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Impact of Technology-Based Learning on LKG–UKG Students in Kerala

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Abstract

This paper examines the impact of technology-based learning on Lower Kindergarten (LKG) and Upper Kindergarten (UKG) students in Kerala, India. Drawing upon existing literature, state-level initiatives, and early childhood education theory, the study considers both benefits and challenges. Key findings suggest that technology, when appropriately integrated, can significantly enhance cognitive, socio-emotional, and language development in pre-primary students; however, there are also risks related to screen time dependency, digital divide, and pedagogical misuse. The paper concludes with recommendations for policymakers, educators, and parents to maximize the positive outcomes of technology in early childhood education in Kerala.

Keywords: Technology-Based Learning; Early Childhood Education; LKG–UKG; Digital Learning; Kerala; Foundational Literacy and Numeracy (FLN); Interactive Learning; ICT in Education;

1. Introduction

Kerala, often lauded for its educational outcomes, has in recent years embraced digital education more aggressively. With initiatives like KITE (Kerala Infrastructure and Technology for Education), the state has introduced ICT (Information and Communication Technology) into its schooling system. While much of this focus has been on primary and secondary level, there is a growing interest in how technology can support foundational years especially LKG and UKG, which are critical for later learning. Early childhood education is a phase marked by rapid cognitive, linguistic, social, and motor development. Introducing appropriate technology at this stage can potentially strengthen foundational skills but must be done thoughtfully, balancing interactivity, play, and human interaction.

The primary objectives of this paper are:

1. To analyse the current state of technology-based learning for LKG–UKG in Kerala.

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2. To investigate potential developmental impacts both positive and negative of technology for this age group.
3. To offer evidence-based recommendations for integrating technology in pre-primary education in Kerala.

Objective 1: To analyse the current state of technology-based learning for LKG–UKG in Kerala

This objective focuses on understanding how technology is currently being used in pre-primary education across Kerala. It includes examining the extent and nature of digital infrastructure, ICT availability, digital classroom initiatives, and educational platforms provided by the state such as KITE-Victers, Samagra Shiksha, First Bell online classes, and smart classrooms. It also explores the level of teacher preparedness, parental involvement, and students' exposure to digital devices at home and school. By analysing these aspects, the study seeks to present a clear picture of how widely and effectively technology is integrated into foundational learning (LKG–UKG), and where gaps continue to exist in accessibility, training, and usage patterns.

Objective 2: To investigate potential developmental impacts—both positive and negative—of technology for this age group

This objective examines technology-based learning influences the overall development of preschool children.

- **Positive impacts** such as enhanced curiosity, concept clarity through visuals, better phonics and language skill acquisition, improved numeracy, creativity, and engagement through interactive learning apps, and increased learning motivation.
- **Negative impacts** such as excessive screen time, reduced physical play, limited real-world social interaction, risk of digital dependency, attention-related issues, eye strain, and emotional difficulties caused by isolation from peer learning environments.

The goal is to evaluate whether technology supports or hinders holistic development—cognitive, linguistic, socio-emotional, and physical—when used in foundational education.

Objective 3: To offer evidence-based recommendations for integrating technology in pre-primary education in Kerala

This objective aims to propose meaningful and research-supported strategies for using technology appropriately and effectively in pre-primary classrooms.

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- Adopting **blended and play-based learning models** rather than fully digital instruction.
- Designing age-appropriate, interactive, and safe digital content aligned with **Foundational Literacy and Numeracy (FLN)** goals.
- Providing structured screen-time guidelines appropriate for 3–6-year-old children.
- Enhancing teacher professional development for digital pedagogy.
- Ensuring equal access through affordable devices, community digital centres, or government support.
- Encouraging collaboration between parents and schools for monitoring learning and well-being.
- Integrating technology as a supplementary tool rather than a replacement for hands-on learning.

  The recommendations are intended to improve policy and classroom practice while maintaining child development standards.

2. Background and Context

2.1 Technology Initiatives in Kerala's Education System

Kerala has long been progressive in integrating technology into education. The agency KITE plays a central role in this, having introduced hi-tech classrooms, digital resource portals, and ICT-enabled teaching.

The KITE VICTERS channel is a state educational television channel used for virtual classrooms. During the COVID-19 pandemic, Kerala launched *First Bell*, a digital teaching platform through VICTERS, which even included a pre-primary program called *Kilikkonchal*. These show that digital infrastructure and policy support for technology-based learning are robust in Kerala.

2.2 Technology in Early Childhood Education: The Global & Indian Perspective

Globally, research shows that ICT can support early childhood development when integrated properly. Tools such as interactive multimedia courseware have shown positive impacts in preschool settings.

In the Indian context, studies have noted that while technology offers opportunities in early childhood, its effectiveness depends heavily on pedagogy, adult mediation, and usage patterns. For example, a 2023 study highlighted how kindergarteners used ICT during the pandemic to support learning across language, numeracy, and social domains.

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3. Literature Review: Potential Impacts of Technology-Based Learning on LKG–UKG Students

In assessing impact, it's essential to categorize by different domains of child development: cognitive, language, socio-emotional, and physical/motor.

3.1 Cognitive Development

- **Computational Thinking & Problem-Solving**: Introducing technology early can foster basic computational thinking. A systematic review found that tools like Scratchers, robotics kits (like KIBO), and other playful digital tools support computational thinking even at very young ages.
- **Scientific Inquiry**: Manipulative kits (e.g., LEGO machines) along with digital technology can encourage hands-on scientific exploration.
- **Engagement and Attention**: Well-designed multimedia content can enhance engagement, leading to better retention of concepts. A study on multimedia courseware for pre-schoolers reported positive outcomes in learning when the design (ADDIE model) was carefully executed.

3.2 Language and Literacy Development

- **Interactive Digital Narratives**: Tablets, storytelling apps, and animated content can provide rich language input, especially in early years. These tools can support vocabulary growth, phonemic awareness, and emergent literacy.
- **Parental and Teacher Mediation**: The positive effect is strongest when teachers or parents scaffold learning, explain content, and engage in joint media interaction. Research has shown that passive use of technology may not be sufficient; active engagement is critical.

3.3 Socio-Emotional Development

- **Peer Interaction & Collaboration**: When used in group settings, digital tools can encourage collaboration, negotiation, and turn-taking, important social skills.
- **Self-regulation & Motivation**: Game-based learning and gamification (e.g., reward systems, challenges) can boost intrinsic motivation, persistence, and self-regulated learning.

3.4 Physical and Motor Development

While technology is often sedentary, certain hands-on, tangible tech (e.g., robotics kits, interactive manipulatives) can support fine motor development. When children manipulate

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physical items (sensors, blocks), they develop coordination, spatial reasoning, and fine motor skills.

4. Specific Considerations for Kerala and Its Pre-Primary (LKG–UKG) Context

4.1 Infrastructure & Access

- Kerala's strong ICT backbone (via KITE) provides potential to scale technology integration even at pre-primary levels. However, whether LKG/UKG institutions (many being small preschools or play schools) have the infrastructure (tablets, internet, trained staff) remains a question.
- Equity issues might emerge: not all preschools in rural or low-resource areas may have access to reliable devices or connectivity.

4.2 Policy and Curriculum

- Currently, much of KITE's technology interventions are oriented toward primary to higher grades (hi-tech classrooms, ICT curriculum).
- There is less documented, formal policy-level intervention specifically for LKG–UKG with respect to structured digital pedagogies — though early education through digital classes (Kilikkonchal) is part of VICTERS / First Bell initiative.
- Teacher training for pre-primary educators may not be as robust as for primary/high school teachers; thus, the capacity to use technology meaningfully might be limited.

4.3 Cultural and Parental Context

- Kerala has high literacy and strong parental engagement in education, which could support mediated technology use.
- However, concerns among parents about screen time, its effect on attention, and the risk of over-dependence are real, particularly if unregulated.

5. Empirical Evidence from Kerala

In examining the impact of technology-based learning and screen use, empirical evidence from Kerala (and analogous contexts) provides valuable insights. Below are key studies and findings aligned with the three categories you mentioned: (1) Digital Education Experience During the Pandemic, (2) Impact of Screen Time on Early Childhood, and (3) ICT Initiatives Success Factors.

5.1 Digital Education Experience During the Pandemic

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While direct studies on **LKG–UKG (pre-primary)** students during the pandemic in Kerala are limited, we can draw from broader state-level digital education initiatives and how they were deployed under COVID-19, and infer relevant lessons.

- **First Bell / VICTERS Digital Classes**: During the COVID-19 lockdown, Kerala's KITE (Kerala Infrastructure and Technology for Education) launched *First Bell*, a digital teaching platform for students (Grades 1–12) via the VICTERS television channel.

Implication for early childhood *(LKG–UKG)*: Though First Bell was formally for Grade 1 and above, the model demonstrates Kerala's capacity to scale remote digital learning quickly, even under crisis conditions. This infrastructure (TV + online) could potentially be adapted for younger learners, e.g., via age-appropriate educational programming or mediated screen time.

- **Teacher Perception of ICT Implementation**: A KITE research report (Hi-Tech School Programme Implementation) assessed how teachers perceived the integration of ICT in instruction.
    - Using a "concerns-based adoption model," the study found that teacher attitudes vary widely; while some saw clear benefits, others were skeptical or had practical concerns (infrastructure, training, workload).
    - *Implication*: For pre-primary or early grades, teacher buy-in is critical. If similar concerns exist among preschool educators, the success of digital initiatives will depend on addressing these attitudes, providing support, and tailoring interventions to teachers' developmental-appropriate expectations.

Overall, the COVID-era experience in Kerala shows that with strong infrastructure (KITE, VICTERS), digital platforms can be rapidly mobilised. However, meaningful integration requires considering teacher concerns, support systems, and adaptation for younger learners.

5.2 Impact of Screen Time on Early Childhood in Kerala

This is perhaps the most directly relevant body of empirical work for LKG–UKG students, especially in terms of developmental risks.

1. **Association of Screen Time with Cognitive Delay**
    - A cross-sectional study conducted in Thiruvalla (Kerala) among **2–5-year-old** children found that **89.4%** of these preschool children had more than 1 hour of daily screen time, with an average of **2.14 hours/day**.

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- The same study used the Werner-David Developmental Pictorial Scale (WDDPS) to screen for cognitive development and found that **inconsistent parental supervision** of screen use was significantly associated with suspected deficits in attention, intelligence, and social skills:
  - Attention: OR = 3.2 (95% CI: 1.3–8.2)
  - Intelligence: OR = 4.1 (95% CI: 1.3–13.3)
  - Social skills: OR = 15.3 (95% CI: 1.9–121.2)
- This suggests that not just screen time, but how it's managed (e.g., supervision, context) matters greatly for developmental outcomes.

2. **Mobile Dependency, Behaviour, Socialization**
   - A descriptive study of **511 parents** across five districts in Kerala (early childhood children aged 3–6) investigated correlations between extended digital gadget use (especially mobile devices) and cognitive, social, and behavioural outcomes.
   - Key findings:
     - Extended use was significantly related to *mobile dependency*.
     - This dependency mediated effects of screen time on behaviour: children showed more **behavioural deviations**, alienation tendencies, and changes in socialization.
     - The study argues for balanced gadget-usage systems and stronger parental mediation to minimize adverse psychoeducational impacts.
3. **Parental Perception & Health Dimensions**
   - A study published in the *Kerala Journal of Ophthalmology* reported that since the COVID pandemic, a significant proportion of children are spending **> 4 hours/day** on electronic devices, per parental responses.
   - Moreover, this rise in screen time was linked by parents to **eye-health concerns** (like myopia).
   - This reflects a real-world, health-oriented dimension of screen exposure beyond cognitive and social developmental factors.
4. **Very Early Exposure**

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- A recent study (November 2025) by the Kerala chapter of the Indian Academy of Pediatrics found that **89.1% of children under 2 years** are regularly exposed to screens.
- Such early exposure is particularly concerning because global pediatric guidelines (e.g., WHO, IAP) recommend very limited or no screen time for infants and toddlers. Early and frequent exposure could have lasting developmental implications, though more longitudinal data is needed.

5.3 ICT Initiatives Success Factors (in Kerala)

There is substantial empirical and evaluative evidence regarding ICT initiatives in Kerala's education system (though not always specific to LKG–UKG). These offer lessons that can inform early childhood technology integration.

1. **KITE Model**
   - **Origins & Scale**: The project (now KITE) began in 2001 and is a flagship ICT-in-education initiative in Kerala.
   - **Open-source Strategy**: One of its defining features is the use of **free & open-source software (FOSS)**.
     - This reduces licensing cost and supports sustainability.
     - It also fosters a culture of sharing and local content adaptation. Little KITEs labs, for instance, use FOSS.
   - **Infrastructure & Administration**: The project-built ICT infrastructure across schools, appointed "School IT Coordinators" (SITCs) and student coordinators (SSITCs), which created local ownership and stewardship.
   - **Policy & Governance**: The project did not rely entirely on external contractors — an "in-house" model was used, giving more control to the education department and schools.
2. **Little KITEs Programme**
   - **Scale & Reach**: Little KITEs is a student ICT network run by KITE. There are over 1.8 lakh active student members across more than 2,174 high schools.
   - **Skills-Oriented Curriculum**: Rather than only "using software," Little KITEs expose students to advanced areas: IoT, AI, robotics, 3D animation, multimedia, mobile apps, etc.

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- **Life Skills & Cyber Safety**: The programme is aligned with UNICEF's life-skills framework, promoting critical thinking, collaboration, communication, and responsible internet use.
- **Peer Teaching and Community Building**: Students (especially older ones) take leadership roles, maintain ICT equipment, help peers, and train others. **External Recognition**: A UNICEF study titled *"Empowering Adolescents with Future-Ready Skills"* highlighted Little KITEs as a globally significant EdTech intervention.
- **Gender Equity**: According to evaluations, Little KITEs has made progress in gender balance: girls participate in nearly equal numbers, including in STEM-related tracks.

3. **E-Language Lab (ELL)**
   - KITE's **E-Language Lab** is another well-evaluated initiative. An end-line study (by RIESI & IT for Change) found that students using the ELL showed **significant improvement** in language skills: listening, image-reading, writing, and speaking.
   - Teachers reported that the interactive design (audio, video stories, simulations) made the content more engaging.
   - However, the study also pointed out challenges: uneven infrastructure and inconsistent implementation across schools.

Implications for LKG–UKG Students: Interpreting the Evidence

- While most ICT initiatives (e.g., Little KITEs, ELL) are focused on **primary or high school levels**, their success factors (peer engagement, open source, life skills) can inform technology integration strategies for **pre-primary** education.
- The screen time risk data is directly relevant: since young children in Kerala are already exposed to high screen use, any technology-based learning in LKG–UKG must carefully manage **how**, **when**, and **with whom** children use devices.
- Teacher readiness and attitudes (as seen in the Hi-Tech School study) are likely to be equally important in pre-primary settings; early childhood teachers must be trained not just as "users" of tech but as mediators and co-learners with children.
- Infrastructure, maintenance, and ownership models used in KITE (in-house staff, student coordinators, open-source tools) can be adapted or scaled down for preschools

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6. Challenges and Risks of Technology-

Based Learning for LKG–UKG Students in Kerala

1. Digital Divide

a) Inequitable Access to Devices and Connectivity

- Despite Kerala's strong focus on ICT in schools via KITE, not all early childhood institutions or preschools may have equal access to hardware or reliable connectivity. KITE's infrastructure primarily targets higher grades; the "Hi-Tech School" programme is more oriented toward primary and secondary schools, not necessarily LKG–UKG.
- According to KITE's policy documentation, there are strict guidelines on what devices are to be provided (e.g., laptops, projectors, broadband) for "Hi-Tech Classrooms," and some devices (like desktops or interactive whiteboards) are explicitly restricted.
- Socioeconomic disparities: Even though Kerala has a comparatively high literacy rate, digital access is not uniform. Some families or preschools (especially in rural or marginalized communities) may lack devices, or children may not have access at home for supplementary learning.

b) Skills Divide (Digital Literacy)

- Having devices is one thing; using them effectively is another. The *digital divide* isn't just about first-level access (having a device) but also second-level (digital skills) and third-level (meaningful use). Literature on digital divides in India points to deeper issues: even if children (or their families) get devices, their ability to use them for educational purposes may be limited.
- In early childhood education (ECE), teachers and parents need digital literacy themselves. If educators or caregivers don't know how to mediate or scaffold learning via technology, children may not benefit fully.

c) Equity and Inclusion

- The risk of exacerbating inequality is real: children from better-resourced preschools or homes will benefit more, while those without access may be left behind.
- There may also be geographic barriers: some areas may have weak internet infrastructure, making synchronous or content-rich digital learning less feasible.

2. Screen Time Concerns

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a) Overuse and Cognitive Risks

- A study in Thiruvalla (Kerala) with preschoolers (aged 2–5) found that **89.4%** of children had more than 1 hour of screen time daily; their average was about **2.14 hours/day**.
- Inconsistently supervised screen time (e.g., during meals, on-demand screen access) was associated with suspected deficits in attention, intelligence, and social skills. (
- These findings suggest cognitive risks: excess screen time may interfere with early developmental processes in language, attention, and socialization.

b) Developmental & Physical Health Impacts

- Extended screen exposure in young children is associated with sedentary behavior, reduced outdoor play, and physical health risks like poor posture, eye strain, or sleep disruption.
- From a developmental standpoint, screen time can displace crucial real-life interactions (like face-to-face communication, play) that support language, emotional regulation, and motor skills.

c) Dependency and Behavioral Changes

- There is evidence from Kerala that "mobile dependency" is already manifesting: a study on early childhood students (3–6 years) found that extended gadget use correlated with mobile dependency, altered cognition, socialization issues, and behavioral deviations.
- In some households, screens are used as "digital pacifiers": children are given devices to calm them, or to keep them occupied while caregivers are busy.
- A more recent alarming report indicates that 89% of children under two in Kerala are exposed to screens. This is especially concerning because pediatric guidelines (e.g., WHO, IAP) recommend very limited or no screen time for infants.
- Such early and frequent exposure can lead to "screen-induced developmental delays," according to medical experts in Kerala, affecting bonding, speech, social recognition, and curiosity.

d) Parental Supervision and Mediation Issues

- In the Thiruvalla study, about **45% of parents reported inconsistent supervision** during their child's screen use.
- Without proper parental mediation (co-viewing, guiding, explaining), screen use may be passive, reducing its educational value and increasing risks.

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3. Teacher Preparedness

a) Lack of Training in Early Childhood Context

- Integrating ICT into early childhood education (ECE) requires different skills than integrating it for older children. Literature identifies first-order barriers (like lack of access or technical support) and second-order barriers (e.g., teachers' beliefs, pedagogical confidence).
- Many early childhood teachers may not have had pre-service training in digital pedagogy, especially for very young learners (LKG–UKG). They may be more comfortable with traditional play-based, hands-on methods and could feel unprepared to blend those with tech-based activities.

b) Resistance or Low Adoption

- In KITE's own evaluation of its Hi-Tech School Programme, some teachers reported low or mechanical use of ICT: according to the Kerala Government's Hi-Tech school report, ~28.65% of teachers were in "Mechanical Use, Orientation, or Non-use" categories.
- These categories indicate that a significant portion of teachers are not fully integrating technology pedagogically — they may be using it superficially or not at all.

c) Time and Logistic Constraints

- Teachers often cite time as a barrier: planning tech-based activities, integrating them into existing curriculum, maintaining devices, and balancing with non-digital, developmentally appropriate activities (play, storytelling) all take extra effort. This is especially true in early childhood settings, where flexibility is key and rigid instructions may not work.

d) Beliefs & Pedagogical Challenges

- Some teachers may believe that young children should focus on concrete, physical play rather than screens; others may not see the pedagogical value of digital tools, or may worry that it detracts from social or motor development.
- There may also be second-order (intrinsic) barriers: even if infrastructure exists, teachers may lack confidence, feel unsupported, or lack long-term vision for using technology meaningfully in ECE. Literature on ECEC (Early Childhood Education & Care) organizations highlights that organizational support, adequate professional development, and time are critical for ICT integration.

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4. Pedagogical Misuse / Misalignment

a) Passive Use vs. Active Learning

- A big risk in early years is that digital tools are used passively — for example, videos are shown rather than interactive, scaffolded learning. Without intentional design, technology may become "screen babysitting" rather than a pedagogically rich tool.
- If educators or parents simply dole out tablets with pre-loaded videos, the potential for exploration, creativity, or critical thinking is lost.

b) Inappropriate or Non-Localized Content

- Tools and content may not be culturally or linguistically adapted to Kerala's context: preschool apps or programs developed elsewhere may not reflect the language (Malayalam), local stories, cultural norms, or learning styles.
- Sometimes the technology used does not align with early childhood pedagogies (e.g., play-based, inquiry-based learning). This misalignment can lead to superficial engagement rather than deep, meaningful learning.

c) Overemphasis on Screen-based Learning

- There might be a temptation (especially in digital initiatives) to lean too heavily on tech-based learning, neglecting other critical non-digital components like hands-on play, socio-emotional interaction, outdoor activities. Over-reliance on tech can displace these developmentally important experiences.

d) Equity of Use

- Even when devices are available, not every child may get equal time or quality of learning. In a class with limited devices, some children may dominate, or the teacher may fall back on conventional teaching for convenience rather than ensure equitable access.

5. Maintenance & Sustainability

a) Physical Safety, Security, and Theft

- In Kerala, one of the reported challenges has been the **safekeeping of ICT devices** in schools. A Times of India report mentioned that schools struggle with theft and security: many devices like laptops, projectors, and cameras need to be locked up, and school authorities often depend on teachers to manage charging, care, and security.
- When schools are closed (e.g., during holidays or closures), maintaining device safety is a major concern.

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b) Technical Maintenance and Repairs

- While KITE provides a five-year warranty for devices deployed under its Hi-Tech programme, hardware failures, wear-and-tear, or damage are inevitable.
- Not all preschools will have onsite IT staff to manage minor issues. In many cases, teachers are the only ones responsible for charging, basic maintenance, and reporting issues. Without timely repair, broken or non-functional devices can quickly be underutilized, reducing the effectiveness of technology interventions.

c) E-waste Management

- As more devices are deployed, there is growing concern about e-waste. KITE has recognized this: their infrastructure strategy includes e-waste disposal. If preschools are not properly equipped or guided in how to handle outdated/damaged devices, the accumulation of e-waste could pose environmental, logistical, and cost burdens.

d) Long-term Funding & Institutional Support

- Sustainability demands ongoing funding for maintenance (beyond warranty), training, connectivity, and replacement. Without dedicated funds or institutional commitment, tech initiatives may falter once initial funding ends.
- There's also a risk that schools may deploy devices but lack a robust plan to integrate them pedagogically over time, leading to underuse.

7. Recommendations

Based on the analysis, the following recommendations can help maximize the benefits and mitigate risks of technology-based learning in LKG–UKG in Kerala:

1. **Policy Integration**:
    - Develop state-level guidelines under KITE or the Directorate of General Education specifically for early childhood digital pedagogy.
    - Encourage integration of digital learning in pre-primary curriculum frameworks, linking technology with play, storytelling, and inquiry.
2. **Teacher Training**:
    - Design professional development programs for pre-primary teachers, focusing on digital pedagogies, play-based learning, and scaffolding.
    - Use mentorship and peer-learning: early adopters can model use of technology in developmentally appropriate ways.
3. **Device & Infrastructure Provision**:

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- Provide low-cost tablets or shared devices to preschools lacking infrastructure.
- Explore partnerships with local bodies or NGOs for connectivity and hardware support.

4. **Parental Engagement**:
   - Conduct parent workshops to educate about healthy screen habits, co-viewing, and mediating use.
   - Provide resources for parents to supplement technology with offline activities.
5. **Design of Learning Materials**:
   - Use multimedia tools, games, and apps that are developmentally appropriate: focus on interactivity, exploration, and joint media engagement rather than passive consumption.
   - Encourage localization: content in Malayalam, culturally relevant stories, and contextually relevant games.
6. **Monitoring and Evaluation**:
   - Conduct longitudinal studies on the impact of technology-based learning on children's development (cognitive, social, emotional) in LKG–UKG.
   - Use feedback from teachers, parents, and children to refine interventions.
7. **Safety and Screen Time Guidelines**:
   - Set clear norms on daily screen time, aligning with health expert recommendations.
   - Promote offline–online balance: every technology session should be complemented by physical play, peer interaction, and hands-on activities.

8. Conclusion

Technology-based learning offers significant promise for enhancing early childhood education in Kerala, especially in LKG–UKG. With its strong ICT infrastructure and progressive education policies, the state is well-placed to leverage digital tools to enrich foundational learning.

However, the successful integration of technology in early years depends on thoughtful policy, adult mediation (teachers and parents), developmentally appropriate design, and vigilant monitoring. Without this, there is a risk of overreliance, inequity, or negative developmental outcomes.

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