The Impact of Screen Time and Mobile Dependency on Cognition, Socialization and Behaviour Among Early Childhood Students During the Covid Pandemic- Perception of the Parents

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Abstract

Digital technology systems are adopted rapidly throughout the globe for the virtual learning process especially with the outbreak of the Covid-19 pandemic. Digital screen-based gadgets are integrated to provide a seamless interactive medium of learning even before the initiation of formal education. Studies on the technology use of younger children are critical as uncontrolled gadget use affects their developmental stages yet these studies are still in the infancy stage. This study analyses the impact of extended use of digital gadgets and mobile dependency on early childhood manifested through their cognition, socialization and behaviour. This descriptive study is based on the random responses of 511 parents about their young children of 3-6 years distributed at five civil districts of Kerala State. From the analysis, it is found that the extended use of digital gadgets influenced young children's mobile dependency, socialization process, cognition and behaviour patterns. The young children exhibited alienation tendencies and behavioural deviations which are correlated to their screen time. Both male and female reported similar results. Significant differences were observed by the parents with respect to the age of the children and their parental characteristics. Their mobile dependency mediated their extended digital Screen Time to the Behaviour. Significant relation was predicted by extended Screen Time on Behaviour of the students with a partial sequential path through mobile Dependency, Cognition and Socialization. The study sheds light on the urgency of parental care and implementation of a balanced gadget usage system to reduce the detrimental impacts of gadget usage.

Key words: Screen Time, Mobile Dependency; Cognition; Socialization; Behaviour, Screen Dependency Disorders

I. Introduction

Education systems were normally resistant to rapid changes compared to the contemporary industrial sectors and followed rather a traditional pedagogy throughout the globe until the emergence of the digital technology systems. The innovations in the classroom-based teaching-learning process were limited to the extent of modification of the blackboard to green board and then to the projectors. The emergence of the digital technology systems with the globalization of the millennium demarked with the rapid changes in the education system across the world (Anderson & Subrahmanyam, 2017; Hutton, Dudley, Horowitz-Kraus, DeWitt, & Holland, 2020). The digital technology systems adopted rapidly throughout the globe for the virtual learning process especially with the outbreak of the Covid-19 pandemic. Digital screen-based gadgets are integrated into the quotidian learning process for providing a seamless interactive learning involvement to the students (Joseph & Thomas, 2021; Limone & Toto, 2021). The learning technology infiltration is readily welcomed even before the initiation of formal education and fascinates students of all ages (Jie, Sunze, & Puteh, 2020). The studies on prolonged digital screen exposure and its impact on psychomotor and socio-cognitive dimensions of the learners have affirmed the need for balanced screen time for the students (Anderson & Subrahmanyam, 2017). Studies on the technology use of younger children are critical as uncontrolled screen exposure affects their developmental stages yet these studies are still in the infancy stage. This study has an objective to analyses the impact of extended use of digital gadgets and mobile dependency on early childhood manifested through their cognition, socialization and behaviour.

II. Prolonged Screen Usage and Dependency

In the technology connected world, the consistent use of digital screen-based gadgets is inevitable for service facilitation, social connectedness and information. During the pre-covid era, the digital screen time was restricted to the students and the in-depth study were fully based on the traditional models of pen and paper at home. The schools were emerging with technology-enabled models that combine the traditional lecturing pedagogy supported through audio-visual and digital facilitation (Jie, Sunze, & Puteh, 2020; Joseph & Thomas, 2021). The digital native students have readily incorporated these learning systems that could even extend the learning process beyond the physical classrooms and the school hours. The emerging concepts of the Personal Learning Environments (PLE) and Social Learning Environments (SLE) could informally establish a supportive learning process for the learners. The spread of social media became pivoting for this informal learning system. The technology-supported learning processes and uninterrupted social media connectedness paved the way to the prolonged use of digital screens for the learners (Hutton et al., 2020; Joseph & Thomas, 2021; Limone & Toto, 2021).

The studies affirm that the lengthy screen time among young learners and infants induces screen-based Sedentary Behaviour (SB) which greatly affected their psychosocial wellbeing. An average 60 daily minutes screen time for the adolescents and school students was considered as the moderate to vigorous physical activity (MVPA), and recommended still reduced duration for the young children and the evidence-based interventions were recommended for the screen time (ST) reduction (Felix et al., 2021; Ponti and Digital Health Task Force 2019; UK Chief Medical Officers 2019). The studies of the post-millennium have indicated the considerable shift of the screen time from non-interactive TV screens to interactive games and internet-enabled screens (Limone & Toto, 2021; Mineshita et al., 2021). Based on the screen usage pattern of the students, their screen time may be categorized as i) recreational, ii) stationary iii) sedentary and (iv) active screen times depending on the educational and contextual concerns of the usage (Throuvala, Griffiths, Rennoldson, & Kuss, 2021; Tremblay et al., 2017).

The outbreak of the Covid pandemic paved the way for the extensive proliferation of technology-based education and virtual learning facilities were almost accepted as the mode of education even for young children (Joseph, Thomas, & Nero, 2021; Wen, Gwendoline, & Lau, 2021). The influx of technology-based services during the pandemic and work from the home facility for the parents increased the availability of unrestricted data connectivity and multiple gadgets at every home which drastically increased the ST of the infants (Mineshita et al., 2021). The studies had indicated the correlation between the ST and gadget dependency (Hutton et al., 2020; Vohr et al., 2021). The initial gadget use among infants and young children is mainly due to the interactive nature and the colourful animations on the screen (Crompton, Burke, Jordan, & Wilson, 2021).   This initial charm of the gadget use leads to the screen dependency, manifested through spending long duration over the gadget to explore its features than sleeping or merrymaking with parents/caretakers (Cabré-Riera et al., 2019; Radesky & Christakis, 2016). The prolonged unmonitored initial stages of screen dependency of the young children gradually led to isolation, sleeplessness, eye dryness, unexpected responses or even violent behaviour when the screen is taken from them which point to the initial stage of the screen dependency disorders (SDD). This initial SDD stage is indicative of the potential risks to neurological development and well-being of the children (Felix et al., 2021; Liu, 2021; Mineshita Y et al., 2021; Vohr et al., 2021).

III. Cognition, Socialization and Behaviour

Early childhood days are remarkable by the rapid development of the emotional, cognitive and moral domains (Zhou et al., 2019). The studies on Jean Piaget's sensorimotor stage affirms that young children aged less than 3 years learn the surrounding world by imitation of the parents and siblings (Radesky & Christakis, 2016). The emotional development theories of Erik Erikson and the moral development concept of Lawrence Kohlberg highlight the need for parental intervention during the early childhood learning process (Jie, Sunze, & Puteh, 2020; Radesky & Christakis, 2016). The learning attentional balance and symbolic thinking skills of the young students are at the utmost immature levels and it became a very hard task for the infants of this age to transfer the learning of the 2D screen to real-life situations (Bigorra, Garolera, Guijarro, & Hervás, 2016). The presence of the adult figure is essential for cherishing the zone of proximal development of the children. The role of the adult figure is to read and understand the vague nonverbal clues and contingently responds to them (Bigorra et al., 2016; Jie, Sunze, & Puteh, 2020; Radesky & Christakis, 2016). The excessive screen exposure to the young students distorts their natural learning priorities and subsequently builds internal inconsistencies stress due to their failure to reconcile the multiple dimensions of the virtual and real-world realities (Joseph & Thomas, 2020; McDaniel & Radesky, 2018; Webster, Martin, & Staiano, 2019). This internal inconsistency stress of the young children manifests through the initial symptoms of screen dependency disorders (SDD). The elevated levels of SDD exhibited through critical health issues and sleep disorders, alienation, obesity, aggression, tends to hinders the development of psychomotor and socio-cognitive domains of the children (Felix et al., 2021; Mineshita et al., 2021; Sigman, 2017; Webster, Martin, & Staiano, 2019).

Ratnasari and Haryanto (2019) denoted that the prolonged screen usage and mobile dependency of young children lead to the maldevelopment of their neurocognitive domain. The moderate gadget uses and parental interventions are supportive in overcoming certain learning disabilities of the differentially abled students (Ratnasari & Haryanto, 2019). The discrepancies in the cognitive development of the young children due to excessive exposure to the gadget screens were found to hinder their creative thinking abilities, imaginative skills, sensorimotor development, language skills, executive functioning, and academic outcomes (Felix et al., 2021; Liu et al., 2021; Sebastian & Martzog, 2021). The frequent digital media interactions and fast-paced activity-based games led to the reduction in the executive functions of young children

(Sigman, 2017). The excessive use of mobile devices lowered self-esteem, increased incidence and severity of mental health issues and addictions, slowed learning and conceptual acquisition, and an increased risk of premature cognitive decline (Neophytou, Manwell, & Eikelboom, 2021).

Socialization skills allow a person to develop and maintain apt interpersonal relationships and engage in relatedness (Hu, 2020). The preschool children and the young students need constant interpersonal interaction for their social wellbeing (Anderson & Subrahmanyam, 2017). The prolonged screen usage and gadget dependency among young children considerably affected their behaviour related to friendship, expression of feelings, and how to treat other people (Martin, Porritt, & Aromataris, 2018; Zhou et al., 2019). The playtime interactions and playful nature of the children are helpful for the intimate expression of curiosity, trust, healthy competition, tolerance, learning from failure, and social belongingness. The diversion of playfulness to the virtual world is devoid of all these social realities (Liu et al., 2021; McDaniel, & Radesky, 2018; Zhou et al., 2019). The covid pandemic related study of Limone and Toto (2021) denotes that the ST dependent children prefer to use the gadget in an isolated space and move away from the places of attention. They may prefer uninterrupted use of the gadgets and avoid the sharing of the systems among the other members of the family (Limone & Toto, 2021; Sigman, 2017). Overindulgence and selfish nature are evident among children without siblings and with less social interaction exposure (Hu et al., 2020).

The behaviour pattern derives from the socialization process and the anomalies of the socialization lead to undesirable psychological states (Yan et al., 2017). The prolonged duration of the screen time reduced the adaptability of the children in the fast-changing environments and gets easily upset with those who interfere with their routine interaction with the gadgets (Merenkova, Elnikova, Faustova, Komlik, & Kolosova, 2021). The prolonged use of digital gadgets leads children to screen dependency disorders (SDD). The SDD critically manifest in the deviant behaviour of the screen dependent persons (Limone & Toto, 2021). The chronic levels of SDD expressed in depressive symptoms, alienation, anxiety, attention-deficit/ hyperactive disorder (ADHD), leads to Alzheimer's disease, and suicidal tendency (Limone & Toto, 2021; Lissak, 2018). The brain structural changes may occur with cognitive emotional imbalance. The studies brought to light that unless the screen dependency is addressed properly it may lead to the Psychoneurological rupture at the later ages with antisocial behaviour, decreased prosocial behaviour and craving behaviour which resembles substance dependence behaviour (Lissak, 2018).

IV. Method

This descriptive study addresses the research problem, how the extended digital gadget usage and mobile dependency impact on cognition, socialization and behaviour among early childhood students? How the early childhood students respond to the screen time in terms of usage factors?

The research study thus set its objectives as:

    1.   To identify the influence of extensive Screen Time on the Mobile Dependency among the early childhood students.

    2.   To understand the impact of extensive Screen Time and Mobile Dependency on Cognition, Socialization and Behaviour among early childhood students.

    3.   To identify the influence of gadget usage factors on the screen time of the early childhood students.

On the basis of the hypothesised relationships derived from the objectives and related review of literature the following research model is formulated for the study
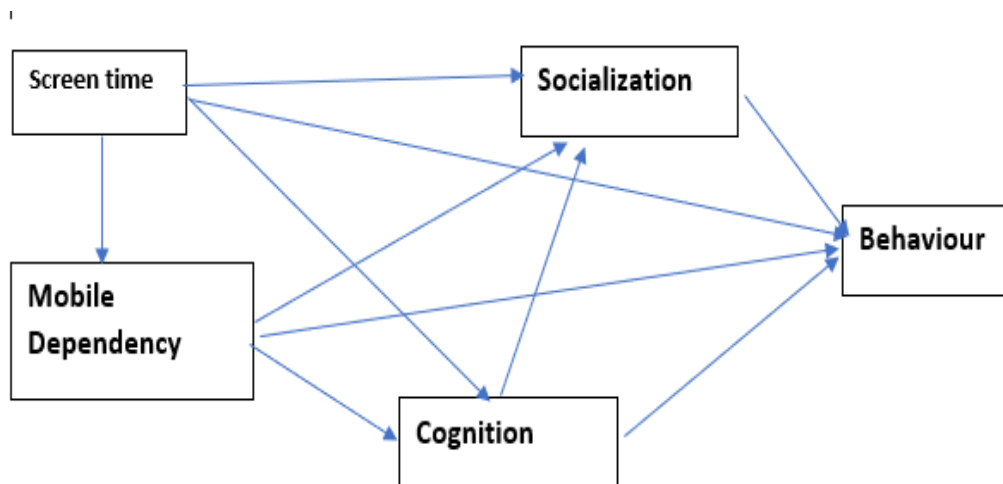
Figure: There proposed research model

Procedure and Participants

This study is based on the analysis of the quantitate data collected through the responses in a five-point scale. A random sample of 511 parents/care takers of young children between 1-6 years are selected from 5 revenue districts of State of Kerala, India. These five districts were classified generally as places predominant with rural, urban, migrant, economically backward, and socially backward nature to ensure an apt sample representation. The mothers or caretakers are selected for the points of response for the children. The digital form of structured questionnaire is filled with the support of the researchers when demanded by the respondent and it ensures the correctness of the responses. The randomness is ensured from the list of students provided from the schools and preschools of the identified districts. Proper permission was availed from the head of the institutions and parents for the study. The validated scale for data collection is adapted from the relevant studies and are validated by a pilot study with 100 valid samples. The validity of the scale was tested using the pilot study data with SPSS V.21 package tools and affirmed the validity of the scale. The Screen Time (ST) data of the children is collected in minutes per day and is divided in to ST for passive screen of TV, ST Mobile use for study purpose and ST Mobile use for entertainments programs.

The sample has 49.3% females, 20% are single children, 47.4% has no elder siblings. The sample has an average of 1.3 siblings (SD= 0.8 4), 8.7% of students are aged between 5-6 and 42.9% are aged below 5 years. The parents of the students are having different employment statuses in an even manner with the majority having self-reported annual income below 1.2 Lakh per annum. The mothers of the children are below 35yrs age (55.4%) with 84.7% having education 10+2 or above. Among the sample, 34.4% of children are at kindergarten levels and 3.7% are not joined in any playschools, 41.75 are at first standard, 17.3% are at second standard and 3.1% are at 3rd standard. Due to the covid pandemic, all the children are having the education online with the support of the parent or caretakers. The children are studying different curriculum as Kerala State Syllabus, CBSE/ICSE syllabus education systems. The data is assumed to be normal with Skewness falls between 0.241 to -0.378 and Kurtosis between 0.039 to -0.406, thus parametric tests are applied for analysis.

V. Results

The average Screen Time of the children for the passive (TV) screen is 70.86 minutes per day (SD ± 1.40), the average ST for the mobile gadgets for study purpose is 68.9 (SD ± 1.55) minutes per day, and the average ST for the mobile gadgets for entertainment is 69.3 (SD ± 1.31) minutes per day. The total ST of the children is 209.06 minutes per day during the covid pandemic period. The mean, standard deviation and Cronbach's alpha values of the constructs are given in the table 1.

Constructs	Items Mean	Std. Deviation	Cronbach's alpha
Screen time	209.06	0.95	-
Mobile Dependency	3.05	1.09	0.859
Cognition	3.17	0.76	0.734
Socialisation	3.18	0.91	0.765
Behaviour	2.77	0.83	0.765

Table 1: The constructs, Mean, Standard Deviation, and Cronbach alpha coefficients of the study.

a. To identify the influence of extensive Screen Time on the Mobile Dependency among the early childhood students

A significant difference *(p<0.05)* is observed in the Screen Time, mobile dependency, cognition, socialisation and behaviour of the children based on their age and classes of study when analysed with one-way ANNOVA. Their total Screen Time has significant influence *(p<0.05)* on their mobile dependency, cognition, socialisation and behaviour. The presence of the siblings has influenced their Screen Time F (4, 506) =4.098, *P*=0.003 and behaviour F (4, 506) =2.797, *P*=0.026. Correlation analysis also affirmed this association with ST (r=0.158, p= 0.00) and behaviour (r= 0.144, p=0.000). Children are similar across the gender categories with respect to Screen Time, mobile dependency, cognition, socialisation and behaviour. The children's Screen Time and their behaviour is influenced with respect to the age group of their parents, and their education levels. Children of the lower aged parents found to behave better than children of other age groups.

b. To understand the impact of extensive Screen Time and Mobile Dependency on Cognition, Socialization and Behaviour among early childhood students.

The Screen Time of the children is significantly (r=0.373, *P*=0.000) related to their mobile dependency in a positive manner. ST and behaviour of the children are negatively correlated (r=-0.724, *p*=0.000). The Cognition domain of the children are not significantly affected by their mobile dependency under study. The correlation between the variables is given in table 2.

	Mob. Dependency	Cognition	Socialisation	Behaviour
Screen Time	0.373**	-0.177**	-0.277**	-0.724**
Mob. Dependency	1	-	-0.651**	-0.353**
Cognition		1	0.168**	0.119**
Socialisation			1	0.321**

** Pearson Correlation is significant at the 0.01 level (2-tailed).

Table 2: Correlation between the variables of the study

c. To identify the influence of gadget usage factors on the screen time of the early childhood students.

The mediation of the mobile Dependency of the children on their Behaviour predicted through the Screen Time use was tested as statistically significant with direct effect [Effect= -0.6222, SE= 0.0296, t=-21.014, CI (-0.6804, -0.5640), p=0.000] and indirect path was existed through the mobile Dependency [Effect= -0.0326, SE= 0.0115, CI (-0.0566, -0.0109)]. The mediation could explain 53.16 % of the relationship [R-squire= 0.5316, MSE= 0.3480, F(2, 508)= 288.316, p= 0.000] of the outcome variable through the mediation.

The sequential mediation analysis is performed with Process macro v3.5 for SPSS v21. Outcome variable for the analysis was Behaviour of the children and the predictor variable was Screen Time. The mediatory path consisted of mobile Dependency, Cognition and Socialisation. The direct effect of Screen Time on Behaviour of the young children was statistically significant [Effect= - 0.6219, SE= 0.0298, p= 0.000, CI (-0.6805, -0.5633)]. The indirect sequential path was also statistically significant [Effect= - 0.0329, SE= 0.0132, CI (-0.0600, -0.0078)]. The model was statistically significant with R-squire= 0.5402 [MSE= 0.3430, F(4, 506)= 148.6323, p= 0.000].

VI. Inference and Conclusion

The covid pandemic has exerted a paradigm shift in the technology-based learning process in terms of spread of the multiple virtual learning systems, interactive online video streaming facility for the live classes, evaluation and exam monitoring systems, learning progression monitoring systems, and made it available in affordable manner globally. The technology-based learning systems were incorporated extensively by the digital native children and this study aimed to analyse the impact of the extensive technology use on the young children aged between 3 year to 6 year old. Technology studies on the early school children are a less explored area. These students were at pre-schooling or at the initial classes of the elementary education system and as per the pre-covid directives they should not be expose to the technology systems and digital screens extensively (UK Chief Medical Officers 2019; Ponti and Digital Health Task Force, 2019). The aim of this study was to explore more on the impact of the extended Screen Time of the young children which can develop a gadget dependency in them which in turn affect their cognitive, social and behaviour domains. Proper development of these domains is essential for the balanced personality and success of the persons.

The young children were exposed to the passive screen of the TV for an average duration of 70.86 minutes per day with a deviation ± 1.40. The smart screen exposure was for study purpose was 68.9 minutes in a day with deviation of ± 1.55. The average ST for the mobile gadgets for entertainment is 69.3 (SD ± 1. 31) minutes per day. As an average the younger students were extensively exposed to the passive and interactive screens with an average Screen Time of 209.06 minutes in a day and it is exorbitantly increased exposure than advised. The average total time for the younger students prescribed was 60 minutes in a day (Ponti and Digital Health Task Force, 2019). The immediate impact of this extensive Screen Time is mobile dependency and health issues of the children. However, the post covid technology use scenario may leads to revise the pre-covid ST standards.

The Screen Time (ST) has statistically significant impact on the mobile dependency, cognition, socialisation and behaviour of the young children. The male and female children do not exhibit any significant difference with respect to their mobile dependency, cognition, socialisation and behaviour. The ANNOVA study revealed that the presence of siblings of the young children

significantly influenced their Screen Time and behaviour. The availability siblings positively modified the young children's behaviour and reduced ST as they could engage in the real games and funs at home.

The Screen Time of the children is significantly predicted their mobile dependency in a positive manner. Rather strong negative correlation existed between the ST and behaviour of the children. It implies that the behavioural adjustments of the young children getting affected negatively due to the excessive ST. Excessive ST is to be controlled to avoid the undesirable psychological deviations and consequent screen dependency disorders (SDD) in the young children (Limone & Toto, 2021; Lissak, 2018; Yan et al., 2017). The Cognition domain of the children are not significantly affected by their mobile dependency under study. This finding is not in convergence with other similar studies and this may be due to the fact that the extensive time spend on the education purpose due to Covid pandemic lockdown and virtual learnings. The average time a young children spend over the mobile for study is reported as 68.9 minutes in a day, which is almost equals to the maximum time prescribed by the paediatric directives.

The mediating impact of the mobile Dependency of the children on their Behaviour predicted through the Screen Time use. The mobile dependency of the children decreased their behavioural adjustment capacity and the total mediation explained 53.16% effect of the behaviour of the children. It is thus inferred that excessive ST of the children can cause rather discrepancies in their behaviour (Sebastian & Martzog, 2021; Liu et al., 2021). Utmost care is needed to monitor the children's digital gadget usage beyond the necessary learning and entertainment purposes to reduce the chances of falling to the SDD related issues.

Mediatory path analysis of the outcome variable Behaviour of the children and the predictor variable Screen Time was also resulted in affirming the significant presence of the mediatory paths through the mobile dependency, cognition and socialisation of the children. The behaviour of the young children could be predicted (54.02%) with respect to the study variable. It is noted that cognition domain of the student is not significantly predicted by their mobile dependency as the mobile gadget are used as the learning medium for the virtual education established during the covid pandemic. The cognitive aspect of the young children influenced their socialisation and behaviour in a positive manner (Crompton et al., 2021). Mobile dependency of the children reduced their socialisation skills and behaviour. Cognitive domain of the children positively influenced their socialisation and behaviour aspects (Liu, 2021). The socialisation aspect of the children positively supported their behaviour development (Ponti & Digital Health Task Force, 2019).). The caretakers and parent to be noted that the extensive ST of the young children could reduce their socialisation process and increase their deviant behaviour (Wen, Gwendoline, & Lau, 2021). The reduction of socialisation can result in antisocial behaviour with personality disorders. ST control measures needed to be taken to moderate this negative impact of the extensive ST for the young children.

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References

Agustin, R. P., Saidah, Q. I., Anggoro, S. D., Huda, N., Widayanti, D. M., Priyantini, D., ... & Nurlela, L. (2019). The Relationship Between The Use Of Gadget And Emotional Development Of Preschool Children. *The Malaysian Journal Of Nursing*, *11*(2), 97-102.

Anderson, D. R., & Subrahmanyam, K. (2017). Digital screen media and cognitive development. *Pediatrics*, *140*(Supplement 2), S57-S61.

Behavior Research Network (SBRN)—Terminology Consensus Project process and outcome. International.

Bigorra, A., Garolera, M., Guijarro, S., & Hervás, A. (2016). Long-term far-transfer effects of working memory training in children with ADHD: a randomized controlled trial. European child & adolescent psychiatry, 25(8), 853-867.

Cabré-Riera, A., Torrent, M., Donaire-Gonzalez, D., Vrijheid, M., Cardis, E., & Guxens, M. (2019). Telecommunication devices use, screen time and sleep in adolescents. Environmental research, 171, 341-347.data/file/832868/uk-chief-medical-officers-physical-activity-guidelines.pdf

Crompton, H., Burke, D., Jordan, K., & Wilson, S. W. (2021). Learning with technology during emergencies: A systematic review of K‐12 education. British Journal of Educational Technology, 52(4), 1554-1575

Domoff, S. E., Harrison, K., Gearhardt, A. N., Gentile, D. A., Lumeng, J. C., & Miller, A. L. (2019). Development and validation of the Problematic Media Use Measure: A parent report measure of screen media "addiction" in children. *Psychology of popular media culture*, *8*(1), 2.

Felix, F., Speech, A. L., Kumaraswamy, S., Anand, H. A., Fathima, D., Sameeha, E. F., & Fida, F. (2021). Impact of Screen Time with Children 2-5 Years A Pilot Study. *Strength for Today and Bright Hope for Tomorrow Volume 21: 11 November 2021 ISSN 1930-2940*, 24.

Hu, B. Y., Johnson, G. K., Teo, T., & Wu, Z. (2020). Relationship between screen time and Chinese children's cognitive and social development. *Journal of Research in Childhood Education*, *34*(2), 183-207.

Hutton, J. S., Dudley, J., Horowitz-Kraus, T., DeWitt, T., & Holland, S. K. (2020). Associations between screen-based media use and brain white matter integrity in preschool-aged children. *JAMA pediatrics*, *174*(1), e193869-e193869.

Jie, Z., Sunze, Y., & Puteh, M. (2020, February). Research on Teacher's Role of Mobile Pedagogy Guided by the Zone of Proximal Development. In *Proceedings of the 2020 9th International Conference on Educational and Information Technology* (pp. 219-222).

Joseph, G. V., & Thomas, K. A. (2021). Integration of technology initiatives with educational neuroscience and its impact on technology readiness to technology adoption by HSS Teachers, Kerala. In *Neuro-Systemic Applications in Learning* (pp. 423-444). Springer, Cham. https://doi.org/10.1007/978-3-030-72400-9_21

Joseph, G. V., Thomas, K. A., & Nero, A. (2021). Impact of Technology Readiness and Techno Stress on Teacher Engagement in Higher Secondary Schools. *Digital Education Review*, (40), 51-65. https://doi.org/10.1344/der.2021.40.51-65

Joseph, G. V., & Thomas, K. A. (2020). Moderating effect of social media usage on Technology Barriers to Technology Adoption by teachers. *International Journal of Advanced Science and Technology*, *29*(03), 5504-5512.

Limone, P., & Toto, G. A. (2021). Psychological and emotional effects of Digital Technology on Children in Covid-19 Pandemic. *Brain Sciences*, *11*(9), 1126.

Lissak, G. (2018). Adverse physiological and psychological effects of screen time on children and adolescents: Literature review and case study. *Environmental research*, *164*, 149-157.

Liu, J., Riesch, S., Tien, J., Lipman, T., Pinto-Martin, J., & O'Sullivan, A. (2021). Screen media overuse and associated physical, cognitive, and emotional/behavioral outcomes in children and adolescents: an integrative review. *Journal of Pediatric Health Care*.Suggate,

Martin, K., Porritt, K., & Aromataris, E. (2018). Effectiveness of interventions to control screen use and children s sleep, cognitive and behavioral outcomes: A systematic review protocol. JBI Database of Systematic Reviews and Implementation Reports, 16(6), 1338–1345. https://doi.org/10.11124/JBISRIR-2017-003522.

McDaniel, B. T., & Radesky, J. S. (2018). Technoference: Longitudinal associations between parent technology use, parenting stress, and child behavior problems. *Pediatric research*, *84*(2), 210-218.

Merenkova, V., Elnikova, O., Faustova, I., Komlik, L., & Kolosova, I. (2021). Psychophysiological markers of students' internet addiction in the era of digitalization. In *E3S Web of Conferences* (Vol. 258). EDP Sciences.

Mineshita, Y., Kim, H. K., Chijiki, H., Nanba, T., Shinto, T., Furuhashi, S., ... & Shibata, S. (2021). Screen time duration and timing: effects on obesity, physical activity, dry eyes, and learning ability in elementary school children. *BMC public health*, *21*(1), 1-11.

Neophytou, E., Manwell, L.A. & Eikelboom, R. (2021). Effects of Excessive Screen Time on Neurodevelopment, Learning, Memory, Mental Health, and Neurodegeneration: a Scoping Review. *Int J Ment Health Addiction* **19,** 724–744 (2021). https://doi.org/10.1007/s11469-019-00182-2.

Ponti, M., & Digital Health Task Force (2019). Digital media: Promoting healthy screen use in school- aged children and adolescents. Retrieved July 15, 2019, from: Canadian Paediatric Society website: https://www.cps.ca/en/documents/position/digital-media.

Radesky, J. S., & Christakis, D. A. (2016). Increased screen time: implications for early childhood development and behavior. *Pediatric Clinics*, *63*(5), 827-839.

Ratnasari, D., & Haryanto, H. (2019). Analysis of Utilization of Gadgets as Effective Learning Media in Innovation Education to improve Student Learning Achievement. *KnE Social Sciences*, 460-467.

Sebastian, & Martzog, Philipp (2021). Children's sensorimotor development in relation to screen-media usage: A two-year longitudinal study. Journal of Applied Developmental Psychology, 74. doi:10.1016/j.appdev.2021.101279

Sigman, A. (2017). Screen Dependency Disorders: a new challenge for child neurology. *The Journal of the International Child Neurology Association (JICNA).* ISSN 2410-6410. Available at: http://jicna.org/index.php/journal/article/view/67

Throuvala, M. A., Griffiths, M. D., Rennoldson, M., & Kuss, D. J. (2021). The role of recreational online activities in school-based screen time sedentary behaviour interventions for adolescents: a systematic and critical literature review. *International Journal of Mental Health and Addiction*, *19*(4), 1065-1115.

Tremblay, M. S. (2017). on behalf of SBRN Terminology Consensus Project Participants, Aubert S, Barnes JD, Saunders TJ, Carson V, et al. Sedentary Behavior Research Network (SBRN)–Terminology Consensus Project process and outcome. *Int J Behav Nutr Phys Act*, *14*(1), 75.

UK Chief Medical Officers (2019). UK chief medical officers' physical activity guidelines. Retrieved 6 October 2019, from ttps://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_

Vohr, B. R., McGowan, E. C., Bann, C., Das, A., Higgins, R., Hintz, S., ... & Rasmussen, M. R. (2021). Association of high screen-time use with school-age cognitive, executive function, and behavior outcomes in extremely preterm children. *JAMA pediatrics*, *175*(10), 1025-1034.

Webster, E. K., Martin, C. K., & Staiano, A. E. (2019). Fundamental motor skills, screen-time, and physical activity in preschoolers. *Journal of sport and health science*, *8*(2), 114-121.

Wen, Y., Gwendoline, C. L. Q., & Lau, S. Y. (2021). ICT-supported home-based learning in K-12: A systematic review of research and implementation. TechTrends, 65(3), 371-378.

Yan, H., Zhang, R., Oniffrey, T. M., Chen, G., Wang, Y., Wu, Y., ... & Moore, J. B. (2017). Associations among screen time and unhealthy behaviors, academic performance, and well-being in Chinese adolescents. *International journal of environmental research and public health*, *14*(6), 596.

Zhou, S., Zhao, C., Huang, X., Li, Z., Ye, R., Shi, H., ... & Scherpbier, R. W. (2019). The effect of a community-based, integrated and nurturing care intervention on early childhood development in rural China. *Public Health*, *167*, 125-135.