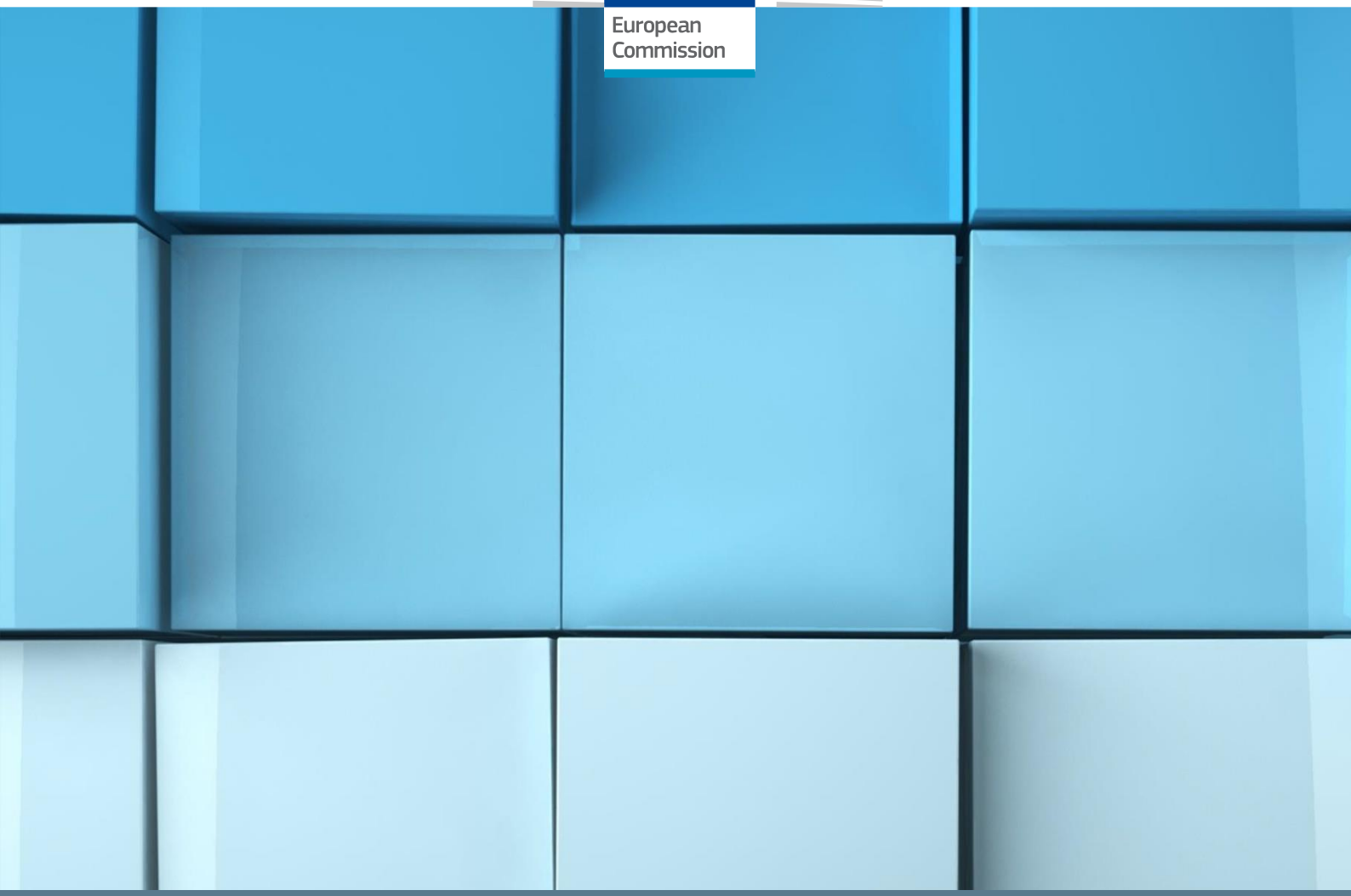

European Commission

Effects of the use of digital technology on children's empathy and attention capacity

Analytical report

NESET

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EUROPEAN COMMISSION

Effects of the use of digital technology on children's empathy and attention capacity

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ABOUT NESET

NESET is an advisory network of experts working on the social dimension of education and training.

The European Commission's Directorate-General for Education and Culture initiated the establishment of the network as the successor to NESSE (2007-2010), NESET (2011-2014) and NESET II (2015-2018).

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Executive summary

Students, teachers, families and other community members use digital technology as an educational tool in formal, non-formal and informal learning environments. While its use is widespread, increasing concern has emerged about its effects on children, particularly in relation to their empathy and attention capacity, as these dimensions are crucial to students' development and success. The effects of using digital technology are embedded in the context in which it is employed. These effects can be different, depending on how technology is used, and to what purpose.

This analytical report reveals the most relevant and up-to-date scientific contributions worldwide about the effects of the use of digital technology on children's empathy and attention capacity. The report synthesises existing knowledge gathered from an extensive literature review that has identified evidence from scientific articles and relevant European Commission (EC) official reports on the topic of focus. The guiding question of the present report is:

- What are the effects of the use of digital technology on children's empathy and attention?

The concepts of digital technology, children's empathy and attention capacity are at the core of this report. The key findings of our in-depth literature review are divided into two main sections: 1) the effects of the use of digital technology on children's empathy; and 2) effects of digital technology use on children's attention capacity. Based on this analysis, the report provides useful recommendations for the diverse agents involved in children's education, from policy makers and stakeholders to teachers and families.

Key findings

1. The effects of the use of digital technology on children's empathy

The report's key findings on the effects of the use of digital technology include evidence about the ways in which it has an impact on children's empathy, and the factors most relevant in explaining such effects. Empathy increases in some children or decreases in others, depending on **the way in which digital technology is used,** and **to what purpose**. The key findings of our literature review are as follows:

- **Digital technology has the effect of increasing children's empathy when its content, use and interactions are prosocial.** Prosocial uses of digital technology can be promoted in very diverse learning activities and environments. Students' interactions and interactive learning approaches play a key role in these effects. This finding is in line with the principles of dialogic education, which is based on the capacity for dialogue to be used as a tool to collectively create meaning. This promotes the inclusion of all voices and fosters the creation of dialogic environments in which participants (teachers, families, volunteers, students) organise themselves and make decisions on a consensual basis. Thus, dialogic learning environments can contribute to an increase in children's empathy through the use of digital technology. In addition, it is important to take into account the need for this prosocial perspective to be present in all spaces within a school. Indeed, the literature highlights the importance of delivering consistent

practice across all spaces, in order to avoid the negative effects of 'not practising what you preach' (double standards).

- **Digital technology has the effect of decreasing children's empathy when it involves antisocial use and violent content.** Choosing violent media content (movies and series), playing violent video games or engaging in bullying and discriminatory actions can exacerbate aggressive attitudes, emotions and behaviours. It can also desensitise participants and decreasing their empathy and prosocial behaviour. Some authors suggest that such effects are not long-lasting, and that playing prosocial video games can have a neutralising effect. The development of critical thinking skills has been identified as key for children and adolescents to reject/critically scrutinise uses of digital technology that influence them negatively. Learning environments that are rich in interactions, such as dialogic learning environments, promote children's capacity to critically assess their use of technology, while fostering solidarity and empathy.
- **Digital technology has the effect of decreasing children's empathy when screen time reduces face-to-face interactions.** Some authors show an association between screen time and reduced capacity to make friends or increased difficulty in learning empathy in real-life contexts. However, online interactions and time spent using digital technology can increase empathy as long as they do not reduce face-to-face interactions. Furthermore, interactively rich environments that foster the collaborative use of digital technology can offer a balanced environment in which the use of digital technology is not detrimental to face-to-face interaction.
- **The use of digital technology presents some perils, including cyberbullying.** The association between empathy and the perpetration of cyberbullying has been the subject of much research. This has focused on exploring the possibility of predicting an individual's likelihood of perpetrating cyberbullying, based on their empathy score. However, the way in which children's capacity for empathy may be affected by their use of digital technology to perpetrate cyberbullying remains an underexplored issue. Further research is required.

These key findings enable us to elaborate a number of recommendations on dealing with the effects of digital technology on children's empathy.

Recommendations on digital technology and children's empathy

1. Digital technology can have the effect of increasing children's empathy when its content and use follow a prosocial approach. Such effects can be enhanced by **promoting interactive learning environments and ensuring coherence** throughout all learning activities.
2. Digital technology can have the effect of reducing children's empathy when its content and use involve antisocial approaches and violent content. Such effects can be avoided through the **development of media literacy, including critical thinking skills**.
3. Digital technology can have the effect of reducing children's empathy when screen time occurs to the detriment of face-to-face interactions. Such effects can be avoided through the **promotion of real interactive environments** that enhance integration of the use of digital technology while fostering student collaboration via dialogic learning environments.
4. The use of digital technology presents some **perils, including cyberbullying**. Further research is required to explore this issue.

2. The effects of the use of digital technology on children's attention capacity

Policy makers, teachers, families and other community members have raised relevant concerns about the attention problems in students that may result from the use of digital technology use, and how such effects can influence students' cognitive functions. Research has focused on diverse uses and devices, making remarkable contributions to the understanding of the effects of computerised cognitive training programmes. In addition, it has explored the effects of integrating smart devices into daily educational activities, approaching in a relevant way the impact of the use of digital technology on children's attention capacity. **Children's use of digital technology can, in some case, improve their attention capacity. In other cases, it can be a distraction that generates attention problems.** Research shows that whether it produces one effect or the other is dependent on the way in which digital technology is used, the time spent using digital technology for non-educational purposes, and the learning approach that is applied.

With respect to this, the key findings of the literature review are as follows:

1. **Computerized cognitive training programs produce diverse effects.** Some such programs improve the attention capacity of children, while others do not exhibit a significant effect in this regard. From the scientific evidence, it can be stated that further research is required to identify the key factors that contribute to an improvement in attention capacity by computerised training programs.
2. **The integration of smart devices (i.e. tablets, smartphones) into educational activities improves children's attention capacity.** A common finding on the effect of the use of smart devices in the classroom is that they have the effect *per se* of improving attention capacity. Research indicates that when the use of digital technology is integrated into a school activity, it has the potential

to improve attention capacity. This effect increases depending on the learning approach of teachers and/or other professionals.

3. **Mobile devices, video games and computers have a distracting effect on attention capacity when the time spent using digital technology for non-educational purposes on a school day exceeds two hours.** Adolescents who spend more than two hours on school days engaging in the non-educational use of digital technology are more likely to report attention deficit and/or hyperactivity problems, compared with those who do not. Time spent using digital technology for non-educational purposes has the effect of distracting students from educational tasks and promoting inattention or hyperactivity problems. Authors identified these issues as being associated with the routine use of digital technology for non-educational purposes. Other authors who focus on the amount of time spent using digital technology results reveal that students who report very frequent use of digital technology have a 10.5 % probability of developing Attention Deficit Hyperactivity Disorder (ADHD), a condition that interferes with functioning or development that is marked by an ongoing pattern of inattention and/or hyperactivity-impulsivity. Some research shows that students mostly agree with the setting of strict controls on the use of digital technology, as well as the need to use it in engaging and meaningful ways, ensuring its proper integration into learning activities.

The key findings identified in this section of the report enable us to make the following recommendations on dealing with the effects that children's use of digital technology has on their attention capacity:

Recommendations on digital technology and attention capacity

1. Research shows that computerised cognitive training programs can have the effect of improving children's attention capacity. The **inclusion of previous evidence** from studies in which an improvement on children's attention capacity was demonstrated is relevant for the future design, development and monitoring of computerised cognitive training programs.
2. Non-educational use of digital technology that exceeds two hours on school days can have the effect of decreasing children's attention capacity. This evidence is relevant for policy makers, teachers, families and other members of the community.
3. Effective strategies to limit the capacity of digital technology to distract children can be elaborated through collaboration between students and their peers.
4. Further research is required to determine the effects of the use of digital technology on attention capacity, depending on the teaching and/or learning approach applied.

Résumé analytique

Les élèves, enseignants, familles et autres membres de la communauté utilisent la technologie numérique comme un outil éducatif dans des environnements d'apprentissage formels, non formels et informels. Bien que son utilisation soit répandue, des préoccupations croissantes sont apparues quant aux effets de la technologie numérique sur les enfants, notamment sur leur empathie et leur capacité d'attention, car ces dimensions sont cruciales pour le développement et la réussite des élèves. Les effets de l'utilisation de la technologie numérique sont intrinsèques au contexte dans lequel elle est employée. Ces effets peuvent être différents, selon la manière dont la technologie est utilisée et à quelle fin.

Ce rapport analytique dévoile les contributions scientifiques les plus pertinentes et les plus récentes au monde concernant les effets de l'utilisation de la technologie numérique sur l'empathie et la capacité d'attention des enfants. Le rapport synthétise les connaissances existantes recueillies dans le cadre d'une analyse documentaire approfondie, laquelle a permis l'identification de preuves provenant d'articles scientifiques et de rapports officiels pertinents de la Commission européenne (CE) sur le sujet. La question directrice du présent rapport est la suivante :

- Quels sont les effets de l'utilisation de la technologie numérique sur l'empathie et l'attention des enfants ?

Les concepts de technologie numérique, d'empathie et de capacité d'attention des enfants sont au cœur de ce rapport. Les principales conclusions de notre analyse documentaire approfondie sont divisées en deux grandes sections : 1) les effets de l'utilisation de la technologie numérique sur l'empathie des enfants ; et 2) les effets de l'utilisation de la technologie numérique sur la capacité d'attention des enfants. Sur la base de cette analyse, le rapport fournit des recommandations utiles pour les divers agents impliqués dans l'éducation des enfants, des décideurs politiques et parties prenantes aux enseignants et familles.

Principales conclusions

1. Les effets de l'utilisation de la technologie numérique sur l'empathie des enfants

Les principales conclusions du rapport sur les effets de l'utilisation de la technologie numérique mettent en évidence la façon dont celle-ci impacte l'empathie des enfants ainsi que les facteurs les plus pertinents pour expliquer ces effets. L'empathie augmente chez certains enfants ou diminue chez d'autres, selon **la manière dont la technologie numérique est utilisée** et **à quelle fin**. Les principales conclusions de notre analyse documentaire sont les suivantes :

- **La technologie numérique a pour effet d'augmenter l'empathie des enfants lorsque son contenu, son utilisation et ses interactions sont prosociaux**. Les utilisations prosociales de la technologie numérique peuvent être encouragées dans des activités et des environnements d'apprentissage très divers. Les interactions des élèves et les approches d'apprentissage interactives jouent un rôle clé dans ces effets. Ce constat est conforme aux principes de l'éducation dialogique, qui repose sur la capacité du dialogue à être utilisé comme

un outil de création collective de sens. Cela favorise l'inclusion de toutes les voix et encourage la création d'environnements dialogiques dans lesquels les participants (enseignants, familles, volontaires, élèves) s'organisent et prennent des décisions sur une base consensuelle. Ainsi, les environnements d'apprentissage dialogiques peuvent contribuer à accroître l'empathie des enfants grâce à l'utilisation de la technologie numérique. En outre, il est important de prendre en compte la nécessité que cette perspective prosociale soit présente dans tous les espaces d'une école. En effet, la littérature souligne l'importance d'une pratique cohérente dans tous les espaces, afin d'éviter les effets négatifs de « ne pas mettre en pratique ce que l'on préconise » (double standard).

- **La technologie numérique a pour effet de diminuer l'empathie des enfants lorsqu'elle implique un usage antisocial et un contenu violent.** Choisir des contenus médiatiques violents (films et séries), jouer à des jeux vidéo violents ou se livrer à des brimades et à des actes discriminatoires peut exacerber les attitudes, les émotions et les comportements agressifs. Cela peut également désensibiliser les participants et diminuer leur empathie et leur comportement prosocial. Certains auteurs suggèrent que ces effets ne sont pas durables et que le fait de jouer à des jeux vidéo prosociaux peut avoir un effet neutralisant. Le développement de l'esprit critique a été identifié comme la clé pour que les enfants et les adolescents rejettent ou examinent d'un œil critique les utilisations de la technologie numérique qui les influencent négativement. Les environnements d'apprentissage riches en interactions, tels que les environnements d'apprentissage dialogiques, favorisent la capacité des enfants à évaluer de manière critique leur utilisation de la technologie, tout en encourageant la solidarité et l'empathie.
- **La technologie numérique a pour effet de diminuer l'empathie des enfants lorsque le temps passé devant l'écran réduit les interactions en face à face.** Certains auteurs montrent une association entre le temps passé devant l'écran et la réduction de la capacité à se faire des amis ou une difficulté accrue à apprendre l'empathie dans des contextes de la vie réelle. Cependant, les interactions en ligne et le temps passé à utiliser la technologie numérique peuvent augmenter l'empathie tant qu'ils ne réduisent pas les interactions en face à face. De plus, les environnements riches en interactivité qui favorisent l'utilisation collaborative de la technologie numérique peuvent offrir un environnement équilibré dans lequel l'utilisation de la technologie numérique ne nuit pas aux interactions en face à face.
- **L'utilisation de la technologie numérique présente certains dangers, notamment le cyberharcèlement.** L'association entre empathie et perpétration de cyberharcèlement a fait l'objet de nombreuses recherches. Celles-ci se sont concentrées sur la possibilité de prédire la probabilité qu'un individu commette des actes de cyberharcèlement, sur la base de son score d'empathie. Cependant, la manière dont la capacité d'empathie des enfants peut être affectée par leur utilisation de la technologie numérique pour perpétrer du cyberharcèlement reste une question sous-explorée. Des recherches plus approfondies sont nécessaires.

Ces conclusions clés nous permettent d'élaborer un certain nombre de recommandations concernant la manière de traiter les effets de la technologie numérique sur l'empathie des enfants.

Recommandations sur la technologie numérique et l'empathie des enfants

1. La technologie numérique peut avoir pour effet d'accroître l'empathie des enfants lorsque son contenu et son utilisation suivent une approche prosociale. Ces effets peuvent être renforcés par la **promotion d'environnements d'apprentissage interactifs et la garantie d'une cohérence** dans toutes les activités d'apprentissage.
2. La technologie numérique peut avoir pour effet de réduire l'empathie des enfants lorsque son contenu et son utilisation impliquent des approches antisociales et un contenu violent. De tels effets peuvent être évités par le **développement de l'éducation aux médias, notamment des compétences de pensée critique.**
3. La technologie numérique peut avoir pour effet de réduire l'empathie des enfants lorsque le temps passé devant l'écran se fait au détriment des interactions en face à face. De tels effets peuvent être évités par la **promotion d'environnements interactifs réels** qui améliorent l'intégration de l'utilisation de la technologie numérique tout en favorisant la collaboration des élèves par le biais d'environnements d'apprentissage dialogiques.
4. L'utilisation de la technologie numérique présente certains **dangers, notamment le cyberharcèlement**. Des recherches supplémentaires sont nécessaires pour explorer cette question.

2. Les effets de l'utilisation de la technologie numérique sur la capacité d'attention des enfants

Les décideurs politiques, enseignants, familles et autres membres de la communauté ont soulevé des préoccupations pertinentes concernant les problèmes d'attention chez les élèves pouvant résulter de l'utilisation des technologies numériques, et sur la manière dont ces effets peuvent influencer les fonctions cognitives des élèves. Les recherches se sont concentrées sur divers usages et dispositifs, apportant une contribution remarquable à la compréhension des effets des programmes d'entraînement cognitif informatisés. En outre, elles ont exploré les effets de l'intégration de dispositifs intelligents dans les activités éducatives quotidiennes, en abordant de manière pertinente l'impact de l'utilisation de la technologie numérique sur la capacité d'attention des enfants. **L'utilisation de la technologie numérique par les enfants peut, dans certains cas, améliorer leur capacité d'attention. Dans d'autres cas, elle peut être une distraction qui génère des problèmes d'attention.** Les recherches montrent que le fait que la technologie numérique produise un effet ou l'autre dépend de la manière dont elle est utilisée, du temps passé à utiliser la technologie numérique à des fins non éducatives et de l'approche d'apprentissage appliquée.

À cet égard, les principales conclusions de l'analyse documentaire sont les suivantes :

1. **Les programmes d'entraînement cognitif informatisés produisent des effets divers.** Certains de ces programmes améliorent la capacité d'attention des enfants, tandis que d'autres ne présentent pas d'effet significatif. Sur la base des preuves scientifiques, on peut affirmer que des recherches supplémentaires sont nécessaires pour identifier les facteurs clés qui contribuent à une amélioration de la capacité d'attention par les programmes d'entraînement informatisés.
2. **L'intégration d'appareils intelligents (p. ex. tablettes, smartphones) dans les activités éducatives améliore la capacité d'attention des enfants.** Un constat commun sur l'effet de l'utilisation des dispositifs intelligents en classe est qu'ils ont pour effet propre d'améliorer la capacité d'attention. Les recherches indiquent que lorsque l'utilisation de la technologie numérique est intégrée dans une activité scolaire, elle a le potentiel d'améliorer la capacité d'attention. Cet effet augmente en fonction de l'approche d'apprentissage des enseignants et/ou d'autres professionnels.
3. **Les appareils mobiles, les jeux vidéo et les ordinateurs ont un effet de distraction sur la capacité d'attention lorsque le temps passé à utiliser la technologie numérique à des fins non éducatives au cours d'une journée scolaire dépasse deux heures.** Les adolescents qui passent plus de deux heures les jours d'école à utiliser la technologie numérique à des fins non éducatives sont plus susceptibles d'être sujets à des problèmes de déficit d'attention et/ou d'hyperactivité, par rapport à ceux qui ne le font pas. Le temps passé à utiliser la technologie numérique à des fins non éducatives a pour effet de distraire les élèves des tâches éducatives et de favoriser les problèmes d'inattention ou d'hyperactivité. Les auteurs ont identifié ces problèmes comme étant associés à l'utilisation courante de la technologie numérique à des fins non éducatives. D'autres auteurs qui se concentrent sur le temps passé à utiliser la technologie numérique révèlent que les élèves qui déclarent utiliser très fréquemment la technologie numérique ont une probabilité de 10,5 % de développer un trouble déficitaire de l'attention avec hyperactivité (TDAH), un état qui interfère avec le fonctionnement ou le développement et qui est marqué par un schéma continu d'inattention et/ou d'hyperactivité-impulsivité. Certaines recherches montrent que les élèves sont pour la plupart d'accord avec la mise en place de contrôles stricts sur l'utilisation de la technologie numérique, ainsi qu'avec la nécessité de l'utiliser de manière engageante et significative, en veillant à son intégration adéquate dans les activités d'apprentissage.

Les principales conclusions identifiées dans cette section du rapport nous permettent de formuler les recommandations suivantes sur la manière de traiter les effets de l'utilisation de la technologie numérique par les enfants sur leur capacité d'attention :

Recommandations sur la technologie numérique et la capacité d'attention

1. Les recherches montrent que les programmes d'entraînement cognitif informatisés peuvent avoir pour effet d'améliorer la capacité d'attention des enfants. La **prise en compte des résultats d'études antérieures** dans lesquelles une amélioration de la capacité d'attention des enfants a été démontrée est pertinente pour la conception, le développement et le suivi futurs des programmes d'entraînement cognitif informatisés.
2. L'utilisation non éducative de la technologie numérique qui dépasse deux heures les jours d'école peut avoir pour effet de diminuer la capacité d'attention des enfants. Ce résultat est pertinent pour les décideurs politiques, les enseignants, les familles et les autres membres de la communauté.
3. Des stratégies efficaces pour limiter la capacité de la technologie numérique à distraire les enfants peuvent être élaborées grâce à la collaboration entre les élèves et leurs pairs.
4. Des recherches supplémentaires sont nécessaires pour déterminer les effets de l'utilisation de la technologie numérique sur la capacité d'attention, en fonction de l'approche d'enseignement et/ou d'apprentissage appliquée.

Kurzfassung

Schülerinnen und Schüler, ihre Familien und andere Bezugspersonen verwenden digitale Technologien als Lernhilfen in formalen, nicht-formalen und informellen Lernumfeldern. Obwohl sie von fast jedem genutzt werden, gibt es auch Bedenken über die Auswirkungen auf Kinder und insbesondere auf deren Fähigkeit zu Empathie und zur Konzentration, also auf zwei Eigenschaften, die Entwicklung und Erfolg von Schülern entscheidend beeinflussen. Wie sich die Nutzung digitaler Technologien auswirkt, hängt unter anderem davon ab, in welchem Zusammenhang sie genutzt wird, aber auch von Art und Weise der Nutzung und deren Zweck.

Dieser analytische Bericht fast die aktuellsten wissenschaftlichen Arbeiten aus aller Welt über die Auswirkungen der Nutzung digitaler Technologien auf die Empathie und Konzentrationsfähigkeit von Kindern zusammen. Der Bericht stellt den aktuellen Stand der Forschung dar, für den im Rahmen einer gründlichen Literaturrecherche die Daten aus wissenschaftlichen Artikeln und einschlägigen Berichten der Europäischen Kommission erfasst wurden. Dabei wurde der vorliegende Bericht von der folgenden Frage geleitet:

- Wir wirkt sich die Nutzung digitaler Technologien auf Empathie und Konzentration von Kindern aus?

Kernbegriffe des Berichts sind „digitale Technologie" und Empathie- und Konzentrationsfähigkeit von Kindern. Die wichtigsten Ergebnisse unserer detaillierten Auswertung der Forschungsliteratur sind in zwei Gruppen gegliedert: 1) Auswirkungen der Nutzung digitaler Technologien auf die Empathie von Kindern und 2) Auswirkungen der Nutzung digitaler Technologien auf die Konzentrationsfähigkeit von Kindern. Auf der Grundlage dieser Analyse formuliert der Bericht Empfehlungen für die verschiedenen Akteuren, die den Bildungsprozess von Kindern beeinflussen, also z. B. für Politik und Interessengruppen, Lehrkräfte und Familien.

Wichtige Ergebnisse

1. Auswirkungen der Nutzung digitaler Technologien auf die Empathie von Kindern

Zu den zentralen Ergebnissen der Untersuchung gehören Erkenntnisse, wie die Verwendung digitaler Technologie die Empathiefähigkeit von Kindern beeinflusst und mit welchen Faktoren sich diese Effekte am besten erklären lassen. Die Empathiefähigkeit nimmt bei manchen Kindern ab und bei anderen zu, **je nachdem, wie die Kinder digitale Technologien nutzen** und **zu welchem Zweck**. Dies sind die wichtigsten Ergebnisse unseres Literaturüberblicks:

- **Digitale Technologie steigert das Empathievermögen von Kindern, wenn ihre Inhalte, Nutzungsweisen und Interaktionen prosozial sind. Die prosoziale Verwendung digitaler Technologien lässt sich in ganz verschiedenen Lernaktivitäten und -umfeldern fördern.** Bei diesen Effekten spielen die Interaktionen und interaktiven Lernansätze des Schülers eine entscheidende Rolle. Dieses Ergebnis entspricht den Grundsätzen einer auf Dialog gestützten Bildung, in der Dialog als Mittel zur kollektiven Erschaffung von Sinnzusammenhängen gesehen wird. Dies ermöglicht die Einbeziehung aller

Stimmen und die Schaffung eines dialogischen Umfelds, in dem die Teilnehmer (Lehrkräfte, Familien, Helfer, Schülerinnen und Schüler) sich selbst organisieren und Entscheidungen im wechselseitigen Einverständnis treffen. Das heißt, dialogische Lernumfelder können durch den Einsatz digitaler Technologien dazu beitragen, die Empathiefähigkeit von Kindern zu verbessern. Dabei muss jedoch darauf geachtet werden, dass diese prosoziale Perspektive in allen Bereichen der Schule zur Geltung kommt. Tatsächlich betont die Literatur, wie wichtig es ist, dass in allen Bereichen einheitliche Verfahren angewendet werden, um negative Auswirkungen durch „Wasser predigen und Wein trinken (Doppelmoral) zu vermeiden.

- **Digitale Technologie mindert das Empathievermögen von Kindern, wenn sie antisozial verwendet wird und Gewalt enthält.** Der Konsum von gewalttätigen Medieninhalte (Filme und Serien) und Videospielen, die Gewalt enthalten, oder die Teilnahme an Mobbing und diskriminierenden Handlungen kann aggressive Einstellungen, Gefühle und Verhaltensweisen verstärken. Dies kann auch zu Desensibilisierung, abnehmender Empathie und weniger prosozialem Verhalten führen. Manche Autoren meinen, dass diese Effekte nur kurzfristig sind und durch das Spielen prosozialer Videospiele neutralisiert werden können. Laut der Forschung ist es wichtig, dass Kinder und Jugendliche ihre Fähigkeit zu kritischem Denken entwickeln, damit sie Nutzungsweisen digitaler Technologien, die sie negativ beeinflussen, vermeiden und/oder kritisch hinterfragen. Lernumfelder mit vielen Interaktionen, also dialogische Lernumfelder, fördern die Solidarität und Empathie von Kindern und gleichzeitig ihre Fähigkeit die eigene Technologienutzunge kritisch zu bewerten.
- **Digitale Technologie mindert das Empathievermögen von Kindern, wenn durch die Zeit vor dem Bildschirm persönliche Interaktionen wegfallen.** Manche Studien zeigen, dass vor dem Bildschirm verbrachte Zeit die Fähigkeit vermindert, Freundschaften zu schließen und in der realen Welt Empathie zu empfinden. Allerdings können Online-Interaktionen und die Nutzung digitaler Technologien das Empathievermögen auch erhöhen, solange sie persönliche Begegnungen nicht ersetzt. Außerdem können Umfelder mit vielen Interaktionsangeboten auch die gemeinsame Nutzung digitaler Technologie fördern und ein ausgewogenen Umfeld bieten, in dem digitale Technologien persönliche Interaktionen nicht beeinträchtigen.
- **Digitale Technologien sind mit Gefahren verbunden, zum Beispiel mit Cyber-Mobbing. Zum Zusammenhang zwischen Empathie und Cyber-Mobbing wurde schon viel geforscht.** Dabei wurde vor allem untersucht, ob es möglich ist, die Neigung einer Person zu Cyber-Mobbing aus deren Empathiewerten abzuleiten. Ob und wie die Nutzung digitaler Technologien zum Cyber-Mobbing die Empathiefähigkeit von Kindern beeinflusst, wurde bisher jedoch noch nicht analysiert. Hier sind weitere Forschungsarbeiten notwendig.

Auf der Grundlage dieser Ergebnisse haben wir eine Reihe von Empfehlungen formuliert, wie die Auswirkungen digitaler Technologien auf die Empathie von Kindern gesteuert werden können.

Empfehlungen zu digitalen Technologien in Bezug auf die Empathie von Kindern

1. Digitale Technologie kann das Empathievermögen von Kindern verbessern, wenn ihre Inhalte und Nutzungsweisen einem prosozialen Ansatz folgen. Diese Effekte lassen sich durch die **Förderung interaktiver Lernumfelder und Kohärenz** zwischen allen angebotenen Lernaktivitäten verstärken.
2. Digitale Technologie kann das Empathievermögen von Kindern mindern, wenn ihre Inhalte und Nutzungsweisen antisozialen Ansätzen entsprechen und Gewalt enthalten. Diese Effekte lassen sich durch die **Vermittlung von Medienkompetenz und der Fähigkeit zu kritischem Denken** vermeiden.
3. Digitale Technologie kann die Empathiefähigkeit von Kindern beeinträchtigen, wenn durch die Zeit vor dem Bildschirm persönliche Interaktionen verdrängt werden. Diese Effekte lassen sich durch die **Förderung von Umfeldern mindern, die echte Interaktionen erlauben,** die Zusammenarbeit zwischen den Schülern durch dialogische Lernumfelder anregen und die Nutzung digitaler Technologien in dieses Umfeld einbetten.
4. Die Nutzung digitaler Technologien ist **mit Gefahren verbunden, zum Beispiel durch Cyber-Mobbing**. Dieses Problem muss jedoch noch näher erforscht werden.

2. Auswirkungen der Nutzung digitaler Technologien auf die Konzentrationsfähigkeit von Kindern

Viele politische Entscheidungsträger, Lehrkräfte, Familien und andere Betroffene sind besorgt, dass die Nutzung digitaler Technologien bei Schülerinnen und Schülern zu Konzentrationsschwäche führen und damit auch deren kognitiven Fähigkeiten beeinträchtigen könnte. Es gibt bereits viele Forschungsarbeiten zu einzelnen Nutzungsarten und Geräten, die bemerkenswerte Beiträge zum Verständnis der Effekte computergestützter Programme zur Stärkung kognitiver Fähigkeiten geleistet haben. Außerdem wurde erforscht, wie sich die Integration intelligenter Geräte in den Unterrichtsalltag auswirkt, wodurch sich die Folgen der Verwendung digitaler Technologie auf die Konzentrationsfähigkeit von Kindern ebenfalls gut beurteilen lässt. **Wenn Kinder digitale Technologien nutzen, kann dies ihre Konzentrationsfähigkeit in manchen Fällen verbessern. In anderen Fällen stellt sie eine Ablenkung dar, die zu Konzentrationsstörungen führt.** Wie die Forschung zeigt, hängt der jeweilige Effekt davon ab, wie digitale Technologien genutzt werden, wie lange sie für andere Zwecke als zum Lernen benutzt werden und welcher Lernansatz verfolgt wird.

Dies sind die wichtigsten Ergebnisse unseres Literaturüberblicks zu dieser Fragestellung:

1. **Die Effekte computergestützter Programme zur Stärkung kognitiver Fähigkeiten sind vielfältig.** Manche dieser Programme verbessern die Konzentrationsfähigkeit von Kindern, andere zeigen in dieser Hinsicht keine signifikanten Effekte. Die wissenschaftlichen Daten zeigen, dass weitere Forschungsarbeiten notwendig sind, um die entscheidenden Faktoren zu identifizieren, die zur Verbesserung des Konzentrationsvermögen durch computergestützte Übungssoftware beitragen.
2. **Die Integration intelligenter Geräte (d. h. Tablet, Smartphones) in die Bildung verbessert die Konzentrationsfähigkeit von Kindern.** Alle Studien über die Effekte der Nutzung intelligenter Geräte im Klassenzimmer zeigen, dass diese *per se* die Konzentrationsfähigkeit verbessern. Sie deuten außerdem darauf hin, dass dieser Effekt besonders dann eintritt, wenn die Verwendung digitaler Technologie in den Schulalltag eingebunden ist. Abhängig vom pädagogischen Ansatz der Lehrkräfte und/oder anderen beteiligten Fachkräften fällt dieser Effekt stärker oder schwächer aus.
3. **Mobilgeräte, Videospiele und Computer haben ein ablenkende Wirkung, wenn digitale Technologie an Schultagen länger als zwei Stunden lang für nicht bildungsbezogene Zwecke genutzt wird.** Jugendliche, die digitale Technologien an Schultagen länger als zwei Stunden lang für nicht bildungsbezogene Zwecke nutzen, weisen häufiger Aufmerksamkeitsdefizite und/oder Hyperaktivität auf, als andere. Die Verwendung digitaler Technologie für nicht bildungsbezogene Zwecke lenkt Schülerinnen und Schüler von ihren schulischen Aufgaben ab und fördert Konzentrationsschwäche oder hyperaktives Verhalten. In Studien konnte ein Zusammenhang zwischen diesen Störungen und der regelmäßigen Nutzung digitaler Technologien für nicht bildungsbezogene Zwecke nachgewiesen werden. Und die Ergebnisse anderer Autoren, die sich auf die mit digitaler Technologie verbrachte Zeit konzentrieren, zeigen, dass bei Schülerinnen und Schüler, die angeben, dass sie häufig digitale Technologien nutzen, die Wahrscheinlichkeit für eine Aufmerksamkeitsdefizit-/Hyperaktivitätsstörung (ADHS) um 10,5 % erhöht ist. Bei dieser Funktions- bzw. Entwicklungsstörung treten Konzentrationsschwäche und/oder Probleme durch Hyperaktivität bzw. Impulsivität. In einigen Studien wurde festgestellt, dass die meisten Schülerinnen und Schüler strenge Regeln für die Nutzung digitaler Technologien akzeptieren und auch verstehen, dass diese auf aktive und sinnvolle Weise genutzt und angemessen in andere Lernaktivitäten integriert werden sollten.

Auf der Grundlage der in diesem Abschnitt des Berichts skizzierten Ergebnisse können wir die folgenden Empfehlungen formulieren, wie die potenziell negativen Auswirkungen der Nutzung digitaler Technologie auf die Konzentrationsfähigkeit von Kindern vermieden werden können.

Empfehlungen zu digitalen Technologien in Bezug auf die Konzentrationsfähigkeit

1. Die Forschung zeigt, dass sich die Aufmerksamkeitsspanne von Kindern durch computergestützte Programme zur Stärkung kognitiver Fähigkeiten erhöhen kann. Daher sollten bei Design, Entwicklung und Kontrolle computergestützter Kognitionstrainingsprogramme **die Erkenntnisse von Studien berücksichtigt werden**, in denen eine Verbesserung des Konzentrationsvermögens bei Kindern nachgewiesen wurde.
2. Wenn Kinder digitale Technologie an Schultagen länger als zwei Stunden für nicht bildungsbezogene Zwecke nutzen, kann dies ihre Konzentrationsfähigkeit beeinträchtigen. Dieses Ergebnis ist für politische Entscheidungsträger, Lehrkräfte, Familien und andere Mitglieder der Gemeinschaft relevant.
3. Effektive Strategien, um die Ablenkung durch digitale Technologien zu begrenzen, sollte gemeinsam mit den betroffenen Schülerinnen und Schülern und ihren Freunden entwickelt werden.
4. Um zu untersuchen, welcher Zusammenhang zwischen dem verwendeten Lern- bzw. Lehransatz und den Effekte digitaler Technologien besteht, sind weitere Studien erforderlich.

Introduction

Aim of the report

The objective of this report is to present the current evidence on the effects of the use of digital technology (in the form of digital tools and software/applications) in relation to children's empathy (social competence) and their capacity to concentrate (attention) at school. For this purpose, a literature review has been conducted to synthesise the best and most up-to-date scientific evidence available on the topic.

Digital technology commonly refers to '*electronic tools, systems, devices and resources that generate, store or process data. Well known examples include social media, online games, multimedia and mobile phones'*(Victoria State Government, n.d.). Thus, digital technology is a crucial means for learning and education, but also represents a major change in approaches to learning and the learning environment (e.g. the transition from print to screen is a major change for human cognition). The use of digital devices in schools is widespread. Among other factors, this influences both formal and informal learning during breaks or after school in both primary and secondary education.

The effects of the use of digital technology in education are still under-explored in relation to several dimensions of students' learning and development. While some attempts have been made in previous literature reviews to explore, for example, the use of tablets in educational settings, most of these have focused on how such use affects students' academic learning outcomes (Dhir, Gahwaji, Nyman, 2013; Nguyen, Barton, Nguyen, 2015). Still, the results remain inconclusive regarding the actual impact of digital technology use on academic achievement.

However, the effects of using digital technology cannot be detached from the context in which the technology is employed. Here, it is relevant to highlight how information and communication technology (ICT) devices (i.e. a physical unit of equipment such as smartphone or tablets) and software (i.e. any program that processes digital data; the terms 'software', 'program' and 'application' are often used as synonymous) are tools that can produce one effect or another depending on the way in which they are used, and to what aim. Scientific literature shows that the introduction of digital technology into the classroom may not lead to learning improvements if the approach behind such use is the same employed in traditional instruction (Keane et al., 2016; Montrieux et al., 2015; Shan Fu, 2013; Underwood and Dillon, 2011). A clear example of this are classes in which children went from engaging in individual work on paper, to carrying out such work in the same way but using a computer (Montrieux et al., 2015). Here, the difference was much smaller than if the learning approach had been changed.

The case of Ariño, a rural village in northern Spain, demonstrates that ICT alone is not enough, and that the effective introduction of digital technology in schools requires the engagement of the entire community (Gatt and Sordé, 2012). When introducing digital technology to the classroom, the Learning Community of Ariño employed a dialogic approach based on the understanding that dialogue is a tool to reach agreements on an egalitarian basis. The whole village was involved in the process. Such was the success of the project that Microsoft dubbed it 'the school of the future', due to the transformative impact it had on the village. Ariño went from being remote and isolated, to enjoying a deep connection with the outside world. The case evidences the need to take into account both the context and the approach when assessing the effects of using

digital technology, since these effects will depend on both the 'how' and the 'why' behind such use.

The lack of knowledge about the consequences of the use of digital technology on students' empathy and attentional capacity is an important factor in this context, since both dimensions are critical for students' development and success in formal and informal learning. To address this knowledge gap, this analytical report provides a review of the literature. Here, we gather together in one place the current evidence on the effects that the use of digital technology has on children's empathy and capacity to concentrate. We also explore how those effects depend on use, approach and agency, in order to provide useful recommendations to parents, teaching professionals and other members of the community.

Our review includes studies whose target population is children in primary and secondary education (5 to 16-year-olds). No limitations have been placed on the countries in which these studies have been carried out (either within the EU or internationally). This allows us to assemble much more robust and consistent evidence for the later analysis of the European educational landscape.

Methodology

The literature review was conducted according to the criteria currently favoured by the leading international scientific research programmes such as Horizon Europe. Among others, these programmes include contributions from COCHRANE, EPPI, PICO and SPICE.

Out of a total of 7,726 primary articles that exist on the subject, a total of 640 were selected for review in accordance with the inclusion criteria. From those, this report gives priority to 15 articles that present evidence for all of the assertions they make, and which meet all of the inclusion criteria.

Both the elaboration and application of the selection criteria were carried through a continuous dialogue between representatives of different fields including, but not limited to, technology and education. Our selection takes into account the voices of both citizens and stakeholders. These are the current standards applied to the most valued studies both worldwide and at European level.

The worldwide scientific contributions identified and analysed are those which address children (Population), which the intervention of digital technology (Intervention), and which investigate the effects that this intervention has on empathy and attention (Outcome). The question applied in this research is:

What are the effects of the use of digital technology on children's empathy and attention?

To this end, studies from various disciplines published in top-ranked journals within the last five years were searched and screened. The search included scientific papers indexed in the Web of Science, mainly those published in impact journals (indexed in the Journal Citation Reports), as well as papers indexed in Scopus and Pubmed. Relevant reports and official EU documents were also considered if they made a notable contribution to the field.

Contributions were identified via searches using combinations of keywords. These are summarised and grouped in Table 1 below:

Table 1. Searchable and combined keywords

Digital Technology	Effects	Target
Digital devices ▪ Smartphones ▪ Tablet ▪ Computer **Software/Applications** ▪ Video (specifically, video games) ▪ Social media	**Empathy** ▪ Positive interactions **Attention** ▪ Capacity to concentrate	Primary school Secondary school High school School Education

Source: compiled by the authors.

Each search incorporated digital technology as a general concept, together with various forms of digital tools (tablet, computers, smartphones, etc.) as well as software/applications (video, video games, social media), and two different educational levels: primary and secondary.

Before conducting the search, the research team established a protocol that includes criteria for the inclusion and exclusion of articles. These are:

Inclusion criteria:

- Articles had to provide evidence that relates to the research question addressed in this report.
- Emphasis was placed on the top-ranked journals in the field of empathy and attention (e.g.. Cognition: Memory, Attention & Learning, Cognitive Neuroscience) and in the field of ICT in education (e.g. Computers in Human Behaviour; Computers and Education). The articles chosen articles had to be highly ranked in the most relevant international scientific databases: either Quartile 1 (Q1) or Quartile 2 (Q2) in Journal Citation Reports (JCR), or Quartile 1 (Q1) in Scopus.
- Priority was given to scientific articles reporting empirical research and which provide quantitative and/or qualitative data on the effects of the use of digital technology on children's empathy and attention.

Exclusion criteria:

- Articles that presented evidence of effects in children using digital technology that were not related to empathy and attention.
- Articles not published in an impact journal (i.e. they did not appear in either Quartile 1 (Q1) or Quartile 2 (Q2) of Journal Citation Reports (JCR) or Quartile 1 (Q1) of Scopus).

Non-empirical or theoretical articles

For each of the databases selected (JCR, SCOPUS and Pubmed), systematic searches were conducted by using a combination of the aforementioned keywords. These searches identified a total of 7,726 articles. Once duplicate articles had been removed from the results, the abstracts of these articles were then reviewed and classified regarding their scope. This resulted in the selection of 640 articles, which were downloaded and read.

An analytical grid was defined to systematise the most relevant information in the studies. This grid included evidence of the effects of the of the use of digital technology on children's empathy and attention capacity. Articles that did not focus on this topic of interest, which were not empirical, or which did not cover the target age range, were discarded. After all of the articles had been read, 602 were excluded: 470 because they did not provide evidence of the effects of digital technology; 27 due to not appearing in Quartile 1 (Q1) or Quartile 2 (Q2) of the Journal Citation Reports (JCR) or Quartile 1 (Q1) in Scopus; and 105 because they were either theoretical or non-empirical in nature.

The resulting 38 articles were read in depth by six researchers and reviewed by two researchers, to thoroughly apply the criteria. Of these articles, 23 were excluded due to not being fully compliant with the aim of the study. This resulted in a list of 15 articles.

The 15 articles were then closely analysed, and the evidence reported in them was collated. The references cited in these articles were also analysed, through the use of a 'snowball' search. During this phase, relevant articles published prior to 2015 as well as meta-analysis and other relevant publications were included. In the end, a total of 33 papers were analysed in the elaboration of this report.

Of these papers, 17 focus on empathy. Of the 17, 12 papers reported digital technology having the effect of increasing children's empathy, while nine reported that the use of digital technology resulted in a reduction in empathy. Six studies reported both increases and decreases in empathy. Regarding the age of participants, six papers reported results on primary students; 12 on secondary students; and three on both. The selected articles covered the effects of the following digital technology devices and software: video games (7), including training programmes (2) and leisure video games (5); virtual reality training programmes (4); augmented reality (1); social media (2); internet use (2); and diverse digital tools including animated stories, discussion forums and a mind mapping tool and learning journal (1).

The remaining 16 of the selected papers focused on children's capacity attention and the corresponding effects of digital technology. Nine reported an improvement in attention capacity; one reported no significant effect, while six explored the distraction effect and attention problems. Regarding the age of participants, six papers reported on primary school students and seven on secondary students; three reported on both. The selected articles covered the effects of the following digital technology devices and software: smart watches (1); smartphones (1); mobile devices (3); tablets (2); touchscreen tablets (2); computerised cognitive training programs (3); augmented reality (1); videogames (1); and digital media (2).

With regarding additional reports consulted, only those published by the European Commission, public administrations and organisations or researchers linked to scientific research projects funded through competitive programmes were included, in order to ensure they were based on validated evidence. The same period (the last five years)

and keywords were used to conduct the searches. Eighteen reports were first retrieved. These were scrutinised, and only those focusing on the age range and topic of interest were included. After applying these criteria, a total of 3 were analysed and included in this report.

In this way, 33 articles and 3 reports were selected and analysed in depth.

Structure of the report

This analytical report is divided into two main chapters, each of which is devoted to one of the report's two topics of interest: *the effects of the use of digital technology on children's empathy and the effects of the use of digital technology on children's attention capacity.*

Each of these sections is divided in three subsections. In the first one of these, we present an overview of the concept being analysed – that is, empathy in Chapter 1 and attention in Chapter 2. In the second subsection, we analyse the effects of the use of digital technology that is directly or indirectly aimed to foster the development of these capacities in children. In the third subsection, we explore the effects on these capacities of the non-educational use of digital technology.

The final chapter of the report summarises the conclusions drawn from Chapters 1 and 2, and provides recommendations for parents, teachers and other members of the community on ways to optimise the effects of the use of digital technology on children's empathy and attention capacity.

1. Effects of the use of digital technology on children's empathy

Key findings

- The use of digital technology increases empathy in some cases, and decreases it in others. Research shows that which of the two effects is achieved depends on how the technology is used, and to what end.
- Digital technology has the effect of increasing children's empathy when its content and use are prosocial. Prosocial uses of digital technology can be promoted through academic activities, training programs, digital communication and the choices of digital technology used for leisure purposes. Students' interactions and interactive learning approaches play a key role in these effects.
- Digital technology has the effect of reducing children's capacity for empathy when it involves violent and antisocial[2] uses. Certain activities, such as playing violent video games, as well as uses of digital technology that are linked to bullying or discrimination, desensitise some children and negatively affect their capacity for empathy.
- Screen time affects the development of empathy if it reduces face-to-face interactions. However, the content and purpose of the use of digital technology have a greater effect on empathy than overall screen time.

1.1. The concept of empathy

The concept of empathy, considered as a means towards positive interactions between people (Eisenberg and Strayer, 1992), has been studied by a wide variety of disciplines (ethology, philosophy, theology, psychology, neurosciences and others). Over the last century, it has been viewed from a number of different perspectives. The concept, translated from the German word *Einfühlung*, was created by psychologist Edward Bradford Titchener in 1909 (Goldstein and Michaels, 1985; Rifkin, 2009; Wispé, 1987). It refers to a person feeling him or herself 'inside' a situation (Wispé, 1987, p. 33).

In the 20th century, the concept of empathy appeared within the field of philosophy as an experience of the consciousness of others in general (Stein and Caballero, 1995). However, it was in the field of psychology that the concept began to gain increasing attention. Freud (1921), Allport (1937), Murphy (1937) and Downey (1929) are among the authors known to have explored this concept.

Nowadays, a variety of definitions and approaches to empathy are employed. Preston and de Waal (2002) used the perception-action model, which includes findings from behavioural sciences, physiology and functional neuroanatomy, to produce an integrated definition. According to these authors, empathy refers to 'any process where the attended perception of the object's state generates a state in the subject that is

[2] According to the American Psychological Association (APA) the term 'antisocial' refers to *denoting or exhibiting behavior that sharply deviates from social norms and also violates other people's rights. Arson and vandalism are examples of antisocial behavior* ('antisocial – APA Dictionary of Psychology,' n.d.).

more applicable to the object's state or situation than to the subject's own prior state or situation' (Preston and de Waal, 2002, p. 4). According to this definition, when individual A perceives the state of individual B, the former automatically activates shared representations of the situation, which allow A to emotionally experience and understand what individual B is experiencing.

Preston and de Waal (2002) add that the closer the subject's and the object's shared representations are, the easier it is for the subject to process the object's state. This, in turn, increases the subject's chances of responding adequately. This suggests that if individual A has experienced a particular situation – for instance, breaking a leg – he or she is more likely to understand what individual B is experiencing in a similar situation. Consequently, the more accurate individual A's representation of the situation is, the better he or she is able to react to what is happening, and to offer a more adequate response to individual B.

Preston and de Waal (2002) also point out that in the empathy process, interrelation plays a key role: the more interrelated the subject and the object are, the more likely the subject is to pay attention to the object's situation. This, in turn, activates a more similar representation, and thus increases the likelihood of an adequate response. In other words, the closely connected we are to the individual experiencing a situation, the more likely we are to pay attention to them, to adequately process how they are feeling, and to successfully respond to it.

Along with other authors, Goleman (2013) refers to the concept of the 'empathy triad'. In this, this author differentiates between three types of empathy (Goleman, 2013):

- **Cognitive empathy** refers to the capacity that allows us to understand what another person may think.
- **Emotional empathy** refers to the capacity that allows us to understand what another person may feel.
- **Empathic concern** refers to the capacity that allows us to understand what another person needs us to do.

Goleman transfers this concept of empathy to the educational field in the book he co-authored with Peter Senge (Goleman and Senge, 2014). In this book, the authors point out that beyond understanding what another person may think and feel, it is also necessary that children develop concern towards others and the situation they are in, so that they feel the need to act upon it. This empathic concern is learnt in school through a classroom culture that fosters such behaviours and attitudes.

The arrival of technology has changed the way in which people, including children, interact and spend their time. More and more communication occurs via online channels, and most children have at their disposal technological devices and apps, both for educational purposes and during their leisure time. It is therefore relevant to investigate the ways in which the use of digital technology affects children's capacity for empathy. Although no conclusive evidence yet exists as to the extent to which digital technology affects children's capacity empathy (James et al., 2017), several relevant findings on the effects of digital technology are summarised in Table 2 below. Findings have been divided into two sections: the effects on empathy of in-school use of digital technology, and the effects on children's empathy at school of other (non-school) uses of digital

technology. The first group covers both the effects of ICT programs deliberately intended to target the child's capacity for empathy, as well as how the integration of digital technology into the classroom may affect this capacity. The second group covers the effects on children's capacity for empathy produced by other uses of digital technology such as online communication or the use of ICT for leisure.

Table 2. Effects of digital technology use on children's empathy

Type	Digital technology	Increase in children's empathy			Decrease in children's empathy
		General/ other	Cognitive	Affective	
Prosocial training programs	*Cybereduca video game 2.0* (Garaigordobil and Martínez-Valderrey, 2015)		x		
	Media Heroes (Schultze-Krumbholz et al., 2016)		x	x	
	Crystals (Kral et al., 2018)	x			
	Inter-Life (Devlin et al., 2015)	x			
	Virtual reality immersive system (Lorenzo et al., 2016)	x			
Digital technology in the classroom	Digital tools: animated stories, discussion forum, mind mapping tool and learning journal (Iaosanurak, Chanchalor, Murphy, 2016)	x			
	Location-based augmented reality (AR) (Efstathiou, Kyza, Georgiou, 2018)	x			
Online Communication	Social Media (General, Facebook, Twitter) (Errasti, Amigo, Villadangos, 2017; Vossen, Valkenburg, 2016)		x	x	x
	Internet use (Flores and James, 2012; Lozada and Tynes, 2017)	x			x
Digital technology for leisure	Screen devices (Prot et al., 2014; Twenge and Campbell, 2018)	x			x
	Media content (series, movies, video games; prosocial, violent) (Prot et al., 2014)	x			x
	Video games (prosocial, violent) (Gabbiadini et al., 2016; Greitemeyer and Mügge, 2014; Harrington and O'Connell, 2016; Prot et al., 2014; Szycik, Mohammadi, Münte, te Wildt, 2017)	x			x

Source: compiled by authors on the basis of the literature review.

1.2. Effects of in-school use of digital technology on children's empathy

Digital technology is present in school in diverse forms, at many different times and linked to a wide variety of activities and purposes. This section presents the effects of using various forms of digital technology. To this end, the section is divided into two subsections. The first considers the effects of training programs specifically designed to improve empathy alongside other relevant life skills and prosocial skills. The second section analyses the effects of digital technology that has not been designed to directly improve empathy. Such technology is normally integrated into lesson plans in which the improvement of children's capacity for empathy is an objective.

1.2.1. The effects of prosocial training programmes

Many of the problems that emerge in school settings are social in nature (e.g. bullying, exclusion, fights). Thus, a variety of programs have been developed to address and prevent such problems. Some of these involve the use of digital technology as a tool to engage students in developing prosocial attitudes and improving behaviours (Garaigordobil and Martínez-Valderrey, 2018; Schultze-Krumbholz et al., 2016). Such technology includes prosocial video games and programs, the effects of which will be explored in this sub-section.

Cyberbullying

One of the main issues targeted via such prosocial programs is bullying/cyberbullying. An example of a prosocial video game analysed in the scientific literature that is aimed at preventing and reducing cyberbullying during adolescence is Cooperative Cybereduca video game 2.0 (Garaigordobil and Martínez-Valderrey, 2018). This is the final stage of the 2.0. Cyberprogram. The video game follows the structure of trivial pursuit and addresses bullying/cyberbullying through the use of a comic, which presents 120 questions about five topics related to bullying: cyberphenomena; computer technology and safety; cybersexuality; the consequences of bullying/cyberbullying; and coping with bullying/cyberbullying (Garaigordobil and Martínez-Valderrey, 2018). In this game, the goal is to restore peace and ensure coexistence. Correct answers from each of the teams earn points, which are added to a global score.

Garaigordobil and Martínez-Valderrey (2018) studied the participation in the game of 176 adolescents aged 13 to 15, attending public and private schools in Spain. A quasi-experimental design was followed, with control and experimental groups and pre- and post-test measurements. The experimental group participated in a one-hour training session on a weekly basis for the entire school year. The results show that the first effect of training with this video game was a reduction in bullying and cyberbullying behaviours and attitudes within the experimental group. In addition, use of the program was linked to an increase in the participants' prosocial behaviours; self-concept and that of others; their cooperative conflict-resolution strategies, and their capacity for empathy, as measured as their ability to understand the emotional state of others. In particular, Topic 4 in the game, Consequences of bullying/cyberbullying, fostered participants' understanding of the emotional, social and intellectual consequences suffered by the victims, perpetrators and observers of bullying/cyberbullying. The authors identify three factors to explain the effects produced by the video game: 1) it fosters understanding of the victim's feelings; 2) it promotes analysis and understanding of the consequences

for all actors involved; and 3) it promotes intervention on the part of bystanders. Moreover, the authors note that the planned activities are dialogue-based, which promotes a good environment in the class as well as the development of prosociality.

Videogames designed to improve empathy

Another example of research on the effects of digital technology designed to promote empathy was conducted by Schultze-Krumbhholz and colleagues (2016). The authors analysed *Media Heroes*, an online video game aimed at improving, among other capacities, cognitive and affective empathy. In the game, students are presented with different cyberbullying situations. They are encouraged to take the role of the different actors involved, reflect on their state and then enact the situations in which these characters are involved. Use of this program by participants aged between 11 and 17 revealed two effects. First, that the long intervention (i.e. 10 90-min sessions in 10 weeks) successfully contributed to maintaining levels of affective levels among the experimental group over the course of the study, compared to the age-related decline in empathy observed in the control group. Second, that the participants in the short intervention (i.e. 1 day) who showed an increase in cognitive empathy also scored lower for cyberbullying perpetration.

Recent advances in affective neuroscience are very informative in analysing these results, since they provide evidence of the effects that such training programs have on the neural circuits responsible for empathy capacity. Research conducted at the Center for Healthy Minds (Kral et al., 2018) investigated whether an empathy training video game could increase empathic accuracy (that is, the capacity to accurately infer the thoughts and feelings of others –Ickes, 1993), as well as identifying any changes it produced in the circuitry of the brain. To that end, an immersive virtual empathy-training video game, *Crystals*, was developed. A total of 159 children and adolescents between 11 and 15 years of age participated in the study. Participants were divided into two groups, the control group and the experimental group. Before training commenced, all participants underwent two Functional Magnetic Resonance Imaging (fRMI) scans: one while resting, and another while completing an Empathy Accuracy task. Participants were then assigned to play a video game on a daily basis for a period of two weeks: those in the control group were assigned the commercial video game *Bastions*, while those in the experimental group were assigned *Crystals*. After the training, participants in both groups again underwent two fMRI scans under the same conditions as the pre-test scans.

The results of this research (Kral et al., 2018) show that even though no differences were detected between the two groups in relation to improvement in the Empathy Accuracy task, training with *Crystals* promoted a greater activation of the empathy-related neural circuits. Data obtained from the study supports the potential positive effects of immersive virtual video games designed to improve empathy. More precisely, those participants who engaged more with the game's mechanics, showing higher emotional recognition and the ability to gauge emotional intensity, were the ones who displayed an increase in their capacity for empathy. Thus, empathy training video games are an engaging tool for adolescents that can be used to improve the neural networks involved in empathy capacity through cognitive tasks such as 'perspective taking' and 'emotion regulation'. However, further research is still required to evaluate if this type of game does indeed improve empathic behaviour.

The ability of empathy training using virtual environments to increase empathy has also been studied in children with autism spectrum disorder (Lorenzo et al., 2016). In this study, 40 primary school students aged 7-12 years engaged in training through the use of an immersive virtual reality (VR)-based system. The study showed that the system had the potential to enhance emotional skills, including empathy, among children with this disorder. Another effect of the training was that children were better able to interpret and generate emotional responses after using the VR immersive system, compared to a desktop environment. Thus, immersive VR provides an immersive environment in which social situations can be replicated, in order that children learn can how to deal with them. Results show that after using immersive VR systems, participants were able to transfer the acquired knowledge to real-world situations, improving the children's emotional behaviours.

Immersive virtual learning environment

Beyond the individual use of immersive virtual environments, other research has focused on the interactive potential such environments offer as 'online in-worlds' (Devlin et al., 2015). Devlin et al. evaluated a novel digital technology – a virtual and immersive, three-dimensional learning environment in which young people could learn meaningful knowledge and life skills, including empathy. *Inter-Life,* as the system is known, offers users situated challenges that must be solved by putting into practice the life skills targeted by the system. Six participants aged 13 to 17 years old participated in the study. Participants and researchers worked jointly in *Inter-life* throughout the workshops, the first five of which were held locally while the rest (seven) were held in a laboratory at the University of Glasgow's Faculty of Education. Some of the researchers only participated via their avatar in the online environment. Throughout the study, participants improved their sense of empathy, created strong relationships based on trust and respect, and developed their critical thinking skills. These findings support the potential of *Inter-life* to create an environment of trust and learning in which adolescents can develop empathy, among other transitional life skills. The findings also highlight the importance of creating environments in which students can interact.

Evidence shows that prosocial training programs have the effect of increasing children's capacity for empathy. These programs offer participants the opportunity to reflect on certain behaviours and attitudes, to take someone else's perspective, or even to practice the target social skills in a situated manner. They can be implemented in the classroom or in other settings and are valuable tools against some of the social problems that particularly affect children and adolescents, such as cyberbullying. One common element of all the programs reviewed was that they promote human interaction as a key element in the development of players' empathy, among other capacities. To achieve the intended effects from these training programs, factors such as cooperation and dialogue are key.

1.2.2. Integrating digital technology in the classroom to foster children's empathy

As seen above, prosocial training programs are designed to increase children's capacity for empathy. However, the scientific literature reports on other effects of digital technology on children's empathy when it is integrated as a tool for content learning and the development of social and emotional skills.

Digital tools

Often, digital tools are integrated into classroom activities as a means of developing social emotional skills, including the capacity for empathy. A study by Iaosanurak et al. (2016) focused on the promotion of social and emotional learning through the use of digital technology. In the study, 23 elementary school children in Thailand and Cambodia engaged in activities targeting the development of social and emotional learning, including empathy, in a cross-cultural and collaborative way. Activities revolved around the use of digital tools comprising eight digital animated stories, a digital discussion forum, the use of a digital mind mapping tool, and a digital learning journal. The Thai Emotional Intelligence Screening Test (TEIST) was administered to participants before and after the intervention.

The effects of integrating digital technology into emotional and social learning activities shown by this research were an increase of the emotional competences of the students, and an improvement in the capacity for empathy and responsibility among female participants (Iaosanurak et al., 2016). However, other factors involved in emotional and social learning also played a relevant role in achieving these effects. In this case, the use of digital technology was integrated into collaborative activities that foster social interactions, rather than requiring children to work on their own. Thus, in order to promote empathy, other activities that focus on the same skills should be considered and incorporated alongside the use of technology. In addition, consideration should be given to the creation of interactive spaces that encourage children to work together.

Augmented reality

Another example of the effects of integrating empathy into the curriculum through the use of digital technology is presented by Efstathiou and colleagues (2018). This study evaluated the potential for using location-based augmented reality (AR) in enquiry tasks, in order to facilitate students' acquisition of historical concepts as well as their personal development of historical empathy. The participants in the study were 53 third-graders from two different primary schools in Cyprus. Of these students, 29 participated in a traditional field trip while the other 24 engaged in a field trip involving augmented reality technology. While both groups scored similarly in the pre-test, students in the experimental group who participated in the augmented reality field trip exhibited an increase in empathy compared to the control group, as shown by the post-test measurements of both groups. Thus, the authors argue that the use of AR learning environments fosters the development of historical empathy among students to a greater extent than traditional and non-technological instruction. In light of these findings, the authors suggest that AR can be incorporated into diverse learning activities. Among others, these include ready-to-use multimedia content, supported exploration through problem-based narratives, integration with other non-AR activities, or as a scaffold (Efstathiou et al., 2018).

The research in this section provides evidence that digital technology can be integrated into the classroom for the purposes of content learning and the promotion of skills, including empathy. Indeed, where classroom activities aim to foster the capacity for empathy, it is key that they effectively integrate digital technology as a tool to promote such capacity, and to contribute to the achievement of the activities' socio-emotional goals. Technology-based activities and the use of digital devices can be complemented

with activities and interactions that are not technology-based, in order to maximise the learning effect of the digital technology in use.

1.3. Effects of other uses of digital technology on children's empathy at school

The previous section analysed the ways in which digital technologies can be used to develop empathy. However, other uses of digital technology are present in schools in diverse situations, even if it is not included in any lesson plan. For instance, during their free time at school, children use digital devices to interact with each other, watch media content, surf the internet or play video games. In addition, effects can be seen in school of the use of digital technology by children and adolescents at other times and in other contexts. In order to explore the effects of these other uses of digital technology on children's empathy at school, evidence will be presented in the following subsections with regard to the effects on children's empathy of using digital technology to communicate in online environments and for the purposes of leisure.

1.3.1. Effects on children's empathy of communicating and interacting in online environments

Children and adolescents are increasingly using online channels to communicate with each other. Some of this communication takes place at a more personal level, via instant messaging apps such as WhatsApp or Telegram, other instances are of a more public nature, via social media such as Twitter or Facebook. A number of research studies have focused on the ways in which social media changes the way children communicate and the effects this has on their capacity for empathy.

Social media use

One study addressing this topic is Errasti, Amigo and Villadangos (2017), which focused on the use social media by adolescents and its relationship to empathy, narcissism and self-esteem. A total of 503 adolescents aged 14-16 took part in the study. Participants came from eight different public, private and charter schools in Spain. The social networks targeted were Facebook and Twitter. To assess each participant's capacity for empathy, the Basic Empathy Scale was administered. This scale evaluates two dimensions in empathy: cognitive empathy and affective empathy. The results of the study reveal a positive correlation between Facebook and Twitter's frequency of use, expression of personal emotions and empathic responses, as well as a positive correlation between an individual's level of affective empathy and the number of people the individual followed on Twitter. Indeed, frequent users of Twitter and Facebook who shared positive and negative emotions and reacted to those of others scored high for both cognitive and affective empathy. The relation that was not statistically significant was that between the frequency of Twitter use and cognitive empathy. The results also showed that Facebook users who enter the network to observe others, but do not publish anything themselves, scored lower for affective empathy than both those who use the social network frequently, and those who do not use it at all. Findings suggest that while a decrease in the empathy capacity of users may be due to an addictive behaviour, moderate use of social media fosters the development of empathy towards others.

Another study analysing the effects of social media use on empathy obtained similar results. Vossen and Valkenburg (2016) investigated the effects of technology use by 942 Dutch adolescents aged between 10 and 14 years. Participants were evaluated twice

using the *Adolescent Measure of Empathy and Sympathy (AMES)*, with a one-year interval between. The AMES evaluation measured the participants' affective and cognitive empathy, as well as their sympathy[3]. In terms of technology, the study focused on instant messaging (WhatsApp and Skype) and the social networking sites (Facebook and Twitter). The results indicate that the use of social media has a positive effect on both the cognitive and affective dimensions of empathy; that is, both understanding and sharing the feelings of their schoolmates. In light of this evidence, the study thus challenges the idea that social media use can be detrimental to empathy. Indeed, it suggests that social media can provide adolescents with an environment in which to practice their social skills. The study's authors hypothesise that social media might have a greater influence on cognitive empathy than on affective empathy, since in online communications (as opposed to face-to-face interactions), users often guess the emotional state of others through cues. However, the results show no significant differences between the two variables, which can indicate that it is not relevant to differentiate between these two components in relation to social media, or that one component benefit the other. In terms of social media use, the only variable taken into account was 'time spent online'. This suggested that further research should focus on *what* children do using social media, and *with whom* they interact.

Internet use and online behaviour

In relation to the effects on empathy of *what is done* in online environments, Lozada and Tynes (2017) provide some more information. This research focused on internet use relating to race among African-American adolescents aged 10 to 18 years. The study involved 337 participants, with evaluations being carried out via an online survey, within a one-year interval between. Results show that African-American teenagers often use the Internet for purposes related to their race, such as connecting with other members of the black community and searching for information about their ethnicity. The study's findings reveal that participants using the Internet for race-related purposes demonstrated greater empathic skills. This provides further evidence that browsing the internet can have the effect of increasing empathy among individuals seeking information and looking for others from the same ethnic groups to communicate with. However, where using the Internet for reasons relating to their race led to children to encounter racial discrimination, this was found to result in a decrease in empathy. The study's findings support positive uses of the Internet, and suggest that the increase in capacity for empathy shown online can also positively influence face-to-face empathy among African-American adolescents in real-world settings. However, since high levels of racial discrimination linked to internet usage hindered these positive effects, the study highlights the importance of providing students with tools to critically assess their online interactions (Lozada and Tynes, 2017).

Another relevant study focuses on moral thinking, which according to the authors includes: '(1) awareness that one's actions affect known others; (2) a capacity for empathy; and (3) adherence to principles such as fairness, justice, and mutual respect in relation to known others' (Flores and James, 2012). This research identified that teen and young adult participants display greater concern for the potential consequences of

[3] As cited in Vossen and Valkenburg (2016) sympathy refers to 'feelings of sorrow and concern about another person's misfortune' (Clark, 2010).

their online behaviour for themselves than they do for the effects their behaviour may have on others. This behaviour includes cheating, lying, piracy or plagiarism, among others. However, the authors also found a prevalence of moral thinking, both among participants whose online interactions are mainly with 'offline' friends (those who are friends in real life), and in participants interacting with 'online-only' friends. The authors conclude that these findings suggest young people's moral thinking is situational, and that a 'disconnect' between thinking and action is likely to occur in online behaviour and interactions.

The research presented in this section provides evidence of the ways in which communication via digital technology can both increase and decrease children's empathy. The effect of increased empathy can be obtained when the prosocial use of communication is fostered across all channels, including social media. In order to achieve such effects, students should be encouraged to develop critical thinking skills through media literacy (Livingstone, 2004), so that they can effectively assess each situation and respond to it in an empathic way. The effects of online communication should also be considered, because of their potential impact on other school measures aimed at improving children's empathy, such as empathy training programs or the integration of digital technology to foster the development of such capacity.

It is also important to note that the use of digital technology to communicate gives rise to some perils, including the risk of cyberbullying. Studies exploring the relationship between empathy and the perpetration of cyberbullying have often focused on how an individual's empathy score may predict his or her likelihood of perpetrating cyberbullying. One study involving British adolescents aged 16–18 years (Brewer and Kerslake, 2010) indicates that as an individual's capacity for empathy decreases, his or her likelihood of being involved in the perpetration of cyberbullying increases. Similarly, a study involving teenage students in Korea (Lee and Shin, 2017) found a negative correlation between cognitive empathy and the perpetration of cyberbullying, while affective empathy did not significantly predict such perpetration. However, how children's capacity for empathy is affected by the use of digital technology to perpetrate cyberbullying remains an under-explored subject. For this reason, we recommend further research on this issue.

1.3.2. Using digital technology for leisure: effects on children's empathy

An increasing number of children and adolescents choose to use technology for their leisure activities (Bucksch et al., 2016; Saunders and Vallance, 2017). Many studies have analysed the effects of the use of digital technology (video games, watching series, etc.) on the empathy of children and adolescents. These studies come to a number of different conclusions. Some argue that screen time affects children's capacity for empathy (Twenge and Campbell, 2018). Others indicate that the effects on empathy of using digital technology differ depending on whether the use of such technology is prosocial, or is related to antisocial or violent content (Prot et al., 2014). Some previous reports also suggest that a child's identification with the character in a video game can affect empathy (González, Hernández, Iglesias, Martín, Rijeka, n.d.).

Screen time

Twenge's and Campbell (2018) evaluated the effect of screen time, including time spent using mobile devices and electronic devices, electronic games and TV, on 40,337

children and adolescents in the United States, aged 2 years and upwards. The authors found a low negative association between screen time and the capacity for empathy towards others. The study found that spending more than one hour each day using screen-based devices was associated with low psychological well-being among children and adolescents, as well as increased difficulty in making friends, among other effects. These findings are in line with those of Prot and colleagues (2014), who argue that time spent online can prevent adolescents from learning empathy from others in real-life contexts.

Digital media content: TV shows, movies and video games

However, Prot and colleagues (2014) also point out that a prosocial use of digital technology during leisure time can have a positive impact on empathy. This is consistent with other research focusing on other prosocial uses of digital technology (e.g. Klapwijk and Van Doorn, 2015). In their first study (Prot et al., 2014), Prot and colleagues focus on prosocial media use, in terms of the choice of TV shows, movies and video games. The research was based on the participation of 2,202 adolescents and young adults from Australia, China, Croatia, Germany, Japan, Romania and the United States. Exposure to prosocial or violent media was documented, as well as the frequency of such exposure. The results show that choosing prosocial media content has the effect of increasing 'trait empathy' (i.e. an individual's reactions to the experiences of others; Davis, 1983), while choosing violent media content decreased the participants' capacity for empathy. These findings were maintained across genders, cultures and age, as well as over time, which suggests that the use of prosocial media can contribute to long-term improvements in empathy capacity and prosocial behaviour (Prot et al., 2014).

Several studies focus on the effects of playing prosocial or violent video games. In their second study, Prot et al. (2014) proposed the idea that while prosocial video games increase prosocial behaviours, playing violent video games decreases them. The study includes the participation of 2,232 children with a mean age of 11.2 years, who attended six different primary and six different secondary schools in Singapore. Evaluations of the participants' prosocial behaviour, as well as their use of prosocial or violent video games, were made using a questionnaire. The results confirmed the effects expected as a result of playing one or other type of video game; namely, that a strong causal association exists between the playing of prosocial or violent video games and players' later social behaviour. The effects on prosocial behaviour of choosing either prosocial or violent media were mediated by changes in the participants' capacity for empathy.

This finding is echoed by the meta-analysis produced by Greitemeyer and Mügge (2014), for which the authors reviewed data from 98 studies involving a total of 36,965 participants. The findings of this meta-analysis reveal a correlation between the playing of prosocial or violent video games and the social behaviour of the players. The authors point out that this not only implies that prosocial games can foster the empathy capacity, but also suggest that playing violent video games can increase aggressive attitudes, emotions and behaviours, as well as desensitising players. These findings suggest that the focus should not be placed on the effects of more or less playing time, but on the effects of playing one type of video game over another.

Within this line of research, we identified another study evaluating the effects of violent and sexist video games on the empathy capacity of adolescents (Gabbiadini et al., 2016). Participants in the study – 154 female and male students aged 15 to 20 – were

required to play either a violent and sexist video game from the Grand Theft Auto series (GTA: San Andreas or GTA: Vice City); a violent but non-sexist video game (Half-Life 1 or Half-Life 2); or a non-violent video game (Dream Pinball 3D or Q.U.B.E. 2). Grand Theft Auto is a series of violent games in which all female characters are sexualised, and many of them are prostitutes with whom the main character must engage in order to restore the character's stamina and health. Half-Life is a 'first-person shooter' video game in which the player adopts the visual perspective of the character shooting. Dream Pinball 3D is a game emulating traditional pinball, while Q.U.B.E. 2 is a video game in which challenges based on physics principles need to be solved.

The study's results reveal that male participants who show a tendency to identify more with the violent male character in the video game were more likely to accept the character's violent masculine beliefs, such as domination and aggressiveness. This decreased their capacity to empathise with the female victims of gendered violence. Thus, adolescent male players in the study who identified with the game's misogynistic character ended up both adopting his beliefs more strongly, and showing less empathy for female victims of violence in comparison with both female players and with male players who did not identify with this character. The results indicated that male players tended to identify more strongly with the game's character when they were playing a violent game, than when they were playing games that were either neutral or games that were both sexist and violent.

Nevertheless, a study (Szycik et al., 2017) of high-frequency adult players of violent games challenges the desensitization hypothesis. Participants in this study had a mean age of 22.5 years), and had played violent games for up to four hours each day since they were 13 years old or younger. Functional magnetic resonance imaging (fMRI) revealed that the brain activations of the experimental subjects when shown pictures depicting emotional and neutral situations did not differ from those obtained from the control subjects. Thus, the effects of engaging with violent media content on emotional processing, including empathy, can be intense, but are not long-lasting.

Other authors argue that prosocial and antisocial behaviours are not binary constructs in real life, and neither are they in virtual games. Harrington and O'Connell (2016) studied 538 children and adolescents ranging from 9 to 15 years old. Participants' choice and habits in terms of video game playing were recorded, along with their capacity for empathy, and prosocial behaviour. The study's results show that playing prosocial video games can enhance prosocial behaviour and empathy in children and adolescents, which has a positive impact on affective relationships. The results also indicate a high correlation between playing violent video games and a negative effect on affective relationships, normative behaviour and empathy. However, the study showed that participants played both types of video games, and that playing prosocial video games could counteract the negative effects on empathy of playing violent video games, by reducing the decline in empathy. Parents and teachers are nevertheless encouraged to assess the potential risks and benefits of video game playing.

Digital technology used for leisure can either increase or decrease the capacity for empathy among children and adolescents. This can also have an effect too on the way they interact with peers and teachers in school, as well as on the digital technology they choose to use during their free time at school. By taking these effects into account,

teachers and other community members can better plan strategies to increase empathy among children.

In addition, the development of critical thinking skills through media literacy (Livingstone, 2004) is relevant in providing children with the knowledge and skills necessary to understand how the digital technology they choose affects their capacity for empathy, as well as how to identify digital media that will have a better effect on them.

2. Effects of the use of digital technology on children's attention capacity

Key findings

- The use of digital technology can improve children's capacity for attention in some cases. In other cases, it can be a distracting factor that triggers various attention problems. Research shows that both cases depend on the way in which digital technology is used, the time spent using technology for non-educational purposes, and the learning approach under which such use is carried out.
- Some computerised cognitive training programs have the effect of improving attention capacity among children; others have no significant effect on it.
- The integration of smart devices (e.g. tablets, smartphones) into educational activities in the classroom has the effect of improving students' capacity for attention. The extent of such improvement depends on the learning approach and instruction model applied.
- Mobile devices, video games and computers have a distracting effect on children's capacity for attention when the time spent each day using digital technology for non-educational purposes exceeds two hours.

2.1. Attention capacity in children and adolescents

Attention, both at an anatomical and a behavioural level, refers to the systems that allow individuals to consciously process information (Fisher, 2019; Petersen and Posner, 2012). Attention relies on three different networks – the alerting network, the orienting network, and the executive network – which are involved in different cognitive tasks.

Fisher (2019) points out that higher-order tasks require attention to be selective and sustained. According to the author, selective attention involves the orienting network and requires attention to be focused on certain stimuli, while ignoring others. Sustained attention involves the alerting network and requires attention to be receptive to incoming stimuli. Selective, sustained attention (Fisher, 2019) relies on control systems that develop with age, beginning by mainly depending on the orienting network and progressively engaging the executive network as a child gets older (Posner et al., 2012). Selective, sustained attention is necessary for the development of executive functions, which are the cognitive processes intervening in goal-oriented tasks – hence the importance of selective, sustained attention for learning and memory processes (Erickson et al., 2015).

The use of digital technology in and outside educational settings has increased greatly over recent years. Technological devices such as computers, smartphones, tablets and laptops are becoming an increasingly common means for learning and completing educational tasks. Children and adolescents use digital technology to access course material, information and tutorials, to take notes, and for reading and sharing documents, among other tasks. Knowledge of the way in which human attention works that has been accumulated from cognitive psychology (Sternberg and Sternberg, 2012) and neuroscience (Posner, 2011) is now being expanded to include the study of attention in relation to the use of digital technology, and the ways in which technological devices are shaping human capacity for attention. Ison (2015, p. 244) indicates that the development of attention is essential for the functioning of other cognitive processes such as the ability to maintain and coherently manipulate information, self-regulation, time management and the ability to anticipate events. Research into the neuroscience of attention is advancing quickly, thanks to the tools now available (fMri and others) for the study of brain activity. These offer an excellent opportunity to achieve a deep understanding of the effects of the use of digital technology on the brain's capacity for attention (Posner, 2011).

So how does digital technology affect attention capacity? Several relevant findings on the effects of technology are summarised in Table 3 below. In this chapter, we present an overview of the effects of the use of digital technology on children's capacity for attention. Findings are divided into two sections: first, the effects of the in-school use of digital technology on attention capacity; and second, other uses of digital technology influencing children's attention capacity in school.

Table 3. Effects of the use of digital technology on children's attention capacity

Type	Digital technology	Improve attention capacity	Reduce attention capacity	No significant effect
Computerised cognitive training programs	BrainGame Brian, a newly developed computerised training program (Aarnoudse-Moens et al., 2018)	X		
	Cogmed, a computer/tablet-based working memory (WM) training program (Pearson 2016; Hessl et al., 2019)	X		
	ACTIVATE™, a computerised intervention addressing multiple cognitive functions (Bikic et al., 2018)			X
Digital technology in the classroom	Tablets in the classroom (Camacho Martí, Esteve Mon, 2017)	X		
	Touch-screen tablets (Duijzer et al., 2017; Chen et al., 2017)	X		
	Wearable and mobile devices (Liang et al., 2019)	X		
	Augmented reality (Cai et al., 2019)	X		
	Mobile Gamification Learning System (Su and Cheng, 2015)	X		

Type	Digital technology	Improve attention capacity	Reduce attention capacity	No significant effect
Influences of using digital technology on children's attention capacity at school	Mobile devices (tablets and smartphones) (Hosokawa and Katsura, 2018)		X	
	Digital technology (Ra et al., 2018) (Aagaard, 2015)		X	
	Video game or computer time outside of school time (Liu et al., 2016)		X	
	Mobile devices (Kay, Benzimra, Li, 2017)		X	
	Tech distractions (online games or videogames, sending or receiving text messages) (Xu, 2015)		X	

Source: compiled by the authors on the basis of the literature review.

2.2. Effects of the in-school use of digital technology on children's attention capacity

There is ongoing debate as to whether the use of digital technology generates attention problems in students and affecting their cognitive function, or whether it actually promotes a greater capacity for attention. A previous research report (Brey, Gauttier, Milam, 2019) found that internet addiction has potentially harmful effects, including problems such as attention deficit. Moreover, other reports indicate that even though the use of digital technology can increase attention capacity, it is important to manage the time spent, since other factors such as the time spent in front of a screen can have an impact on the children's capacity for attention (González et al., n.d.). The overuse of digital technology in adolescents can result in physical, behavioural, attentional and psychological problems (Gottschalk, 2019), but it is important to ascertain with greater certainty how, when and why these effects occur. Other authors such as Daniel Levitin have reflected on the way in which technology can result in information overload or multitasking, and what the effects these may have on the brain (Levitin, 2014). To address this concern, we include in this report discussion of the effects on attention capacity of diverse uses of digital technology.

In particular, relevant contributions have been identified regarding:

1. The effects of computerised cognitive training programs.
2. The effects of integrating smart devices into daily educational activities.
3. The effects of the use of digital technology on children's capacity for attention at school.

2.2.1. The effects of computerized cognitive training programmes

Research findings identify certain computerised cognitive training programs that have the effect of improving attentional problems and attention capacity, while others do not lead to significant improvements in sustained attention.

A pilot study (Aarnoudse-Moens et al., 2018) evaluated the effects of *BrainGame Brian*, a newly developed computerised training program. The study demonstrated the efficacy of the program in improving attention problems. In particular, the research focused on

ways to solve attention problems associated with executive functions (EFs) among children born pre-term. *BrainGame Brian* comprises 25 training sessions devoted to the improvement of working memory, impulse control and cognitive flexibility. The pilot study included one assessment at baseline, and another follow-up assessment at the end of the study period. The participants in the pilot study were 12 children and their parents, out of which 11 children completed the entire programme of sessions over a six-week period. Once the pilot study had ended, the results showed 'the efficacy of *BraingGame Brian* in improving attention problems in very preterm-born children' (Aarnoudse-Moens et al., 2018, p. 179), with at least half of the participating parents reporting that they would recommend the training to others.

Another example of a cognitive training program is *Cogmed*, a computer/tablet-based training program aimed at improving working memory (WM). The program has been evaluated in over 80 peer reviewed papers and meta-analysis (Pearson, 2016). Evidence on the use of *Cogmed* to improve attention capacity includes several studies on under-performing children. Among these, research by Hessl and colleagues (2019) explored the potential of Cogmed in relation to 100 children and adolescents with fragile X syndrome (FXS). These children tend to show severe deficits in executive functions (EF), including selective and divided attention. *COGMED JM* comprises seven different computerised visuospatial memory-training tasks. In each training session, participants should complete three out of seven training activities. The measures used to evaluate cognitive aspects include the *Leiter-Revised (Leiter-R) Spatial Memory* subtest and the *Standford Binet 5 Block Span* subtest. In relation to the Executive Function Outcomes Measure, the *Kiddie Test of Attentional Performance* (KiTAP) was administered, while in relation to Behavioral Ratings of Attention and Executive Function, the measure selected was the *Conners Third Edition.* This is an assessment tool for ADHD-related behaviour, which takes into account home, social and school settings. The results show that training with *Cogmed* for 5-6 weeks contributes to improvements in some executive functions and in working memory. Parents and teachers also reported observing improvements in attention capacity and the EF of their children and students. Moreover, the perceived changes were still maintained three months after participating in the training. Accordingly, the authors support the use of *Cogmed* with FXS children and adolescents. However, since those in the control group also showed improvements, they acknowledge that further research is needed to determine the therapeutic potential of the program.

Nevertheless, not all attention training programs demonstrate success in improving attention. This was the case for *ACTIVATE*™, a computerised intervention addressing multiple cognitive functions, demonstrated no significant effect used to train children with ADHD (Bikic et al., 2018). The study aimed to investigate the effects of ACTIVATE™ on multiple cognitive functions, including sustained attention, response inhibition, cognitive flexibility, working memory, pattern recognition and category formation and use. To that end, a multicentre, randomised clinical superiority single-blind trial was conducted. A total of 70 children aged 6-13 with ADHD participated either in the intervention or as part of the control group. The intervention focused on the use of *ACTIVATE*™ for eight weeks. The cognitive functions of participants in both groups were assessed during the implementation of the programme, as well as at eight, 12 and 24 weeks after the intervention. In relation to sustained attention, one of the cognitive functions assessed, results showed no significant effect after the training had been completed.

2.2.2. Integrating digital technology into the classroom to foster children's attention capacity

The integration of digital technology into daily classroom life improves the attention of children and adolescents when its use is integrated via an effective learning strategy (Cai et al., 2019; Liang et al., 2019; Su and Cheng, 2015). Overall, digital technology helps to overcome the attention problems that occur in traditional instructional classes. Evidence shows that the use of tablets in classrooms has the effect of improving attention capacity; certain touchscreen applications activate attentional anchors (Duijzer et al., 2017); and augmented reality increases attention capacity (Cai et al., 2019). Some of these studies are based on self-assessment techniques, and thus, rely on self-perception.

Use of smart devices and educational apps in the classroom

Several studies (Cai et al., 2019; Martí and Mon, 2017; Chen et al., 2017; Duijzer et al., 2017; Liang et al., 2019) have focused on the effects of the use of smart devices on the students' capacity for attention.

One such study (Martí and Mon, 2017) used mixed methods to observe the effects of using tablets in classroom. To that end, a number of instruments were implemented. A survey was carried out at the beginning and end of the study period on teachers (70 initial responses; 97 at the end) and students (initial 594; end 897). The study also collected biodata; evidence on the use and availability of digital technology; perceptions of self-competence in ICT and attitudes towards digital technology. A content analysis of lesson plans was carried out, as were interviews with 13 teachers, and eight focus groups (two with teachers, six with students, and one with family members). The data collected from teachers regarded aspects of methodology and perceived learning impact. The data collected from students provided information about which didactic aspects, such as types of activities, groupings or evaluation, they most appreciated, as well as their self-perceptions of learning impact. Family members talked about ICT use, attitudes towards ICT, and perceived learning impact on their children. The results obtained from the analysis of the students' and teachers' answers coincide, affirming that the use of tablets improves three main aspects: attention, motivation and classroom climate. One quote from a student participant underlines the study's findings on attention: 'the book is boring and then they become more distracted, but with the tablet they can be more focused because it is more fun' (Martí and Mon, 2017, p. 185).

Indeed, according to research, touchscreen applications are a unique way to foster the activation of attentional anchors (AA). In Duijzer et al. (2017), 45 fifth- and sixth-grade students from five different schools in the Netherlands were asked to perform a mathematics proportion task using touchscreen tablets. The effect of the device was to demonstrate the role played by attentional anchors in bimanual coordination. During the completion of the task, many students moved from simpler additive strategies to multiplicative ones, allowing students to develop new and more complex strategies in their understanding of the concept of proportion. The methodology used in this research included the application of different instruments: in one pilot study involving four

students (aged 7-10 years), the MIT-Ext application[4] and instruction strategy were tested; in another involving four students (11-12 years), only the instructional strategy was tested. In both pilots, the instructional strategy consisted of providing cues *(e.g.* 'Try to make the bars green and maintain the green bars even when you move your hands'*).* The other instrument applied to all students involved in the pilot studies was semi-structured interviews. The data analysis consisted of coding utterances from verbal transcripts, as well as eye-tracking data using four eye-tracking variables. The sum of the fixation counts within each AA Area of Interest (AoI) was divided by segment time, while the average fixation duration per visit was calculated by dividing fixation duration by visits in AoIs; unique visits were calculated by dividing the total visits by segment time, and the scan path, which provided a count of participants looking at several AoIs successively. Among the relevant findings in this study is evidence that the use of tablets activates attentional anchors and fosters students' learning.

However, some evidence indicates that the type of tablet used can have different effects on children's attention. One study compared the effects of using touch-screen tablets against those of stylus-based tablets (Chen et al., 2017). Six fifth-grade mathematics students from a public elementary school in Taiwan were asked to solve fraction problems using virtual manipulation on each of these devices in a classroom setting. The methodology focused on qualitative and interpretive exploration of the students' attention while using the two different devices. Qualitative data were collected via video recordings of the students using the devices. The first activity involved touchscreens, while the second task involving stylus-based tablets was carried out four months after the first, in order to minimise sequencing effects (Chen et al., 2017). Data analysis of the video recordings assessed individual students' attention by focusing on time-on-task and the number of distractions. Results show that when using touchscreen devices, students remain on-task for longer and suffered fewer distractors than they did when using stylus-based tablets. In addition, when using the touchscreen tablets, students also engaged in more pointing gestures. In light of these findings, the authors support the use of touchscreen devices in problem solving tasks for their potential to maintain students' attention and foster peer interaction and discussion on the topic of interest. In particular, the authors conclude that 'using touchscreens may engage students' attention with regard to solving mathematics problems, and facilitate more discussions about the focal learning tasks' (Chen et al., 2017, p. 102)

Smart interactive educational learning system

Other studies, notably Liang et al. (2019), have focused on the effects of the use of wearable and mobile devices, which have also been shown to enhance students' attention when used for educational purposes. This study focuses on a *smart interactive educational learning system* to increase students' interest in the task. According to the authors, when students are more interested, they concentrate more, and thus their attention will be better. In this case, two mobile devices were used, a smart watch and a smartphone, connected via an app. Evidence from the study shows that the use of these smart watches increases the interest and motivation of the students, which

[4] MIT-Ext application is the interactive touchscreen tablet application used in this study and extended version of the Mathematical Trainer based on the theory of embodied cognition grounded in sensorimotor schemes.

promotes student attention. According to the authors' results, this interest and motivation is due to the fact that students enjoyed the learning process. The methodology used in this research was the evaluation of the implementation of the trial *smart interactive educational learning system* using two methods, Linear Regression (LR) and Local Weights Linear Regression (LWLR).

Augmented reality

Likewise, augmented reality (AR) increases students' attention, particularly among those with high self-efficacy profiles. 'Self-efficacy of Learning Mathematics' (SLM) describes students' self-belief in their ability to overcome difficulties or obstacles to solving maths problems. Thus, students with high self-efficacy profiles have a strong belief in their ability to solve maths problems. One study (Cai et al., 2019) involving 101 students aged between 13 and 15 from the same high school, focused on the implementation of AR games in mathematics classes. Students cooperatively played an AR-based game using an Android tablet. The students had not previously been introduced to the game's probability-related content. The methodology used included a pre-lesson test before the AR-assisted mathematics lesson, as well as a second test after the lesson. Both the pre- and post-lesson tests included three self-administered questionnaires: COLM, which investigates students' perceptions' on mathematics learning and includes a memoristic dimension; Approaches to Learning Mathematics (ALM), which provides a multidimensional framework on students' approaches to mathematics learning; and the Self-efficacy of Learning Mathematics (SLM), which test students' level of self-efficacy. The results indicate that participants with high self-efficacy profiles paid greater attention to higher-level mathematical contents when using this digital technology. In particular, among these students, the aspects of 'Application', 'Understanding' and 'Seeing in a new way' were markedly improved when using AR-based learning games. No differences in performance were found between students with high self-efficacy profiles and those with low self-efficacy profiles when working on lower-level concepts.

Gamification

The 'gamification' of classroom content also appears to boost children's motivation and consequently their capacity to remain focused on tasks. A study involving Taiwanese children aged 10 and 11 (Su and Cheng, 2015) explored the effects of gamified learning activities in science classes in accordance with the Mobile Gamification Learning System (MGLS) . Students were first introduced to basic concepts in the unit, and then participated in an outdoor activity using either a gamified approach, a non-gamified approach, or traditional instruction. The methodology used to evaluate MGLS consisted of a survey created by the researchers to measure 'natural science learning motivation'. This survey contained four subscales: attention, relevance, confidence and satisfaction. Questions were answered by the participants on a 5-point Likert scale. Of the dimensions of motivation measured by the study, the one in which students scored highest was attention. The results show that the effects of mobile technology depend on the type of approach used. In this case, adopting a 'gamification' approach to the use of mobile technology led to higher levels of student attention, as compared to traditional non-ICT supported instruction.

2.3. Effects of the use of digital technology on children's attention capacity at school

Wider study has been made of the distracting effects of technology. For instance, Aagaard (2015) introduces the concept of 'habitual distraction' to explain how students are attracted to the use of digital technology for their own purposes, and distracted from educational activities. This finding coincides with a finding identified in our review of the literature: the distracting effect of digital technology on children's capacity for attention when it is used for non-educational purposes during the completion of educational tasks.

Some studies report evidence of the this outcome in students during their first years of primary education (Hosokawa and Katsura, 2018). This study involved 1,787 parents of six-year-old children. Data was gathered through self-report questionnaires (SDQ) aimed at colleting parents' perceptions of their children's prosocial and difficult behaviours. These questionnaires consisted of 25 items, one of which referred to hyperactivity/inattention. The study's findings suggest that the use of mobile devices such as tablets and smartphones increases the chances of children presenting with behaviour problems, including hyperactivity/inattention. The authors identify these issues as being associated with the routine, non-educational use of digital technology. Thus, children that spend more time using technological devices are more isolated, which prevents them from learning social competences and results in emotional and behavioural problems.

It appears too that these problems accumulate over time. A longitudinal study (Ra et al., 2018) followed a group of 2,587 of tenth-grade students from 10 different high schools in Los Angeles (mean age: 15.5 years old) with no significant ADHD symptoms over a period of two years. Between September 2014 (10th grade) and December 2016 (12th grade), surveys were conducted at baseline, 6, 12, 18 and 24 months. The primary sample was integrated by 2,587 10th-graders, who were surveyed at the baseline assessment. This survey gathered information about respondents' self-reported engagement in 14 different modern digital media activities. A high frequency over the preceding week was defined as many times a day (yes/no), and was summed in a cumulative index (range, 0-14). The results revealed that an increase in the frequency of use of digital technology was modestly associated with higher risk of presenting with ADHD symptoms in subsequent evaluations. Students who reported that they did not frequently engage with digital media had, on average, a 4.6 % chance of developing ADHD problems. Among students who reported frequent use of digital technology, this rose to 10.5 %. The rapid feedback and continuous stimulation provided by digital technology affects the development of children and adolescents' patience and impulse control. Further research is required to confirm if this association is causal.

Video games or screen time outside school

Another aspect of the effects of the use of digital technology outside school time is evidence that screen time without any educational purposes can promote attention deficit or hyperactivity. In Liu et al. (2016), focused on the effects that playing video games or spending computer time without any educational purpose on school days had on 13,659 adolescents from Chinese urban areas. The study's methodology included a self-report questionnaire pack administered to participating adolescents (N = 13,659; mean age: 15.18 ± 1.89). Students were asked 'How many hours do you watch television or play VG/CU [video games; non-educational computer use] (including

activities such as Nintendo, Game boy, Xbox, computer games, and the internet) on a typical school day?'. The authors grouped possible responses into four categories: non-ST [screen time] (0 h/day); occasional ST (>0 to ≤1 h/day); moderate ST (>1 to ≤2 h/day); and high ST (>2 h/day). Researchers found that adolescents who spent two or more hours on school days in front of a screen, with no educational purpose, were more likely to report, among other difficulties, attention deficit and/or hyperactivity problems, compared with those who did not spend excessive screen time on school days. In addition, Liu et al. report other psychiatric problems associated with excessive screen time.

Other research has evaluated the effects of the non-educational use of digital technology in classrooms. One study on educational computing examined the frequency and influence of distracting behaviours in 'Bring Your Own Device' secondary school classrooms (Kay, Benzimra, Li, 2017). To that end, a questionnaire was administered that included both quantitative and qualitative questions. The dependent variables, distractions, were assessed using two survey questions: 'a) the extent to which students engaged in on-task activities' and 'b) the frequency with which students were involved in specific distracting activities (e.g., email, instant messaging, social media, playing games and surfing the web)'. The independent variables included factors influencing distracting activities. These were assessed via questions on gender, peer behaviour involving laptops, and instructional methods. In addition, an open-ended question was included to explore students' beliefs about how laptops could be made less distracting and more beneficial. Out of the 181 secondary school students in Canada who participated in the study, nearly 80 % reported focusing regularly on the instructed task when this involved the use of mobile devices. In fact, using mobile devices helped them to remain more on-task. Nevertheless, students also reported engaging in distracting activities such as going online, sending or reading email, engaging with social media, chatting or playing games, to varying extents. The study's results show that girls spent more time on social media, whereas boys were more likely to be distracted by video games. The findings also reveal that students were not usually distracted by their classmates' use of mobile devices, and were less distracted during lectures and presentations. Individual and group activities appeared to be subject to the greatest number of distractions. According to students, restrictions imposed by teachers and schools can effectively manage the distractions that occur using mobile devices. Regarding measures to avoid distraction or increase the benefits of using mobile devices, students suggested for 'strict controls to be enforced', as well as 'using digital technology in engaging and meaningful ways, ensuring its proper integration in the learning activities'.

Other research shows that the use digital technology for non-educational purposes while doing homework decreases attention to the task. In this study (Xu, 2015), 1,799 Chinese high school students' were assessed in connection with distractions while completing math homework. The study assessed students' initiative in selecting and structuring the homework environment through a self-administered multi-item scale. This consisted of 10 scales, each comprising several items. Two of the scales referred to 'conventional distractions' and 'tech-related distractions'. The former included '(a) daydream during a math homework session, (b) start conversations unrelated to what I'm doing, and (c) stop math homework to watch a favorite TV show' (Xu, 2015, p. 307). Tech-related distractions included '(a) stop math homework to play online games or

videogames, (b) stop math homework to send or receive email, and (c) stop math homework to send or receive text messages.' (Xu, 2015, p. 308).The results of this study show that traditional and digital technology distractions have distinctive features. Both types of distraction – traditional and tech-related – were positively associated with time spent playing video games, peer-oriented reasons, and time spent completing homework. Both types were negatively associated with the effort students put into homework, the homework environment, learning-oriented reasons, and value-belief. However, a positive association was also found between tech-related distractions and parental education level. In addition, a negative association was found students' grade level and both their expectancy-belief and affective attitude. The author claims that digital technology is a new and more powerful source of distraction and suggests that parents foster distraction-free study environments, while teachers are recommended to prioritise the setting of quality, relevant homework over a quantity of tasks to be performed at home. In addition, given that peers are one of the main distractions identified, the author (Xu, 2015) also suggests that students should collaborate with their friends to come up with strategies to limit the distracting power of digital technology.

Conclusions and recommendations

1. Effects of the use of digital technology on children's empathy

Digital technology increases empathy in some cases and decreases it in others. According to the evidence gather from the scientific literature, such effects depend on the way in which digital technology is used, the content of the technology, and the amount of time spent using the technology. These aspects are considered in greater detail in the paragraphs below.

First, the effect of digital technology to increase empathy in children is highly dependent on prosocial content and use, with human interaction being a key factor. Studies evaluating the effects of prosocial training programs aimed at increasing children's empathy show that the empathy of participants increased after such training. Specifically, research demonstrates that two training programs that target bullying, *Cybereduca video game 2.0* and *Media Heroes,* succeeded in reducing this phenomenon within the group in which they were implemented. In addition, this training program had the effect of increasing participants' capacity for empathy. Research on virtual environments also shows their effect on increasing the capacity for empathy. *Crystals*, *Inter-life* and immersive virtual reality systems developed for children with autism provide evidence of how these immersive environments enable some children to develop fundamental life and social skills such as empathy. Thus, evidence exists that the empathy capacity of children and adolescents can be trained using digital programs. In connection with all the programs mentioned, the promotion of human interaction was a key factor.

Other studies have focused on the effects of integrating digital technology into classroom activities on empathy. These predominantly show an increase in this capacity. The integration of digital technology includes the use of digital tools (animated stories, discussion forum, mind mapping tool and learning journal); location-based augmented reality; and context-mapping tools. Consistent with research findings on prosocial training programs, the effects on children's empathy of the integration of digital technology into the classroom depend very largely on the interactive character of such activities. Indeed, rather than using digital technology individually, the ICT mentioned in these studies encouraged students to engage in dialogue, to investigate and to learn more about others around them. Thus, integrating digital technology into classroom activities has the effect of fostering empathy when it is purposefully designed to do so, with interaction being a key factor.

Communication via digital tools and networks also has the effect of increasing empathy when such communication adopts a prosocial approach. The use of social media or instant messaging apps to exchange feelings and connect with others increases the empathy capacity of some users. In addition, no significant differences are observed between the effects of communications technology on cognitive empathy and affective empathy. This indicates that in relation to digital communication, this distinction is not relevant or that these two dimensions support each other. Similarly, the effects of choosing prosocial media content and playing prosocial video games are to enhance empathy, since using this type of digital technology positively correlates with higher capacity for empathy and prosocial behaviour.

Drawing on these findings, interaction is a key and recurrent factor in the use of digital technology achieving such enhancing effects on children's empathy. In relation to this, dialogic approaches and spaces can contribute to further promoting the effects identified. Dialogic education is based on the use of dialogue as a tool to collectively create meaning (Racionero and Valls, 2007). Dialogic spaces promote the inclusion of all voices and foster the creation of contexts organised by the participants (teachers, families, volunteers, students) themselves, and in which decisions are made on the basis of consensus. These interactively rich spaces have also been demonstrated to contribute to the development of prosocial behaviours and attitudes such as empathy (García-Carrión and Villardón-Gallego, 2016). Thus, dialogic environments contribute to increasing empathy through the use of digital technology.

It is also important to take into account the need for this prosocial perspective to be present in all spaces within schools. Coherence between the different activities planned can maximise the enhancing effects on empathy of the use of digital technology, and can prevent the occurrence of double standards (Redondo-Sama, et al., 2014).

Second, the effect of digital technology in decreasing empathy in children is highly dependent on the antisocial use of such technology, and on violent content. In studies, users of social media who did do not interact with others (i.e. those entering the network to observe others, but not posting their own content) showed lower affective empathy than either those who frequently and actively used these social networks, or those who did not use social networks at all. The addictive use of digital technology also had the effect of decreasing children's capacity for empathy. Similarly, negative effects on empathy were identified when the use of digital technology to interact involved antisocial behaviours. When digital technology involves violent and/or sexist content, its use also has the effect of reducing empathy. The choice of media content (i.e. video games, movies and series) that is violent also correlates with a lower capacity for empathy and a reduction in prosocial behaviour. Players of violent video games tend to identify themselves more with the game's character, and boys who identify themselves with a misogynistic game character show less capacity to empathise with female victims of gender violence. However, evidence also indicates that the negative effects of video gaming on players' capacity for empathy, as well as the potential of games to desensitise, can be intense but are not long-lasting.

Against this backdrop, the promotion and development of critical thinking skills through media literacy becomes relevant (Livingstone, 2004). Such skills enable children and adolescents to reject those uses of digital technology that can have the effect of reducing their empathy capacity, and instead choosing those which promote empathy. Learning spaces that are rich in interactions, such as dialogic spaces, promote the development of critical thinking and reasoning, while fostering solidarity and empathy (García-Carrión and Villardón-Gallego, 2016). Such spaces also promote the participation of all members of the community (teachers, students, parents, and other community members), increasing the coherence of any intervention promoted by schools and other educational spaces in which children participate (Gatt and Sordé, 2012).

Third, digital technology has effect of decreasing empathy when screen time reduces face-to-face interactions. Research shows that spending more than one hour a day using screen-based devices decreases children and adolescent's well-being, as well as their capacity to make friends. Excessive screen time can also be detrimental

to face-to-face interactions, and reduce children's opportunities to learn empathy from others in real-life contexts. However, as previously mentioned, the use of digital technology can increase empathy when the nature and content of online communication and media are prosocial. Such prosocial use can boost children's capacity for empathy. This suggests that beyond total screen time, the use and content of digital technology are key to promoting such increases in empathy, and should therefore always be taken into account. Fostering interaction-rich contexts into which digital technology can be integrated helps to create an environment in which the use of digital technology is not detrimental to face-to-face interaction, but contributes to increases in children's capacity for empathy.

Finally, the use of digital technology presents some perils, including cyberbullying. Studies exploring the relationship between empathy and the perpetration of cyberbullying often focus on the correlation between an individual's empathy score and the likelihood of him or her engaging in the perpetration of cyberbullying. However, the effect that the use of digital technology to perpetrate cyberbullying may have on children's capacity for empathy remains an under-explored subject. Further research is needed to clarify this issue.

Recommendations in this section are summarised in the box below:

Recommendations on the use of digital technology to improve children's capacity for empathy

1. Digital technology has the effect of increasing children's empathy when its content and use follow a prosocial approach. Such effects can be enhanced by **promoting interactive learning environments and ensuring coherence** throughout all learning activities.
2. Digital technology yields negative effects on children's empathy when its content and use involve antisocial approaches and violent content. Such effects can be avoided through the **development of media literacy, including critical thinking skills**.
3. Digital technology yields negative effects on children's empathy when screen time occurs to the detriment of face-to-face interactions. Such effects can be avoided through the **promotion of interactive environments** that enhance the integration of digital technology while fostering student collaboration through dialogic learning.
4. The use of digital technology presents some **perils, including cyberbullying**. Further research should be conducted to explore this issue.

2. The effects of the use of digital technology on children's capacity for attention

Digital technology improves the children's for capacity attention in certain cases. In others, it is a distracting factor that promotes various attention problems. Research shows that whether the use of digital technology results in one or other of these effects depends on the way in which it is used, the time spent on non-educational purposes, and the learning approach under which it is applied.

First, some computerised cognitive training programs have been shown to improve children's capacity for attention, while others exhibit no significant effect on it. These results indicate that further research is needed to identify the key factors that ensure such computerised training programs can produce improvements in children's attention capacity.

Second, the ability of smart devices in the classroom to improve children's capacity for attention is dependent on the way in which such devices are used, and the learning approach applied. Research indicates that when digital technology is integrated into school activities, it has an effect of improving children's capacity for attention, but that the extent of this effect is dependent on the learning approach applied. For instance, integrating tablets into classroom activities improves the attention capacity of students, according to the perceptions of teachers and students. Furthermore, activities that involve manipulating touchscreen tablets improve attentional anchors. It has been shown that touchscreen tablets can achieve a greater effect in improving attention capacity than stylus-based tablets (Liang et al., 2019). The use of augmented reality also achieves the effect of improving children's capacity for attention, but this effect is higher in the case of students with high self-efficacy profiles.

Research findings also concur that the effect of digital technology in increasing children's attention capacity is dependent on the learning approach applied.

Third, adolescents who spend two or more hours on school days in front of a screen with no educational purpose are more likely to report attention deficit and/or hyperactivity problems compared with those who do not spend excessive screen time on school days. Time spent using digital technology for non-educational purposes has the effect of distracting children from educational tasks, and increase inattention or hyperactivity problems. Some researchers (Liu et al., 2016) identified these issues as being associated with the routine, non-educational use of digital technology. Other researches focus on the time children spend in front a screen, revealing that students who reported high-frequency use of digital technology have a 10.5 % probability of developing ADHD problems (Ra et al., 2018). According to students (Kay, Benzimra, Li, 2017), restrictions imposed by teachers and schools can effectively manage distractions associated with the use of mobile devices. Students suggested that strict controls should be enforced, and digital technology should be used in engaging and meaningful ways, ensuring its proper integration into learning activities.

Fourth, the effect of the use of digital technology for non-educational purposes while doing homework decreases student's attention to the task. In this research (Xu, 2015), students were assessed for distractions while completing math homework. Xu (2015) claims that digital technology is a new and more powerful source of distraction and suggests that parents should create distraction-free study environments,

and that teachers should prioritise the quality and relevance of homework over the quantity of tasks set. In addition, given that peers are one of the main distractions, the author also suggests that students should collaborate with their friends to come up with strategies to limit the distracting power of digital technology.

Recommendations on the use of technology to improve children's capacity for attention:

1. Scientific research provides evidence that computerised cognitive training programs achieve significant effects in improving children's capacity for attention.
2. Non-educational uses of digital technology exceeding two hours on school days decrease children's capacity for attention.
3. Effective strategies to limit the distracting power of digital technology should be elaborated through collaboration between students and their peers.

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