. For example, the use of experimental studies is a widely-used methodology for the examination of the impact of certain design decisions on children's cognitive processes. However, there are other areas that are novel, or situations that are unique because of the nature of AI-systems and that require novel methodological approaches.

For example, children's rights for non-discrimination require an AI system to perceive and meaningfully process information from children with different cognitive stages or socio-emotional behaviours. In such a case, an AI system should not discriminate against minorities. One of the methodological decisions that would mitigate discrimination and promote fairness among children is the inclusion of under-represented populations.

There are already initiatives that propose certain methodologies for the investigation of the impact of AI on human behaviour such as the "IEEE: IEEE Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems on Human Well-Being. IEEE Std 7010-2020, pp.1–96".

However, special attention should be given when researching with children. For example, because of the children's fundamental and unique characteristic of rapid development, it is important for research methods to focus on the developmental process over time.

**Longitudinal studies** are needed to provide evidence on the impact of AI on children over the

***Children's participation with a focus on inclusion and diversity.***

*In 2020, the JRC piloted UNICEF's Policy Guidance on AI for Children in collaboration with the Honda Research Institute, Japan. For this pilot, we invited children with a* ***diverse cultural background*** *focusing on the* ***inclusion of children from typically under-represented geographical areas****, namely Uganda, Japan and Greece. The proposed requirements were implemented into a robotic prototype platform, called Haru, which is being developed by the Honda Research Institute. This is a table-top social robot that can be used to support children's cognitive and social development with a design based on animation principles.*

*We used* ***Participatory Action Research*** *to provide the space for the local community to talk about their* ***values, interests and needs****. The educators and the children became part of the research team and interacted with the researchers and the developers. This helped us gain a deep understanding of the ecosystem in which AI system will be integrated in the future and, at the same time, the local communities were an integral part of the global dialogue about AI for Children (Charisi et al. 2021b; UNICEF, 2021).*

long term. This is often a subject of contention in the online safety/well-being field, where there is a tendency to prioritise immediate impressions of, for example, mental health, screen time, etc. over long-term impacts.

**Child-centred methodologies** should be considered; some cognitive and metacognitive skills are still developing in children and the consideration of children's developmental stage would benefit the studies on AI and child's rights (e.g. Zaman, 2020).

**Cross-cultural studies** would allow the identification of patterns of similarities and patterns that differ among children which grow-up in diverse cultural contexts.

**Children's critical reflections** would greatly benefit not only the study of AI and children's rights, but children themselves. This requires the creation of opportunities and the support of children to reflect on AI in a critical way (Charisi et al., 2020b).

**Novel short-term methods** as for certain AI areas, policymakers need scientific evidence in short term. In such cases, we might need to think of some methods that are not used typically. For example, qualitative ethnographic studies that provide answers on the "why" of a phenomenon would allow getting an in-depth understanding of children's behaviour in the context of AI, and would provide some alternatives in long-term studies.

Some of the questions emerged during the workshops are the following:

- Participatory design: How can children participate and be heard in the design and deployment of these AI systems?
- What kind of evaluation and monitoring methods are the most appropriate for children?
- How can we focus on the process of the design and evaluation of the system?

- How can we combine community and child needs with designs derived by companies?
- How can we ensure that our methodologies are human-centred?
- How can we undertake the multidisciplinary approach in AI, in a systematic way?

Most importantly, the consideration of children as one of the stakeholders and actors in the development of policy and research on AI for children would not only benefit all the parties involved, but it would entail a significant learning experience for children as well.

Lastly, we observed that the research on AI-based systems for children often has as its starting point the development and availability of a specific technology with a limited consideration of the impact of the integration of this technology in the wider eco-system of children. For this reason, we propose a critical approach starting with questioning existing problems that children currently face and whether AI is a viable candidate to solve those problems.

### 5.2.4 Balancing conflicting rights

Preparatory work for this report highlighted that various situations involving children's rights in the use of AI technology may appear to be in conflict with one another. For example, adopting restrictive positions on the use of AI by children with the aim to protect their privacy and personal data could impact on children's rights of participation in the public debate. By contrast, using AI technology to improve internet safety among children would require large data collection and profiling exercises, putting additional pressure on children's rights to privacy and protection of personal data. We can find the same conflict when using AI technology to personalise and tailor educational tools to the pupils' needs.

Also, children's rights might conflict with other priorities of society, such as the agility of industry (e.g. developing safe and secure products adds time and uses resources in the development of products).

Not withstanding the increased attention of children's rights, the situation depicted by Livingstone (2015), when considering the internet in 2015, is still valid today regarding the recent development of AI, "technology ambitions of many companies and governments still include little mention of children and even less careful attention to their actual needs and desires". Sometimes the discourse of digital natives seems to be accepted uncritically (i.e. children and young people are already ahead of adults online, so there is no need to address them specifically). Or they are assumed to be the sole responsibility of their parents, who, after all, bare the consequences. Or they are simply forgotten, seemingly invisible in general talk about "the population".

Considering Bronfenbrenner's Ecological Theory of the development of the child, all entities/levels (see Fig.11) that constitute the context in which children live need to address these conflicting issues, together and in relation one with each other.

- Parents are traditionally the ones seeking to balance and accommodate the use of technology by children, arbitrating between provision, protection and participation rights (Diaz et al. 2016). Yet, the experience with new technology is new to them and for this reason they lack points of reference and ask for guidance and support (Chaudron et al. 2017).
- Schools, teachers and caregivers have taken up the challenge in many instances too, either with enthusiasm regarding the possibilities offered, or due to the pressing needs for protecting children from harm, generated by the use of the technology. Nonetheless, their progress is slower than the technology itself; they need training and support to keep pace and to use the technology in a meaningful and profitable way.
- Policymakers have made notable progress over the last decade in considering children in their rights. Still, major concerns are linked to the technology ambitions of many companies, whose business model puts constant pressure on children's data and attention, as it is based on data collection, data flow and data analysis and commercial maximisation of the retro-nurture of this cycle.

It seems urgent for the society – as a whole – to listen to children's needs and desires and to help find a fruitful balance.

## 5.3. Identified knowledge gaps requiring further research

Pressing knowledge-gaps and three priority areas for research have been stressed by the results of this research:

I. Children's cognition, development, and play,

II. Empowering through education, and

III. Age verification systems. We conclude here with a table displaying pressing research questions that need to be addressed (see Table 4).

### 5.3.1 Children's cognition, development, and play

From a research and policymaking perspective, one of the most fundamental challenges to understand and address is the impact of AI-based systems on children's cognition and their socio-emotional development. During the workshop, the topic of the role of AI and robots on child development emerged numerous times. Accordingly, the literature reviews we conducted and presented in Section 3 (on the three examples of AI-based applications) shows that there is already scientific evidence about the impact (positive and negative) of AI applications on children's development and well-being. However, the current evidence is scattered and has certain limitations that need to be resolved for research to support policymaking sufficiently and effectively.In a similar line, during the discussions, it was evident that the following questions are high policy priorities for further research:

- What does AI do to children's brains? What happens when we hand over cognitive tasks to AI?
- How do our findings regarding the impact on children's cognition and development inform the design of AI?

Below we elaborate some of the relevant topics that relate to the above-mentioned questions and which were discussed during the workshop as areas that need further research investigation and policy support:

**Impact**. As indicated by the relevant literature in Section 3, the design characteristics of an AI-system as well as the context and the way it is used can have a positive or a negative impact on children's cognition and development. Robots, for example, have been shown to support the development of children's pro-social behaviours (Shiomi et al., 2017). But they can also trigger aggressive ones (Nomura et al. 2016; Brščić et al., 2015). What induces (or not) such behaviours should receive more attention in future research.

Similarly, opportunities and risks appeared in the literature review for conversational agents and recommender systems. While over-generalisations about the use of these systems for children should be avoided, it seems that further scientific evidence is needed on the elements that constitute child-centred AI, and the criteria that define the positive or negative impact of the use of AI in relation to children.

**Children's online-offline play**. During the youth workshop, our participants commented on their experience with AI-based systems integrated in videogames and other leisure and play activities. The relevant literature indicates that children's free play is essential to their development and growth, and contributes hugely to their well-being. However, while there is an extensive literature on children's off-line play and the ways children develop in safe play environments with the use of their imagination and creativity, it is still unclear how existing AI systems, embedded in devices that children use in their play (personal assistants, smartphones, tablets, video game consoles or Internet connected toys) transform children's play activities and possibly the ways they develop and behave. One concrete example are children's smart toys. While from a policy perspective, the European Commission is active in regulating smart toys for children, the question is still open regarding not only children's protection during play but how these devices should be designed to facilitate children thriving.

**Use findings to design AI better for children**. While understanding the impact of AI systems on children's cognition, development and play is necessary for the formulation of policies regarding AI and children, this also has the potential to affect the development of AI for children. Our understanding of child's cognition and behaviour in the context of AI, the policymaking for AI systems, as well as the actual AI design and development of AI systems are all interrelated. While some of the

connections between the elements are already emerging, such as children's participation in the design of AI-based technology or recently in the policymaking process, the connections and the interplay among these three dimensions still need to be supported further.

### 5.3.2 Empowering through education

As discussed in Section 3, the use of AI and robotics technology may have an impact on children's well-being as well as on their development, especially cognitive and socio-emotional aspects. This report looks at these two interconnected issues through the lens of children's rights. To both protect children, but also empower them to take advantages of these modern technologies to participate in society and for young persons to enter the labour market successfully, two separate sets of competences stand out from the common European reference for Key Competences for Life, namely *digital competences and personal, social and learning to learn competences*.[64]

We take a brief look at how policymakers, education and training providers, as well as social partners could use this common reference framework to guide their implementations, in order to leverage AI systems for children's education, health care and right to play, while upholding children's rights and empowering their agency. Using a common reference framework helps to create an agreed vision and a collective understanding through a common vocabulary – a linga franca. This helps mobilise stakeholders to take initiatives and to learn from each other.[65]

Following the Council's Recommendation on Key Competences for Life (mentioned above), the Digital Competence Framework for Citizens (DigComp) defines the knowledge, skills, and attitudes that citizens need to engage with digital technologies in a confident, critical, and responsible way for learning, at work, and for participation in society.[66] The European Commission first published the DigComp framework in 2013, and today, many of the European education systems refer to the European key competence definition for digital competence, in their report on digital education, Eurydice (2020).[67]

DigComp is also referenced in the new Recovery and Resilience Plans for developing human capital through digital upskilling.

The DigComp update 2.2, released in spring 2022, adds new aspects by considering competences that citizens need when interacting with AI systems. These include aspects such as interacting with virtual assistants like conversational agents and chatbots, while being cognisant about sharing personal data (e.g. one's voice and facial image) and taking steps to safeguard them from being overly shared and processed (e.g. sensibility towards digital data, protection, and privacy). Equally, the update will consider examples of knowledge, skills and attitudes related to creating digital content and non-digital artefacts such as tinkering with sensors and robotics in a way that it can benefit STEAM activities. Such examples can help education systems further consider, for example, makerspace activities as part of STEM education which can be conducive for developing a wider array of cognitive processes and strategies such as creative thinking, reasoning and creativity.[68]

Therefore, the DigComp 2.2 update can be considered as an important tool for empowering children in compulsory education (ISCED 1-3), as it is well-known that national/regional curriculums are often the place where values related to education equity are translated into action. By the way of offering a gateway for education systems to consider including these new aspects in their curriculums, the DigComp update 2.2 can play a significant role in creating a more equitable education system.

## NOTES

[64] https://ec.europa.eu/education/education-in-the-eu/council-recommendation-on-key-competences-for-lifelong-learning_en

[65] See for example "The use of reference frameworks to support digitally competent citizens – the case of DigComp": https://academy.itu.int/sites/default/files/media2/file/Digital%20Skills%20Insights%202019%20ITU%20Academy.pdf

[66] https://ec.europa.eu/jrc/digcomp

[67] https://eacea.ec.europa.eu/national-policies/eurydice/content/digital-education-school-europe_en

[68] Makerspaces for Education and Training: Exploring future implications for Europe: https://publications.jrc.ec.europa.eu/repository/handle/JRC117481

In general, AI applications and systems could gain from focusing more on children's well-being. For example, placing more focus on aspects that engage and foster children's personal, social and emotional learning could help developing AI applications that reinforce competences such as taking agency and initiative, perseverance and intellectual openness, self-regulation, negotiation and conflict resolution skills.[69] Some of such competences are also part of the LifeComp framework developed by the European Commission in 2020.[70]

The LifeComp framework can be used as a basis for curriculum development and learning activities (a repository of teaching practices will be published in spring 2022).[71] This is a way of empowering young users of AI-driven systems, which sometimes are designed to circumvent user's own will through nudging, gamification and manipulation, in order to influence behaviour: for example, to continue watching videos or interacting through chats, as mentioned in previous sections.

### 5.3.3 Developmentally appropriate systems and age verification

Easy access to the online world has provided certain opportunities for children, yet it also poses severe threats to their protection. AI systems should be developmentally appropriate and adapt their content and the communication styles according to the children's cognitive and socio-emotional levels. In addition, AI age verification tools have been explored to protect children online. These tools are used to ensure people do indeed show the required age to sign up to certain platforms. Meta (the umbrella company for Facebook, Instagram and Whatsapp) states that it is using AI as "the cornerstone approach" to estimate its users' age.[72] However, experts emphasise that age in itself does not entail strict correspondence with the competences, capacities, the agency or the resilience of a child. Other elements, such as levels of cognition, of (digital) literacy, context and background in which he/she grows matter greatly, and can lead to varied skills and capacities among children sharing the same age.

Further important questions emerged in the experts' discussions: how can the legal obligation of privacy-by-design take children's views to safeguard their privacy? How can age verification tools powered by AI be used in full compliance with the right to privacy and EU legislation? International organisations and foundations such as IEEE and the 5Rights foundation have already done considerable work along these lines, by publishing a new standard[73] on the age-appropriate verification of AI systems for children.[74]

### 5.3.4 Other research questions to be addressed

During the workshops we requested the participant experts and policymakers to contribute questions relevant to AI and children's rights that they would prioritise for a future integrated policy and research agenda. We received 50 questions in total. However, when examining and commenting on the questions, we observed that they tackled topics that could be grouped and abstracted into categories. For this reason, we performed a thematic analysis which resulted in the categorisation of the questions into 7 groups: Inclusion, Education, Privacy, Explainability-Transparency-Accountability, Cognition-Development, Conflicting Rights and Evaluation-Monitoring. Table 4 presents the merged categories with the corresponding questions.

**NOTES**

[69] Emerging technologies and the teaching profession (2020): https://publications.jrc.ec.europa.eu/repository/handle/JRC120183

[70] https://ec.europa.eu/jrc/lifecomp

[71] A self-paced MOOC for teachers: https://www.schooleducationgateway.eu/en/pub/teacher_academy/catalogue/detail.cfm?id=232029&cbmid=45658275

[72] How Facebook Knows an App User Is Old Enough | Meta (fb.com), https://about.fb.com/news/2021/07/age-verification/, accessed on 02/02/2022

[73] https://standards.ieee.org/standard/2089-2021.html

[74] https://5rightsfoundation.com/static/ieee-2089-2021.pdf?_cchid=edb63f689841fb8cfba977a86edf49c3

## TABLE 4

**Indicative questions generated during the Experts' workshops**
Source: EC

| Inclusion | Education | Privacy | Explainability/ transparency/ accountability |
|---|---|---|---|
| Disproportionate collection of data to ensure the inclusion of underrepresented groups of children ?<br><br>How can bias and lacking representativity in data sets used for machine learning be addressed to avoid discriminatory outcomes?<br><br>How can we ensure that the development of AI apps considers children from different contexts and backgrounds, different socio-economic status and ethnic identity?<br><br>How do the specific context (e.g. those more vulnerable) may lead to different ethical impacts (dilemmas) in the use of AI systems?<br><br>How do we measure inclusion? | How can we build the agency of students (K-12) to be informed, empowered citizens and users of AI?<br><br>What are and how can we develop the self-protection skills that children need to develop for a healthy use of AI systems (e.g. social media), including digital skills but also socio-emotional skills? | What is 'fair ' processing of children's personal data? | Who are the stakeholders that should be involved, given a particular use case?<br><br>What kind of partnerships are needed in the long term?<br><br>Should, and if so how, AI systems embed educational features (as "teachable moments" favoring transparency and skill development) being triggered when needed in an open use of AI systems? |

| Cognition / development | Conflicting rights | Evaluation / monitoring |
|---|---|---|
| What are children expected to understand at different developmental stages.<br>What is the impact of specific ai-based technologies on children's cognitive and socio-emotional development?<br><br>What are the cognitive and socio-emotional processes resulting from the use of AI systems that advance or inhibit children well-being?<br><br>Impact of greater integration of datasets (single digital identity, etc.) on rights of children, beyond general data protection. Example: incentivisation of behavioural change in one environment with rewards in another.<br><br>How should we design hybrid AI-human systems that hand over the right cognitive tasks to AI vs. human, given effects on children development and agency? Should the behaviour of these systems be adaptive towards less AI support<br><br>How the changes in the ways we access the internet (from screens to environmental access through IoTs and voice-based assistants) change our knowledge of the world (our epistmeology)? | How to conciliate inclusion needs (more data collection) and data protection - privacy?<br><br>Are some rights more important than others for children in relation to AI? What is the framework for evaluating/balancing them? AND how to deal with conflicting rights? (e.g. protection - autonomy | Are users aware of the presence of AI technology on the online platform they decide to visit<br><br>When we feed the AI with data, are the users well informed about which data it is and for what purpose will it be used?<br><br>Are children (potentially all users) informed about it in a clear and easy-to-understand way? |

# 6. RESEARCHERS, POLICYMAKERS AND CHILDREN: A TRIANGULATION OF PERSPECTIVES

In this section, we elaborate on a set of topics and questions that can indicate the future directions for research and policy. These topics are the results of questions and feedback received by policymakers, experts, researchers, and young participants that we involved in our workshops.

We are interested in understanding the connections among the perspectives of these three types of stakeholders in terms of priorities for future directions. We performed a thematic content analysis which resulted in the identification of 5 basic topics that were discussed across stakeholders. We also annotated additional topics that were discussed from a single stakeholder as well.

As illustrated in the figures below, this analysis reveals that while *children and policymakers emphasised* ***education****, researchers emphasised more* ***children's cognition and development in relation to AI***.

In addition, **inclusion** *appeared to be a topic of priority for policymakers and researchers* while for children this did not appear as a priority. Interestingly, **transparency and explainability** seem to be important for researchers and children while for policymakers this was the topic given the least priority of all. The reason for these differences might be identified by the fact that topics that are still in their infancy from a research point of view (such as explainability) are of less interest to policymakers, whereas topics that can already demonstrate research findings (such as education and privacy) are more interesting for policymakers while being less attractive from a research point of view.

These findings indicate it is important to consider that different stakeholders have different priorities for the development of an integrated agenda. This should be communicated among stakeholders in a transparent way and in future agendas to consider their harmonisation.

In this section, we present the comparison of the topics mentioned by all the three types of stakeholders (children, policymakers, and researchers) while considering AI technology and discussing future directions for research and policymaking. For us to clarify how different stakeholders prioritise different topics for further research and policy, we performed a thematic content analysis of their contributions to our workshops. These are summarised by the following topics:

1. Questions that we received from invited policymakers from the European Commission and other policy-oriented institutions (n=28 questions);

2. Questions that emerged during the series of three workshops with expert researchers (n=22 questions);

3. Topics that emerged during the series of two workshops with children and young people (n=35 topics).

Figure 7 shows that the questions we received by the Policy DGs and bodies, emphasised mainly children's inclusion, education and on the impact of AI on children's cognition and development. In addition, children's exploitation is a topic of interest from a policy point of view, in addition to privacy and explainability.

Regarding the questions that emerged in the discussions among invited experts during the workshops (Fig.8), we observe that an emphasis was placed on children's inclusion and to the impact of AI on children's cognition and development. The topics of explainability and evaluation/monitoring of AI systems are among the topics researchers believe should be given priority as well. By contrast, education and privacy were not classified among the top priorities from a research point of view. The question of conflicting rights was an additional topic emerged during the discussions.

If we examine the perspectives of researchers (Fig.8) compared to those of policymakers (Fig.7), we can conclude that for both groups, children's inclusion for the development and use of AI and the impact of AI on children's cognition and development are among the priorities. Interestingly, although education and privacy appear to be a priority for policymakers, it seems that they receive less attention from a research point of view, while the explainability of systems was put forward by researchers but not by policymakers. The reason for these differences might be identified by the fact that topics that are still in their infancy from a research point of view (such as explainability) are of less interest to policymakers, whereas topics that can already demonstrate research findings (such as education and privacy) are more interesting for policymakers while being less attractive from a research point of view.

Lastly, we contrasted the above-mentioned perspectives of policymakers and researchers with the results drawn from children's perspectives (Fig.9). As expected, for children, education and AI literacy are priorities while they are curious about the evaluation and monitoring of the AI systems that are being designed for them. Interestingly, privacy is among of the priorities which for children appear as more important than it does for policymakers and researchers.

Children are also interested in understanding better the development of explainable systems for them and they introduced topics that were not discussed with the other two stakeholders, such as the impact of AI on employment. The topic of employment might appear as a priority in the results of this workshop because of the age-group of our participants who were in late adolescence.

To summarise, this analysis revealed some patterns in terms of the prioritisation of future directions from three stakeholders, policymakers, researchers, and children. It appears that all the stakeholders introduce several similar topics for examination; however, it seems that the priorities might differ. We acknowledge that these results are based on a very small sample of participants in all the three categories (policymakers N=28, researchers N=22, children N=35) and they are biased by the participants' background, speciality and interests.

However, these findings provide initial indications for directions of future work and the need to develop structures and frameworks for the systematic combination of the perspectives of various stakeholders who might have different priorities in terms of AI for children, as well as for systematic ways of communication among stakeholders.

**FIGURE 7**
Questions received from policymakers (N=28)
Source: EC

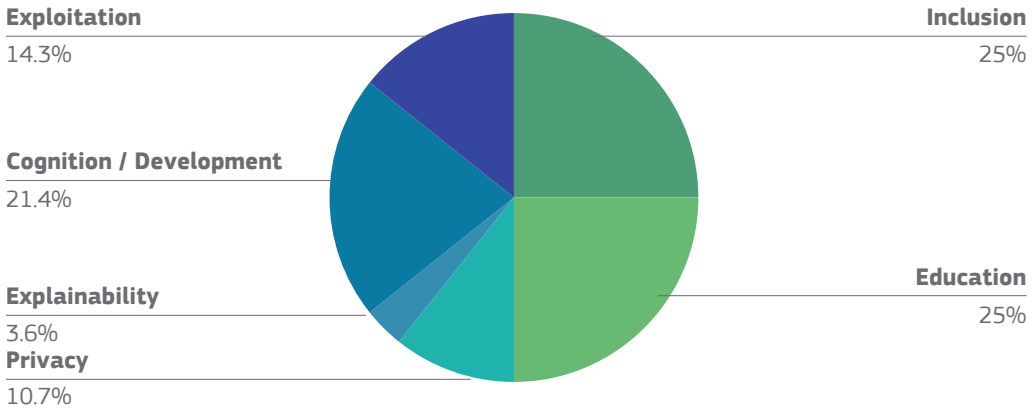



**FIGURE 8**
Questions emerged through the discussions with experts (N=22)
Source: EC

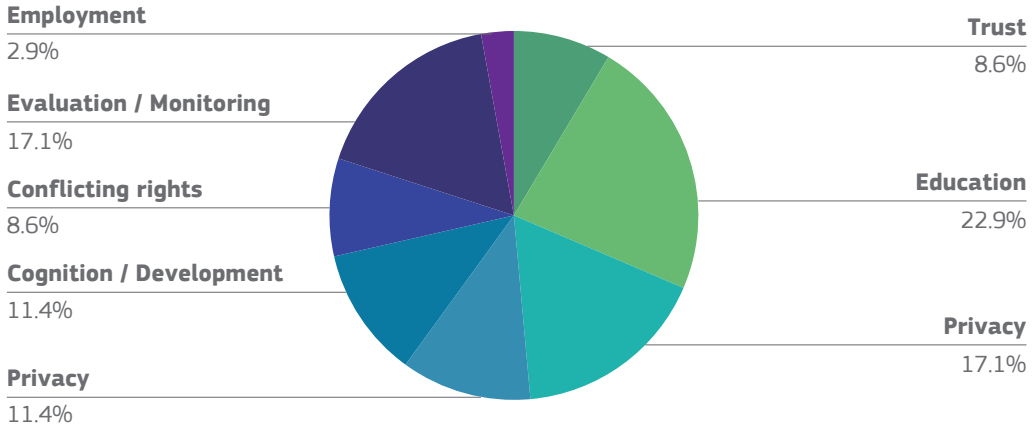
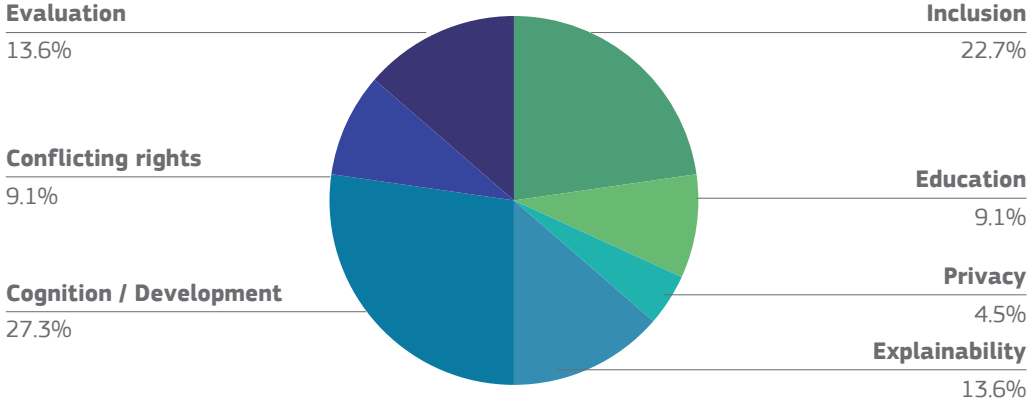



**FIGURE 9**
Topics posed by children and youth (N=35)
Source: EC



# 7. LIMITATIONS AND CONSIDERATIONS

We acknowledge that this report and the workshops included come with certain limitations.

- First, it was beyond the scope of this report to consider an exhaustive and systematic review of all existing policy initiatives and the AI-based applications for children. Instead, we decided to make a **representative selection** of them, being aware that other important work is not included in the report.

- The results of the workshops with children and experts were based on a **selection of a small number of participants**; we acknowledge that the outcome of the discussions might be biased, given the background of the participants. However, we tried to include participants that represent a variety of disciplines, sectors as well as geographical areas, in order to achieve increased diversity in the group of participants.

- The young people in the workshop were adolescents; children of younger age-groups and their insights and needs are not fully represented in our findings. We acknowledge that there are large **developmental differences among different age-groups** of childhood and adolescence which should be considered in future work.

- The participants of the workshops came from various backgrounds and locations. Yet, they provided a **Northern and Western perspective** of a topic that spans the world's population. It was beyond the scope of this report to consider populations outside Europe. However, we are aware that developments in the EU cannot be seen in isolation; rather, they need to be placed in the context of the global developments, in North America, China and the emerging opportunities and challenges in developing countries, such as in sub-Saharan Africa. Decisions taken in the EU are inextricably linked to developments at a global level.

- Lastly, it has been beyond the scope of this report to **include perspectives of industry**, during the workshops with experts and policymakers, it was made clear that the involvement of industry should be considered and reviewed as an additional dimension in the future. This requires coordinated actions that would ensure the best interests of children with well-documented and transparent procedures.

Based on the results of this report, we will continue our work considering the requirements, the methods and the areas of knowledge-gaps in research. It is important to meet these gaps in the current policymaking agenda. For our future work, we will consider the following prerequisites:

- Policy and research on artificial intelligence and children need to consider the **best interest of children as indicated in the UN Convention on the Rights of the Child**, in the context of the current and future technical development of AI. The relevant **regulatory frameworks for AI-based applications** that are meant to be used by children or might impact children's well-being in the short or long term should prioritise children's best interests and benefit the research & development of AI for children.

- The pervasiveness of AI-based technologies in children's lives calls for strategic **planning for a joint coordinated approach to their governance through international cooperation**. Regulatory frameworks could be designed in a way that fosters innovation in line with EU values and standards set to leverage the EU's ability for leadership.

- Policy decisions need to be made in the context of the **global technical AI-specific advancements and the corresponding ethical perspectives**.

- Policy decisions need to consider not only the current financial and societal impact but also the **dynamic long-term impact** that these decisions have in future societies via the directions of children's development.

- Multistakeholder collaboration requires the **strategic planning of coordinated ac-**

**tions** with an agreed threshold of values that prioritise children's best interests and that ensure a balanced combination with special attention paid to possible conflicting areas of application.

- **Involvement of industry**. The evaluation of AI-based tools for children often needs real-world scenarios. This means that industry should be considered as one of the actors that play a significant role in our further understanding and decision-making regarding AI and children. During the workshop discussions, however, many concerns were raised regarding possible conflicting agendas in the interaction of industry with researchers and policymakers. For this reason, the group highlighted the need for developing and establishing frameworks and structures that would ensure transparent interactions and collaborations among different stakeholders, including industry. Most importantly, the participants of the workshop focused on the need for defining and agreeing upon a set of common values and goals regarding the development and use of AI for children.

In the future, the JRC aims to create an open-access pool of best practices for projects that integrate science and policymaking, with the active participation of children. The main goal of this pool is to develop further the existing tools and strategies and to encourage the use of them by stakeholders that are involved in the development of AI for children.

# 8. CONCLUSIONS

This Science for Policy report presents the results of a series of activities on artificial intelligence (AI) and children's rights, with a focus on emerging issues, considering the following perspectives. First, it provides an overview of the current policy discussions on AI and children's rights initiated by major international organisations.

It elaborates on a selected set of examples based on the current state-of-the-art regarding the design, development and use of three AI-based applications for children, namely recommender systems, conversational agents and robotic systems. It then reflects on the emerging opportunities and risks in relation to children's rights.

The report goes on to consider the results of a series of workshops with children and youth, experts, researchers and policymakers to identify a set of **requirements** for child-centred AI-based systems, and **methods** in order to address these requirements, as well as **knowledge gaps** requiring further research and an examination from a policy perspective.

Furthermore, we triangulated the perceptions of the stakeholders involved in our workshops (policymakers, researchers and young people, who are legally children). We performed a thematic content analysis on their contribution which clarified how different stakeholders prioritise different topics in view of further research and policy.

## REQUIREMENTS

### *AI minimisation, valuable purpose, sustainability and environmental issues*

*There is a need to consider the use of AI technology as a limited resource and a need for strategic and systemic choices to develop AI-based services, both at the public and private level.*

- In parallel to the concept of "data minimisation", an approach to AI minimisation would limit the use of AI to complete tasks that are really necessary to accomplish a valuable purpose. Despite relevant research in the domain, even more research is needed to determine the "valuable purposes" of AI for children.

- AI technology shows potential to address some challenges in several fields, including environmental ones. Still, data centres, which are critical for storing the large amounts of data needed to power AI systems, demand a huge amount of energy and are already pointed to as important contributors to increased CO2 emissions. Experts and the literature now recommend measures to minimise the footprint of digital products and services, and AI technology is no exception. Considering the negative environmental impact and the positive implications of AI for climate change will be crucial moving forward to better children's lives.

### *Inclusion, non-discrimination and algorithmic bias*

*There is a need for child-friendly AI technology and for ensuring that AI systems do not systematically reflect discriminatory biases due to the quality of the data and algorithms they rely on.*

- Risks of exclusion and discrimination due to the use of 'data biased' AI have been the subject of extensive debates worldwide, and the case of children among the users has raised special attention. Developing a socio-ecological approach that considers at least four levels of interactions (individual/child, community, societal and policy levels) and their diversity, interplay, and relations, seems promising, in order to enhance children's rights to inclusion and non-discrimination, by fostering capacity-building and knowledge sharing.

- AI technology developers and designers should be encouraged and supported to integrate children's rights dimensions in risks and impact assessments, evaluation frameworks and guidelines.

***Privacy, data protection, safety***

*There is a need for children to be empowered to control how their personal data is used by AI technology and what the implications are.*

- Considering its opaqueness and complexity, the specific nature of AI poses additional risks on top of those already relating to privacy and data protection. There must be an effort – as mandated by the GDPR – to make privacy statements understandable by children, and support them in exercising their data protection rights.

- Data protection principles, such as privacy-by-design, should take children into consideration and translate into effective mechanisms to ensure their protection.

***Transparency, explainability, accountability***

*There is a need for transparency, explainability and accountability to inform and empower young citizens and all users of AI technology, preventing over-trust or mistrust in AI systems.*

- Transparency and explanability are related to the right of children to information but also linked to their right to education and literacy. Both are judged essential to promote children's empowerment, critical thinking and to fight misinformation.

- Reaching transparency and explainability requires the involvement and collaboration of all relevant stakeholders (children, researchers, policy makers, civil society, industry and parents).

- Along with performance and accuracy, transparency and explainability have become additional criteria and a priority for evaluating algorithms.

- Accountability is essential, at an organisational and system level, in auditing procedures. Still, AI systems pose unique challenges as their input and operations are not always visible, especially to the end-users. For AI systems that are designed for children, particularly, designers must identify minimum requirements that would ensure and monitor the accountability of the actors involved.

***Respecting children's right for agency***

*There is a need for further research on how agency is developed in children when they interact with AI-based systems.*

- Children's right to agency is one of the fundamental requirements to be met when designing and using AI for children: allowing children to be consciously agents and actors within their interaction with AI technology. Research, while recognising children's agency to be a complex process, has so far only considered children's perceived agency.

## METHODS

***Anticipation, evaluation and monitoring***

*There is a need to create frameworks and toolkits that can enable/guide the design and evaluation of AI systems in the short- and long-term, having children as their main users or including them among users. These frameworks should incorporate aspects such as data protection and risk assessment.*

- Research dedicated to the evaluation and monitoring AI technology used by/designed for children are most of the time rather limited in terms of case-studies, stakeholders and time frames.

- Literature and experts participating in this work agreed that children-centric evaluation should expand and combine different methodologies, including participatory methods, interdisciplinary research, collaborative consultation of stakeholders and large-scale studies. It should also consider different time scales: short, medium and long-term studies, the latter being the implemented most rarely.

***Multi-stakeholder collaboration***

*There is a need of communication and collaboration between stakeholders to seek balance in the use of AI technology by children and resolve the conflicts between their provision, protection and participation rights.*

- Each stakeholder group (children, parents, teachers, carers, academia, industry and policymakers) has specific aims and goals in using/developing AI technology and supporting children's rights. Communication

and collaboration are key to defining common goals and to building child-friendly AI by design.

- The future agenda for AI technology should include the outline of a simple framework (or guiding questions) that would facilitate communication among stakeholders.

- Platforms that would support and facilitate the interaction and collaboration of different stakeholders, including children and industry, should be developed further.

***Children's participation***

*Children's participation, provision, and protection (the 3 Ps model) are equally important. Yet it is challenging to meet these fully, and all policy decisions need to ensure that the 3 P's model is performed in a timely and meaningful manner, by taking into consideration the cognitive and socio-emotional stage of each child and its fundamental right to development through play.*

- Scientific evidence requires innovative child-centred methods that consider children's rapid development, the importance of context and the local value-ecosystems in which children develop, as well as AI-specific characteristics such as adaptation.

- The different characteristics of applications require a fine-tuned approach indicating that we cannot have one solution that fits all applications within the various contexts and for different users. We need principles and best practices that provide directions for multiple characteristics of AI-based applications for children and their different uses, in accordance with children's characteristics.

- Children's meaningful participation and their consideration as core stakeholders can be the means to in-depth understanding of their perspectives, needs and interests. At the same time, this process is important for children's holistic grasping of the process of AI systems which would allow them to make connections and create personal meanings.

***Conflicting rights***

*There is a need for regulation and policies on AI technology to consider the full range of children's rights (not only protection), and to define the correct degree of compromise between different, sometimes conflicting rights.*

- According to the United Nations Convention of the Rights of the Child, rights can be categorised into three areas, namely: protection, participation and provision. Conflicts among these rights are not rare. For instance, adopting restrictive positions on the use of AI by children with the aim of protecting their privacy and personal data could impact on children's rights in participating public debate. By contrast, using AI technology to improve Internet safety among children would require large data collection and profiling exercises, putting additional pressure on children's rights to privacy and protection of personal data.

- Decisions concerning the correct degree of compromise demand careful consideration of trade-offs between different, sometimes conflicting rights.

- Also, children's rights might conflict with other priorities of society, such as the agility of industry (i.e. developing safe and secure products adds time and the use of resources in the development process of products).

- Regulation and policies on artificial intelligence should consider the full range of children's rights, especially when these are conflicting. Likewise, industry would need to take the necessary time and care to develop safe tools respectful of children's rights by design.

## KNOWLEDGE GAPS

***Cognition, development and children's play***

*There is a need to study deeper the impact of the use of AI technology, embodied or not, on children's behaviour, the brain, as well as the cognitive and socio-emotional capacities of children.*

There is already scientific evidence about the impact (positive and negative) of AI-based applications on children's cognition and development. However, the current evidence is scattered and has certain limitations. Understanding and addressing the impact of AI-based systems on children's cognition and their socio-emotional development is one of the most fundamental challenges from a research

and policymaking perspective. The following questions appear to be of high policy priority for further research:

- What does AI do children's brains? What happens when we hand over cognitive tasks to AI, in a positive and in a negative way?
- How do AI systems transform children's play activities, imagination and creativity, and eventually the ways they develop and behave?
- How do our findings regarding the impact on child's cognition and development inform the design of AI?

***Provision from the perspective of education***

*There is a need to develop competences and literacy that will prepare children for a world transformed by AI technology but also to develop AI that can develop competences supporting children's well-being.*

- Young people show concerns regarding the future of their education and work in a world transformed by AI technology. They request schools to develop adequate digital and technical competences, but also critical and ethical thinking as well as personal, social and self-learning competences.
- AI applications and systems could gain a lot from focusing on children's well-being. For example, more emphasis could be placed in developing AI applications that reinforce competences, such as: taking agency and initiative; perseverance and intellectual openness; self-regulation; negotiation and conflict resolution skills.

***Age verification systems while using AI***

*There is a need to expand further age recognition tools so as to consider the large variety of skills, capacities and agency levels of children sharing the same age, as well as children's views on how to safeguard their privacy.*

- Age verification tools have been considered to ensure the protection of children online and keep them away from content or services that are not meant for them. However, focusing only on age might lead to a false sense of security or, on the contrary, limit children's opportunities. Other elements, such as the level of cognition, of (digital) literacy, social context and the background in which a child grows up matter greatly and can lead to varied skills and capacities among children of the same age.

## TRIANGULATION OF THE RESULTS: DIFFERENT PRIORITIES BY DIFFERENT STAKEHOLDERS

While most of the above-mentioned topics were mentioned by all the three types of stakeholders involved in our workshops (children, policymakers and researchers) during the discussions, we observed that different stakeholders emphasise and prioritise different topics.

This was confirmed by their written contributions and the questions they proposed on AI and children's rights. In order to clarify how different stakeholders prioritise different topics for further research and policy, we performed a thematic content analysis of their contributions.

As illustrated by the figures in Section 6, this analysis reveals that while children and policymakers emphasised education, researchers emphasised more children's cognition and development in relation to AI. In addition, inclusion appeared to be a topic of priority for policymakers and researchers while it did not appear as a priority for children. Interestingly, transparency and explainability seem to be important for researchers and children.

These findings indicate that for the development of an integrated agenda, it is important to consider that different stakeholders have different priorities. This should be communicated among stakeholders in a transparent way, with a view to harmonising future agendas.

# 9. FOR DEEPER CONSIDERATION – REFLECTIONS OF INVITED EXPERTS

In this section we report reflections by the invited experts on AI and child's rights workshop based on their expertise, namely (in alphabetic order):

**"Regulation and policies on artificial intelligence should consider the full range of children's rights, especially when these conflict"**

Victoria Baines, Bournemouth University, UK

**"AI education: Beyond mere transfer of knowledge"**

Tara Chklovski, Technovation, USA

**"Directions for the responsible design and use of AI by children and their communities: Examples in the field of Education"**

Davinia Hernández-Leo, Universitat Pompeu Fabra, Barcelona, Spain

**"Children's identities and partial algorithmic identifications: A gap to bridge with human agency"**

Giovanna Mascheroni, Catholic University of Milan, Italy

**"Evaluating and monitoring AI applications in the classroom: Open Challenges"**

Sole Pera, Bose State University, USA

**"Children's right to protection from economic exploitation in an AI-world"**

Valerie Verdoodt, Ghent University, Belgium

## 9.1. Regulation and policies on artificial intelligence should consider the full range of children's rights, especially when these conflict

**Victoria Baines**
Bournemouth University, UK

Having worked in child online protection for many years, I have seen the very worst that malevolent adults and peers can do to children and young people, and I am all too aware of the long-term impact of child sexual exploitation and abuse on victims' emotional and physical well-being. Not for nothing is the provision of specialist psycho-social support a requirement of both the Council of Europe Convention on Protection of Children against Sexual Exploitation and Sexual Abuse, also known as 'the Lanzarote Convention', and the We Protect Global Alliance Model National Response for preventing and tackling these crimes.[75]

It stands to reason, then, that as citizens, caregivers, stakeholders and policymakers, we should do everything in our power to prevent children from experiencing child sexual exploitation and abuse in the first place. In addition to its primary goal of reducing the incidence of harm, effective prevention also alleviates the burden on law enforcement, the criminal justice sector, social care specialists and healthcare practitioners.

In recent years, prevention and detection of child sexual exploitation and abuse has been increasingly facilitated by technological innovation: many parents and caregivers now use apps that monitor and restrict children's use of digital communications; law enforcement uses big data analysis to find needles in investigative haystacks; hotlines for reports of child sexual abuse material use image hashing and matching to minimise vicarious trauma from unnecessary exposure to content that has already been investigated; large technology companies use similar tools to conduct automated scanning for such material, which is then removed and reported to law enforcement.

But protection from all forms of sexual abuse and exploitation enshrined in Article 34 of the United Nations Convention on the Rights of the Child is not the only right to which children and young people are entitled. Indeed, among the articles of this binding instrument, children have the right to:

> be free to express their thoughts and opinions and to access all kinds of information, as long as it is within the law (Article 13);
>
> think and believe what they choose and also to practise their religion, as long as they are not stopping other people from enjoying their rights (Article 14);
>
> privacy (Article 16)
>
> the right to reliable information from a variety of sources, and governments should encourage the media to provide information that children can understand. Governments must help protect children from materials that could harm them (Article 17);
>
> education (Article 28).

Consideration of these articles en masse reveals links but also potential conflicts between them. For instance, children are entitled to access "all kinds of information" but should be protected from "materials that could harm them." Moreover, a child's right to privacy may be compromised by measures that intrude into their and others' private lives in order to keep them safe. Decisions

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[75] https://www.coe.int/en/web/children/convention; https://www.weprotect.org/model-national-response/

concerning the correct degree of compromise not infrequently demand careful consideration of trade-offs between different, sometimes conflicting rights.

Despite best efforts, there can be unintended and unproductive consequences, a high-profile example being the extension in December 2020 of the scope of the E-privacy Directive (2002/58/EC) to "number-independent interpersonal communications services" such as voice chat, messaging and web-based mail.

The Directive's provisions for the confidentiality of communications and traffic data (Articles 5(1) and 6(1)) immediately prohibited social media platforms' predominant method of scanning for child sexual abuse material.

The impact on detection and reporting was immediate, the US National Center for Missing and Exploited Children (NCMEC) observing a 58% reduction in reports of child sexual abuse material from the largest US platforms to the European Union.[76] Considerable, fast-time, effort by child protection specialists and other stakeholders was required to ensure the passing of a temporary derogation from the problematic provisions.

Similar tensions apply to children's use of digital technology. The proliferation of what has come to be known as 'safety tech' has been stimulated by significant government support in some countries.[77] Tools that conduct surveillance on children's communications and activities, considered intrusive or 'stalkerware' when used on adult subjects, are regularly marketed and deployed in the interest of child protection. As some developers are discovering, these solutions may contravene data protection legislation and prohibitions on unlawful interception of communications.[78]

AI accelerates and accentuates this tension: as Stanford University's 2021 AI Index Report has observed, "The technologies necessary for large-scale surveillance are rapidly maturing, with techniques for image classification, face recognition, video analysis, and voice identification all seeing significant progress in 2020".[79] A growing number of safety tech products claim to make use of AI and/or Machine Learning to identify harmful content or risky behaviours.

But what is harmful and risky does not always equate with what is illegal or criminal. Often these tools target pre-criminal situations, such as online contact from an unknown adult, or searches outside pre-determined parameters. The aim of preventing harm and criminal activity is well-placed. But it may well come at a price, both for the privacy of the child and their development of effective risk mitigation skills. Our understandable inclination to remove the risk of harm may have the unintended consequence of hindering children's and young people's resilience to unwanted experiences.

From this perspective, and that of children's rights to a private life and access to information, child protection stakeholders should perhaps ask ourselves, "Just because we can collect even more data from children and block even more content in order to protect them, does that mean we always should?"

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[76] https://www.missingkids.org/blog/2020/we-are-in-danger-of-losing-the-global-battle-for-child-safety

[77] https://www.gov.uk/government/publications/safer-technology-safer-users-the-uk-as-a-world-leader-in-safety-tech/safer-technology-safer-users-the-uk-as-a-world-leader-in-safety-tech

[78] See, for example, the experience of UK company SafeToNet: https://www.theregister.com/2021/11/26/safetonet_message_scanning_legal_warning/

[79] https://aiindex.stanford.edu/report/

## 9.2. AI education: Beyond mere transfer of knowledge

**Tara Chklovski**
Technovation, USA

We know that sugar is bad for us, but that knowledge is still not enough to stop us from eating more than the daily recommended amounts (a meager 25 g!). In fact corporations thrive on adding more and more sugar in their products to increase sales. So knowledge itself is not enough to prevent bad decision making and action.

When thinking about equipping, arming and empowering children to stay safe while using AI-based devices, our first reactions would be to institute protective regulations and in parallel to educate children on how the AI is working and its uses and dangers. Yes and yes!

But in reality, this is a more complex issue and if we really want to make a difference, we need to go deeper.

We need to not only teach children how these AI-based systems work, but to actually build and train their own AI models to tackle problems children care about. We all know that the best learning is when you actually apply, build, create, improve and innovate. If we know this, then we should not just stop at the knowledge transfer stage, but build systems and programs where children are learning about AI by applying, building and creating AI-based systems that make the world better for all of us. This is especially important when learning about something as intangible as AI systems, because it takes so much imagination and understanding of different human conditions and experiences, to be able to predict edge cases and when the AI could potentially harm others.

How can we do this?

Below is a 3-step plan to create an effective AI education program for children that not only educates them about how AI works, but also nurtures empathetic, kind innovators and inventors.

* **Step 1** - Learn to think about complex systems and how to train AI-based systems to tackle a complex, social problem, aligned with the UN sustainable development goals (ideal examples of really important, unsolved, complex, real-world problems that impact a huge number of people).

* **Step 2** - Learn to identify your own values, that of your family and community. This is a critical step in understanding what values are important to you and which ones are worth defending and protecting.

* **Step 3** - Learn to connect with different groups and communities, get their feedback and thoughts on the AI solution and build a map of edge cases.

A hands-on, AI-education program that covers the three facets outlined above, will most likely last between 60-100 hours and is not for the faint of heart, but such a program will be transformational. In earlier societies, children did not have to understand complex concepts and systems to survive (although we have always had the exceptional dreamers and the explorers who went far afield!) But to survive and thrive, one didn't need the sophisticated set of tools that we need now. Most importantly, our circle of influence has increased dramatically through technology. We can do good or cause damage at great distances, and to people we have never met. These are much harder concepts to understand, and to do so, will require time.

But the rewards could not be greater.

We need to invite children to be co-creators and co-designers of AI-based tools that can be used to tackle the big, complex problems we all face as a planet and as a people. And if we invest in them with depth and conviction, then we will not only have informed users today, but empathetic, innovative leaders tomorrow who truly care about making sure all of us, and our planet thrives.

## 9.3. Directions for the responsible design and use of AI by children and their communities: Examples in the field of Education

**Davinia Hernández-Leo**
Universitat Pompeu Fabra, Barcelona

Our digital world is advancing towards an increasingly complex ecosystem driven by Artificial Intelligence technologies. Advances in the field of AI are often accomplished by actively exploring new techniques related to the collection and analysis of data to perform tasks normally requiring (and thus, potentially replacing) human intelligence as well as new tasks not achievable by humans. This scenario carries with it new risks that conflict with ethical principles, such as children rights.[80] Yet, a perspective focused on preventing children from using AI or from the effects of others using AI (e.g. their educators) is a strategy also to the detriment of their rights.

On the one hand, applications of AI can bring benefits. For example, AI and data-driven technologies bring opportunities to design enhanced educational environments for children to learn. Examples include systems that scaffold the development of learners' self-regulation skills (Molenaar, 2021) or teacher-facing actionable learning analytics dashboards to orchestrate productive learning scenarios (Amarasinghe & Hernández-Leo, 2021), and many others (Tuomi, 2018). Indeed, children have *the right to an education that enables them to fulfil their potential*.[81]

On the other hand, children need to be prepared to live healthily in our real world. For example, social interactions, entertainment and access to information and products are increasingly occurring in (social) media and web platforms, which are increasingly incorporating AI features. Indeed, children have the right to get ready for a life and a development in our real world.

Education and risk prevention used to be a sufficiently good strategy to address the challenges identified in available digital technologies previous to AI. But risk prevention is not enough in a digital world with AI. What is rather needed is a responsible provision that considers ethics principles in the early conception of AI and data-driven technologies and its expected use. To actually care for the rights of the child in the design of AI technology, a policy and societal perspective should also consider the perspective of their interplay with individual children and their communities. In the following, I suggest some methods towards this end.

**Honest AI**. Beyond trustworthy AI, AI applications should be designed in a way in which the intelligence of AI is continuously questioned. This design-thinking approach will often lead to hybrid AI-human systems that involve humans in the loop, actually giving them the control in a rights-based manner. For example, smart alerts visualised in a teacher-facing dashboard may explain predictions about potential learners' failures or lack of engagement. The prediction is visualised with indicators about the trustworthiness of the prediction (e.g. related to fairness and level of transparency in the way the prediction is designed and presented) but recognises its ignorance about many elements in the specific context and their values. In such an example, the teacher will be able to react to the alert or not, depending on her own interpretation about how a derived action may benefit the children in their actual context.

**AI minimisation**. In parallel to the concept of "data minimisation", an approach to AI minimisation would limit the use of AI to complete tasks that are really necessary to accomplish a valuable purpose and without falling into a technological solutionism trap (Selbst et al., 2019). For example, in systems that scaffold the development of learners' self-regulation skills, AI-based scaffolds are

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[80] https://www.unicef.org/globalinsight/reports/policy-guidance-ai-children

[81] https://www.ohchr.org/en/professionalinterest/pages/crc.aspx

helpful in early phases of skill development but they should fade out when the individual is ready to practice the meta-cognitive tasks without support. Yet, and despite there is already relevant research in the domain, even more research, and especially longitudinal and community-scale studies (see below), is needed to accumulate sufficient evidence about what actually are the "valuable purposes" of AI for children.

**Agency** and well-being **by design**. AI applications and systems should promote children's self-fulfilment. More than inhibiting their decision making options, AI should be designed in a way that activates their agency so children are able to participate in decisions about matters influencing themselves. Enacting agency leads to enhanced physiological well-being (e.g. sense of autonomy and capability) (Peters et al., 2018). Moreover, there are opportunities in the design of AI features to consider how to counter-effect the factors emerging from the use of digital technologies contributing to mental health conditions (e.g. FOMO in social media) and to focus on applications that support the development of socio-emotional skills (e.g. critical thinking, empathy, stress management) for safeguarding their well-being. Finally, recommended practises for assessing the impact of AI applications on children well-being, as proposed by the IEEE for human well-being (IEEE, 2020; sample application in Hakami & Hernández-Leo, 2021) would be also useful in the iterative design of AI for children and its impact in diverse societal dimensions.

**Reduce AI gap (or AI divide, or AI exclusion)**. AI brings a new perspective to the already established notion of "digital gap". While the notion of digital gap has been more connected to how unequal access to ICT leads to social inequality, the notion of AI gap relates more to how unequal access to AI literacy leads to higher levels of AI-derived risks for disadvantaged children when they (or others in their behalf) use AI-enabled systems. This effect is amplified if connected with the need of socio-emotional or well-being self-protection skills in the use of AI, as vulnerable populations are more likely to have suffered from early life well-being challenges and often have less opportunities to develop those skills. In a world where AI applications and systems are to be used also by disadvantaged populations, the design of those applications should consider this new notion of AI gap, both by involving those populations in the human-centred design of the technologies and by considering the gap in the design of how requirements like transparency should be implemented (i.e. the explanation required for an AI feature depends on the level of AI literary of the user).

**Embedded teachable moments**. AI applications could embed educational features being activated when meaningful in the use of those applications. These features would offer "teachable moments" eventually playing two roles, favouring transparency and honest AI and facilitating skill development. For example, social media could embed educational features about the mechanisms and effects of filter bubbles (Hernández-Leo et al., 2021).

**Community approach**. Specific contexts may lead to different ethical impacts in the use of AI applications (e.g. vulnerable context mentioned above). This aspect has an effect on, for example, the way it is possible to answer questions about what should be the role of AI in formal education and informal learning. A community approach would be suitable to tackle this challenge. Through collective knowledge construction processes (Ley et al., 2020), where individuals create knowledge collaboratively as well as acquire attitudes and skills, communities can enact a collective agency influencing decisions regarding purposes, design and use of AI in their context. This applies to local communities involving the different relevant actors (children, parents, schools, associations, researchers, policymakers etc.) or to teacher communities (in a particular context or across contexts and geographies) willing to contribute to the sharing and co-design of strategies and the assessment of impacts.

## 9.4. Children's identities and partial algorithmic identifications: A gap to bridge with human agency

**Giovanna Mascheroni**
Catholic University of Milan, Italy

When we think of children and AI we often think of some extraordinary, yet to come technology embodied in anthropomorphic social robots able to interact with the child on an empathic basis. Yet, children already encounter a variety of AI-based technologies in their everyday lives: from the recommendation systems of YouTube or SVOD platforms, to the conversational agents embedded in domestic smart speakers, the school platform's algorithms, the facial recognition software that detects them in the photos shared by their parents, etc. That these and other technologies are not recognised as AI suggests their profound integration into everyday life.

The invisibility and taken-for-grantedness of AI in children's lives is a sign of both its commercial success and its social legitimation, which conceals the wider power structures on which AI depends. AI systems have been designed as infrastructures for massive data extraction, predictive analysis and monetisation within the business logic of surveillance capitalism (Zuboff, 2019). The extension of data-driven processes of governance from the market to ever more domains of social life, including the intimacy of our homes, has been legitimised through discourses and imaginaries that present datafication and automation—the two key components of every AI system— as inevitable and desirable. It is the ideology of data, or "dataism" (Van Dijck, 2014), which sustains the pervasive colonisation and profitable annexation of everyday life through data extraction (Couldry & Mejias, 2019). To put it simply, children's everyday lives—their contexts, practices, and emotions—are turned into profitable resources for data capitalism. Therefore, AI-based technologies are never neutral: they are inscribed with a data-driven business model that rests upon the belief in a perfect conversion from life to data, and in data as natural traces and more objective knowledge. However, as I remind of in my latest book with my colleague Andra Siibak (Mascheroni & Siibak, 2021), every act of translation is always partial, a corruption in which something gets inevitably lost.

As a consequence, a gap comes to exist between children's lives and identities—nuanced, complex, messy—and their algorithmic identifications—partial and inaccurate, yet absolute, opaque and therefore unchallenged. It is in such gap that the risks of AI for children's rights are inscribed and enacted: decisions are made automatically by algorithms on children's behalf, which are based on often inaccurate, partial data about them and in ways that are not accessible to them.

Researchers and policymakers now call for equity, inclusion and diversity in the design of AI systems (for children). However, the epistemic gap between embodied individuals and their data doubles, on one side, and the training of machine-learning based on historical datasets on the other side complicate any attempt at making AI more inclusive, equitable and non-discriminatory. Algorithmic bias, either in the historical data used to train machine-learning or in the very abstraction and classification of data or, probably, on both, turns the human errors that algorithms should replace into a systemic under- or over-representations of probabilities for certain populations, defined by their age or gender, ethnic group or education, income or residence, psychometrics, etc.

This generates "allocative" and "representational harms" (Burkell & Bailey, 2018): that is, the unequal allocation of resources legitimised on the basis of presumably "impartial" algorithmic classifications, and the influence of stereotyped classifications on an individual's representation, their understanding of the social world and, ultimately, their agency. There is raising concern that AI systems could inform unequal policies that systematically exclude certain categories of children from access to opportunities, with the effect of pre-determining their future. In order to ensure that

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[82] It is their lack of autonomy in learning which renders AI ultimately non intelligent, according to Crawford (2021).

data and algorithmic decision-making are re-purposed for the social good—i.e. to inform long-term evidence-based preventive programmes to ensure that vulnerable children have equal access to resources—certainly we have to ask what data are collected, by whom, how and with what purposes.

This is what regulation around children's data protection has been concerned with. And, yet, two more challenges arise in this regard. First, such legal frameworks often bring to the fore children's rights to privacy and protection from commercial exploitation to the detriment of other children's rights: GDPR Article 8, for example, has been criticised not only for its difficult implementation, but also for potentially conflicting with children's right to participation, freedom of expression and association, to information and media, education and play.

Second, privacy itself is framed as an individual rather than social problem (Mascheroni, 2018). This is problematic, for the burden of privacy itself is placed mainly, if not solely, on parents. Furthermore, an individual approach on privacy fails to acknowledge that children's data are often collected as part of their parents profiles, so that their own protection as vulnerable data subjects is hindered by the everyday practices of many. Moreover, in order to repurpose AI for a better future for children, we should not limit policy interventions to data protection regulation. We should also need to envision ways to let children have a voice in the automated decisions made for them by AI systems. That is, we need to bridge the gap between identities and algorithmic identifications with more, rather than less, human agency.

## 9.5. Evaluating and monitoring AI applications in the classroom: Open Challenges

**Sole Pera**
Boise State University, USA

The impact of Artificial Intelligence (AI) is far-reaching, as it now is seamlessly integrated behind the scenes into the daily lives of adults and children alike (Wong et al., 2020). Steered by the rights of the child, there is a setting that serves as the perfect ecosystem to reflect on the trade-offs between the ample opportunities AI affords and the risks emerging from children's interactions with AI applications: the classroom.

Why the classroom? AI applications—robots, recommender systems, conversational systems, and even search systems—are widely utilised by educators and children of all ages (Beelen et al., 2021; Allen et al. 2021; Ekstrand et al. 2020; Lovato et al. 2019; Pera et al. 2019; Murgia et al., 2019 For example, consider the use of smart toys among preschoolers (Akdeniz & Özdinç, 2021) or the integration of AI-based assistants to aid skill development among high schoolers (du Boulay, 2016). The nature of the classroom provides a minimal set of requirements expected of AI applications. Still, the adoption of these applications is not without consequence, thus making this complex scenario the right one to identify how policy enforcing the rights of the child can drive design and regulate deployment. Where to start? I would argue in favour of using a particular application as a case study. A case study would enable identifying open challenges about design and deployment, along with exploring how to address these challenges. Moreover, it could facilitate organic policy development, assuring that AI applications empower and explicitly respond to their rights.

What are some of the known hurdles? Regardless of the application of choice—from a recommender system that offers reading materials to help promote literacy among the youth to search engines embedded in the classroom to support information discovery—the first step involves undertaking a holistic approach that regards the voices of all the stakeholders involved. It is critical to consider at the design stage, not as an afterthought, the needs, wants, and possibilities (from the user and system perspectives), if AI applications are to be safe and valuable for children while practical to deploy and adopt. In this setting, there are plenty of stakeholders to consider: children, of course, but also educators, parents, industry partners, researchers, and policymakers. Further, we must assess what developmental psychology tells us about cognitive development and the stages through which children progress that define the limits of what they can assimilate (Piaget, 1997) if aiming to treat

AI applications as learning tools to expand knowledge (Hansen & Rieh, 2016). Most children, however, cannot develop the ability to use AI applications effectively by themselves without assistance. The technology itself could help via built-in scaffolding that explicitly considers developmental stages (Luckin & Cukurova 2019; Roschelle et al., 2000). Doing so is vital to ensure that for each child, AI applications are not only accessible but instructional as well. Lastly, taking theory to practice in this complex setting demands a broad range of experts actively informing design and deployment. Literacy and cognitive development experts, computer scientists (with expertise in natural language processing, machine learning, information retrieval, and child-computer interaction), in addition to experts in matters of privacy, law, and ethics, are only the starting point.

What are some of the primary considerations? Children have particular cognitive, social, physical, and emotional needs that make the information they seek, their experiences, their sense-making, and their skills different from those of adults. Paraphrasing Bilal (2010), children are not simply short users; they are unique users. As such, there are plenty of open questions that cannot merely be answered by turning to what we know about the design, deployment, and adoption of AI technology targeting adult users in varied domains. Among the more immediate situations to address, we find the trade-off between privacy and personalisation (a must for AI applications that support learning); the digital divide (as not all children have access to the same level of support when it comes to the proper use of AI applications for the classroom); the need to train the trainers (as the adults in the life of children might not possess the know-how to impart best practices); the concept of misinformation (as AI applications should offer content children can rely on), and, more importantly, the issue of interactions among engagement, distraction, and learning (as AI applications integrated in the classroom should not be a detriment to traditional teaching practices).

What is next? Lessons learned from a case study can guide the deployment and integration into children's everyday lives of AI applications that are safe and attentive to their needs and expectations. AI applications that also abide by principles of fairness and, most of all, explicitly understand and respond to the fact that there is no such a thing as one-size-fits-all when it comes to children.

## 9.6. Children's right to protection from economic exploitation in an AI-world

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Since the adoption of the United Nations Convention on the Rights of the Child in 1989, the living, playing and learning environment of children has changed dramatically. While AI-enabled toys and voice assistants have entered children's homes, in schools, it's AI-powered tutors, learning assistants and personalised educational programmes that are gaining momentum.[83] Children's interactions and communications are also increasingly mediated by AI-enabled platforms and applications like social media, video-sharing- and interactive gaming platforms. These platforms rely on advanced machine learning to deliver content and personalise – or in their own words "improve"[84] - user experience and maximise engagement.

The specific features of these technologies make them not only particularly appealing to children, but also potentially harmful . A particular challenge to children's rights relates to the fact that many AI technologies children engage and play with are developed by private companies and offered on a for-profit basis. This raises the concern that the inherently commercial and opaque nature of these technologies may lead to an increasingly monetised digital playground for children, often without them realising it (Van Der Hof et al. 2020; Verdoodt & Lievens, 2017; Verdoodt et al. 2016).

### NOTES

[83] UNICEF, The State of the World's Children 2017: Children in a Digital World (UNICEF 2017) 58.

[84] For instance TikTok's For You Feed, see https://newsroom.tiktok.com/en-us/how-tiktok-recommends-videos-for-you.

The potential misuse of AI for commercial purposes is also clearly on the minds of children and young people themselves (cfr. section 6.3). Therefore, one important question that deserves special attention from policymakers, researchers and other stakeholders is the following: Where should we draw the line between acceptable commercial practices and AI-enabled exploitation?

This, of course, is not a simple question. Longitudinal studies on how the intrusion of commercial interests and monetisation techniques through AI-based applications and systems affects children's long-term well-being and development are still missing. Then again, even if there is no (hard) evidence yet on the harmfulness of these practices to children's well-being, scholars like LIEVENS have advocated a 'better safe than sorry'-approach, based on the 'precautionary principle' (Lievens, 2021). More specifically, she argues that "the principle compels society to act cautiously if there are certain – but not necessarily absolute – scientific indications of a potential danger and if not acting upon these indications could inflict harm" (Lievens, 2021). At present, exploitative practices in the digital world have already reached the point where they are specifically designed for and are becoming ever more sophisticated in manipulating children into sharing more personal data or spending more money.

Moreover, when (commercial) persuasive algorithms dictate children's decision-making there is a danger that their autonomy, creativity and ultimately their development will be compromised . In response to this, the argument is often made that we need to empower children so that they can cope with the commercial pressures that these new technologies bring. We see this for instance with (proposed) legal and ethical frameworks (for AI) prescribing empowerment measures such as transparency and information rights as a means of protection. While such rights and measures are indeed crucial for children's education and development, they are not a panacea. The lack of insight into how exactly AI-systems generate certain outputs makes it extremely difficult for children – or adults for that matter - to anticipate potential risks, harms or violations of their rights.

In that respect, the responsibility for understanding how AI-systems operate, process data and make decisions, or assessing the fairness of outputs cannot be placed solely on the shoulders of children or their parents (Lievens, 2021). Instead, a precautionary approach requires other actors such as policymakers, businesses, and regulators to step up and ensure that children's rights become a reality. When these actors make policies or (commercial) decisions on AI that may affect children, they must carefully assess their potential impact on all children's rights - including their right to protection from economic exploitation - and take the best interests of the child as a primary consideration. During this process, children and young people must be actively listened to and their views must be effectively taken into account (Verdoodt 2021). Only when meaningful child participation becomes the norm in decision- and policy-making on technology will children's rights be fully realised in an AI-world.

## NOTES

[85] OECD, 'Children in the Digital Environment - Revised Typology of Risks' 5.

[86] (Van Der Hof et al. 2020; Verdoodt 2019). Thereby negatively impacting children's rights to privacy (Article 16 UNCRC) and to protection from economic exploitation (Article 32 UNCRC).

[87] This is problematic from the perspective of Article 6 UNCRC. The Council of Europe's Committee of Ministers, for instance, has warned that the "fine grained, sub-conscious and personalised levels of algorithmic persuasion may have significant effects on the cognitive autonomy of individuals and their rights to form opinions and take independent decisions" Council of Europe, Committee of Ministers, 'Declaration by the Committee of Ministers on the Manipulative Capabilities of Algorithmic Processes'.

[88] See for example: Proposal for a Regulation of the European Parliament and of the Council laying down harmonised rules on artificial intelligence (Artificial Intelligence Act) and amending certain Union legislative acts Com/2021/206 Final; AI HLEG, 'Ethics Guidelines for Trustworthy AI'; Regulation (EU) 2016/679 (General Data Protection Regulation); UNICEF, 'Policy Guidance on AI for Children' (2021). See also Lievens (2020).

[89] Marietje Schaake, 'The European Commission's Artificial Intelligence Act' 7, 2.

[90] In relation to this, various means should be explored, including (1) establishing legal restrictions for AI (e.g. Article 5 of the Proposal for the AI); (2) ensuring responsibilities for companies (and other actors) that develop and use AI technologies; (3) and having regulators with the necessary know-how and financial resources to monitor and handle complaints. See (Lievens, 2021; Verdoodt 2020).

[91] Article 3 UNCRC and Article 24 CFEU.

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**N.B. The references to policy-related reports appear as footnotes throughout the text. Below, we list the references to scientific works.**


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