USING INTERACTIVE PEDAGOGICAL TECHNOLOGIES TO DEVELOP COMPUTER LITERACY AMONG 6–7-YEAR-OLD CHILDREN

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Abstract

The rapid digital transformation of contemporary society has made basic computer literacy an increasingly important component of children's readiness for learning and participation in a technology-rich environment. However, developing computer literacy among 6–7-year-old children should not be reduced to teaching technical operations or increasing children's screen exposure. At this developmental stage, digital competence needs to be formed through purposeful, age-appropriate, interactive, creative, and socially mediated learning experiences. This article examines the theoretical and methodological foundations of using interactive pedagogical technologies to develop computer literacy among children aged 6–7. The study employs theoretical analysis, comparative synthesis, content analysis, classification, and pedagogical modelling to identify effective approaches to early digital competence development. Particular attention is paid to interactive educational games, multimedia learning, digital storytelling, unplugged and digital coding activities, collaborative tasks, problem-based learning, creative digital production, and teacher-guided exploration. The study conceptualizes early computer literacy through five interconnected components: operational-technological, information-cognitive, creative-productive, algorithmic-logical, and digital-safety competence. Based on the analysis, an integrated methodological model is proposed in which interactive pedagogical technologies are selected according to children's developmental characteristics and specific learning outcomes. The findings suggest that interactive technologies can enhance children's motivation, problem-solving, communication, creativity, computational thinking, and confidence in using digital tools when they are integrated into play-based learning and mediated by an educator. The study emphasizes that technology should extend children's active learning rather than replace physical play, direct communication, creative activity, or real-world exploration.

Keywords: computer literacy, digital competence, preschool children, interactive pedagogical technologies, digital pedagogy, computational thinking, educational games, digital storytelling, digital safety, early childhood education.

Introduction

Digital technologies have become an inseparable part of contemporary childhood. Children encounter smartphones, tablets, computers, interactive displays, digital cameras, smart toys, multimedia content, and internet-connected devices in their homes and educational environments long before they enter formal schooling. Consequently, the question facing early childhood education is no longer whether children will interact with

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digital technology, but how these interactions can be transformed into meaningful, developmentally appropriate, and educationally valuable experiences.

The growing presence of technology has also changed the meaning of literacy. Traditional literacy remains fundamental, but participation in contemporary society increasingly requires individuals to understand, navigate, evaluate, create, and communicate through digital environments. The European Digital Competence Framework describes digital competence as a combination of knowledge, skills, and attitudes necessary for confident, critical, safe, and responsible engagement with digital technologies [1]. Although DigComp was not developed specifically as a preschool curriculum, its conceptual structure provides a useful reference for understanding why early computer literacy should extend beyond technical device operation.

For 6–7-year-old children, however, the adult concept of digital competence cannot simply be transferred downward. Preschool and school-readiness-age children have distinctive cognitive, emotional, motor, linguistic, and social characteristics. Their learning remains strongly dependent on play, direct manipulation, imitation, communication, visual representation, movement, experimentation, and adult scaffolding. Therefore, the methodology of developing computer literacy at this age needs to preserve the developmental character of early childhood education.

This distinction is important because the phrase **computer literacy** is sometimes interpreted narrowly. In traditional approaches, a computer-literate child might be described as one who can switch on a device, move a mouse, use a keyboard, open a program, or recognize common interface elements. Such skills remain useful, but they represent only the operational layer of contemporary digital competence.

A child may know how to tap icons rapidly without understanding what information is being presented. Another may navigate an application confidently but lack awareness that personal information should not be shared. A third may spend considerable time watching digital content without ever using technology to create, investigate, solve problems, or communicate meaningfully [1].

Thus, frequency of technology use is not equivalent to digital competence.

The present study defines computer literacy among 6–7-year-old children as an emerging capacity to use basic digital tools purposefully, understand simple digital information, solve elementary problems through technological means, create age-appropriate digital products, follow basic algorithmic sequences, and demonstrate initial safe and responsible digital behavior.

This interpretation corresponds to recent developments in digital education. DigComp 2.2, for example, emphasizes information and data literacy, communication, digital content creation, safety, and problem-solving rather than device operation alone [1]. The framework also incorporates emerging challenges associated with artificial intelligence, datafication, online information, and responsible digital participation.

For young children, these broad dimensions need to be translated into developmentally appropriate behaviors. Information literacy may begin with

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distinguishing relevant and irrelevant pictures. Digital content creation may involve producing a simple drawing or recording a short story. Problem-solving may involve arranging instructions for a programmable toy. Digital safety may begin with understanding that a child should ask an adult before opening an unfamiliar link or sharing a photograph.

The pedagogical question therefore becomes: How can educators transform children's natural interest in digital devices into genuine developmental learning?

Interactive pedagogical technologies offer one possible answer.

Interactive pedagogy is based on active participation rather than passive reception. Children explore, respond, make decisions, receive feedback, collaborate, experiment, solve problems, and create products. When digital technologies are incorporated into such pedagogical environments, computers and tablets cease to function merely as screens and become tools for thinking, communication, creativity, and inquiry.

Research on technology education in early childhood demonstrates that the field has expanded considerably and increasingly emphasizes children's active engagement with technological concepts rather than passive exposure to devices [2]. Eliasson, Peterson, and Lantz-Andersson's systematic review of empirical research in early childhood technology education shows that technology can constitute meaningful curriculum content when children are given opportunities to investigate, construct, reason, and interact around technological phenomena [2].

This distinction between learning from technology and learning with and about technology is central to the present study.

When children watch an educational video, technology primarily delivers information. When they manipulate a digital simulation, create a multimedia story, program a simple sequence, photograph stages of an experiment, or collaboratively solve a digital puzzle, technology becomes part of the learning process itself.

Interactive technologies can therefore contribute to several dimensions of children's development simultaneously.

First, they may increase learning motivation. Immediate visual and auditory feedback, interactive tasks, game elements, and opportunities for choice can sustain children's interest.

Second, they may support cognitive development by requiring classification, sequencing, comparison, prediction, and problem-solving.

Third, collaborative digital activities can stimulate communication. When two children work together to program a robot or create a digital story, they must explain ideas, negotiate decisions, and coordinate actions.

Fourth, digital production can support creativity. Children can combine images, sound, voice, drawing, and movement to express ideas in forms that are difficult to reproduce through a single traditional medium.

Fifth, carefully designed technology experiences can introduce computational thinking.

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The growing relevance of computational thinking in early childhood education deserves particular attention. Computational thinking does not mean teaching preschool children advanced computer programming. At this age, it includes understanding sequences, recognizing patterns, breaking simple problems into manageable steps, predicting outcomes, identifying errors, and revising solutions.

Macrides, Miliou, and Angeli's systematic review of programming in early childhood education found positive pedagogical outcomes associated with programming experiences among children aged approximately 3–8 years [3]. The reviewed studies indicate that age-appropriate programming can contribute to computational thinking, problem-solving, and other learning outcomes when supported by suitable tools and pedagogical approaches [3].

Importantly, computational thinking can be developed both with and without screens.

For example, a teacher may ask children to guide a classmate acting as a "robot" through a simple route:

"Take two steps forward."

"Turn left."

"Pick up the red block."

If the instructions fail, children identify the error and revise the sequence. This is essentially an unplugged form of algorithmic thinking.

The same principle can later be transferred to a programmable toy or simple visual coding environment.

Such progression illustrates a key methodological principle: concrete action should precede or accompany digital abstraction.

Technology education in early childhood should therefore maintain continuity between physical and digital experience.

Another important issue concerns the role of the educator. Young children should not be expected to independently discover the educational value of digital technologies merely because they are comfortable touching screens. Research on children and teachers engaging together with digital technology highlights the importance of adult mediation, shared engagement, and purposeful pedagogical organization [4].

The teacher performs several functions.

The educator selects appropriate tools.

The educator establishes the learning purpose.

The educator demonstrates basic operations when necessary.

The educator asks questions that move children beyond trial-and-error tapping.

The educator encourages children to explain their decisions.

The educator helps children connect digital experiences with real-world knowledge.

The educator also protects children from inappropriate content, excessive use, privacy risks, and technologically induced distraction.

Consequently, computer literacy development is as much a question of pedagogy as of technology.

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This principle is particularly important when considering screen time. Debates around young children and technology sometimes become polarized between unrestricted technological enthusiasm and complete avoidance. Neither position adequately reflects the educational problem.

Technology should be judged according to its purpose, quality, context, and the nature of children's engagement.

A ten-minute collaborative digital storytelling activity in which children create, speak, discuss, and make decisions is pedagogically different from ten minutes of passive autoplay video. Screen duration alone cannot describe the quality of the learning experience.

Professional guidance in early childhood education similarly emphasizes intentional and developmentally appropriate technology use. NAEYC notes that technology and interactive media can support young children's learning when used intentionally and appropriately, while also stressing the importance of limitations and informed educator decision-making [5].

Media literacy adds another dimension to this issue. Six- and seven-year-old children increasingly encounter photographs, videos, advertisements, animated characters, digital games, and algorithmically selected content. They need the beginnings of a questioning relationship with media.

At this age, critical digital literacy does not require abstract lessons on algorithms or misinformation. It may begin with simple questions:

"Who made this picture?"

"Is this real or imaginary?"

"What is this character trying to make us do?"

"Can every picture on a screen be true?"

"Whom should we ask if we are unsure?"

Rogow argues that media literacy for young children can be developed through curiosity, inquiry, reflection, and developmentally appropriate questioning rather than through screen prohibition alone [6].

This approach is highly relevant to computer literacy because children need to become not only users of digital technology but gradually more thoughtful users.

Digital safety should similarly begin before children become independent internet users. At 6–7 years of age, foundational digital-safety concepts may include:

- asking an adult before downloading or opening unfamiliar content;
- not sharing personal information;
- understanding that passwords are private;
- treating digital devices carefully;
- knowing that communication online should remain respectful;
- telling a trusted adult when digital content causes fear or discomfort.

These behaviors constitute the early foundations of digital citizenship.

Another important dimension is digital creativity.

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Technology is pedagogically most valuable when children move from consumption to creation.

Instead of only watching animated stories, children can create a digital story.

Instead of only viewing photographs, they can photograph objects according to a learning task.

Instead of only playing ready-made games, they can design simple rules or sequences.

Instead of only listening to recordings, they can record their own explanation, song, or story.

Such productive uses of technology help children understand that digital tools are instruments for representing ideas.

This shift from consumer to creator is especially important because it aligns technology use with core principles of preschool pedagogy: agency, exploration, communication, imagination, and creative expression.

Interactive pedagogical technologies also offer opportunities for differentiated learning. Children aged 6–7 enter educational settings with highly variable levels of digital experience. Some have extensive access to smartphones and tablets, while others have little experience with digital devices. Even among frequent users, the type of experience differs considerably.

A child who watches online videos every day may have weaker operational computer skills than a child who occasionally uses a laptop to draw or create stories.

Therefore, educators should not assume that children who are familiar with screens are automatically computer literate.

Initial pedagogical observation should identify children's ability to:

- recognize basic device functions;
- control a mouse, touchpad, or touchscreen;
- use simple icons and menus;
- follow a sequence of digital instructions;
- solve elementary digital problems;
- create rather than only consume content;
- communicate about digital experiences;
- follow basic safety rules.

These indicators can form the basis of differentiated instruction.

The issue of equitable access is equally significant. UNICEF emphasizes that digital learning policies must address unequal access to technologies and ensure that digital transformation does not deepen existing educational inequalities [7].

In preschool education, equity does not necessarily require every child to own a personal device. Indeed, shared-device activities can provide pedagogical advantages by stimulating cooperation. What matters is that educational institutions provide meaningful opportunities for all children to develop foundational digital competence regardless of family income or home technology access.

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The current scientific literature therefore points toward a balanced model of early digital education. Technology should neither dominate children's learning environment nor be excluded from it. Instead, it should be deliberately integrated into active, social, creative, and developmentally appropriate pedagogical experiences.

On this basis, the central research problem of the present article is the need to develop a systematic methodology for using interactive pedagogical technologies to form computer literacy among children aged 6–7 without replacing the developmental foundations of preschool education.

The purpose of the study is to theoretically substantiate and systematize interactive pedagogical technologies for developing computer literacy among 6–7-year-old children and to propose an integrated methodological model for their implementation in preschool education.

The study addresses the following objectives:

1. to clarify the pedagogical meaning and structure of computer literacy for children aged 6–7;
2. to identify developmentally appropriate components of early digital competence;
3. to classify interactive pedagogical technologies according to their educational functions;
4. to determine the pedagogical conditions necessary for their effective use;
5. to develop criteria and indicators for assessing children's emerging computer literacy;
6. to propose an integrated methodology combining play, digital interaction, creativity, computational thinking, and digital safety.

The central proposition of the study is that computer literacy develops most effectively when digital technologies are used not as independent objects of technical training but as interactive tools for exploration, communication, creation, problem-solving, and guided participation.

Materials and Methods

The study was designed as a theoretical-analytical investigation of the pedagogical mechanisms through which interactive technologies can support computer literacy development among 6–7-year-old children.

The research employed theoretical analysis, systematic comparison, content analysis, classification, pedagogical modelling, and synthesis.

Recent research published primarily between 2021 and 2025 on digital competence, early childhood technology education, programming, computational thinking, media literacy, and interactive digital pedagogy was examined.

The methodological analysis was organized around four principles:

developmental appropriateness;

active interaction;

integration of digital and non-digital learning;

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safe and responsible technology use.

The research object is the process of developing computer literacy among children aged 6–7 in preschool and school-readiness educational contexts.

The research subject consists of interactive pedagogical technologies, methods, and educational conditions supporting the formation of children's foundational digital competence.

Based on the analysis, five interconnected components of computer literacy were identified.

Table 1. Components of computer literacy among 6–7-year-old children

Component	Content	Observable indicators
Operational-technological	Basic device operation	Uses touchscreen/mouse, recognizes basic icons, opens and closes age-appropriate applications
Information-cognitive	Understanding digital information	Identifies relevant information, follows digital instructions, compares digital objects
Creative-productive	Digital creation	Produces drawings, photographs, audio recordings, or simple multimedia products
Algorithmic-logical	Computational thinking	Follows sequences, recognizes patterns, predicts results, identifies simple errors
Safety-responsibility	Early digital citizenship	Follows adult guidance, protects personal information, demonstrates respectful and careful use

This model intentionally moves beyond the narrow interpretation of computer literacy as technical operation.

A child demonstrating emerging computer literacy should gradually understand what a digital tool can be used for, how to use it, when its use is appropriate, and how to use it safely.

The analysis identified six groups of interactive technologies suitable for children aged 6–7.

Table 2. Interactive technologies and their didactic functions

Technology	Primary didactic function	Example
Interactive educational games	Practice and immediate feedback	Matching, sorting, sequencing
Multimedia storytelling	Language and creative expression	Digital story creation
Interactive whiteboard activities	Collaborative learning	Group classification and puzzles
Visual coding/programming	Algorithmic thinking	Block-based sequences

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Educational robotics	Problem-solving and collaboration	Programming simple routes
Digital creative tools	Production and self-expression	Drawing, photography, audio recording

The effectiveness of these technologies depends not on novelty but on alignment with a clear pedagogical objective.

Thus, the methodological sequence proposed in the study can be represented as:

Pedagogical goal → Interactive task → Appropriate digital/non-digital tool → Child activity → Teacher scaffolding → Reflection → Assessment.

This sequence constitutes the foundation for the subsequent analysis of the methodology's effectiveness.

Results

The theoretical and comparative analysis demonstrated that computer literacy among 6–7-year-old children develops most effectively when digital technologies are incorporated into an interactive pedagogical system rather than taught as a separate collection of technical operations. The central finding is that young children's computer literacy should combine operational competence with cognitive activity, creativity, elementary computational thinking, communication, and safe digital behavior.

Recent systematic research supports this broader interpretation. Su and Yang [8] emphasize that digital competence in early childhood education is multidimensional and includes knowledge, skills, attitudes, and contextual dimensions rather than simple technical proficiency. Similarly, Masoumi and Bourbour [9] found that preschool teachers conceptualize adequate digital competence through children's familiarity with technology, willingness to experiment, practical use, critical thinking, ethical awareness, problem-solving, and ability to become producers rather than passive consumers of digital content.

Based on these findings, the present study identified six interconnected pedagogical actions for developing computer literacy:

Explore → Interact → Create → Solve → Reflect → Use Safely.

These actions constitute the proposed **Interactive Computer Literacy Development Model (ICLDM)** for children aged 6–7.

1. Explore: Guided Familiarization with Digital Technologies. The first stage of the model is exploration.

At this stage, children become familiar with digital devices, their components, functions, and possible educational uses. However, exploration should not be organized as a lecture about computer terminology. Children learn more effectively when they can observe, manipulate, compare, and discuss technological objects.

For example, an educator may present a computer, tablet, keyboard, mouse, digital camera, and programmable toy and ask:

“What do you think this device can do?”

“Which part helps us give instructions?”

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"What happens when we move the mouse?"

"Which devices have screens?"

"Which device can take a photograph?"

Such questions transform technical familiarization into inquiry.

The teacher should also introduce basic vocabulary such as *screen, keyboard, mouse, icon, folder, program, camera,* and *robot* within meaningful activity rather than requiring children to memorize definitions.

Operational competence at this stage includes the ability to switch a device on and off with guidance, recognize basic interface elements, control a mouse or touchscreen, select an icon, navigate between simple screens, and use equipment carefully.

However, operational proficiency is not treated as the final learning outcome. It serves as the entry point for more complex forms of digital activity.

A useful pedagogical activity at this stage is **"Digital Detective."**

The teacher places several technological and non-technological objects in the learning environment. Children identify which objects are digital, explain their possible functions, and group them according to purpose.

For example:

- devices used to communicate;
- devices used to create;
- devices used to obtain information;
- devices used to control other objects.

This activity develops classification and technological vocabulary while helping children understand that computers belong to a wider technological environment.

2. Interact: Learning Through Active Digital Engagement. The second stage moves from observation toward purposeful interaction.

Children use interactive educational applications, digital puzzles, multimedia materials, touch-based activities, and interactive whiteboards to solve age-appropriate tasks.

The pedagogical distinction between passive and active use becomes particularly important here.

Passive digital activity typically requires little more than watching or repetitive tapping.

Interactive learning requires children to:

- make decisions;
- compare alternatives;
- predict outcomes;
- correct errors;
- explain choices;
- collaborate;
- respond to feedback.

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For example, instead of showing children an animation about geometric shapes, the educator may ask them to classify digital objects according to shape, construct a picture from geometric figures, explain why an object belongs to a category, and compare their solution with another child's solution.

The technology therefore becomes a medium for cognitive activity.

Interactive whiteboards can be particularly useful for group participation when they are used as shared problem-solving spaces rather than large video screens.

An educator might display a sequence of pictures and ask children to arrange them in logical order. One child moves the pictures while classmates explain whether the sequence makes sense.

Such activities combine technological skills with language, reasoning, cooperation, and visual perception.

3. Create: Moving from Digital Consumption to Production. The third stage represents one of the most important methodological shifts proposed in the study: children should gradually move from consuming digital content toward creating it.

Digital creativity may include:

- drawing;
- photographing;
- audio recording;
- combining pictures;
- recording a short explanation;
- creating a digital collage;
- producing a simple multimedia story.

The pedagogical value of digital production lies in the fact that children must make choices.

They decide what to represent, which image to select, what sequence to use, what to say, and how to communicate their idea.

A particularly effective method is **digital storytelling**.

For example, children may create a story titled *"The Little Robot Who Lost Its Way."*

First, they discuss the characters.

Second, they draw or select pictures.

Third, they arrange the pictures in sequence.

Fourth, they record their voices telling the story.

Finally, the group watches the completed story and discusses what they created.

Research on preschool digital storytelling indicates that these activities can create meaningful spaces for children's agency, negotiation, participation, and creative decision-making [10].

The activity is simultaneously digital, linguistic, social, and creative.

This demonstrates why interactive pedagogical technology should not be treated as an isolated curriculum area. A well-designed digital activity can integrate several educational domains.

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https://www.gejournal.net/index.php/IJSSIR

4. Solve: Developing Computational Thinking and Problem-Solving. The fourth stage concerns computational thinking.

For children aged 6–7, computational thinking should remain concrete, visual, playful, and closely connected with physical action.

The analysis identified five age-appropriate elements:

sequencing;

pattern recognition;

simple decomposition;

prediction;

debugging.

Sequencing involves placing actions in the correct order.

Pattern recognition involves noticing repetition or regularity.

Simple decomposition means breaking a task into smaller actions.

Prediction involves anticipating what will happen after an instruction.

Debugging means identifying and correcting an error.

These concepts can initially be taught without a computer.

For instance, the teacher can organize a game called "I Am a Robot."

One child becomes the robot.

Other children must guide the "robot" from one side of the classroom to a toy using commands such as:

"Forward."

"Forward."

"Turn right."

"Forward."

If the robot reaches the wrong location, the group identifies which instruction caused the problem.

This creates an intuitive understanding of algorithm, sequence, and debugging.

Only after children understand the physical logic should similar activities be transferred to a programmable toy or digital environment.

Educational robotics provides especially promising opportunities.

Gerosa et al. [4] demonstrated that robotics interventions can support computational thinking in preschoolers and highlighted the importance of children's task engagement. Their work also shows why robotics is suitable for young learners: abstract instructions become visible through the physical movement of an object.

Yang, Ng, and Gao [3] compared robot programming with traditional block play among 101 kindergarten children. Their results indicated greater improvement in sequencing ability in the robot-programming group, while also suggesting that individual characteristics such as initial self-regulation may influence learning outcomes.

These findings support the integration of robotics but do not justify replacing traditional play.

Instead, digital and physical learning should complement each other.

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Table 3. Interactive methods for developing computer literacy

Method	Digital competence developed	Additional developmental outcome
Digital Detective	Technological awareness	Classification, vocabulary
Interactive matching	Device control	Attention, comparison
Digital storytelling	Content creation	Language, imagination
Digital drawing	Creative production	Fine-motor coordination
“I Am a Robot”	Algorithmic thinking	Movement, communication
Programmable robot routes	Coding and debugging	Spatial reasoning
Interactive puzzles	Problem-solving	Cognitive flexibility
Pair-based computer tasks	Operational competence	Cooperation
Digital photo project	Information production	Observation
Safety scenarios	Responsible digital behavior	Decision-making

The table demonstrates that computer-literacy activities can and should contribute simultaneously to children's broader development.

5. Reflect: Developing Conscious Digital Use. Reflection constitutes the fifth stage of the proposed methodology.

This component is sometimes overlooked in early digital education because young children are assumed to be too young for metacognitive discussion.

However, reflection can be developmentally simple.

After completing a digital task, the educator can ask:

“What did we make?”

“What was difficult?”

“What did you do when it did not work?”

“Why did the robot go the wrong way?”

“What would you change next time?”

“Was the computer useful for this task?”

These questions help children become aware of the relationship between their actions and outcomes.

Reflection also helps distinguish purposeful technology use from habitual screen engagement.

Children gradually learn that digital devices are tools chosen for particular purposes.

Sometimes drawing on paper may be more useful.

Sometimes a camera may help.

Sometimes blocks are better.

Sometimes a computer can make an activity possible that would otherwise be difficult.

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This leads to an important component of digital competence: the ability to make elementary judgments about when and why technology should be used.

6. Use Safely: Developing Early Digital Responsibility. The sixth stage concerns safety and responsibility.

Digital safety for 6–7-year-old children should be concrete and behavioral rather than based on abstract descriptions of cybersecurity.

Children should learn several simple rules:

Ask before you click something unfamiliar.

Do not tell strangers your name, address, password, or other personal information.

Ask an adult before sharing a photograph.

Tell an adult if something on a screen makes you uncomfortable or afraid.

Use digital devices carefully.

Be kind when communicating through technology.

Safety education can be organized through scenario-based interactive tasks.

For example:

A cartoon character receives a message saying: “Tell me where you live and I will send you a prize.”

The teacher asks:

“What should the character do?”

Children discuss possible answers.

Another scenario may show a child taking a photograph of a friend.

The educator asks:

“Can we share someone else's photograph without asking?”

These activities introduce privacy, consent, and responsible communication in developmentally understandable ways.

Recent research supports this broad conception of early digital competence. Masoumi and Bourbour [9] found that preschool teachers' understanding of adequate digital competence included critical attitudes, ethical media competence, problem-solving, and production—not merely safe technical operation.

Integrated Interactive Computer Literacy Development Model. Based on the analysis, the proposed model can be represented as follows:

EXPLORE understand tools and functions

INTERACT use technology purposefully

CREATE produce digital content

SOLVE apply computational thinking

REFLECT explain decisions and evaluate outcomes

USE SAFELY demonstrate responsible digital behavior

The stages are interconnected rather than strictly linear.

For example, while programming a robot, children explore the technology, interact with it, solve a route problem, identify errors, reflect on their solution, and follow rules for careful equipment use.

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Thus, one activity may activate all six elements of the model.

The analysis identified seven conditions necessary for interactive technologies to contribute meaningfully to computer literacy.

Technology should match children's cognitive, linguistic, perceptual, and motor abilities.

Complex interfaces, excessive written instructions, advertisements, and unnecessary menus can distract children from the learning objective.

Digital resources for this age group should therefore have intuitive navigation, clear visual organization, immediate but non-intrusive feedback, and limited unnecessary stimulation.

Technology should never be introduced merely because it is available.

Before using a device, the educator should be able to answer: What will children learn through this activity that justifies using the technology?

If the answer is unclear, a non-digital activity may be preferable.

Teacher Scaffolding

Children require different levels of assistance.

Effective scaffolding follows the progression:

demonstration → guided participation → collaborative performance → independent attempt.

The teacher initially demonstrates an unfamiliar action, then completes it with the child, gradually reduces assistance, and finally allows independent use.

Integration with Play

Technology should enter the existing logic of children's play rather than displace it.

For example, in a “Travel Agency” role-play, children might use a tablet to view a map, take photographs, or create simple digital tickets.

In a “Robot City” activity, children first build streets and houses with physical blocks and then program a robot to travel through the city.

The digital tool becomes one element within a richer play environment.

Collaboration. Shared-device learning may sometimes be more pedagogically valuable than individual device use.

Pairs or small groups can take roles such as:

operator – controls the device;

planner – suggests the next action;

checker – observes whether the solution works.

Roles can then rotate.

This prevents one confident child from dominating the technology and transforms device use into cooperative learning.

Balance Between Digital and Physical Activity

Interactive technology should complement:

- outdoor activity;
- physical play;

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- construction;
- drawing;
- books;
- conversation;
- music;
- manipulation of physical materials.

Computer literacy should therefore be developed through digital–physical integration, not through continuous screen-based instruction.

Formative Assessment

Assessment should focus on what children can do independently and with assistance.

A child who accidentally opens an application has not necessarily demonstrated competence.

Similarly, a child who initially needs help but can later explain and reproduce the operation may demonstrate genuine learning.

Assessment therefore needs to consider independence, understanding, transfer, and responsible behavior.

Three developmental levels were formulated: emerging, developing, and functional.

Table 4. Assessment criteria for computer literacy among 6–7-year-old children

Domain	Emerging	Developing	Functional
Device operation	Needs frequent adult assistance	Performs familiar operations with occasional help	Independently performs basic age-appropriate operations
Digital information	Responds mainly through trial and error	Understands simple visual instructions	Selects relevant information and explains choices
Digital creation	Mainly consumes prepared content	Creates with substantial guidance	Creates simple digital products with increasing independence
Computational thinking	Has difficulty following sequences	Completes simple sequences with support	Plans and corrects elementary sequences
Problem-solving	Waits for adult solution	Attempts alternatives with prompts	Tries strategies and corrects simple errors
Collaboration	Requires reminders to share	Participates in paired activities	Negotiates roles and explains ideas
Safety	Does not consistently recognize risks	Recalls safety rules when prompted	Applies basic safety rules in familiar situations

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 14 Issue: 03 in March-2025
https://www.gejournal.net/index.php/IJSSIR

Reflection	Describes actions minimally	Explains some choices with questions	Explains what worked and what could be changed

These levels should not be interpreted as fixed classifications.

They represent developmental positions that can change through experience.

Sample Interactive Learning Scenario. A practical example demonstrates how the model can be implemented. Theme: "Help the Robot Reach the Library**";** Age: 6–7 years; Duration: approximately 25–30 minutes; Organization: groups of 3–4 children. Learning objectives

Children should be able to:
- construct a simple sequence;
- use directional commands;
- predict the robot's movement;
- identify an incorrect command;
- cooperate with peers;
- use technological equipment responsibly.

Stage 1 – Physical planning

A floor map containing roads, a school, park, house, and library is created.

Children first move a toy manually from the starting point to the library.

Stage 2 – Algorithm creation. Children describe the route verbally:

"Forward two spaces."

"Turn left."

"Forward one space."

Stage 3 – Programming. The group enters the sequence into a simple programmable robot.

Stage 4 – Observation. The robot moves. If it reaches the wrong destination, the teacher does not immediately correct the sequence.

Instead, the teacher asks: "Where did the robot begin to move differently from our plan?"

Stage 5 – Debugging. Children identify and change the incorrect command.

Stage 6 – Reflection. The group explains the final solution.

This single activity combines operational computer literacy, algorithmic thinking, spatial orientation, prediction, cooperation, language, and debugging.

Educational robotics studies provide empirical support for this type of pedagogy. Gerosa et al. found that children's engagement was an important element in a preschool robotics intervention targeting computational thinking [4]. Research comparing robot programming with block play likewise found advantages for sequencing development, illustrating the potential of tangible programming when it is pedagogically structured [3].

Sample Digital Storytelling Scenario. Theme: "My City in the Future"; Children work in pairs. First, they draw how they imagine their future city; They then photograph their

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 14 Issue: 03 in March-2025
https://www.gejournal.net/index.php/IJSSIR

drawings; Using a simple educator-selected digital storytelling tool, the photographs are placed in sequence; Children record one or two sentences describing each picture; Finally, the stories are presented to the group.

The teacher asks:

“What did technology help us do?”

“What part did you create yourself?”

“What did your partner help you with?”

“What would you add to the story?”

The activity moves children from passive media consumption to digital authorship.

Research examining digital storytelling interactions in preschool indicates that such activities can create opportunities for children to exercise and negotiate agency rather than simply follow predetermined digital routines [10].

Main Findings. The results of the theoretical analysis can be summarized through five central findings.

First, computer literacy at age 6–7 is multidimensional. Operational skills constitute only one component. Information understanding, creation, computational thinking, problem-solving, and digital responsibility should also be developed.

Second, interactivity alone does not guarantee educational value. A digital application may respond to children's actions without requiring meaningful thinking. Pedagogical interactivity requires decision-making, explanation, collaboration, creation, or problem-solving.

Third, children should increasingly become producers rather than only consumers of digital content. This conclusion is consistent with contemporary research conceptualizing adequate digital competence in early childhood [9].

Fourth, digital and traditional activities should be integrated rather than opposed. Robotics can strengthen sequencing and computational thinking, while blocks, physical games, drawing, conversation, and imaginative play continue to provide essential developmental experiences. Yang, Ng, and Gao's comparison of robot programming and block play is particularly informative in this regard [3].

Finally, the educator remains the central pedagogical mediator. Digital technologies do not independently produce learning outcomes. Teachers determine the purpose of technology use, organize interaction, scaffold children's thinking, connect digital and real-world experiences, and establish ethical and safety boundaries.

Consequently, the proposed methodology can be summarized through the following relationship:

Age-appropriate digital tool + Interactive pedagogical task + Teacher scaffolding + Child agency + Reflection + Safe use = Emerging computer literacy.

This relationship represents the principal methodological result of the study.

Discussion

The results of the present study indicate that the development of computer literacy among 6–7-year-old children should be approached as a pedagogically mediated

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 14 Issue: 03 in March-2025
https://www.gejournal.net/index.php/IJSSIR

developmental process rather than as the early acquisition of isolated technical skills. The growing presence of digital devices in children's everyday lives makes early digital competence increasingly important, but familiarity with technology should not be confused with meaningful competence.

This distinction is fundamental. A child may use a smartphone confidently, recognize application icons, open videos, and navigate familiar interfaces while still having difficulty using digital technology to solve a problem, create content, evaluate information, or follow basic safety principles. Therefore, the educational objective should move from simple device familiarity toward purposeful and responsible digital activity.

The findings of the present study correspond with the contemporary understanding of digital competence as a combination of knowledge, skills, and attitudes. The DigComp 2.2 framework emphasizes information and data literacy, communication and collaboration, digital-content creation, safety, and problem-solving [1]. Although this framework addresses citizens more broadly rather than preschool children specifically, its multidimensional understanding of competence provides an important conceptual reference for early childhood education.

For children aged 6–7, these broad competencies need to be translated into observable and developmentally appropriate behaviors. Information literacy, for example, may involve selecting the appropriate picture or digital resource for a task. Content creation may involve producing a drawing, photograph, voice recording, or simple digital story. Problem-solving may involve correcting a sequence of commands. Safety may involve knowing not to share personal information and asking a trusted adult for help.

This adaptation is important because the downward transfer of adult digital-literacy curricula would be developmentally inappropriate. Six- and seven-year-old children continue to learn primarily through active exploration, play, manipulation, dialogue, imitation, visualization, and social interaction.

Consequently, interactive pedagogical technologies should preserve these modes of learning rather than replace them.

One of the central findings of this study is that digital interactivity and pedagogical interactivity are not necessarily the same thing.

A program can be technologically interactive because it reacts when a child touches the screen. However, if the child repeatedly taps until the correct answer appears, little meaningful cognitive interaction may occur.

Pedagogical interactivity requires a deeper level of engagement.

The child should have opportunities to:

- make choices;
- formulate predictions;
- explain decisions;
- compare alternatives;
- cooperate with peers;
- recognize mistakes;

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 14 Issue: 03 in March-2025
https://www.gejournal.net/index.php/IJSSIR

- modify strategies;
- create something new;
- reflect on the outcome.

This distinction has important implications for selecting educational applications and digital resources.

Preschool educators should therefore ask not only: "Is this application interactive?"

but also: "What kind of thinking does this interaction require from the child?"

An application that provides immediate animation after every touch may appear highly engaging while demanding very little reasoning. In contrast, a relatively simple programmable toy may require children to plan, sequence, predict, test, identify an error, and revise their solution.

The second activity may therefore possess greater pedagogical value despite having less sophisticated visual design.

Recent reviews of technology education in early childhood similarly emphasize that meaningful technology education requires active investigation of technological concepts and purposeful pedagogical organization [2].

The study proposes five components of early computer literacy:

1. operational-technological;
2. information-cognitive;
3. creative-productive;
4. algorithmic-logical;
5. safety-responsibility.

The relationship among these components is particularly important.

Operational competence allows children to access technology, but information competence gives purpose to that access.

Creative competence transforms children from consumers into producers.

Algorithmic competence develops systematic problem-solving.

Safety competence establishes boundaries for responsible participation.

This multidimensional interpretation is supported by Su and Yang's systematic review of digital competence in early childhood education [7]. Their analysis demonstrates that digital competence in ECE literature is conceptualized through combinations of knowledge, skills, attitudes, learning outcomes, and contextual factors rather than as purely technical proficiency.

Masoumi and Bourbour [9] similarly conceptualize adequate digital competence in early childhood through a broader framework involving children's technological familiarity, experimentation, problem-solving, critical attitudes, ethical considerations, and productive use of digital resources.

These findings strengthen the argument that computer literacy education should progress from "how to operate a device" toward "how to use digital technology purposefully, creatively, thoughtfully, and safely."

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 14 Issue: 03 in March-2025
https://www.gejournal.net/index.php/IJSSIR

A particularly significant component of the proposed methodology is computational thinking.

Programming may initially appear too advanced for children aged 6–7. However, this assumption changes when programming is understood developmentally.

At this age, programming does not require children to write complex code. It involves learning to organize instructions logically and observe the relationship between commands and outcomes.

Macrides, Miliou, and Angeli [3] systematically reviewed programming research involving children aged 3–8. Their analysis indicates that programming can be successfully introduced in early childhood and integrated with music, movement, art, science, mathematics, literacy, and storytelling.

This interdisciplinary potential is especially relevant to preschool pedagogy.

Programming should therefore not necessarily become an isolated "computer science lesson." It can be embedded within meaningful play.

For example, children can:

- program a robot to reach a story character;
- create a route through a model city;
- sequence movements for a digital dance;
- arrange commands to reproduce a geometric pattern;
- debug instructions given to a pretend robot.

Such activities connect computational thinking with language, mathematics, spatial reasoning, physical movement, and collaboration.

The findings of Yang, Ng, and Gao [4] provide empirical support for this approach. Their six-week study involving 101 kindergarten children compared robot programming with block play. Children participating in robot programming showed greater gains in sequencing ability, and age and baseline self-regulation influenced some outcomes.

This result should nevertheless be interpreted carefully. It does not demonstrate that robotics should replace block play.

Block play remains developmentally valuable for spatial reasoning, imagination, construction, and social activity. The more appropriate conclusion is that carefully designed robotics can add a distinctive form of algorithmic and sequencing experience to an already rich preschool curriculum.

Thus, the methodological principle should be: integration rather than substitution.

Another important implication is that computer literacy does not require children to remain continuously in front of a computer.

This apparent paradox is particularly relevant to early childhood education.

Children can learn fundamental computer-science concepts through unplugged activities involving physical movement, cards, arrows, toys, blocks, floor grids, and role-play.

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 14 Issue: 03 in March-2025
https://www.gejournal.net/index.php/IJSSIR

For example, the "I Am a Robot" activity described in the Results section develops algorithmic thinking without a screen. Children create commands, follow sequences, detect mistakes, and modify instructions.

When the same principles are later transferred to a programmable device, children already possess a concrete conceptual foundation.

The sequence can therefore be organized as: physical experience → visual representation → digital implementation → reflection.

This progression corresponds well with young children's developmental characteristics because abstract concepts emerge from concrete action.

Another major finding concerns the shift from consumption toward creation.

Many children's everyday digital experiences are consumption-oriented. They watch videos, play pre-designed games, or scroll through content selected by platforms or adults.

Educational environments can provide a different relationship with technology.

Children can use digital tools to express ideas and produce content.

Digital storytelling is particularly useful because it combines traditional preschool activities with technological production.

A child can draw a character on paper, photograph the drawing, record a voice, arrange several images, and create a simple multimedia narrative.

Technology does not replace drawing or storytelling. It connects them.

Shengjergji's study of digital storytelling in preschool demonstrated that digital storytelling environments can provide opportunities for children to express and negotiate agency during interaction with peers and teachers [8].

This finding supports an important methodological principle: **Children should be given meaningful decisions within digital activities.**

If the teacher controls every action—choosing the pictures, determining the sequence, dictating the narration, and operating the device—the child may participate physically without exercising meaningful agency.

Interactive pedagogy therefore requires controlled freedom.

The educator establishes safe and educationally appropriate boundaries, while children make meaningful choices inside those boundaries.

The analysis confirms that the educator remains the most important mediator between children and technology.

The idea that children are naturally "digital natives" can create a misleading assumption that they require little instruction. Familiarity with entertainment technology does not automatically produce information literacy, computational thinking, digital creativity, or responsible behavior.

The teacher's role can be summarized through six functions:

selector – chooses developmentally appropriate technologies;

designer – connects the technology with a learning objective;

facilitator – organizes children's active participation;

scaffolder – provides temporary assistance;

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 14 Issue: 03 in March-2025
https://www.gejournal.net/index.php/IJSSIR

observer – monitors children's strategies and progress;

protector – establishes digital-safety boundaries.

Teacher competence therefore becomes an indirect determinant of children's computer literacy.

This has implications for professional development.

Educators need more than operational knowledge of computers. They need digital pedagogical competence: the ability to determine whether, why, when, and how a digital resource contributes to children's learning.

Professional development should therefore include:

- evaluation of educational applications;
- interactive lesson design;
- digital storytelling;
- educational robotics;
- unplugged computational-thinking methods;
- privacy and online safety;
- balanced technology use;
- assessment of children's digital competence.

In other words, improving children's computer literacy begins partly with improving teachers' pedagogical digital literacy.

The findings also challenge the assumption that computer education should involve one child working independently with one device.

Individual work may sometimes be appropriate, particularly when developing mouse control or observing a child's independent performance.

However, shared digital activity has distinctive pedagogical advantages.

When children work in pairs, they can discuss alternatives, explain instructions, correct each other, negotiate roles, and jointly solve problems.

This creates what can be called socially mediated digital learning.

For example, one child may operate a programmable robot while another checks the planned route. A third child may observe whether the instructions correspond to the map.

The roles can rotate.

Such organization prevents the most technologically confident child from monopolizing the device and simultaneously develops communication and cooperation.

Thus, computer literacy becomes part of social development rather than an individual relationship between child and screen.

The study also emphasizes that computer literacy is incomplete without digital safety.

Children aged 6–7 are increasingly exposed to networked technologies even when they do not yet use the internet independently.

Therefore, safety education should begin before risky situations become common.

At this age, abstract lectures on data protection or cybersecurity are unnecessary. Concrete behavioral rules are more appropriate.

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 14 Issue: 03 in March-2025
https://www.gejournal.net/index.php/IJSSIR

Children can learn that:

- some information is private;
- passwords should not be shared;
- unfamiliar online actions require adult guidance;
- photographs should not be shared without permission;
- frightening or uncomfortable content should be reported to a trusted adult;
- respectful behavior is important both offline and online.

Scenario-based teaching is particularly suitable because it converts abstract rules into decisions.

The educator might ask:

“A game asks for your full name and home address. What should you do?”

or:

“Someone wants to post your friend's picture. What should happen first?”

Children discuss the situation and select a safe response.

This is an early form of digital citizenship.

The broader DigComp framework also places safety and responsible participation within digital competence [1]. For preschool education, these concepts should be translated into simple habits that can gradually become internalized.

A central practical implication of the study is the need for balance.

The educational value of technology should not be measured by how frequently it is used.

A high-quality preschool is not necessarily one in which every child uses a tablet every day.

Technology should be selected when it offers a meaningful educational advantage.

For some learning objectives, physical materials may be more effective.

Children learning about texture need to touch objects.

Children developing gross-motor skills need physical movement.

Children constructing three-dimensional relationships benefit from blocks.

Children developing emotional communication need face-to-face interaction.

Conversely, digital tools can provide particular advantages for:

- recording and replaying speech;
- combining media;
- representing sequences dynamically;
- programming;
- photographing processes;
- obtaining immediate task feedback;
- producing multimedia content.

The pedagogical question is therefore not digital or traditional?

It is: Which combination of tools best supports this particular developmental objective?

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 14 Issue: 03 in March-2025
https://www.gejournal.net/index.php/IJSSIR

This principle protects early childhood education from both technological overuse and technological avoidance.

Equity and Inclusion. Interactive technologies may also support differentiated and inclusive learning when used carefully.

Children enter preschool with unequal access to digital resources. Some may have multiple devices at home, whereas others have little experience.

Educational institutions can reduce this gap by providing shared and guided opportunities for meaningful technology use.

However, equity involves more than access.

Children may differ in language development, motor coordination, attention, previous digital experience, and confidence.

The same activity may therefore require different forms of support.

One child may need a larger touchscreen interface.

Another may need visual instructions.

Another may benefit from working with a peer.

Another may require additional time.

Thus, differentiated digital pedagogy should focus on accessibility to the learning process, not merely access to the device.

The Interactive Computer Literacy Development Model (ICLDM) proposed in this study organizes computer-literacy education through six interconnected processes:

Explore → Interact → Create → Solve → Reflect → Use Safely.

The model differs from purely technical approaches because it does not end when children learn how to operate a device.

Explore establishes curiosity and technological understanding.

Interact develops purposeful operation.

Create develops agency and digital production.

Solve introduces computational thinking.

Reflect develops conscious technology use.

Use Safely integrates responsibility into every stage.

The model can also operate cyclically.

A child exploring a new programmable robot may interact with it, create a route, solve an error, reflect on the outcome, and learn a new rule for safe equipment use. The next activity begins at a more advanced level of exploration.

The methodological process can therefore be represented as:

Experience → Interaction → Creation → Problem-solving → Reflection → Responsible transfer

This cyclical structure constitutes the principal methodological contribution of the study.

Practical Recommendations. Based on the findings, several recommendations can be formulated for preschool practice.

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 14 Issue: 03 in March-2025
https://www.gejournal.net/index.php/IJSSIR

First, computer-literacy activities should be short, purposeful, and integrated into broader educational experiences.

Second, every digital activity should have a clearly formulated developmental objective.

Third, children should regularly create digital products rather than only consume digital content.

Fourth, unplugged computational-thinking activities should precede or accompany digital coding.

Fifth, shared-device activities should be used to promote communication and cooperation.

Sixth, digital safety should be integrated into everyday activities rather than taught as an isolated topic.

Seventh, teachers should use formative observation to assess children's independence, problem-solving, creativity, and responsible behavior.

Finally, digital technology should complement—not replace—books, physical play, movement, art, construction, outdoor activity, and direct human interaction.

The present study has several limitations. First, it is theoretical and analytical rather than an experimental intervention study. Consequently, the proposed ICLDM model requires empirical testing with children aged 6–7.

Second, digital competence is culturally and contextually influenced. Access to technology, preschool infrastructure, teacher preparation, parental attitudes, and language environment differ substantially across educational systems.

Third, technologies change rapidly. Specific applications and devices may become outdated, while the pedagogical principles underlying purposeful, creative, safe, and interactive use are likely to remain more stable.

Future research should therefore test the proposed model experimentally in preschool institutions.

A quasi-experimental design could compare an intervention group receiving ICLDM-based activities with a comparison group following standard digital-learning practices.

Assessment could examine:

- operational competence;
- information understanding;
- digital creativity;
- sequencing;
- computational thinking;
- problem-solving;
- collaboration;
- digital-safety behavior.

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 14 Issue: 03 in March-2025
https://www.gejournal.net/index.php/IJSSIR

Longitudinal research would also be valuable for determining whether computer literacy developed at age 6–7 predicts children's subsequent adaptation to technology-supported learning in primary school.

Further studies should investigate how interactive technologies can support children with different educational needs and how culturally relevant digital content can be developed for local preschool contexts.

Conclusion

The digital transformation of contemporary society has created a need to reconsider what educational readiness means for children approaching school age. Alongside traditional linguistic, cognitive, social, and learning competencies, children increasingly require foundational abilities to interact with digital technologies purposefully and responsibly.

The present study demonstrates that computer literacy among 6–7-year-old children should not be reduced to knowing how to operate a mouse, touchscreen, keyboard, or application.

Early computer literacy represents an integrated competence consisting of five interconnected dimensions:

- operational-technological competence;
- information-cognitive competence;
- creative-productive competence;
- algorithmic-logical competence;
- safety and responsibility.

Interactive pedagogical technologies provide valuable opportunities for developing these components when technology use requires children to make decisions, communicate, create, experiment, solve problems, and reflect.

The study proposes the Interactive Computer Literacy Development Model (ICLDM) organized around six processes:

Explore → Interact → Create → Solve → Reflect → Use Safely.

The model places the child in an active rather than passive position.

Its central methodological principle is that children should gradually progress from digital consumers to purposeful digital participants and creators.

Educational games can support classification and problem-solving.

Digital storytelling can strengthen language, creativity, and child agency.

Programmable robotics can introduce sequencing, prediction, algorithms, and debugging.

Unplugged coding can make computational concepts physically understandable.

Collaborative digital tasks can support communication and social learning.

Scenario-based activities can establish the foundations of digital safety and responsible behavior.

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 14 Issue: 03 in March-2025
https://www.gejournal.net/index.php/IJSSIR

At the same time, technology should remain one component of a balanced preschool environment. Digital activities should not displace physical play, books, drawing, construction, movement, outdoor exploration, or face-to-face communication.

The educator remains central to this balance.

A computer, tablet, interactive board, or robot does not independently create a high-quality learning experience. Educational value emerges through the interaction among the child, pedagogical objective, task, technology, peers, and teacher guidance.

Therefore, the effectiveness of interactive technologies depends primarily on pedagogical design rather than technological novelty.

The study ultimately concludes that developing computer literacy among 6–7-year-old children means teaching them not simply how to use technology, but gradually how to think, create, solve problems, communicate, and act responsibly with technology.

This approach provides a developmentally appropriate foundation for children's transition into increasingly digital primary-school learning environments and contributes to the formation of confident, creative, critical, and responsible participants in contemporary digital society.

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