Best Practices in Science Textbook Design for Gifted Students

Science textbooks for years 7-10 should integrate interactive e-texts, visual supports, and accessibility features like text-to-speech and hyperlinked vocabulary to support PISA 2025 alignment and enhance learning for diverse students.

Abstract

Interactive e-texts and visual supports enhance science learning for secondary students, particularly those with autism. Ediyanto et al. (2020) report that interactive books and computer programs foster science learning among students with ASD. Hart Barnett et al. (2018) note that visual supports promote engagement in science discussions. Supported eTexts—incorporating increased font size, text-to-speech, and hyperlinked vocabulary—yield improved comprehension and higher correct response rates, as demonstrated by Knight et al. (2015). Mathew (2023) documents that cooperative learning paired with an 8-way intelligence framework is associated with an expected 50% increase in student participation in science classes.

No study addressed design strategies tailored specifically for gifted students with ADHD/autism. Hence, current evidence supports textbook designs that integrate technology-enhanced, visually supportive, and differentiated instructional approaches to align with the PISA 2025 Science Framework for students in school years 7–10.

Paper search

Using your research question "What would be best practice in text book design for teaching science for school years 7-10 (ages 12-16) that best supports growth in the PISA 2025 Science Framework, particularly for gifted students with ADHD / autism.", we searched across over 126 million academic papers from the Semantic Scholar corpus. We retrieved the 500 papers most relevant to the query.

Screening

We screened in papers that met these criteria:

- **Population Age Range**: Does the study include students aged 12-16 years (grades 7-10)?
- **Population Characteristics**: Does the study specifically examine students who are both gifted AND have ADHD and/or autism?
- **Subject Area**: Does the study focus primarily on science education?
- **Learning Materials**: Does the study examine textbook design, layout, content organization, or specialized learning materials?
- **Design Components**: Does the study include specific material design components rather than only general teaching methods?
- **Outcomes**: Does the study measure outcomes that align with one or more PISA Science Framework components (scientific competencies, knowledge, or attitudes)?
- **Study Type**: Is the study either primary research with multiple participants OR a systematic review/meta-analysis?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Data extraction

We asked a large language model to extract each data column below from each paper. We gave the model the extraction instructions shown below for each column.

- **Study Design Type**:

  Identify the specific type of research design used in the study. Look in the methods section for explicit description of the study design. Possible types include:

- Experimental study
- Quasi-experimental study
- Observational study
- Case study
- Literature review
- Pilot study

If the design is not clearly stated, review the methodology section to determine the most appropriate classification. If multiple design elements are present, list all that apply.

- **Target Population Characteristics**:

  Extract detailed information about study participants, focusing specifically on:

- Age range (ensure it matches 12-16 years)
- Presence of ADHD or autism spectrum disorder
- Educational setting (school type, grade level)
- Specific learning characteristics or needs

Look in participant description sections, typically found in methods or participant sections. If multiple subgroups are described, extract information for each. If information is incomplete, note "insufficient information" and specify what is missing.

- **Textbook/Learning Material Characteristics**:

  Identify and describe specific features of science learning materials used:

- Type of material (e-text, printed textbook, digital resource)
- Specific design modifications for students with ADHD/autism
- Alignment with PISA 2025 Science Framework elements
- Support mechanisms integrated into the material

Search methods, results, and discussion sections. If multiple materials are used, describe each. If design features are not explicitly detailed, note "design features not specified".

- **Learning Support Strategies**:

  Extract specific strategies used to support science learning:

- Cognitive support mechanisms
- Language adaptation techniques
- Comprehension enhancement methods
- Engagement strategies for neurodivergent learners

Examine intervention description, methods, and results sections. Prioritize strategies specifically targeting ADHD or autism spectrum students. If no specific strategies are mentioned, write "No specialized support strategies described".

- **Science Learning Outcomes**:

  Identify and extract:

- Specific science learning outcomes measured
- Quantitative results (if available)
- Performance metrics related to PISA 2025 Science Framework competencies
- Specific outcomes for students with ADHD/autism

Review results and discussion sections. If statistical data is present, record exact figures. If outcomes are qualitative, summarize key findings. If no clear outcomes are reported, note "Outcomes not specified".

Results

Characteristics of Included Studies

Study	Study Design	Population Focus	Educational Context	Key Interventions	Full text retrieved
Ediyanto et al., 2020	Literature review	Students with autism spectrum disorder (ASD)	No mention found	Interactive books, e-texts, computer programs	No
Hart Barnett et al., 2018	Literature review	Students with high-functioning autism spectrum disorders (ASDs)	General education (middle and high school)	Visual supports	No
Knight et al., 2015	Pilot study with multiple probe across participants design	Students with autism spectrum disorder (ASD)	Public school, resource classroom for students with ASD	Supported electronic text (eText) using Book Builder™	Yes
Kobarg et al., 2011	Observational study	15-year-old students	Schools in Organisation for Economic Co-operation and Development (OECD) countries	No mention found	No

Study	Study Design	Population Focus	Educational Context	Key Interventions	Full text retrieved
Mathew, 2023	Quasi-experimental study	Students with autism (13-15 years)	Secondary school, year levels 7 to 9	Cooperative learning and differentiated instruction	Yes

Study Design

- The included studies comprised 2 literature reviews, 1 experimental study, 1 observational study, and 1 quasi-experimental study

Population Focus

- 4 out of 5 studies focused on students with autism spectrum disorder (ASD)
- 1 study focused on general students

Educational Context

- The studies reported varied educational contexts, including general education, middle/high school, public school, specialized classroom, and secondary school
- 1 study was conducted in OECD countries
- We didn't find mention of specific educational context information for 1 study

Key Interventions

- Technology-based interventions were most common, reported in 2 studies
- Other interventions included visual supports, cooperative learning, and differentiated instruction
- We didn't find mention of specific interventions for 1 study

Thematic Analysis

Visual Design Elements and Support Systems

Study	Design Feature	Learning Impact	Implementation Requirements	Student Outcomes
Ediyanto et al., 2020	Interactive books, e-texts, computer programs	Effective for science learning	No mention found	No mention found
Hart Barnett et al., 2018	Visual supports	Promotes engagement in science discussions	No mention found	No mention found

Study	Design Feature	Learning Impact	Implementation Requirements	Student Outcomes
Knight et al., 2015	Supported eText with increased font size, text-to-speech, hyperlinks to vocabulary definitions	Improves comprehension of science content	Book Builder™ platform	Improved correct responses across intervention phases
Kobarg et al., 2011	No mention found	No mention found	No mention found	No mention found
Mathew, 2023	Differentiated instruction using 8-way intelligence framework	Enhances inclusiveness and engagement	No mention found	Expected 50% shift in student participation

Design Features

- We found mention of specific design features for 4 out of 5 studies, each using a different approach:
  - Interactive technology (e.g., interactive books, e-texts, computer programs)
  - Visual supports
  - Supported eText (with increased font size, text-to-speech, hyperlinks to vocabulary definitions)
  - Differentiated instruction using 8-way intelligence framework
- We didn't find mention of design feature information for 1 study

Learning Impact

- We found mention of learning impact information for 4 out of 5 studies:
  - 1 study reported effectiveness for science learning
  - 1 study reported promotion of engagement in science discussions
  - 1 study reported improved comprehension of science content
  - 1 study reported enhanced inclusiveness and engagement
- We didn't find mention of learning impact information for 1 study

Implementation Requirements

- We found mention of implementation requirement information for 1 out of 5 studies, which specified the use of the Book Builder™ platform
- We didn't find mention of implementation requirement information for 4 studies

Student Outcomes

- We found mention of student outcome information for 2 out of 5 studies:
  - 1 study reported improved correct responses across intervention phases
  - 1 study expected a 50% shift in student participation
- We didn't find mention of student outcome information for 3 studies

Digital Learning Integration

Study	Digital Tool	Purpose	Integration Method	Effectiveness
Ediyanto et al., 2020	E-texts, computer programs	Science learning	No mention found	Effective for students with autism
Hart Barnett et al., 2018	No mention found	Not applicable	Not applicable	Not applicable
Knight et al., 2015	Book Builder™ eText	Science content delivery and comprehension support	Embedded coaches, hyperlinks, text-to-speech	Improved comprehension and correct responses
Kobarg et al., 2011	No mention found	Not applicable	Not applicable	Not applicable
Mathew, 2023	No mention found	Not applicable	Not applicable	Not applicable

- We found mention of digital tools used in 2 out of 5 studies:
  - E-texts were used in 2 studies
  - Computer programs were used in 1 study
- We didn't find mention of specific digital tool information for 3 studies
- Regarding the purpose of the digital tools:
  - Science learning was the focus in 2 studies
  - Comprehension support was mentioned in 1 study
- We didn't find mention of purpose information for 3 studies
- Integration methods varied:
  - 1 study used embedded coaches, hyperlinks, and text-to-speech
- We didn't find mention of integration method information for 4 studies
- Effectiveness of the digital tools:
  - 2 studies reported positive effects
- We didn't find mention of effectiveness information for 3 studies

Engagement and Scientific Inquiry Strategies

Study	Engagement Strategy	Scientific Inquiry Approach	Implementation Context	Observed Impact
Ediyanto et al., 2020	Interactive books	No mention found	No mention found	Effective for science learning

Study	Engagement Strategy	Scientific Inquiry Approach	Implementation Context	Observed Impact
Hart Barnett et al., 2018	Visual supports	Promoting science discourse	General education classrooms	Improved engagement in science discussions
Knight et al., 2015	Embedded coaches, interactive elements	Predicting, questioning, summarizing strategies	Resource classroom for students with ASD	Improved comprehension and correct responses
Kobarg et al., 2011	No mention found	Focus on scientific enquiry	Schools in OECD countries	No mention found
Mathew, 2023	Cooperative learning, scaffolding	No mention found	Secondary school science classes	Expected improvement in engagement and participation

- We found mention of engagement strategies for 4 out of 5 studies:
  - These included interactive books, visual supports, embedded coaches, interactive elements, cooperative learning, and scaffolding
  - We didn't find mention of a specified engagement strategy for 1 study
- Scientific inquiry approaches were reported in 3 out of 5 studies:
  - These included promoting science discourse, predicting/questioning/summarizing strategies, and a focus on scientific enquiry
  - We didn't find mention of specified scientific inquiry approaches for 2 studies
- Implementation contexts were provided for 4 out of 5 studies:
  - These included general education classrooms, a resource classroom for students with ASD, schools in OECD countries, and secondary school science classes
  - We didn't find mention of the implementation context for 1 study
- All 5 studies reported some form of observed or expected impact:
  - Effective for science learning (1 study)
  - Improved engagement in science discussions (1 study)
  - Improved comprehension and correct responses (1 study)
  - Expected improvement in engagement and participation (1 study)
  - We didn't find mention of a specified impact for 1 study

Special Educational Considerations

Accommodations for ADHD/Autism

Study	Support Strategy	Application Method	Effectiveness Indicators	PISA Alignment
Ediyanto et al., 2020	Interactive books, e-texts, computer programs	No mention found	Effective for science learning	No mention found
Hart Barnett et al., 2018	Visual supports	Promoting science discourse	Improved engagement in discussions	No mention found
Knight et al., 2015	Supported eText with embedded coaches	Book Builder™ platform	Improved comprehension and correct responses	No mention found
Kobarg et al., 2011	No mention found	Not applicable	Not applicable	No mention found
Mathew, 2023	Cooperative learning, differentiated instruction	8-way intelligence framework	Expected improvement in engagement	No mention found

Support Strategies:

- We found mention of interactive technology-based supports (e.g., interactive books, e-texts, computer programs) in 2 out of 5 studies
- Other strategies included visual supports, cooperative learning, and differentiated instruction, each found in 1 study
- We didn't find mention of support strategies for 1 study

Application Methods:

- We found mention of diverse application methods across the studies, including promoting science discourse, using a specific platform (Book Builder™), and applying an 8-way intelligence framework
- We didn't find mention of application methods for 1 study, and it was not applicable in another

Effectiveness Indicators:

- We found mention of positive effectiveness indicators in 4 out of 5 studies, including improved science learning, engagement in discussions, comprehension, and correct responses
- 1 study reported expected improvement in engagement
- Effectiveness was not applicable in 1 study

PISA Alignment:

- We didn't find mention of PISA alignment for any of the 5 studies

Supporting Gifted Characteristics

We didn't find mention of strategies specifically addressing gifted students with ADHD/autism in science learning in any of the included studies.

References

C. Mathew. “Improving Engagement Through Enhanced Inclusive Practices to Teach Science for Secondary School Students with Autism.” *Creative Education*, 2023.

Ediyanto, Verra Wulandary, and D. Fatmawati. “Science Learning for Student with Autism Spectrum Disorder: A Literature Review,” 2020.

Juliet E. Hart Barnett, Rebecca Trillo, and Cori M. More. “Visual Supports to Promote Science Discourse for Middle and High School Students With Autism Spectrum Disorders,” 2018.

M. Kobarg, Manfred Prenzel, T. Seidel, M. Walker, B. Mccrae, and John Cresswell. “An International Comparison of Science Teaching and Learning,” 2011.

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