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The Screen Time Ecological Model (STEM): The Development of a Conceptual and Practice Model on Screen Time for Children

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Abstract

It is undeniable that technology has become part of modern society that extends to children's grasp. However, the amount of screen time exposure in children and its effects are increasingly becoming a significant concern for families, educators, and child-related health professionals, such as occupational therapists. This study aims to help child-related health professionals understand the factors contributing to screen time and describe children's screen time levels to enable proper assessment and intervention planning. The Screen Time Ecological Model (STEM) follows the Socio-Ecological Model in describing influencing factors to screen time behavior, the Ecology of Human Performance in conceptualizing intervention approaches, and the Developmental Frame of Reference in describing the age-appropriate screen time recommendation children based on the American Academy of Pediatrics Media Use Guidelines for Families. The optimal goal of STEM is to promote the just-right screen time use within the pediatric population.

Key Words: *Gadget-use, Occupational therapy, Conceptual framework, Children*

INTRODUCTION

Screen Time (ST) is conventionally defined as the amount of time a person spends using electronic or digital devices, such as computers, tablets, smartphones, or televisions. In this regard, the use of screens has even expanded to children, as exposure to daily entertainment media is being encouraged through the growing accessibility of technology. As a result, positive and negative effects can be observed in the association between children's screen time and development.^{1,2}

Notably, young children can pick up imitation skills and remember brief scenes from television, but they need help using them in everyday scenarios. Moreover, early childhood education is best served by meaningful in-person interactions with other individuals and objects rather than by information displayed on

screens.¹ Furthermore, excessive media use negatively impacts learning, growth, and social skills.

In the Philippines, there is a heightened likelihood of children engaging in excessive screen media use.¹ While four to five hours or more a day affect children's play and leisure skills, personal skills, and interpersonal interactions, more than two hours of screen time is significantly linked to a decline in receptive and expressive language skills.¹

In response, the American Academy of Pediatrics provided guidelines for managing screen usage from infancy through adolescence in an effort to reduce these negative impacts. The said guidelines recommended against exposing kids under two years of age to screens and against allowing kids between the ages of two and five

years of age to use screens for longer than an hour each day. As such, children's exposure to digital media should be restricted to an hour before bed or during mealtimes to maintain average growth and development.^{2,3}

Several studies have identified the negative effects of screen time exposure in early ages and the factors affecting a child's development when used excessively.⁴ This led to the creation of the Screen Time Ecological Model or STEM, which aims to develop a conceptual and practice model on screen time for children. Another objective is to help therapists and educators look into the factors contributing to screen time and determine the level of screen time children have. Lastly, it also serves as a guiding framework in providing the appropriate interventions in relation to screen time problems. The optimal goal of the model is to help children achieve *Just-right ST* by developing healthier screen-time habits, which will significantly improve their cognitive, language, physical, and social-emotional development.

DEVELOPMENT PROCESS

The researchers, upon reflecting on their current practice, recognized inappropriate screen time exposure in children as a clinical roadblock, hindering gains in therapy and causing further delays in cognitive, language, physical, and socio-emotional development.^{5,6} In light of this observation, the researchers proposed the creation of a model that could potentially address this roadblock.

As reflected in this study, the researchers created and integrated a literature review involving studies, research papers, and other reliable materials sourced from trusted sites using the following keywords: screen time in children, factors of screen time, effects of screen time, and the like. As part of the literature review, the researchers reviewed occupational therapy models and frameworks such as the Ecology of Human Performance (EHP) and the Developmental Frame of Reference, as well as related models like the Socio-Ecological Model.

By combining concepts from the gathered literature, the researchers have developed the said model that lays out factors that influence

screen time in children, following the Socio-Ecological Model; the screen time spectrum, following the Developmental Frame of Reference; and the possible intervention approaches, influenced by the EHP Model, all of which are within the context of occupational therapy.

After writing the initial draft of the paper, the researchers sought guidance from the last author and two external reviewers to improve the paper's rigor and trustworthiness.

THEORETICAL BASES

The STEM highlights the impact of inherent and external factors on children's screen time, categorized as *Excessive ST*, *Just-right ST*, or *Restrictive ST*. The Socio-Ecological Model, the Ecology of Human Performance, and the Developmental Frame of Reference were the key concepts and frameworks adapted to develop and achieve the objectives of STEM.

Socio-Ecological Model (SEM). This model offers a framework that supports changes in health and behaviors at different levels. The levels are sequenced accordingly: intrapersonal, interpersonal, organizational, community, and public policy. In theory, every level affects the result independently, and the effect intensifies when the influencing elements interact at other levels.⁷ The general classes of factors affecting screen time are arranged in congruence with five levels of SEM. These are related starting from the intrinsic elements to the external characteristics affecting screen time use. Thus, child-related, caregiver-related, micro-environmental, and macro-environmental factors were determined as signaling factors that affect screen time use. These factors were determined to establish the link between the child and factors that influence their screen time, beginning with the most internal factors to the external factors of their environment.

Ecology of Human Performance (EHP). This model was adapted to develop interventions for screen time problems and is used in occupational therapy to emphasize the interactions between the person, the task, the setting, the performance, and the therapeutic intervention to gain a comprehensive understanding of human

occupation. The concepts of “establish,” “alter,” “adapt,” “prevent,” and “create” were used to guide the development of strategies for screen time management.

The first intervention is to “establish” the child’s skills and abilities. Here, the level of functioning and occupation barriers are assessed to improve occupational performance. In this part of the intervention, the practitioner identifies the child’s capabilities and performance in order to develop an appropriate intervention leading to an established skill.

The next intervention is to “alter” the actual context in which the child performs. Thus, intervention highlights the need to choose a setting that supports the child in performing tasks within current skills. This intervention adapts the context to what is already available for the family.

“Alter” is then followed by “adapt.” Here, the context is altered and organized to enhance performance. This intervention influences any changes or additions to context.

The next intervention is to “prevent”. This could be achieved by addressing individual, task, and contextual factors that may contribute to the development or incidence of maladaptive performance. It deals with avoiding the problems that had occurred before.

Last is the intervention to “create.” This approach makes no assumptions about the existence of a disability or the potential to impair functioning. Opportunities for change in a more significant factor are determined and done to improve quality of life.⁸ The interventions are incorporated into the model to help guide therapists in addressing the factors that contribute to screen time use.

The Developmental Frame of Reference. This framework views development sequentially and assesses behavior as determined by how well a person has mastered and integrated the earlier phases of action. The STEM aims to establish and maintain suitable age-appropriate screen time for children, based on the Media Use Guidelines for Families of the American Academy of Pediatrics (AAP).⁹ These guidelines provide comprehensive details of the age-appropriate number of hours recommended, the quality of

shows to be considered, and precautions for excessive screen time use. Thus, the following screen time spectrum was developed: *Excessive ST*, *Just-right ST*, and *Restrictive ST*, to describe the levels of screen time of children.

CONCEPTUAL FRAMEWORK

Figure 1 illustrates how various factors affect screen time in children.

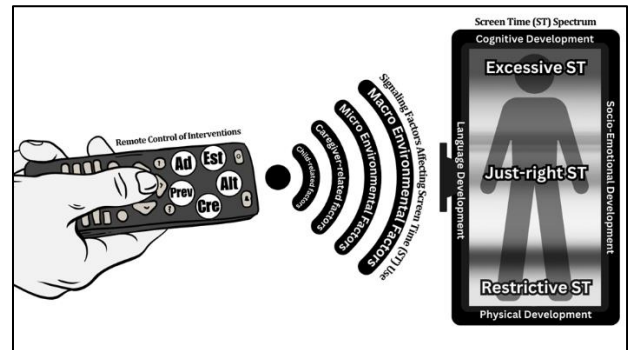


Figure 1. The Screen Time Ecological Model (STEM)

The signaling factors range from factors inherent in children to external factors in the broader environment. These factors play a role in determining the child's screen time spectrum. Said levels in the spectrum are categorized as *Restrictive*, *Just-right*, or *Excessive*. Determination of where the child is on the spectrum is dependent on the time spent and quality of screen use of the child. Consequently, the child’s placement within the spectrum determines the effects of exposure to digital media on their cognitive, language, physical, and socio-emotional development.

The desired outcome is for the child to achieve a *Just-right ST* use. Therefore, if the screen time is classified as *Restrictive ST* or *Excessive ST*, then the same indicates potential issues. This model helps establish a link between the child's level in the screen time spectrum and the contributing factors. For example, if a parent lacks knowledge on screen time recommendations (*a Caregiver-related Factor*), it may result in the child having excessive screen time (*ST spectrum*).

The model also includes intervention approaches in the form of the remote control. Therapists can utilize these approaches based on their clinical judgment to address specific problematic factors that contribute to low or excessive screen time.

It is important to note that different factors may require different intervention approaches, and therapists should tailor their interventions accordingly. The model provides a framework for practitioners to systematically evaluate and intervene in the complex interplay of factors influencing screen time use, with the ultimate goal of promoting healthier screen time habits among children, thus leading to greater gains in cognitive, physical, language, and socio-emotional development.

DISCUSSION

The STEM describes signaling factors that contribute to the child’s screen time use and developmental domains affected. Appropriate interventions are provided to address these factors to improve the child’s media use to achieve a *Just-right ST* use.

Signaling Factors Affecting Screen Time (ST) Use. Figure 1 includes the signaling factors that influence screen time use among children. These factors are based on the SEM and provide a unifying framework for defining and comprehending how different factors could affect how much time children spend on screens.¹⁰ The factors to be identified range from within the child (inherent factors) and extend outward to the macro-environment (external factors). Below is an expanded explanation of each signal bar, with Table 1 showing the list of sub-factors under each signaling factor:

1. **Child-related factors:** This signal bar represents factors inherent to the child, such as, but not limited to, their age, sex, personality, behavior, and preferences.² These individual characteristics can play a role in shaping the child's screen time habits.
2. **Caregiver-related factors:** This signal bar includes factors related to the child's immediate caregivers, particularly parents. Parents have a significant influence on their child's screen time behavior.¹¹ Factors such as parental age, parental screen time habits, parental self-efficacy, and parental rules regarding screen time can impact the amount of time a child spends on screens.^{2,11,12}

3. **Micro-environmental factors:** This signal bar represents the child’s immediate environment, such as the home, community, and school. Micro-environmental factors could include access to electronic devices, availability of alternative activities, the influence of peers or siblings who may have their own screen time habits, and school policy on screen media use.^{2,10,12}
4. **Macro-environmental factors:** This signal bar represents larger-scale factors that influence the behaviors of individuals in the target population. These factors can include legislation, the media industry, and government guidelines.^{2,10}

Table 1. Signaling factors affecting screen time use^{2,10,11,12}

Factors	Sub-factors
Child-related factors	Age Sex Personality Behavior Preferences Early life span media exposure Addiction vulnerability Ethnicity Level of physical activity
Caregiver-related factors	Age Sex Parental socioeconomic status Level of education of parents or caregivers Parental work characteristics (i.e., work hours) Parenting style Parental screen time Parental psychological stress Parental knowledge of the professional screen viewing recommendations Parental perception towards screen time and its influence on the child’s development Parental rule-setting practices (i.e., time and program content) Parental self-efficacy
Micro environmental factors	Family screen media rules Sibling media use Availability and access to screen media Availability of toys and other materials for play Availability of and access to outdoor play equipment at home Availability of and access to public physical activity and recreational facilities The school policy on screen media use

Macro environmental factors	Legislation Media industry Government guidelines
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Screen Time (ST) Spectrum. In this model, Screen Time (ST) refers to the quality (i.e., nature of media and manner of use) and quantity of use (i.e., duration and extent of usage).¹⁶ Children and adolescents experience different types of interactions with technology. Therefore, taking into account both the quality, as well as the quantity or length of media used should be considered to establish guidelines for screen use.¹⁶ Media Use Guidelines for Families by the AAP is the criteria adapted to define the *Just-right ST* of a child. On the one hand, *Excessive ST* is defined as when a child uses media more than the guidelines provided. On the other hand, *Restrictive ST* is described as a child’s media use less than the provided guidelines, which includes but is not limited to the complete banning of the use of gadgets, micromanaging screen time use, and restricting the access of the child to the use of technology.^{17,18}

Screen time may have potential benefits and risks to a child’s development.¹³ Researchers

have identified four developmental domains that are mostly affected by ST, namely (1) Cognitive Development, (2) Language Development, (3) Physical Development, and (4) Socio-emotional development. *Cognitive development* refers to the child’s development of mental functions, including but not limited to higher-level cognitive functions, work behaviors (i.e., attention, concentration, impulse control, frustration tolerance), memory, thought, mental functions of sequencing complex movement, and the capacity to switch between tasks.^{5,13,14} *Language development* includes the child’s language skills and other aspects of language development, including but not limited to vocabulary, phonology, comprehension, and expressive language.^{5,13} *Physical development* refers to the child’s neuromusculoskeletal and movement-related functions that affect their gross and fine motor development.^{6,13,14} Lastly, *Socio-emotional development* is the child’s temperament and personality, emotional function, psychosocial function, and sleep quality.^{5,13,14} Table 2 shows the ST Spectrum with the corresponding possible effects on the development of a child.

Table 2 Screen time spectrum^{5,6,9,13,14,17,18}

Spectrum	Criteria	Possible Effects on a Child’s Developmental Domains
Excessive ST	Media use is MORE than the adapted AAP Media Use Guidelines for Families under the <i>Just-right ST</i> .	<p><i>Cognitive Development</i> Negative impact on executive functioning, sensorimotor development, memory, impulse control, and shifting attention Decreased opportunities for the child to develop optimally Delays in learning Lower academic performance Delays in cognition affecting attention and early reading abilities Easily distracted in activities done, such as during play</p> <p><i>Language Development</i> Negative effects on language development, use, and acquisition Negative effects on reading abilities Poorer vocabulary acquisition Language delay</p> <p><i>Physical Development</i> Sedentary lifestyle Obesity Lower levels of physical activity</p>

Decreased gross and fine motor skills
Increased risk of developing myopia

Socio-emotional Development

Delays in social skills
Not getting enough sleep
Behavior problems
Decreased engagement with nature
Adverse effects on mental health and well-being
Occurrence of depressive symptoms, attention-deficit/hyperactivity disorder (ADHD)-related behaviors, and increased severity of anxiety
Emotional reactivity
Aggression
Externalizing behaviors
Lower levels of emotional understanding
Increased chances of engaging in antisocial behavior
Decreased social coping skills
Formation of craving behaviors similar to substance dependence
Having a higher risk of developing an addictive digital media behavior
Reduced the amount and quality of parent-child interaction
Diminished opportunities for parent-child interactions

Just-right ST

Younger than 2 years old
Screen usage is very limited and only permitted when an adult is present to co-view with the child (i.e., video chatting with relatives along with parents).

When introducing digital media to children aged 18–24 months, parents should choose high-quality programming, use media together with the child, and avoid the child's solo media use.

2 to 5 years old
Screen use is limited to only 1 hour per day. Other activities are looked into for the child to do that are good and beneficial for their bodies and minds.

The media chosen is interactive, non-violent, educational, and pro-social—parent co-views or co-plays with the child.

5 years and older
It is ensured that media use does not replace the child's other vital occupations, such as physical activity, family time, and rest and sleep. Parents continue to monitor their child's media use for their health and safety.

Beyond this age range, there is no established guideline regarding the duration of screen time for children. Parents can decide what is suitable for their children once they surpass preschool age.

Pre-teens and Teens

Cognitive Development

Stimulate cognition and encourage learning, social, and play skills
Fostered sustained attention
Improved early reading skills and creative thinking capacities

Language Development

Enhanced language skills
Promotes early language and literacy development

Physical Development

Promote light to moderate exercise and improve overall body functions
Earlier achievement of fine motor milestones
Increased active play

Socio-emotional Development

Enhanced social skills
Promotes ant violence attitudes, empathy, tolerance, and respect

Discussions about media use, digital citizenship, what they have seen or read, who they are communicating with, and what they have learned from their media use are some of the few topics parents should have with their children in their pre-teenage and teenage years.

Restrictive ST

Media use is LOWER than the adapted AAP Media Use Guidelines for Families under the *Just-right ST*. This includes, but is not limited to, the complete banning of the use of gadgets, micromanaging screen time use, and restricting access to the use of technology.

Cognitive and Language Development
 Long-term effects on children's opportunities for learning
 Difficulty developing knowledge of how to use technology to find, organize, and communicate ideas

Socio-emotional Development
 Problems with self-regulatory development
 Hampered ability to engage with other people virtually
 Strained relationships with parents or caregivers due to the implication that the child cannot be trusted when using technology

Remote Control of Interventions. This symbolizes the ability of the therapist and family to control the factors using the intervention approaches in the EHP Model. Examples of possible approaches to intervention are listed in Table 3.

Establish (Est). This intervention can be applied wherein occupation barriers and functioning levels are evaluated to enhance employment performance. The practitioner assesses the child's performance and capacities in this phase of the intervention to create a suitable plan that will help the child acquire a new skill.⁸

Alter (Alt). The emphasis of this intervention is on choosing an environment that helps the child do tasks within the scope of their existing abilities. With this approach, the context is adjusted to the family's current resources.⁸

Adapt (Ad). The approach of this intervention is rearranging and modifying the environment to improve the child's performance. Any alterations or additions to the context are influenced by this activity.⁸

Prevent (Prev). Another intervention can be used to address environmental, task-specific, and individual factors that may contribute to the occurrence or development of maladaptive performance. Its focus is on averting the pre-existing issues. The focus of this approach is on

averting pre-existing issues and preventing the occurrence of the evolution of factors that affect the child's screen time use and developmental domains.⁸

Create (Cre). This intervention focuses on the overall promotion of functional performance without presuming that limitations could occur or interfere with the performance. It also emphasizes setting up conditions that encourage more complicated or adaptive performance in the given context.⁸

UTILIZATION OF THE MODEL

The STEM can be used for both evaluation and intervention to address the child's screen time use. Factors contributing to screen time use will be identified through semi-structured interviews. Once the factors are gathered, the practitioner will ask the client to describe their screen time use to determine whether it is *Excessive, Just-right, or Restrictive ST* using the given criteria. With the *ST Spectrum* identified, possible effects of screen time on the child's developmental domain will be discussed with the child's parent or caregiver. The practitioner may then use the applicable intervention approaches to change the factors contributing to screen time use in order to achieve the *Just-right ST*.

Table 3. Approaches to Intervention^{5,9,13,15,16}

Intervention	Examples
Establish	<ul style="list-style-type: none"> • Building family routines that minimize the use of screens during meal times and outdoor activities • Establish what type and how exceedingly media are used and what media behaviors are appropriate for each child or teenager and parents • Establish consistent limits on hours per day of media use as well as types of media used • Designate quiet, media-free areas at home, like the bedroom and dining area • Establish guidelines for caregivers so that media rules are followed consistently
Alter	<ul style="list-style-type: none"> • Offer some alternative options to screen time (such as parent-child play activities) that better facilitate development • Suggest exposing the child to other environments that encourage outdoor play
Adapt	<ul style="list-style-type: none"> • Modify the type of media that is used by choosing and watching media with the child to promote learning and creativity, and be able to share these experiences with the family • Teach parents strategies to help improve self-regulation skills without the use of screen time • Limit or remove background TV and keep the screen off when not in use • Remove devices from bedrooms before bed
Prevent	<ul style="list-style-type: none"> • Teach parents about early brain development and the importance of hands-on, unstructured, social play for the development of language, cognitive, and socio-emotional skills in young children • Work with families and schools to promote understanding of the benefits and risks of media • Prevent entertainment media while doing homework • Prevent excessive media use by checking the child’s media use for their health and safety • Monitor and choose age-appropriate and child-friendly media content • Put screens away an hour before bedtime to improve sleep patterns • Refrain from fast-paced shows and programs, distracting app content, and media content showing violence
Create	<ul style="list-style-type: none"> • Make a “Family Media Use Plan”¹⁹ • Create enriching and interactive experiences for parents with their children • Collaborate with educators and developmental psychologists to build interfaces that are not distracting, are age-appropriate for children's developmental abilities, and encourage parent-child media use as well as the application of acquired skills in real-world scenarios.

LIMITATIONS

The STEM is limited to the pediatric population as the guidelines used in the *ST Spectrum* criteria focus on the media use of children from infancy to adolescence. Also, this model describes factors influencing the child’s time and quality of screen use and how it affects their development. Thus, this model is not an indicator of screen dependency or addiction.²⁰ The intervention approaches listed in this model are limited to occupation-based strategies and may require

guidance from an OT practitioner to implement the appropriate interventions. Furthermore, this model is limited to describing factors and effects of a child’s ST but does not determine which specific intervention should be used. It is the practitioner's discretion to choose and use applicable approaches and strategies suggested in this paper.

CONCLUSIONS AND RECOMMENDATIONS

The STEM is designed to tackle concerns related to inappropriate screen time for children, causing setbacks in their cognitive, physical, language, and socio-emotional development, as well as hindering therapeutic progress. The purpose of the model is to provide guidance to educators and child-related health professionals such as occupational therapists by describing factors that contribute to a child's screen time habits. By understanding these factors, professionals can gain deeper insights into a child's screen time engagement.

Additionally, the model suggests the use of clinical reasoning in employing appropriate intervention approaches to effectively address identified problematic factors. These intervention approaches aim to mitigate the negative effects of age-inappropriate screen time and promote healthier screen time habits in children. To fully utilize and achieve the intended outcomes of this ecological model, it is crucial for the therapist to work with the child, their family, and key stakeholders.

Further research on media guidelines for adult screen time use is recommended to be able to use this model for the adult population. Future developers are recommended to further study determining factors to a child's screen time use and specific intervention approaches per factor that affect the child's screen time. Also, future research on interventions that can be used by other disciplines is suggested. Furthermore, more research regarding the different types of screen time is also recommended.

Individual Author's Contributions

S.R., K.S., and C.A.V. were responsible for the conception of the work, acquiring data, analyzing and interpreting the data, drafting the manuscript, critically revising the manuscript, approving the final version for submission, and being accountable for most aspects of the work. R.C.D., on the other hand, was involved in drafting and critically revising the manuscript and also approved the final version for submission.

Disclosure Statement

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Conflicts of interest

The authors of this paper declare no conflict of interest.

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