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Research Paper

Explaining the Elements of a Statistical Literacy Curriculum: A Synthesis Study

Reyhaneh Taleby[1], Khaironnesa Ramazanzade[2*], Hossein Shokohi Fard[3]

1. Ph.D. student of Curriculum Planning, Faculty of Educational Sciences and Psychology, Birjand University, Birjand, Iran.
2. Assistant Professor of Educational Sciences, Factually of Educational Sciences and Psychology, University of Birjand, Birjand, Iran.
Corresponding author: ramazanzade.kh@birjand.ac.ir
3. Assistant Professor of Educational Sciences, Factually of Educational Sciences and Psychology, University of Birjand, Birjand, Iran.

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Abstract
In today's data-driven era, statistical literacy has become an essential competency for informed decision-making and active citizenship. This study aims to identify and synthesize the key elements of a statistical literacy curriculum. Employing a qualitative synthesis method, the research analyzed 68 peer-reviewed articles selected from an initial pool of 1,830 studies. The findings reveal that an effective statistical literacy curriculum must address multiple dimensions of educational goals: cognitive (understanding theories and data processing), skill-based (data collection, analysis, visualization, and use of technology), as well as ethical and emotional objectives (adherence to ethics and fostering positive attitudes). Learners are expected to be active, independent knowledge constructors who engage pragmatically with real-world data. Teachers should assume the role of facilitators, designing impactful lessons, integrating modern technologies, and creating interactive learning environments. Meaningful learning experiences include analyzing authentic data, solving problems, and participating in game-based activities. Assessment methods should go beyond traditional tests to include performance evaluation, concept mapping, oral presentations, and peer reviews. Furthermore, the learning environment must be reasoning-based, emotionally engaging, safe, and dynamic. The study concludes that implementing evidence-based, well-rounded curricula across all educational levels is crucial for developing statistical literacy and preparing individuals to critically navigate a data-rich world.

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Introduction

The world is dominated by data and information, which require processing to be transformed into knowledge. In the current era, generating data is not a challenge; rather, the critical need lies in developing data and information processing skills both as a basic competency and as a specialized ability (*Porciani & Rondinella, 2019*). Therefore, the skills required to understand and critically evaluate statistical information must be explicitly taught (*Budgett & Rose, 2017*). This data processing skill, known as statistical literacy, is a vital ability in daily life and professional environments (*Febrinna & Dadang, 2023*).

In our data-driven technological society, the need to understand and apply statistical literacy across all aspects of life is paramount (*Galesic & Garcia-Retamero, 2010*). Statistical literacy refers to the ability to critically interpret and use statistics as evidence (*J. Grant, 2018*). The definition of statistical literacy is broad and continuously evolving. Wallman argues that statistical literacy involves the ability to critically understand and evaluate statistical results in daily life, coupled with an understanding of the contributions of statistical thinking (*Sharma, 2017*). *Gal (2003)* describes statistical literacy as the ability to interpret, critically evaluate, and communicate statistical information and messages.

Statistical literacy entails the capability to accurately interpret and appropriately use statistical information, whether disseminated through media or official statistical services, for personal development and for directly or indirectly influencing institutional and governmental progress. Statistical information provides an overview of conditions across various domains and enables tracking changes in phenomena over time (*Poljičak Sušec et al., 2014*).

Due to the information explosion, statistical literacy is now considered an essential life skill for fully functional citizens (*Gonda et al., 2022*). This skill is particularly critical in an era of data fabrication and misinformation. Lack of awareness about information sources and processes undermines public trust in the data they receive, leading individuals to trust information that aligns most closely with their existing beliefs (*Porciani & Rondinella, 2019*).

Research highlights the growing integration of statistical and data literacy into STEM education (*Doğan, 2023*; *Monteiro & Carvalho, 2023*). With digitalization in schools, fostering citizens' ability to critically evaluate data and uncertainty is essential (*Gould, 2017*). Lacking these skills, individuals may struggle with identifying credible information and responding to statistical messages. Statistical literacy empowers individuals to address complex issues, engage in public debates, and assert their rights (*Castillo et al., 2023*; *English & Watson, 2016*).

Building statistical literacy requires statistical knowledge alongside general literacy, numeracy, contextual understanding, and critical reasoning (*Gal, 2003*). Basic

literacy is foundational, as statistical data often appear in textual, tabular, or graphical formats (*Yuniawatika, 2018*). Early exposure to statistical concepts, even for children under five, emphasizes the importance of integrating statistical thinking in education from a young age.

Promoting statistical literacy through experiences that develop understanding of uncertainty, evidence evaluation, and generalization is essential. Surveys highlight a significant need for education in this area (*Fadlila et al., 2024*; *Kurnia et al., 2024*), while studies have explored teaching methods (*Gonda et al., 2022*; *Lu, 2023*; *Nahdi et al., 2021*) and improving learning in schools (*Budgett & Rose, 2017*) and higher education (*Van Dijke-Droogers et al., 2025*).

Statistical literacy enhances reasoning, academic performance, and other competencies. However, research often focuses on fragmented aspects. Many students, even at university, lack sufficient statistical literacy (*Berndt et al., 2021*), highlighting the need for earlier interventions (*Chan et al., 2014*). Furthermore, the absence of comprehensive curriculum models impedes progress, despite their importance for guiding learning pathways (*Ben-Zvi et al., 2017*; *J. Grant, 2018*; *Weiland, 2017*). This study addresses these gaps by synthesizing insights to define the key elements of a statistical literacy curriculum.

Materials and Methods

This study employs a qualitative synthesis approach, chosen for its interpretive process to identify themes in qualitative studies (*M. J. Grant & Booth, 2009*). It integrates insights from users (e.g., students) and professionals (e.g., educators), offering generalizable findings for practice (*M. J. Grant & Booth, 2009*). Additionally, it explores new knowledge, evaluates research reliability, and highlights implications for practice or future studies (*Bearman et al., 2012*).

- Data Collection and Analysis

This research utilized a content analysis approach to examine scientific documents, employing open, axial, and selective coding for data analysis. Guided by Cooper's six-stage model, the process involved problem formulation, literature search, data collection, quality evaluation, result integration, and evidence interpretation. The study aims to synthesize findings on statistical literacy and identify key curriculum elements, addressing all critical aspects of curriculum design.

- Search Strategy

After identifying the research problem, a comprehensive search was conducted in databases such as SID, Normagas, Magiran, Scopus, Web of Science, ScienceDirect, ProQuest, and Google Scholar. The search strategy included: ("Statistical Literacy" OR "Statistical Competency" OR "Statistical Reasoning") AND ("Education" OR "Instruction" OR "Teaching" OR "Pedagogy"). Two researchers independently performed the search to ensure quality, and duplicates were removed using Zotero.

- Inclusion and Exclusion Criteria

Inclusion Criteria: The study focuses on statistical literacy and examines curriculum

elements like educational goals, teaching methods, assessment strategies, and the roles of teachers and students. Only peer-reviewed, full-text articles in online or print formats were included.

Exclusion Criteria: Studies were excluded if they lacked sufficient information on the research objectives or were of low scientific quality, published in unreliable journals or conferences.

- Selection Process

The search yielded 1,830 studies based on the defined keywords. After removing unrelated studies through title screening, 300 studies remained. These were further reviewed for relevance to the study's aims, resulting in 68 articles being selected for final analysis.

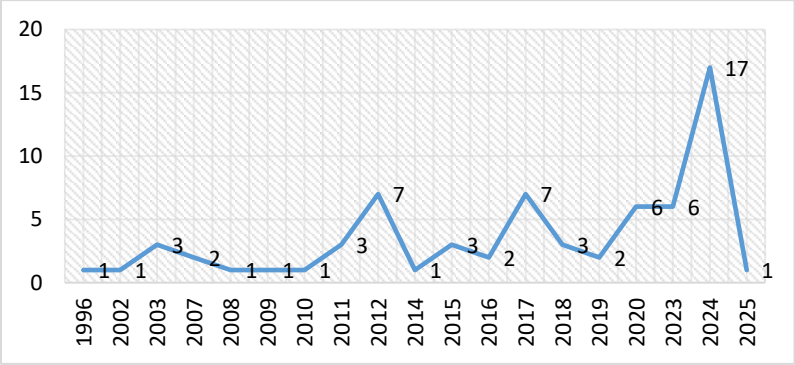

Figure 1. illustrates the distribution of selected studies by publication year

The analysis of the selected articles was conducted using a conceptual framework that intersected two primary domains: statistical literacy and curriculum elements.

Finding

- Process of Synthesis Analysis

Step 1: Identifying Curriculum Elements

In the initial phase of the synthesis process, the various elements of a curriculum were identified. This began with a broad description of all elements, followed by open coding of the data.

Step 2: Open Coding and Combining Findings

Open coding extracted relevant concepts, which were grouped using axial coding to identify overlaps. The process ended with selective coding, organizing the concepts into categories representing the seven core curriculum elements.

Step 3: Consolidating Findings into Unified Components

The synthesis process aimed to integrate all scientific findings on the specific topic into a cohesive whole. This involved regrouping the extracted codes and combining similar concepts into components (categories). Each identified component corresponded to one of the seven curriculum elements.

- Inferential findings Result

The coding and synthesis results were organized into seven tables (Tables 1–7), each representing a key curriculum element: Educational Goals, Content, Teaching Methods, Assessment Strategies, Teacher's Role, Learner's Role, and Learning Environment. These tables offer a detailed breakdown of the components derived from the articles, providing a clear overview of how statistical literacy is integrated into each curriculum element.

Table 1. Coding of the Educational Goals Element in the Statistical Literacy Curriculum

Category	Concept	References
Cognitive Goals	Understanding theories and concepts	(*Elfitra & Siregar, 2020*; *Huynh & Baglin, 2017*; *Maryati et al., 2019*; *Schüller, 2022*)
	Understanding data and processing it	(*Hafiyusholeh et al., 2018*; *Maryati et al., 2019*; *Nahdi et al., 2021*; *Schüller, 2022*; *Van Dijke-Droogers et al., 2025*)
	Understanding decision-making processes	(*Schüller, 2022*)
	Identifying advantages and limitations	(*Schüller, 2022*)
	Awareness of inaccuracies	(*Schüller, 2022*)
	Awareness of human value judgments	(*Schüller, 2022*)
Skill-based Goals	Data collection and management	(*Hafiyusholeh et al., 2018*; *Huynh & Baglin, 2017*; *Koga, 2025*; *Kurnia et al., 2024*; *Nahdi et al., 2021*; *Schüller, 2022*; *Sharma, 2017*)
	Data analysis and interpretation	(*Aoyama & Stephens, 2003*; *Huynh & Baglin, 2017*; *Schüller, 2022*)
	Visualization and communication skills	(*Elfitra & Siregar, 2020*; *Kurnia et al., 2024*; *Schüller, 2022*; *Tishkovskaya & Lancaster, 2012*)
	Application of technology and artificial intelligence tools	(*Schüller, 2022*)
	Application of data	(*Elfitra & Siregar, 2020*; *Koga, 2025*; *Schüller, 2022*)
	Metacognitive skills	(*Gal, 2003*; *Koga, 2022*, *2025*; *Tishkovskaya & Lancaster, 2012*)
Ethical and Emotional Goals	Adherence to ethics	(*Raman et al., 2023*)
	Developing a positive attitude towards statistics and its application	(*Schüller, 2022*)

Table 2. Coding of the Teaching and Learning Strategies Element in the Statistical Literacy Curriculum

Category	Concept	References
Evidence-based Methods	Evidence-based	(*Castillo et al., 2023*)
	Learning Trajectory	(*Van Dijke-Droogers et al., 2025*)
	Real-world research	(*Gonda et al., 2022*; *Hourigan & Leavy, 2020*)
Interactive Learning Methods	Inquiry-based	(*Schoen et al., 2025*)
	Inquiry	(*Lavigne & Lajoie, 2007*)
	Workshops	(*Bradstreet, 1996*; *Olimpo et al., 2018*)
	Peer instruction	(*Parke, 2008*)
	Team teaching and collaborative learning	(*Tishkovskaya & Lancaster, 2012*)
	Direct and indirect methods	(*Gal, 2003*)

	Group discussion	(*Franklin & Bargagliotti, 2020*; *Lavigne & Lajoie, 2007*; *Parke, 2008*)
Active Learning Methods	Project-based learning approach	(*Lu, 2023*; *Spence et al., 2011*)
	PBL	(*Tishkovskaya & Lancaster, 2012*)
	Statistical modeling	(*Hasim et al., 2024*)
	Laboratory method	(*Purwadi, 2021*)
Game-based Methods	Coin toss game	(*Estrella et al., 2022*)
	Simulation-based methods	(*Corredor, 2012*; *Van Dijke-Droogers et al., 2025*)
	GeOrder Simulator	(*Orozco-Rodriguez et al., 2023*)
	GeoGebra (as a dynamic visual tool)	(*Aizikovitsh-Udi & Radakovic, 2012*)
	Gamified modules	(*Smith, 2017*)
	Gamification	(*Çakıroğlu & Güler, 2021*; *Legaki et al., 2020*)

Table 3. Coding the "Learner" Element in the Statistical Literacy Curriculum

Category	Concept	Sources
Active	Engaging in discussions	(*Franklin & Bargagliotti, 2020*)
	Active participation, practice	(*Tishkovskaya & Lancaster, 2012*)
	Being involved in learning	(*Bradstreet, 1996*)
Knowledge Construction	Engaging in knowledge construction	(*Garfield & Ben-Zvi, 2007*; *Tishkovskaya & Lancaster, 2012*)
Independent	Conducting statistical surveys, preparing reports	(*Koga, 2025*)
Practical	Reviewing and synthesizing statistical reports	(*Weiland, 2017*)
	Active participation in research activities	(*Sailer et al., 2020*)

Table 4. Coding the "Teacher" Element in the Statistical Literacy Curriculum

Category	Concept	Sources
Facilitation and Counseling	Encouraging learners to engage in discussions	(*Parke, 2008*)
	Explaining the importance of learning statistics	(*Tishkovskaya & Lancaster, 2012*)
	Making students aware of reasoning errors	(*Garfield & Ben-Zvi, 2007*)
	Providing problem-based learning strategies	(*Tishkovskaya & Lancaster, 2012*)
	Focusing on misconceptions through discussion and evaluation	(*Tishkovskaya & Lancaster, 2012*)
	Providing examples of incorrect analyses and statistical illiteracy	(*Tishkovskaya & Lancaster, 2012*)
Effective Use of Technology in Teaching	Using technological tools	(*Garfield & Ben-Zvi, 2007*)
	Identifying real capabilities for teaching within a dataset	(*Chick & Pierce, 2012*)
	Creating various charts for learners	(*Kurnia et al., 2024*)
	Using mobile phones, hardware, and statistical software	(*Elfitra & Siregar, 2020*)
	Using information technology in the classroom	(*Chan et al., 2014*)
	Utilizing artificial intelligence	(*Weiland, 2017*)
	Using Moodle Learning Management System	(*Maryati et al., 2019*)
Design and Planning	Personalizing content	(*MacCuirc, 2015*)
	Preparing and planning	(*Bradstreet, 1996*)
	Creating systematic methods to improve literacy and pre-reading skills	(*Cotič, 2009*)
Organizing Content Properly	Integrating statistics with other subjects, such as social sciences	(*Medley-Rath et al., 2024*)
	Separating the teaching of statistics from mathematics	(*Rosal et al., 2024*)

Category	Concept	Sources
Providing Effective Learning Experiences	Using real media reports and fostering discussions among learners	(*Budgett & Rose, 2017*; *Mvududu & Kanyongo, 2011*; *Parke, 2008*; *Tishkovskaya & Lancaster, 2012*)
	Using current media reports	(*Franklin & Bargagliotti, 2020*)
	Using government reports	(*Tishkovskaya & Lancaster, 2012*)
	Providing multiple examples	(*Bradstreet, 1996*; *MacCuirc, 2015*)
Creating Active Learning Opportunities for Learners	Involving students in data collection, thinking, exploring statistical concepts, and solving problems	(*Ben-Zvi et al., 2017*)
	Using class workbooks with active learning approaches	(*Carlson & Winquist, 2011*)
Interactive Feedback	Providing continuous and useful feedback	(*Garfield & Ben-Zvi, 2007*)
	Offering interactive feedback to learners	(*Bradstreet, 1996*)
Motivation and Engagement	Building rapport and commitment	(*Bradstreet, 1996*)
	Stimulating frequent research activities	(*Medová et al., 2022*)
	Using game-based learning materials	(*DePascale & Ramani, 2024*)
	Creating interest and motivation	(*Hourigan & Leavy, 2020*; *Nousak et al., 2024*)
	Making learning enjoyable and engaging	(*MacCuirc, 2015*)
	Using humorous content	(*Bradstreet, 1996*)
	Valuing lessons and statistical learning	(*Krishnan, 2015*)
Developing Pedagogical Skills	Acquiring pedagogical knowledge and skills	(*Franco Segui et al., 2024*; *Odom & Bell, 2017*; *Schreiter et al., 2024*)
	Enhancing teacher competencies	(*Ferreira Monteiro & Teixeira Lima de Carvalho, 2021*; *Kalobo, 2016*; *Schreiter et al., 2024*)
Building Confidence and Self-Efficacy	Developing statistical self-efficacy	(*Zhang & Han, 2024*)
	Examining statistical anxiety	(*Bradstreet, 1996*)

Table 5. Coding the "Learning Experiences" Element in the Statistical Literacy Curriculum

Category	Concept	Sources
Design and Creation	Graphic visualizations and applets	(*Bromage et al., 2022*)
	Constructing tables and interpreting them	(*García Alonso et al., 2023*)
Study	Studying everyday practical materials	(*Lawson et al., 2003*)
	Critical journal articles and book reports	(*Elfitra & Siregar, 2020*)
Games	Games	(*Franco Segui et al., 2024*)
Engagement with Real Data	Examining real-life experiences	(*Carvalho & Solomon, 2012*; *Delport, 2023*; *Franco Segui et al., 2024*)
	Nepso	(*Oliveira & Reis, 2021*)
	Analyzing real data	(*Franco Segui et al., 2024*; *Hasim et al., 2024*; *Phadke et al., 2024*; *Tu & Snyder, 2017*)
	Big data	(*Kadijević & Stephens, 2020*)
Problem Solving	Solving PISA-like problems	(*Fadlila et al., 2024*)
	Solving assignments	(*Budgett & Rose, 2017*)

Table 6. Coding the "Assessment" Element in the Statistical Literacy Curriculum

Category	Concept	Sources
Performance Assessment	Appropriate assessment of statistical reports	(*Koga, 2025*)
	Displaying work	(*Kurnia et al., 2024*; *Tishkovskaya & Lancaster, 2012*)
	Assessing interpretive statistical thinking ability	(*Tishkovskaya & Lancaster, 2012*)
	Critiquing statistical ideas or issues in the news	(*Tishkovskaya & Lancaster, 2012*)
Concept Maps	Graphical representations of concepts	(*Tishkovskaya & Lancaster, 2012*)
Written Tests	Multiple-choice and descriptive tests	(*Tishkovskaya & Lancaster, 2012*)
Oral Assessment	Minute reports and oral presentations	(*Tishkovskaya & Lancaster, 2012*)
Peer Assessment	Reviewing a project by peers	(*Tishkovskaya & Lancaster, 2012*)
Criteria-Based Assessment	Mastery rubric	(*Özmen & Baki, 2017*; *Tractenberg, 2016*)
	Learning-focused assessment	(*Harpe et al., 2012*)

Table 7. Coding the "Learning Environment" Element in the Statistical Literacy Curriculum

Main Category	Subcategories	Source
Reasoning	Statistical reasoning learning environment	(*Chan et al., 2014*)
Emotional and Engaging	Emotional environment	(*Batur & Baki, 2022*)
	Engaging environment	(*MacCuirc, 2015*)
Safe and Comfortable	Reducing learner anxiety	(*Korolkiewicz et al., 2025*)
Flexible and Dynamic	Creating situational learning contexts	(*Bradstreet, 1996*)
	Dynamic learning environment	(*Aizikovitsh-Udi & Radakovic, 2012*)

Integration of Findings from Synthesis Research:

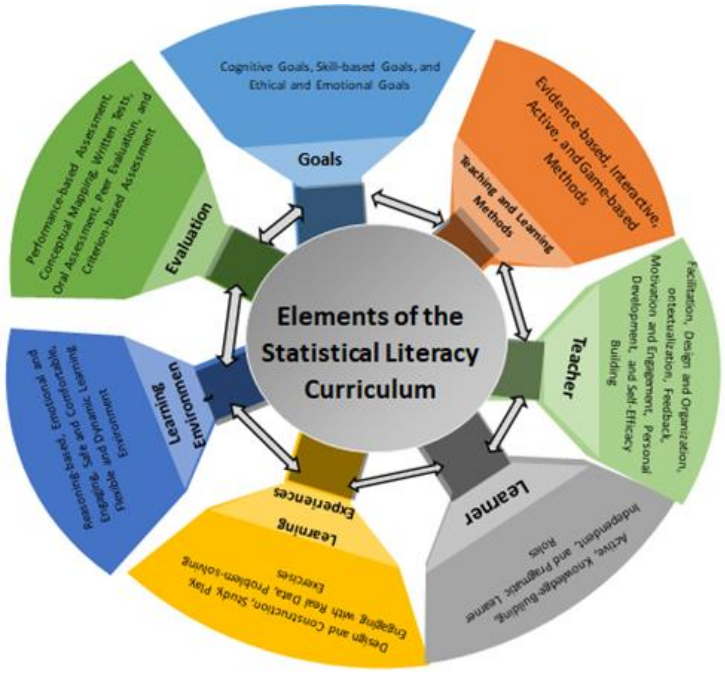

Figure 2: Elements of the Statistical Literacy Curriculum

The conceptual model derived from the findings can contribute to a better understanding of effective teaching. Therefore, based on scientific evidence, the elements of the curriculum can be classified and integrated into seven general dimensions. These seven dimensions are essential to consider when developing a statistical literacy teaching model, and their characteristics must be taken into account. The findings from the review of scientific evidence suggest that the educational goals of statistical literacy should encompass cognitive goals, skill-based goals, and ethical and emotional goals. In the statistical literacy curriculum, the learner is expected to be active, a knowledge constructor, independent, and pragmatic. Furthermore, the teacher's role in the statistical literacy curriculum involves facilitation and guidance, appropriate use of modern technological tools, design and planning, proper organization of educational content, providing effective learning experiences, creating active learning opportunities for learners, offering interactive feedback, fostering motivation and interest, developing pedagogical skills, and building self-confidence and self-efficacy. In statistical literacy education, learning experiences include activities such as designing and constructing tools, studying reports and books, engaging in games, working with real data, and solving exercises, all of which actively engage learners in the learning process. The findings also indicate that assessment of learners in statistical literacy includes performance evaluation, concept mapping, written tests, oral assessments, peer evaluations, and criterion-based assessments. Additionally, the learning environment for statistical literacy education should be reasoning-based, emotionally engaging, safe and comfortable, flexible, and dynamic.

Discussion & Conclusions

The increasing influence of data on modern society underscores the importance of statistical literacy (*Weiland, 2017*).

A recent conceptual synthesis highlights three fundamental pathways to achieving statistical literacy in educational settings: statistical reasoning, multiple forms of representation, and engagement with real data (*Jones, 2026*). This study aimed to summarize the results of research on statistical literacy education by reviewing relevant studies and extracting their implications for the curriculum elements (such as goals, learners, teachers, teaching and learning methods, features of the learning environment, assessment, learning experiences, and educational technology).

Educational Goals Dimension: There is no unified definition of learning goals for statistical literacy in the research discourse (*Büscher, 2022*). The synthesis of the scientific evidence suggests that educational goals for statistical literacy should include cognitive goals (understanding theories and concepts, interpreting and processing data, understanding decision-making processes, recognizing advantages and limitations, awareness of errors, and understanding value judgments); skill-based goals (data collection and management, data analysis, visualization and communication skills, utilizing

technology and artificial intelligence tools, using data, and metacognitive skills); and ethical and emotional goals (adhering to ethical standards, fostering a proper attitude towards statistics and its applications). It is essential to note that, in addition to cognitive and skill-based goals, ethical aspects regarding data sources, such as privacy, data acquisition methods, and participants' consent for the use of their data (*Raman et al., 2023*), must also be considered. Thus, studies suggest a competency framework for data literacy, encompassing knowledge, skills, and values for managing data responsibly and ethically (*Schüller, 2022*). Moreover, this gap in statistical literacy persists even at the graduate level; for instance, master's students in educational administration have shown difficulties in understanding basic statistical concepts and interpreting data, indicating a clear need for targeted professional development (*Garcia & Pantaleon, 2025*).

Teaching and Learning Methods Dimension: Effective teaching strategies are essential for enhancing student interaction, understanding, and academic success. Modern education emphasizes the creativity of teaching processes, but it is crucial to identify appropriate content for these new methods (*Palioura & Dimoulas, 2022*). Ongoing revisions in teaching, especially in statistics education, are necessary (*Tishkovskaya & Lancaster, 2012*). Policymakers should focus on enhancing students' statistical literacy through targeted learning models (*Riwayani et al., 2024*). Teaching methods can be categorized into five groups, with evidence-based approaches proving effective for developing statistical literacy (*Castillo et al., 2023*). Interactive strategies, such as inquiry-based methods, workshops, peer teaching, and collaborative learning, have shown positive outcomes, improving attitudes and fostering progress among diverse ethnic groups (*Tishkovskaya & Lancaster, 2012*). Active learning methods, where students are engaged in the learning process, are vital, and game-based methods are particularly effective for the new generation (*Çakıroğlu & Güler, 2021*; *Legaki et al., 2020*).

Learning Experiences: Creating meaningful learning experiences is a fundamental stage in instructional design, relating to situational factors and aligning with the elements of goals and objectives, feedback and assessment methods, and teaching and learning activities (*Collins, 2007*). Research on effective learning experiences to improve statistical literacy emphasizes the design and construction of charts and graphical representations (*García Alonso et al., 2023*), the study of textbooks and reports, as well as games. Most importantly, engaging with real-world data (*Delport, 2023*; *Franco Segui et al., 2024*) is highlighted, along with solving exercises and statistical problems (*Fadlila et al., 2024*). A concrete example is a structured lesson sequence based on critical thinking principles, where high school students successfully demonstrated statistical literacy skills by reading and evaluating authentic statistical reports (*Koga, 2025*).

Learner Dimension: Constructivism emphasizes the learner's role in constructing

their own perspective or model of the content (*Tishkovskaya & Lancaster, 2012*). According to studies, the learner in a statistical literacy curriculum should be active, a knowledge builder, independent, and practical. The one-way transfer of knowledge creates a dry environment in statistical literacy education. Given the nature of statistical content, learners must independently engage in hypothesis testing, data collection, and analysis, to the point where they can analyze real-world data and interpret it with a constructive critical mindset (*Koga, 2025*).

Teacher Dimension: Studies highlight the crucial role of teachers in promoting statistical literacy among students (*Gulzhaukhar et al., 2024*). Key responsibilities include facilitating learning, utilizing modern technologies like AI, designing content that integrates social issues, and distinguishing mathematics from statistics. Teachers should create effective learning experiences through real statistical reports, active learning environments, and interactive feedback, while fostering motivation and self-efficacy. Active learning methods that involve data and real examples are essential (*Chu, 2025*). Identifying learning gaps aids understanding, and lesson planning should reflect this (*Fernández-Chamorro et al., 2020*). Additionally, building trust in learners towards statistics is vital (*Zhang & Han, 2024*), as well as alleviating any "fear" associated with the subject (*Odom & Bell, 2017*). Clear learning objectives and practical applications related to students' lives should be incorporated into lessons (*Tran et al., 2023*). However, even after completing teacher education programs, pre-service mathematics teachers may still lack adequate statistical literacy and thinking, particularly in selecting appropriate graphs and producing statistical arguments (*Rodríguez-Alveal & Aguerrea, 2025*).

Furthermore, a systematic framework for data science teacher education has recently been proposed, emphasizing three essential knowledge domains: mathematical knowledge for teaching, statistical knowledge for teaching, and statistical technological pedagogical knowledge (Groth, 2026).

Evaluation Dimension: The type of evaluation influences learners' learning approaches (*Chen et al., 2015*). Based on the review of studies on statistical literacy, appropriate assessment can be categorized into seven main types: performance evaluation, concept mapping, written tests, oral assessments, peer evaluations, and criterion-based assessments. Each of these evaluation types can be used to assess specific learning objectives. Traditional paper-and-pencil assessment tools often focus on computational skills or problem-solving. Concept maps visually represent the relationships between concepts understood by learners, while critique of statistical ideas or issues in the news can demonstrate students' reasoning abilities (*Garfield & Ben-Zvi, 2007*). Moreover, it is not always clear whether statistical literacy and statistical reasoning are empirically distinguishable constructs; some evidence suggests that a single overall score of statistical knowledge

may suffice for assessing both (*Sabbag et al., 2025*).

Learning Environment Dimension: The nature of the educational and learning environment plays a significant role in motivation (*Kember et al., 2010*). The use of the metaphor of environment emphasizes that classrooms, instead of being a collection of resources, tasks, and activities or a list of separate factors influencing learning, should include social, cultural, physical, psychological, and educational systems (*Ben-Zvi et al., 2017*). The statistical literacy learning environment should foster learners' participation and responsibility. Properly, social constructivist theory can be applied to design such an environment, allowing students to develop a deep and meaningful understanding of statistics and the ability to think critically and reason statistically (*Gonda et al., 2022*). Evidence from scientific studies shows that the statistical literacy learning environment should be rational, emotional, engaging, safe, comfortable, flexible, and dynamic.

This study identified and analyzed key elements of the statistical literacy curriculum to enhance understanding. Results indicate that a blend of scientific content, active teaching methods, and practical applications can improve students' statistical literacy. However, limitations include a focus on specific texts and a lack of exploration of teachers' and students' experiences, as well as potential cultural and educational differences affecting results. Future research should prioritize field and comparative studies in statistical literacy education to develop more effective curriculum solutions. The findings aim to assist policymakers and curriculum designers in emphasizing the importance of statistical literacy in education and improving educational programs.

References

Aizikovitsh-Udi, E., & Radakovic, N. (2012). Teaching Probability by Using Geogebra Dynamic Tool and Implemanting Critical Thinking Skills. *Procedia - Social and Behavioral Sciences, 46*, 4943-4947. doi:https://doi.org/10.1016/j.sbspro.2012.06.364

Aoyama, K., & Stephens, M. (2003). Graph interpretation aspects of statistical literacy: A Japanese perspective. *Mathematics Education Research Journal, 15*(3), 207-225. doi:https://doi.org/10.1007/BF03217380

Batur, A., & Baki, A. (2022). Lise öğrencilerinin istatistik okuryazarlık düzeyleri ile istatistik okuryazarlık öz yeterlik algıları arasındaki ilişkinin incelenmesi. *Eğitim ve Bilim, 47*(209). doi:https://doi.org/10.15390/EB.2022.9970

Bearman, M., Smith, C. D., Carbone, A., Slade, S., Baik, C., Hughes-Warrington, M., & Neumann, D. L. (2012). Systematic review methodology in higher education. *Higher education research & development, 31*(5), 625-640. doi:https://doi.org/10.1080/07294360.2012.702735

Ben-Zvi, D., Gravemeijer, K., & Ainley, J. (2017). Design of statistics learning environments. In *International handbook of research in statistics education* (pp. 473-502): Springer.

Berndt, M., Schmidt, F. M., Sailer, M., Fischer, F., Fischer, M. R., & Zottmann, J. M. (2021). Investigating statistical literacy

and scientific reasoning & argumentation in medical-, social sciences-, and economics students. *Learning and Individual Differences, 86*, 101963. doi:https://doi.org/10.1016/j.lindif.2020.101963

Bradstreet, T. E. (1996). Teaching introductory statistics courses so that nonstatisticians experience statistical reasoning. *The American Statistician, 50*(1), 69-78. doi:https://doi.org/10.1080/00031305.1996.10473545

Bromage, A., Pierce, S., Reader, T., & Compton, L. (2022). Teaching statistics to non-specialists: Challenges and strategies for success. *Journal of Further and Higher Education, 46*(1), 46-61. doi:https://doi.org/10.1080/0309877X.2021.1879744

Budgett, S., & Rose, D. (2017). Developing statistical literacy in the final school year. *Statistics Education Research Journal, 16*(1), 139-162. doi:https://doi.org/10.52041/serj.v16i1.221

Büscher, C. (2022). Design principles for developing statistical literacy in middle schools. *Statistics Education Research Journal, 21*(1), 8-8. doi:https://doi.org/10.52041/serj.v21i1.80

Çakıroğlu, Ü., & Güler, M. (2021). Enhancing statistical literacy skills through real life activities enriched with gamification elements: An experimental study. *E-learning and Digital Media, 18*(5), 441-459. doi:https://doi.org/10.1177/2042753020987016

Carlson, K. A., & Winquist, J. R. (2011). Evaluating an active learning approach to teaching introductory statistics: A classroom workbook approach. *Journal of Statistics Education, 19*(1). doi:https://doi.org/10.1080/10691898.2011.11889596

Carvalho, C., & Solomon, Y. (2012). Supporting statistical literacy: What do culturally relevant/realistic tasks show us about the nature of pupil engagement with statistics? *International Journal of Educational Research, 55*, 57-65. doi:https://doi.org/10.1016/j.ijer.2012.06.006

Castillo, A. G. R., Silva, G. J. S., Arocutipa, J. P. F., Berrios, H. Q., Rodriguez, M. A. M., Reyes, G. Y., . . . Arias-Gonzáles, J. L. (2023). Effect of Chat GPT on the digitized learning process of university students. *Journal of Namibian Studies: History Politics Culture, 33*(1), 1-15. doi:https://doi.org/10.59670/jns.v33i.411

Chan, S. W., Ismail, Z., & Sumintono, B. (2014). A Rasch Model Analysis on Secondary Students' Statistical Reasoning Ability in Descriptive Statistics. *Procedia - Social and Behavioral Sciences, 129*, 133-139. doi:https://doi.org/10.1016/j.sbspro.2014.03.658

Chen, Y., Henning, M., Yielder, J., Jones, R., Wearn, A., & Weller, J. (2015). Progress testing in the medical curriculum: students' approaches to learning and perceived stress. *BMC medical education, 15*(1), 147. doi:https://doi.org/10.1186/s12909-015-0426-y

Chick, H. L., & Pierce, R. (2012). Teaching for statistical literacy: Utilising affordances in real-world data. *International Journal of Science and Mathematics Education, 10*(2), 339-362. doi:https://doi.org/10.1007/s10763-011-9303-2

Chu, P. K. K. (2025). Attitudes toward statistics among business students: Do majors, mathematical background, sex, and field of secondary education matter? *Teaching Statistics, 47*(1), 63-74. doi:https://doi.org/10.1111/test.12390

Collins, J. (2007). Designing learning experiences. *Radiographics, 27*(5),

1511-1517. doi:https://doi.org/10.1148/rg.275065208

Corredor, J. A. (2012). Effects of the Amount of Activity on the Learning of Data Analysis and Sampling Distribution in the Context of Statistics Teaching: An Imperfect Comparison. *Revista Colombiana de Psicología, 21*(2), 285-302. doi:https://psycnet.apa.org/record/2013-14516-007

Cotič, M. (2009). Developing basic statistical literacy at the beginning of schooling. *Zunanja učna diferenciacija in čustveno-osebnostni vidik učenja, 92*. doi:https://www.pedagoska-obzorja.si/Revija/Vsebine/PDF/DSPO_2009_24_2.pdf#page=92

Delport, D. H. (2023). The development of statistical literacy among students: Analyzing messages in media articles with Gal's worry questions. *Teaching Statistics, 45*(2), 61-68. doi:https://doi.org/10.1111/test.12308

DePascale, M., & Ramani, G. B. (2024). Promoting children's mathematical and statistical understanding through parent-child math games. *Cognitive Development, 71*, 101480. doi:https://doi.org/10.1016/j.cogdev.2024.101480

Doğan, E. (2023). A meta-analysis study on data literacy education for school administrators and teachers. *Journal of Theoretical Educational Sciences, 16*(1), 199-217. doi:https://doi.org/10.30831/akukeg.1134207

Elfitra, & Siregar, T. (2020). *Statistical Literacy Analysis of Mathematics Education Students Through KKNI Assignments.* Paper presented at the Journal of Physics: Conference Series.

English, L. D., & Watson, J. M. (2016). Development of probabilistic understanding in fourth grade. *Journal for Research in Mathematics Education, 47*(1), 28-62. doi:https://doi.org/10.5951/jresematheduc.47.1.0028

Estrella, S., Mendez-Reina, M., Olfos, R., & Aguilera, J. (2022). Early statistics in kindergarten: analysis of an educator's pedagogical content knowledge in lessons promoting informal inferential reasoning. *International Journal for Lesson & Learning Studies, 11*(1), 1-13. doi:https://doi.org/10.1108/IJLLS-07-2021-0061

Fadlila, N., Hilmi, I., & Sugiman. (2024). *Students' statistical literacy: An analysis in solving PISA-like problems.* Paper presented at the AIP Conference Proceedings.

Febrinna, M., & Dadang, J. (2023). Student's statistical literacy skills (1980-2023): A systematic literature review with bibliometric analysis. *Journal of Education and Learning Mathematics Research (JELMaR), 4*(1), 31-45. doi:https://doi.org/10.37303/jelmar.v4i1.105

Fernández-Chamorro, V., Pamplona, S., & Pérez-Fructuoso, M. J. (2020). Assessing prior knowledge of statistics in students attending an online university: V. Fernández-Chamorro et al. *Journal of Computing in Higher Education, 32*(1), 182-202. doi:https://doi.org/10.1007/s12528-019-09236-9

Ferreira Monteiro, C. E., & Teixeira Lima de Carvalho, L. M. (2021). Statistics education from the perspective of statistical literacy: Reflections taken from studies with teachers. *The Mathematics Enthusiast, 18*(3), 612-640. doi:https://scholarworks.umt.edu/tme/vol18/iss3/10/

Franco Segui, J., Alsina, Á., & Vásquez, C. (2024). Teaching statistics for sustainability across contexts: Exploring the knowledge and beliefs of teachers. *Sustainability, 16*(2), 692.

doi:https://doi.org/10.3390/su16020692

Franklin, C., & Bargagliotti, A. (2020). Introducing GAISE II: A guideline for precollege statistics and data science education. *Harvard Data Science Review, 2*(4). doi:https://hdsr.mitpress.mit.edu/pub/cqncbp3l/release/5

Gal, I. (2003). Teaching for statistical literacy and services of statistics agencies. *The American Statistician, 57*(2), 80-84. doi:https://doi.org/10.1198/0003130031469

Galesic, M., & Garcia-Retamero, R. (2010). Statistical numeracy for health: a cross-cultural comparison with probabilistic national samples. *Archives of internal medicine, 170*(5), 462-468. doi:https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/415709

García Alonso, I., Alsina, Á., Muñiz Rodríguez, L., Rodríguez Muñiz, L. J., Vásquez, C., & López Serentill, P. (2023). Alfabetizando estadísticamente a niños de 7-8 años a partir de contextos relevantes. doi:https://riull.ull.es/xmlui/handle/915/35419

Garcia, M. T. T., & Pantaleon, A. P. (2025). Statistical literacy among MAEd students: A needs assessment for a professional development program in research statistics. *Asian Journal of Education and Social Studies, 51*(10), 520-533. doi:https://www.researchgate.net/profile/Alfred-Pantaleon

Garfield, J., & Ben-Zvi, D. (2007). How students learn statistics revisited: A current review of research on teaching and learning statistics. *International statistical review, 75*(3), 372-396. doi:https://doi.org/10.1111/j.1751-5823.2007.00029.x

Gonda, D., Pavlovičová, G., Ďuriš, V., & Tirpáková, A. (2022). Implementation of pedagogical research into statistical courses to develop students' statistical literacy. *Mathematics, 10*(11), 1793. doi:https://doi.org/10.3390/math10111793

Gould, R. (2017). Data literacy is statistical literacy. *Statistics Education Research Journal, 16*(1), 22-25. doi:https://doi.org/10.52041/serj.v16i1.209

Grant, J. (2018). Principles of curriculum design. *Understanding medical education: Evidence, theory, and practice*, 71-88. doi:https://doi.org/10.1002/9781119373780.ch5

Grant, M. J., & Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. *Health information & libraries journal, 26*(2), 91-108. doi:https://doi.org/10.1111/j.1471-1842.2009.00848.x

Groth, R. E. (2026). Data Science Teacher Education Goals: Essential Elements of Pre-K-12 Data Science Curriculum Implementation. *Journal of Statistics and Data Science Education, 34*(1), 88-100. doi:https://doi.org/10.1080/26939169.2025.2526627

Gulzhaukhar, A., Aigul, D., Aizada, K., Dayana, K., Kairden, B., & Akzhan, A. (2024). The influence of teachers' statistics knowledge on the academic performance of high school students in math lessons. *International Journal of Education and Practice, 12*(3), 574-583. doi:https://ideas.repec.org/a/pkp/ijoeap/v12y2024i3p574-583id3732.html

Hafiyusholeh, M., Budayasa, K., & Siswono, T. (2018). *Statistical literacy: High school students in reading, interpreting and presenting data.* Paper presented at the Journal of Physics: Conference Series.

Harpe, S. E., Phipps, L. B., & Alowayesh, M. S. (2012). Effects of a learning-centered approach to assessment on students'

attitudes towards and knowledge of statistics. *Currents in Pharmacy Teaching and Learning, 4*(4), 247-255. doi:https://doi.org/10.1016/j.cptl.2012.05.002

Hasim, S. M., Rosli, R., & Halim, L. (2024). A systematic review on teaching strategies for fostering students' statistical thinking. *International Journal of Learning, Teaching and Educational Research, 23*(1), 136-158. doi:https://doi.org/10.26803/ijlter.23.1.8

Hourigan, M., & Leavy, A. M. (2020). Using integrated STEM as a stimulus to develop elementary students' statistical literacy. *Teaching Statistics, 42*(3), 77-86. doi:https://doi.org/10.1111/test.12229

Huynh, M., & Baglin, J. (2017). Teaching statistics through data investigations in Australian secondary schools: An island-based pilot project. *International Journal of Innovation in Science and Mathematics Education, 25*(1). doi:https://openjournals.library.sydney.edu.au/CAL/article/view/11109

Jones, R. C. (2026). Reasoning, Representation, and Real Data in Statistics Education: Pathways to Statistical Literacy. In (Vol. 48, pp. 101-102): Wiley Online Library.

Kadijević, Đ., & Stephens, M. (2020). Modern statistical literacy, data science, dashboards, and automated analytics and its applications. *Teaching of Mathematics, 23*(1), 71-80. doi:https://ipir.ipisr.org.rs/handle/123456789/322

Kalobo, L. (2016). Teachers' perceptions of learners' proficiency in statistical literacy, reasoning and thinking. *African journal of research in mathematics, Science and Technology Education, 20*(3), 225-233. doi:https://doi.org/10.1080/18117295.2016.1215965

Kember, D., Ho, A., & Hong, C. (2010). Characterising a teaching and learning environment capable of motivating student learning. *Learning Environments Research, 13*(1), 43-57. doi:https://doi.org/10.1007/s10984-009-9065-8

Koga, S. (2022). Characteristics of statistical literacy skills from the perspective of critical thinking. *Teaching Statistics, 44*(2), 59-67. doi:https://doi.org/10.1111/test.12302

Koga, S. (2025). Lessons to demonstrate statistical literacy skills: A case study of Japanese high school students on reading statistical reports. *Journal of Statistics and Data Science Education, 33*(1), 77-89. doi:https://doi.org/10.1080/26939169.2024.2334903

Korolkiewicz, M., Fewster-Young, N., Marmolejo-Ramos, F., Gabriel, F., Kariuki, P., López Puga, J., . . . Ruiz-Ruano García, A. M. (2025). Fear of the unknown: Relationship between statistics anxiety and attitudes toward statistics of university students in three countries. *Teaching Statistics, 47*(1), 17-38. doi:https://doi.org/10.1111/test.12381

Krishnan, S. (2015). Fostering students' statistical literacy through significant learning experience. *Journal of Research in Mathematics Education, 4*(3), 259-270. doi:https://doi.org/10.17583/redimat.2015.1332

Kurnia, A. B., Lowrie, T., & Patahuddin, S. M. (2024). The development of high school students' statistical literacy across grade level. *Mathematics Education Research Journal, 36*(1), 7-35. doi:https://doi.org/10.1007/s13394-023-00449-x

Lavigne, N. C., & Lajoie, S. P. (2007). Statistical reasoning of middle school children engaged in survey inquiry. *Contemporary Educational*

Psychology, 32(4), 630-666. doi:https://doi.org/10.1016/j.cedpsych.2006.09.001

Lawson, T. J., Schwiers, M., Doellman, M., Grady, G., & Kelnhofer, R. (2003). Enhancing students' ability to use statistical reasoning with everyday problems. *Teaching of Psychology, 30*(2), 107-110. doi:https://doi.org/10.1207/S15328023TOP3002_04

Legaki, N.-Z., Xi, N., Hamari, J., Karpouzis, K., & Assimakopoulos, V. (2020). The effect of challenge-based gamification on learning: An experiment in the context of statistics education. *International Journal of Human-Computer Studies, 144*, 102496. doi:https://doi.org/10.1016/j.ijhcs.2020.102496

Lu, H.-F. (2023). Statistical learning in sports education: A case study on improving quantitative analysis skills through project-based learning. *Journal of Hospitality, Leisure, Sport & Tourism Education, 32*, 100417. doi:https://doi.org/10.1016/j.jhlste.2023.100417

MacCuirc, E. (2015). You Don't Teach, Students Learn: Lessons Learned in Statistical Literacy and Statistical Education in Ireland. *Austrian Journal of Statistics, 44*(2), 73-83. doi:https://doi.org/10.17713/ajs.v44i2.62

Maryati, I., Priatna, N., & Martadiputra, B. (2019). *Analysis of madrasah Tsanawiyah students for statistical literacy abilities.* Paper presented at the Journal of Physics: Conference Series.

Medley-Rath, S., Gillespie, M. D., Novosel, N., Combs, S., & Fearnow, D. (2024). Figures and charts and tables, oh my!: A content analysis of textbook data visualizations. *Teaching sociology, 52*(3), 257-265. doi:https://doi.org/10.1177/0092055X231214006

Medová, J., Sedmáková, Z., Uhrecký, B., & Valovičová, Ľ. (2022). Designing activities to develop statistical literacy in primary pupils while conducting physics laboratory work in informal settings. *Education Sciences, 12*(4), 246. doi:https://doi.org/10.3390/educsci12040246

Monteiro, C. E. F., & Carvalho, R. N. (2023). Toward statistical literacy to critically approach big data in mathematics education. In *Research on reasoning with data and statistical thinking: International perspectives* (pp. 227-242): Springer.

Mvududu, N., & Kanyongo, G. Y. (2011). Using real life examples to teach abstract statistical concepts. *Teaching Statistics, 33*(1), 12-16. doi:https://doi.org/10.1111/j.1467-9639.2009.00404.x

Nahdi, D., Jatisunda, M. G., Cahyaningsih, U., Kurino, Y., Juliar, E., & Bilda, W. (2021). *Statistical literacy analysis of pre-service elementary teachers education.* Paper presented at the Journal of Physics: Conference Series.

Nousak, S., Barry, L., & Fisk, S. R. (2024). Deepening learning and addressing inequalities: A psychosocial approach to improving statistical literacy throughout sociology curricula. *Teaching sociology, 52*(3), 276-287. doi:https://doi.org/10.1177/0092055X231222280

Odom, A. L., & Bell, C. V. (2017). Developing PK-12 preservice teachers' skills for understanding data-driven instruction through inquiry learning. *Journal of Statistics Education, 25*(1), 29-37. doi:https://doi.org/10.1080/10691898.2017.1288557

Olimpo, J. T., Pevey, R. S., & McCabe, T. M. (2018). Incorporating an interactive statistics workshop into an introductory biology course-based undergraduate research experience (CURE) enhances

students' statistical reasoning and quantitative literacy skills. *Journal of Microbiology & Biology Education, 19*(1), 10.1128/jmbe. v1119i1121. 1450. doi:https://doi.org/10.1128/jmbe.v19i1.1450

Oliveira, F. J. D. S., & Reis, D. A. D. F. (2021). The Nepso and opinion educative survey in Latin America: discussions on statistical literacy in the perspective of this approach. *Statistics Education Research Journal, 20*(2), 4-4. doi:https://doi.org/10.52041/serj.v20i2.316

Orozco-Rodriguez, C., González, A. P., & García, C. V. (2023). A realistic situation, proposed from data generated within the GeOrder Simulator to elicit the statistical reasoning. *Heliyon, 9*(9). doi:https://www.cell.com/heliyon/fulltext/S2405-8440(23)06538-6

Özmen, Z., & Baki, A. (2017). Evaluating the practices of instructors teaching statistics courses from different undergraduate programs in terms of statistical literacy. *Education and Science, 42*(191), 323-349. doi:https://doi.org/10.15390/EB.2017.6984

Palioura, M., & Dimoulas, C. (2022). Digital storytelling in education: A transmedia integration approach for the non-developers. *Education Sciences, 12*(8), 559. doi:https://doi.org/10.3390/educsci12080559

Parke, C. S. (2008). Reasoning and communicating in the language of statistics. *Journal of Statistics Education, 16*(1). doi:https://doi.org/10.1080/10691898.2008.11889555

Phadke, S., Beckman, M., & Morgan, K. L. (2024). Examining the role of context in statistical literacy outcomes using an isomorphic assessment instrument. *Statistics Education Research Journal, 23*(1), 4-4. doi:https://doi.org/10.52041/serj.v23i1.529

Poljičak Sušec, M., Jerak Muravec, N., & Stančić, H. (2014). Statistical literacy as an aspect of media literacy. *Medijska istraživanja: znanstveno-stručni časopis za novinarstvo i medije, 20*(2), 131-155. doi:https://hrcak.srce.hr/clanak/197514

Porciani, L., & Rondinella, T. (2019). Teaching official statistics in universities. Recommendations from a direct experience. *Statistical Journal of the IAOS, 35*(3), 425-433. doi:https://doi.org/10.3233/SJI-190494

Purwadi, I. (2021). *Students' statistical literacy through lab school car model in STEM activity.* Paper presented at the Journal of Physics: Conference Series.

Raman, R., Utts, J., Cohen, A. I., & Hayat, M. J. (2023). Integrating ethics into the guidelines for assessment and instruction in statistics education (GAISE). *The American Statistician, 77*(3), 323-330. doi:https://doi.org/10.1080/00031305.2022.2156612

Riwayani, R., Istiyono, E., Supahar, S., Perdana, R., & Soeharto, S. (2024). Analyzing students' statistical literacy skills based on gender, grade, and educational field. *International Journal of Evaluation and Research in Education, 13*(2), 842-851. doi:https://doi.org/10.11591/ijere.v13i2.26299

Rodríguez-Alveal, F., & Aguerrea, M. (2025). Statistical literacy and thinking in future mathematics teachers. *Educação & Realidade, 50*, e131123. doi:https://doi.org/10.1590/2175-6236131123vs02

Rosal, J. C. C. d., Machado, A. M., Ñungo, O. M., & Gómez, A. C. (2024). Approaching Statistics as a Distinct Subject and Its Impact on Reasoning and Conceptual Errors. *Revista de*

Gestão Social e Ambiental, 18(4), e06843. doi:https://rgsa.openaccesspublications.org/rgsa/article/view/6843

Sabbag, A., Zieffler, A., & Ng, C. (2025). Can we distinguish statistical literacy and statistical reasoning? *Statistics Education Research Journal, 24*(1), 2-2. doi:https://doi.org/10.52041/serj.v24i1.587

Sailer, M., Berndt, M., Schmidt, F. M., Fischer, M. R., & Zottmann, J. M. (2020). Statistical literacy and scientific reasoning & argumentation in physicians. *GMS journal for medical education, 38*(4). doi:https://cir.nii.ac.jp/crid/1873116917967309440

Schoen, R. C., Rhoads, C., Perez, A., Jacobbe, T., & Li, L. (2025). Improving the teaching and learning of statistics. *Learning and Instruction, 95*, 102018. doi:https://doi.org/10.1016/j.learninstruc.2024.102018

Schreiter, S., Friedrich, A., Fuhr, H., Malone, S., Brünken, R., Kuhn, J., & Vogel, M. (2024). Teaching for statistical and data literacy in K-12 STEM education: a systematic review on teacher variables, teacher education, and impacts on classroom practice. *ZDM–mathematics education, 56*(1), 31-45. doi:https://doi.org/10.1007/s11858-023-01531-1

Schüller, K. (2022). Data and AI literacy for everyone. *Statistical Journal of the IAOS, 38*(2), 477-490. doi:https://doi.org/10.3233/SJI-220941

Sharma, S. (2017). Definitions and models of statistical literacy: a literature review. *Open Review of Educational Research, 4*(1), 118-133. doi:https://doi.org/10.1080/23265507.2017.1354313

Smith, T. (2017). Gamified modules for an introductory statistics course and their impact on attitudes and learning. *Simulation & Gaming, 48*(6), 832-854. doi:https://doi.org/10.1177/1046878117731888

Spence, D. J., Sharp, J. L., & Sinn, R. (2011). Investigation of factors mediating the effectiveness of authentic projects in the teaching of elementary statistics. *The Journal of Mathematical Behavior, 30*(4), 319-332. doi:https://doi.org/10.1016/j.jmathb.2011.07.006

Tishkovskaya, S., & Lancaster, G. A. (2012). Statistical education in the 21st century: A review of challenges, teaching innovations and strategies for reform. *Journal of Statistics Education, 20*(2). doi:https://doi.org/10.1080/10691898.2012.11889641

Tractenberg, R. E. (2016). How the mastery rubric for statistical literacy can generate actionable evidence about statistical and quantitative learning outcomes. *Education Sciences, 7*(1), 3. doi:https://doi.org/10.3390/educsci7010003

Tran, D., Nguyen, A. T. T., Nguyen, D. T., Ta, P. T. M., Pham, N. T., & Huynh, B. T. (2023). Changes in lesson plans as teachers participate in a professional development on statistical literacy. *International Journal of Learning, Teaching and Educational Research, 22*(5), 281-301. doi:https://www.researchgate.net/profile/Fatima-Belkhir/publication/372400006

Tu, W., & Snyder, M. M. (2017). Developing conceptual understanding in a statistics course: Merrill's First Principles and real data at work. *Educational Technology Research and Development, 65*(3), 579-595. doi:https://doi.org/10.1007/s11423-016-9482-1

Van Dijke-Droogers, M., Drijvers, P., & Bakker, A. (2025). Effects of a Learning Trajectory for statistical inference on 9th-grade students'

statistical literacy. *Mathematics Education Research Journal, 37*(1), 187-210. doi:https://doi.org/10.1007/s13394-024-00487-z

Weiland, T. (2017). Problematizing statistical literacy: An intersection of critical and statistical literacies. *Educational Studies in Mathematics, 96*(1), 33-47. doi:https://doi.org/10.1007/s10649-017-9764-5

Yuniawatika, Y. (2018). *Statistical literacy and its urgency for students.* Paper presented at the 3rd International Conference on Educational Management and Administration (CoEMA 2018).

Zhang, P., & Han, C. (2024). Examining statistical literacy, attitudes toward statistics, and statistics self-efficacy among applied linguistics research students in China. *International Journal of Applied Linguistics, 34*(2), 433-449. doi:https://doi.org/10.1111/ijal.12500