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Developing interactive technology-enhanced lessons in science (TELSci) for Grade 7

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Abstract

This study developed Technology-Enhanced Lessons in Science (TELSci) for Grade 7 using the Research and Development methodology. Conducted in Junior High Schools within the Schools Division of Ilocos Norte (SDOIN), the research involved two sample groups: Grade 7 science teachers and a panel of validators, via purposive sampling. Data collection employed three instruments: needs-assessment survey checklist, content quality rating scale, and technical quality rating scale. The needs-assessment survey identified the top five topics per quarter, total of 20 topics in Grade 7 Science needing technological enhancement, as basis for the development, using the Input-Process-Output (IPO) model and the Cognitive Theory of Multimedia Learning (CTML). The TELSci material was evaluated by experts for its content and technical quality. Frequency counts, percentage, and rank were used to analyze the results of the needs-assessment survey, and weighted mean for the validity of TELSci. Validation results based on its content and technical quality indicated that TELSci was very highly valid affirming its appropriateness for teaching Grade 7 Science. TELSci's interactive features like teacher-made simulations, quizzes and games with immediate feedback enhance active engagement of students. It is a self-paced instructional material following the 7-E model that ensures activities are interesting and relevant. By incorporating the principles of Cognitive Theory of Multimedia Learning, TELSci encourages learners to use multiple senses and integrate prior knowledge with new concepts through ICT.

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Introduction

Science plays a crucial role in national progress, as recognized in the 1987 Philippine Constitution. This aligns with Sustainable Development Goal (SDG) 4, which advocates for inclusive and equitable quality education. Science education fosters critical thinking, problem-solving skills, and technological literacy, all of which contribute to individual and societal advancement. However, the Philippines faces significant challenges in science education, as demonstrated by low performance in international assessments such as the Programme for International Student Assessment (PISA) 2022 and the Trends in International Mathematics and Science Study (TIMSS) 2019. These results underscore the urgent need for educational reforms to enhance science learning outcomes.

In response to these challenges, the Department of Education (DepEd) launched the Sulong Edukalidad initiative, which aims to align the Philippine education system with global standards. Translating these national-level reforms into tangible classroom improvements requires overcoming local implementation barriers, particularly in science education. The K to 12 Science Curriculum also emphasizes the integration of technology and 21st-century skills to enrich learning experiences through inquiry-based instruction. However, the success of these reforms depends on their implementation at the local level, where schools and educators face unique challenges. The effective implementation of this curriculum is hindered by inadequate instructional materials and limited access to educational resources, particularly in science education. A study by Sadera et al. (2020) highlighted the lack of instructional resources as a major obstacle in teaching science, affecting students' engagement and comprehension.

ICT-based learning materials can significantly improve student engagement and understanding, but their integration into science education is hindered by resource limitations and insufficient teacher training. Digital resources such as interactive simulations and multimedia content promote active learning and help students grasp complex scientific concepts. Despite these advantages, many schools face significant barriers to effectively implementing technology-enhanced instruction, preventing students from fully benefiting from technology-based education. Schools face challenges such as inadequate technology resources, insufficient teacher training, and infrastructure constraints, which limit the potential impact of technology-enhanced learning in science education. As a result, there remains a significant shortage of well-developed technology-based instructional materials provided by DepEd. In the Schools Division of Ilocos Norte (SDOIN), efforts have been made to integrate technology into instructional material development. However, challenges such as limited resources, infrastructure deficiencies, and connectivity issues continue to hinder the full utilization of these materials (Chuaungo et al., 2022). These limitations call for the development of well-structured, accessible, and pedagogically sound technology-enhanced lessons in science.

To address these gaps, this study aims to develop Technology-Enhanced Lessons in Science (TELSci) for Grade 7, a structured instructional material that utilizes ICT to support interactive and self-paced learning. TELSci incorporates engaging activities and multimedia elements to strengthen students' understanding of scientific concepts, foster critical thinking, and promote environmental awareness. TELSci incorporates principles from the Input-Process-Output (IPO) model and the Cognitive Theory of Multimedia Learning (CTML) to enhance content delivery and ensure effective instructional design. The IPO model structures the research process, identifying key inputs (educational challenges and resource gaps), processes (development of technology-enhanced materials), and outputs (validated TELSci materials). Meanwhile, CTML provides the theoretical foundation for designing digital lessons that optimize cognitive processing and knowledge retention. Specifically, it sought to answer the following questions: (1) What topics in Grade 7 Science need technology enhancement as perceived by science teachers?; (2) What technology-enhanced material can be developed based on the identified topics?; (3) How valid is the TELSci in terms of content quality and technical quality?

Literature Review

The following topics are presented as the review of literature for the study: (1) Challenges and ICT Integration in Science Teaching; (2) Instructional Materials Development in Science; and (3) Technology-Enhanced Lessons in Science.

Challenges and ICT Integration in Science Teaching

One of the most significant challenges faced by science teachers is ensuring students' readiness to engage in learning while designing effective instructional materials that help them master the required competencies. Teachers also encounter difficulties in facilitating student retention and comprehension of scientific concepts. Idulsa (2017) highlights the need to address these challenges by employing strategies that enhance students' learning experiences and cognitive development.

Another major challenge is the scarcity of instructional resources. Sujariati and Wanci (2023) emphasize that the lack of classroom supplies, including textbooks and technological tools, negatively impacts the effectiveness of teaching and learning. Schools with inadequate resources often struggle to deliver the same quality of instruction as those with better access to educational materials.

Given the rapid advancement of technology, the integration of ICT into science teaching is crucial for engaging 21st century learners. Kafu-Quvane and Chikoko (2019) discuss the difficulties teachers face in successfully incorporating ICT into their instructional practices. Despite these challenges, ICT has been recognized as a valuable tool in fostering interactive and inquiry-based learning. The K to 12 Curriculum Guide (2016) underscores the importance of ICT in enhancing science education, making lessons more engaging and meaningful. Research by Orhani et al. (2023) provides strong evidence that integrating ICT into teaching improves student engagement and active learning.

Several studies have proposed various solutions to these challenges, such as providing professional development for teachers, ensuring accessibility to ICT tools, and designing instructional materials that align with technology-driven pedagogies. For example, Orhani et al. (2023) suggest that integrating ICT-based activities significantly enhances student participation and learning outcomes. Additionally, Kafu-Quvane and Chikoko (2019) recommend targeted training programs to equip teachers with the necessary skills for effective ICT integration. Addressing these challenges requires a combination of curriculum reform, infrastructure improvement, and teacher training to create a conducive learning environment for ICT-enhanced instruction.

This study aims to address these challenges by developing TELSci, a structured set of technology-enhanced lessons designed to improve students' motivation, participation, and academic performance. Utilizing ICT-based instruction enhances science education by integrating interactive and multimedia elements that align with the educational goals of the K to 12 curriculum while responding to the persistent issue of limited instructional materials, particularly in the Schools Division of Ilocos Norte.

Instructional Materials (IM) Development in Science

Instructional materials play a critical role in enhancing teaching and learning. According to Portana et al. (2021), well-designed instructional materials improve knowledge acquisition, foster inquiry-based learning, and promote self-directed learning. A strong theoretical framework is necessary for developing effective instructional materials, ensuring that they align with pedagogical best practices and educational goals.

The development of TELSci is grounded in the 7E Learning Model, an instructional framework that extends the 5E Learning Model originally developed by the Biological Science Curriculum Study (BSCS). Eisenkraft (2003) elaborates on the seven stages: elicit, engage, explore, explain, elaborate, evaluate, and extend. Each stage fosters student-centered learning, ensuring that students actively construct knowledge rather than passively receive information. The structure of TELSci follows this model, with each stage carefully integrated to enhance student engagement and comprehension. The "Elicit" stage gauges students' prior knowledge, while "Engage" captures their interest and stimulates curiosity. Additionally, "Explore" allows hands-on activities to build foundational understanding, and "Explain" involves teachers clarifying concepts while students articulate their understanding. On the other hand, "Elaborate" deepens comprehension through extended activities, "Evaluate" assesses students' understanding and learning, and "Extend" encourages the application of knowledge in new contexts. Research by Rahman and Chavhan (2022) supports the effectiveness of the 7E Learning Model in improving conceptual understanding, critical thinking, and science process skills.

Building on the principles of inquiry-based learning, the 7E Learning Model serves as a structured framework that aligns with the instructional goals of this study. It ensures that students actively engage in meaningful learning experiences, promoting deeper understanding and retention of scientific concepts. This model is particularly suited for technology-enhanced lessons in science as it emphasizes active participation, problem-solving, and conceptual reinforcement through digital tools. Integrating ICT elements into each stage of the model enhances TELSci's ability to foster deeper student engagement and knowledge retention, making abstract scientific concepts more tangible and accessible.

To guide the design and development of TELSci, this study also utilizes the Cognitive Theory of Multimedia Learning (CTML), which emphasizes that meaningful learning occurs when visual and verbal information are effectively combined (Mayer, 2009). CTML posits that integrating multimedia elements—such as animations, simulations, and interactive content—enhances comprehension and retention, making it particularly relevant for technology-enhanced lessons. Incorporating CTML principles into TELSci enhances students' learning experiences by creating an immersive and interactive environment that promotes deeper understanding and engagement in Grade 7 Science.

The development of TELSci follows the Input-Process-Output (IPO) model to ensure a systematic approach. The input phase considers the legal bases of ICT integration in teaching and learning, the K to 12 curriculum framework, science learning competencies, availability of ICT tools such as computers and the internet, and results from the needs assessment survey. The process consists of development, designing, writing, and validation. During validation, a panel of evaluators assessed TELSci in terms of content quality and technical quality to ensure its effectiveness. The final output is the validated Technology-Enhanced Lessons in Science (TELSci), designed to aid students in mastering and comprehending science concepts effectively.

Several studies have demonstrated the impact of technology-based instructional materials on student achievement. Arcangel (2022) developed Technology-Enriched Lessons in Disaster Readiness and Risk Reduction (TELDRRR) integrating physics concepts, while Calzada and Antonio (2023) designed the Technology-Enhanced Lessons in Optics (TELO). These studies provide evidence that ICT-based instructional materials enhance learning by making complex concepts more accessible and engaging. Similarly, TELSci aims to address the scarcity of instructional materials in science education while supporting student-centered learning through technology.

Technology–Enhanced Lessons in Science

Technology-Enhanced Lessons (TEL) serve as valuable tools for fostering student motivation, engagement, and conceptual understanding. Research by Ginzburg and Barak (2023) highlights the interactive nature of TEL, which enables learners to engage in hands-on activities and explore scientific concepts dynamically. Incorporating multimedia elements into TEL strengthens instructional practices and supports teachers in achieving their educational objectives.

Calzada and Antonio (2023) emphasize that TEL aligns with the K to 12 curriculum's mandate for ICT-based instruction. Technology-enhanced lessons bridge the gap between traditional teaching methods and modern digital tools, ensuring that students develop competencies necessary for success in a technology-driven world. The development of TELSci in this study follows this trend, providing Grade 7 Science students with an innovative learning resource that supports inquiry-based learning and critical thinking.

The structure of TELSci is patterned after Arcangel's (2022) instructional material development process. The incorporation of the 7E Learning Model ensures that the lessons are student-centered, while CTML principles enhance multimedia integration for improved comprehension and retention. TELSci is expected to make science lessons more interactive, improving student motivation and learning outcomes.

In summary, existing studies on ICT integration, instructional materials, and student engagement provide a strong foundation for the development of TELSci. Addressing key issues such as resource limitations and the need for interactive learning materials, this research aims to create a technology-enhanced learning resource that supports effective science instruction. The 7E Learning Model, CTML, and the IPO model serve as guiding frameworks to ensure that TELSci meets the needs of Grade 7 learners while aligning with the goals of the K to 12 curriculum. This research helps close the gap between traditional and technology-based instruction, equipping both teachers and students with effective, ICT-integrated science lessons.

Methodology

This study employed the descriptive research design utilizing the Research and Development (R and D) methodology. The development of TELSci followed a three-stage process: planning, development, and validation.

During the planning phase, as shown in Figure 1, a needs-assessment survey was conducted to identify science topics that required technology enhancement using a needs-assessment survey checklist, used to identify the topics in Grade 7 Science that needed technology enhancement. The researchers considered the top five topics per area/quarter in the development of the TELSci.

The development phase is where critical processes were carried out in order to meet TELSci's standard characteristics. The result of the needs-assessment survey was used as a basis in the development of the material. In writing of TELSci specifications, the following steps were observed during the construction process: (1) formulation of behavioral objectives; (2) determination of prerequisite concepts and skills; (3) identification of appropriate technologies for the lessons; (4) identification of innovative learning activities essential to the achievement of the objectives; and (5) preparation of evaluative items based on the lesson content. Microsoft PowerPoint 365 was used in creating the layout design for the TELSci.

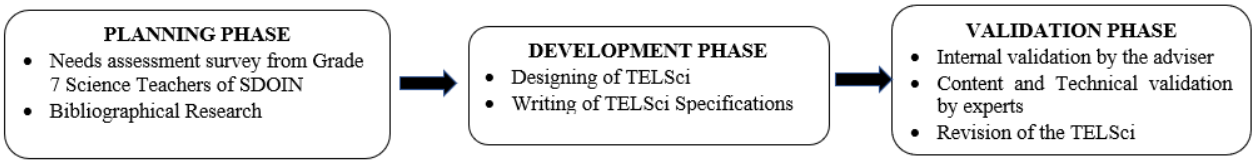


Figure 1 Schematic Diagram of the R&D Methodology

The validation phase of the developed material as shown in Figure 1, started with the evaluation of the TELSci by the research adviser in terms of its content and technical quality prior to its validation by the experts. The researcher revised the material based on the adviser's initial comments and suggestions. After the revision, the TELSci was validated by eight science experts to establish its content quality. Also, three ICT experts were tapped to evaluate the technical quality of the material developed. After being validated by experts, revisions of the material were made incorporating all their suggestions and recommendations.

The content quality and technical quality rating scale were modified to suit the needs and objectives of the study. The responses to these instruments were assessed using a five point rating scale.

Three different instruments were employed to gather data. The first instrument used was a need-assessment survey checklist after the learning competencies of the K to 12 Curriculum to identify the topics in Grade 7 Science that needed technology enhancement. The list of topics in the survey checklist was based on the learning competencies of the K to 12 curriculum guide of Grade 7 Science. The researchers considered the top five topics per quarter in the development of the TELSci. A panel of four Science educators reviewed the checklist for clarity, relevance, and completeness. Their feedback was incorporated to refine the final version of the instrument. The second instrument was a content quality rating scale, adapted from Calzada and Antonio (2023) and Castillo (2019). Modifications were made by adding instructional characteristics as a criterion to align it with the study's objectives. The responses to the content quality items were assessed using a five-point rating scale. To ensure content validity, the revised scale was subjected to expert validation, where four Science educators assessed whether the items effectively measured content quality. Their suggestions led to minor revisions in item phrasing. The reliability of the instrument was tested using Cronbach's alpha, yielding a coefficient of 0.78, which indicates acceptable internal consistency. The third instrument was a technical quality rating scale, adapted from Acido (2020) and Castillo (2019), with modifications in the descriptive interpretation of the scale. The responses to the technical quality items were also assessed using a five-point rating scale. Content validity was ensured through expert validation, following the same process as the content quality scale. The reliability of this scale was also assessed using Cronbach's alpha, resulting in a coefficient of 0.78, confirming its acceptable reliability.

Participants

This study was conducted on public secondary schools in the Schools Division of Ilocos Norte (SDOIN). It involved two groups of samples: Grade 7 Science teachers and a panel of validators, who were purposively chosen as they are the qualified group of people who can provide accurately the necessary data in the study.

Group 1 participants

A total of 38 Grade 7 Science teachers, selected purposively from the SDOIN, provided input through a needs-assessment survey checklist to identify topics in Grade 7 Science that needed technology enhancement. Their feedback guided the development of the TELSci materials.

Group 2 participants

The panel of content validators selected purposively included eight science experts. It was composed of two chemistry teachers, two biology teachers, two physics teachers, and two earth and space science teachers. All these validators had master's degrees, one from MMSU and the other from SDOIN. They validated the material in terms of its content quality along objectives, contents, activities, instructional characteristics, and assessment techniques. For the technical quality, three ICT experts consisting of two from SDOIN and one from MMSU, who have rich experience in ICT-based instructional materials served as validators. They evaluated the technical quality of the material in terms of its efficiency, presentation, and usability.

Data Collection

The data were collected during the school year 2023–2024. However, prior to data collection, the researcher obtained ethical clearance from the University Research Ethics Review Board (URERB) to ensure adherence to ethical guidelines and protect the rights of participants. Permission was also sought from the superintendent and school heads of the SDOIN. The researcher made all the research instruments in Google Forms and find time to distribute the survey online to the target respondents. This same routine was observed in the retrieval of the checklist. The Grade 7 science teachers of SDOIN served as respondents for the needs-assessment survey. The results of the survey became the bases in the development of TELSci.

After developing the TELSci, the research adviser initially checked the material's content and technical quality. The researcher incorporated the recommendations of her adviser. The revised TELSci underwent content evaluation by eight science experts and three ICT experts for the technical quality. The TELSci was published in a Google Site, which allowed the experts to validate the material via online or by downloading to access it offline. In case of intermittent internet connection, flash drives were distributed and were retrieved personally from the experts. In response to the content experts' suggestions, the researcher made sure that all learning objectives were covered in the discussion of the content and aligned with the activities given. Whereas, for the recommendations of technical experts, the researcher incorporated instructions into the general guidelines or operations manual, emphasizing the activation of Macros or Developer in the software. Also, inclusion of QR codes and links ensures continued interactivity, facilitating engagement in the material.

Data Analysis

The data gathered were analyzed using descriptive statistics. The study used frequency counts, percentages, and ranks to identify the topics in Grade 7 Science that need technology enhancement. Likewise, to analyze the content and technical quality of the developed TELSci, mean was used. The interpretation of the mean was based on a range of values, with corresponding descriptive interpretations as follows: 4.51–5. 00: Very Highly Valid (VHV); 3.51–4.50: Highly Valid (HV); 2.51–3.50: Moderately Valid (MV); 1.51–2.50: Needs Improvement (NI); 1.00–1.50: Not Valid (NV).

Results and Discussion

Topics in Grade 7 Science Needing Technology Enhancement

Table 1 shows the results of the needs-assessment survey on the topics in Grade 7

Science that need technology enhancement. Based on the set qualification, only the top five topics per quarter were included in the development of the material. Thus, among the 31 listed topics from the four quarters, 20 needed technology enhancement. The topics that need technology enhancement in the first quarter under Matter are: (1) expressing the concentrations of solutions; (2) substances and mixtures; (3) elements and compounds; (4) solutions; and (5) scientific method. These findings suggest that matter-related topics in Grade 7 Science present conceptual difficulties for students. This aligns with the study of Chakarov (2022), which highlights that Chemistry topics in Grade 7 require prior math knowledge, consistent effort, and visualization skills, making them difficult for students to grasp. Chakarov (2022) explored Bulgarian teachers' perspectives on challenging topics within the chemistry curriculum. The study identified specific areas where students struggle, emphasizing the need for targeted instructional strategies. Similarly, the current study highlights that integrating technology can aid in teaching complex scientific concepts, suggesting that technology-enhanced lessons could address some of the difficulties identified.

By Chakarov (2022). One potential explanation for this finding is that technology offers multiple representations of abstract concepts, such as interactive simulations and visualizations, which may bridge the gap between theoretical content and practical understanding. Unlike the teacher-centered perspective in Chakarov's work, our study provides empirical evidence that technology not only supports learning but also fosters student engagement by offering alternative pathways to understand challenging topics. Moreover, while Chakarov (2022) focused on the perceptions of teachers regarding the inherent challenges in the curriculum, our findings extend this discussion by demonstrating that a well-designed technology-enhanced approach can specifically address these challenges. Overall, the consistency between our findings and Chakarov (2022) underscores the persistent challenges in teaching complex scientific topics and highlights the potential for innovative solutions.

Table 1 Frequency distribution of topics that need technology enhancement

Topics in Grade 7 Science	*F*	Percent	Rank
A. 1st Quarter (Matter)			
1. Scientific Method	23	60.53	5
2. Solutions	26	68.42	4
3. Expressing the concentrations of Solutions	30	78.95	1
4. Substances and Mixtures	29	76.32	2
5. Elements and Compounds	28	73.68	3
6. Acids and Bases	22	57.89	6
7. Metals and Nonmetals	16	42.11	7
B. 2nd Quarter (Living Things and their Environment)			
1. Microscopy	30	78.95	1
2. Levels of Biological Organization	22	57.89	5
3. Animal and Plant Cells	28	73.68	2
4. Fungi, Protists, and Bacteria	27	71.05	3
5. Transfer of Energy through Trophic Levels	26	68.42	4
6. Asexual and Sexual Reproduction	19	50.00	6
7. Ecological Relationships	14	36.84	7
8. Components of Ecosystem	13	34.21	8
C. 3rd Quarter (Fore, Motion, and Energy)			
1. Descriptors of Motion (Speed or Velocity)	31	81.58	1
2. Descriptors of Motion (Acceleration)	28	73.68	5
3. Light	29	76.32	3
4. Heat Transfer	29	76.32	3
5. Electricity	29	76.32	3
6. Sound Waves	25	65.79	6
7. Types and Characteristics of Waves	23	60.53	7
8. Descriptors of Motion (Distance or Displacement)	21	55.26	8
9. Motion Detectors	18	47.37	9
D. 4th Quarter (Earth and Space)			
1. Locating places using coordinate system	30	78.95	1
2. Greenhouse effect and Global Warming	27	71.05	3
3. Wind Systems (Land and Sea Breeze, Monsoons, and ITCZ)	26	68.42	5
4. Seasons	28	73.68	2
5. Eclipse	27	71.05	3
6. Location of the Philippines with respect to landmasses and bodies of water	23	60.53	6
7. Layers of the Atmosphere	23	60.53	6
8. Protection and conservation of natural resources	20	52.63	8

In the second quarter, the topics under Living Things and their Environment that need technology enhancement include: (1) microscopy; (2) animal and plant cells; (3), fungi, protists, and bacteria; (4) transfer of energy through trophic levels; and (5) levels of biological organization. These findings suggest that topics in Grade 7 Science under Living Things and their Environment often involve elements that are either too small to see with the naked eye, too complex to illustrate easily, or occur over extended periods of time. These conform with the findings of Cardak et al. (2015), that the complexity of Grade 7 Science Biology topics involving microscopic elements, intricate concepts, and long-time scales may challenge readability and understanding of the students to the topics. Thus, integration of technology can bridge this gap by providing magnified views, interactive 3D models, simulations of ecological processes, and animations that demonstrate biological hierarchies in dynamic ways. Similarly, topics in the third quarter under Force, Motion, and Energy that need technology enhancement include: (1) descriptors of motion (speed or velocity); (2) light; (3) heat transfer; (4) electricity; and (5) descriptors of motion (acceleration). This implies that topics in Grade 7 Science under Force, Motion, and Energy often deal with invisible forces and abstract concepts that can be challenging for students to understand through theoretical explanations alone. These coincide with the study of Tenzin et al. (2022) that abstract concepts in Physics are challenging due to invisibility and complexity. Hence, technology is needed for it offers powerful tools like simulations, interactive models, and real-time data collection, making the invisible visible and transforming complex ideas into engaging experiences. This approach leads to deeper understanding and prepares students for success in a science and technology-driven world.

Technology-Enhanced Lessons in Science (TELSci) for Grade 7

Technology-Enhanced Lessons in Science (TELSci) is an interactive and self-paced material that integrates ICT to provide instructions and applications of knowledge in real-life situations. It includes various activities, audio-visual materials, and multimedia elements sourced from the internet to promote critical thinking skills, expand knowledge, and cultivate environmental awareness. TELSci utilizes tools like Microsoft PowerPoint, 3D objects, trigger buttons, animations, transitions, teacher-made simulations, and interactive quizzes created with Google Forms. It also incorporates multimedia elements sourced from the internet, such as images and videos, to enhance visual understanding. comprehensive instructions, insights, and overviews through its menus. TELSci offers convenient access via computer, laptop, or smartphone, ensuring users can engage with it seamlessly across devices in an online and offline mode. The mode could address the challenge on internet connection.

The home page of the TELSci has three main menus positioned at the upper right corner: Home, About TELSci, and Topics. The Home menu serves as an initial point of entry, extending a welcome gesture, offering users a brief introduction to four key areas of science: Matter, Living Things and their Environment, Force, Motion, and Energy, and Earth and Space. Additionally, it encourages the users to explore various resources available on TELSci. In the About TELSci section, it provides users comprehensive instructions on navigating the platform and offers insights into its various features and functionalities. Lastly, the Topics menu categorizes science into four same fundamental areas of science. Clicking on each area reveals a selection of topics along with brief overviews.

There are seven parts of the TELSci that are aligned to the 7E Learning Model: (1) Elicit, (2) Engage (3) Explore, (4) Explain, (5) Elaborate, (6) Evaluate, and (7) Extend. A navigation page is presented after the overview of each lesson wherein a clickable icon is provided for each part. Likewise, these clickable icons are visible at the bottom of each slide.

The *Elicit* is the part of the lesson where students' prior knowledge is tested on what they already know about the topic. It also serves as an introduction of the lesson. For the *Engage* part, it draws students' attention, stimulate their thinking and access prior knowledge. The *Explore* allows students time to think and investigate, make decision, collect information, judge, and interpret through various activities. Meanwhile, the *Explain* provides a discussion of the lesson which includes texts and videos. For *Elaborate*, it enables students to expand and solidify their thinking and/or apply their learnings to a real-world situation. *Evaluate,* on the other hand, is a task which aims to evaluate the student's level of mastery in achieving the learning competency. Lastly, *Extend* seeks to improve students' understanding or skill of the lesson they have already mastered.

There are five topics per quarter that are based on the result of the needs assessment survey: Quarter 1 – Chemistry; Quarter 2 – Biology; Quarter 3 – Physics; and Quarter 4 – Earth and Space. The Topic Menu in the Home page serves as initial entry for the topics per quarter.

The alignment of TELSci with the 7E Learning Model ensures a comprehensive approach to science education, engaging students through eliciting prior knowledge, exploring concepts, and extending their understanding to real-world scenarios. Each lesson incorporates interactive activities, visual aids, and practical applications to solidify learning. By fostering curiosity, critical thinking, and practical skills, TELSci equips students with the tools necessary to navigate and contribute to an increasingly complex world.

Validity of the Technology-Enhanced Lessons in Science (TELSci) for Grade 7

Content quality

The validity of the content quality of the TELSci was determined based on the rating of eight science experts. Table 2 shows that the TELSci was rated *very highly valid* in the five aspects of its content quality as shown by the overall mean of 4.89 and an overall standard deviation of 0.32, which indicates a low level of dispersion of data across the five criteria. This result implies that the TELSci is valid in terms of objective, content, activities, instructional characteristics and assessment techniques. This suggests that the objectives are well-written and highlight the result of learning by the end of instruction (De Guzman, 2022). In terms of content, the lessons are clear, easy to understand, and relevant to the Grade 7 Science Curriculum Guide. The result of the study corroborates with the findings of Arcangel (2022) that in developing learning materials, the content should be relevant to the skill which the teacher wants to develop and suited to the level of the learners. In addition, the activities of the TELSci are highly effective in enhancing science education and engaging students in meaningful learning experiences. According to Batdı et al. (2018), technology-based learning strategies have a positive impact on students' performance and academic achievement. Moreover, the instructions are suitable for the intended users, enjoyable, stimulating, challenging, and engaging. This result is confirmed based on the positive feedback from the experts which suggests that the TELSci effectively fosters creativity, empowers users to control the pace and sequence of learning, and effectively delivers concepts. Lastly, the assessment techniques of TELSci

are well-designed and closely aligned with the intended objectives of the lesson. This agrees with the idea of Earl (2003) that assessments that are strongly tied to learning objectives provide clear guidance for students and promote focused study.

Technical quality

The validity of the technical quality of the TELSci was determined by the ICT experts. Table 3 shows that the TELSci was rated very highly valid in the three aspects of its technical quality as shown by the overall mean of 4.83 and an overall standard deviation of 0.33, which indicates a low level of dispersion of data across the three criteria. This result implies that the system of the TELSci is efficient, presentable, and usable. This means that the material functions smoothly and suggests a high level of technical optimization that contributes significantly to the overall positive evaluation of TELSci. This result conforms with the claim of Calzada and Antonio (2023) that highlights the significance of prioritizing functionality and efficiency when developing ICT-based materials. In addition, the presentation for both texts and non-texts are clear, easy to interpret, can sustain interest, do not distract users' attention and provide accurate representation of the concepts discussed. The design allows the user to navigate freely through the material and the adapted videos play smoothly and are appropriate to the concept. According to Dufitumukiza and Twizeyimana (2023), instructional materials are supposed to be interesting, contextual, attractive, and motivated so that learners are willing to use such both during the face-to-face teaching-learning process and independent or autonomous learning out of the classroom. Furthermore, TELSci has effective user support materials and an easily navigable interface. These findings collectively affirm the usability and effectiveness of TELSci, as recognized by the experts in the field of ICT.

Table 2 Mean ratings of the science experts on the content quality of the TELSci

Criteria	Mean	*SD*	DI
Objectives	4.92	0.28	Very Highly Valid
Content	4.88	0.33	Very Highly Valid
Activities	4.83	0.37	Very Highly Valid
Instructional characteristics	4.94	0.24	Very Highly Valid
Assessment techniques	4.88	0.33	Very Highly Valid
Overall Mean	4.89	0.32	Very Highly Valid

Note:

Ranges of Means	Descriptive Interpretation (DI)
4.51 – 5.00	Very Highly Valid (VHV)
3.51 – 4.50	Highly Valid (HV)
2.51 – 3.50	Moderately Valid (MV)
1.51 – 2.50	Needs Improvement (NI)
1.00 – 1.50	Not Valid (NV)

Table 3 Mean ratings of the ICT experts on the technical quality of the TELSci

Criteria	Mean	*SD*	DI
Efficiency	4.67	0.47	Very Highly Valid
Presentation	4.90	0.29	Very Highly Valid
Usability	4.92	0.28	Very Highly Valid
Overall	4.83	0.33	Very Highly Valid

Note:

Ranges of Means	Descriptive Interpretation (DI)
4.51 – 5.00	Very Highly Valid (VHV)
3.51 – 4.50	Highly Valid (HV)
2.51 – 3.50	Moderately Valid (MV)
1.51 – 2.50	Needs Improvement (NI)
1.00 – 1.50	Not Valid (NV)

Conclusion and Recommendation

Based on the findings, the following conclusions were drawn:

There are 20 topics in Grade 7 Science that need technology enhancement as perceived by the teachers. This result was used as basis for the development of the Technology-Enhanced Lessons in Science (TELSci).

The developed Technology-Enhanced Lessons in Science (TELSci) for Grade 7 has successfully met the standard qualifications for a Technology-Enhanced Learning (TEL) material in terms of content and technical quality. TELSci is a self-paced interactive material that can be accessed via online or offline mode using computer, laptop, or smartphone.

Based on the assessment results of content experts, it can be concluded that the content of TELSci is valid in terms of objectives, contents, activities, instructional characteristics, and assessment technique. Likewise, based on the assessment of technical experts, it can be concluded that the technical quality of the developed TELSci is valid in terms of efficiency, presentation, and usability.

The features of the TELSci adhere with the tenets of Cognitive Theory of Multimedia Learning. This theory emphasizes that information is better learned when presented in both words and images, as it helps the brain process the information more effectively.

In the light of the findings and conclusions, the researcher strongly recommends that science teachers utilize the TELSci in the classroom to improve students' academic performance in Grade 7 Science. By integrating the TELSci into their teaching strategies, teachers can actively engage students, test the effectiveness of the material, and potentially improve learning outcomes. The TELSci could be used as a supplementary material as enhancement to traditional classroom instruction, providing engaging, interactive, and personalized learning experiences. As supplementary material, a teacher could incorporate collaborative learning like peer-to-peer learning and support. Moreover, teachers could likewise utilize it as a primary tool in situations that call for alternative delivery mode since it is a self-paced material. In addition, teachers could evaluate the impact of TELSci by monitoring the results of assessment in the material as well as the extent of engagement and motivation of students to learn when using the material, and in addition, the retention of concepts as a result of summative assessments.

Also, students are encouraged to actively engage with the TELSci, seek clarification when needed, collaborate with peers, and provide feedback to ensure an effective learning experience.

Moreover, school administrators may encourage science teachers to develop and utilize the TELSci as instructional materials for explaining scientific concepts. Also, school administrators should look into the needs for facilities to support the use of TELSci as well as possible training for teachers.

Instructional material developers, including ICT experts, may collaborate with teachers to create more interactive, computer-based tools for classroom instruction. Furthermore, policy and curriculum makers may consider the findings of this study when designing science education policies and curriculum. Lastly, future researchers may conduct experimental research to determine the effectiveness of TELSci in science education. Also, comparative studies may evaluate TELSci alongside other digital learning platforms to identify its unique contributions and potential areas for improvement. Researchers are also encouraged to explore the scalability of TELSci by implementing it in diverse educational settings (e.g., rural vs. urban schools) and across various socio-economic contexts, ensuring that the findings can be generalized and effectively inform policy and practice in science education.

Conflict of Interest

The authors declare that there is no conflict of interest.

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References

Acido, L. (2020). *Microlearning-based lessons in chemistry* [Unpublished master's thesis, Mariano Marcos State University-Graduate School]. Mariano Marcos State University.

Arcangel, C. (2022). *Technology-enriched lessons in disaster readiness and risk reduction (TELDRRR) integrating physics concepts,* [Unpublished master's thesis, Mariano Marcos State University-Graduate School]. Mariano Marcos State University.

Batdı, V., & Semerci, Ç. (2018). The effect of technology supported teaching on students' academic achievement: a combined meta-analytic and thematic study. *International Journal of Learning and Teaching*, *10*(2), 86–104. https://doi.org/10.1504/IJLT.2018.091632

Calzada, M. P. T. and Antonio, V. V. (2023). Development of technology-enhanced lessons in optics (TELO). *American Journal of Environmental Economics*, *2*(3). https://europub.co.uk/articles/-A-721874

Cardak, O., Dikmenli, M., & Guven, S. (2015). 7th grade science textbook readability and compatibility with the target age level. *International Research in Higher Education*, *1*(1). https://doi.org/10.5430/irhe.v1n1p101

Castillo, C. (2019). *Technology-enhanced instructional material (TEIM) to develop student's conceptual understanding in mathematics*, [Unpublished master's thesis, Mariano Marcos State University-Graduate School]. Mariano Marcos State University.

Chakarov, K. (2022). Difficult topics in the Chemistry curriculum – Bulgarian teachers' view. *Obučenie Po Prirodni Nauki I V"rhovi Tehnologii*, *31*(6), 530–552. https://doi.org/10.53656/nat2022-6.03

Chuaungo, N. M. L., Lalnunsiami, N. K., & Mishra, N. L. (2022). Opportunities and barriers in ICT integrated education: A Critical analysis. *International Journal of Engineering Technology and Management Sciences*, *6*(5), 753–759. https://doi.org/10.46647/ijetms.2022.v06i05.117

De Guzman, N. (2022). *Mobile apps-enhanced strategic intervention materials (MAeSIM) in junior high school physics*, [Unpublished master's thesis, Mariano Marcos State University-Graduate School]. Mariano Marcos State University.

Dufitumukiza, B., & Twizeyimana, E. (2023). Instructional materials in science education: Secondary school teachers' perceptions. *Journal of Global Research in Education and Social Science*, 28–34. https://doi.org/10.56557/jogress/2023/v17i38235

Earl, L. M. (2003). *Assessment as learning: Using classroom assessment to maximize student learning.* Corwin Press. https://eric.ed.gov/?id=ED482570

Eisenkraft, A. (2003). Expanding the 5E model. A proposed 7E model emphasizes "transfer of learning" and the importance of eliciting prior understanding. *Science Teacher*, *70*(6), 56–59.

Ginzburg, T., & Barak, M. (2023). Technology-enhanced learning and its association with motivation to learn science from a cross-cultural perspective. *Journal of Science Education and Technology*, *32(4)*, *597*–606. https://doi.org/10.1007 / s10956-023-10048-x

Idulsa, E. (2017). *Teachers' expectations, challenges and problems with grade 7 science in the K-12 curriculum in the Philippines.* GRIN. https://www.grin.com/document/920176

Kafu-Quvane, B., & Chikoko, V. (2019). Factors shaping teachers' experiences in managing teaching in the era of Information and Communication Technology (ICT) integration across the curriculum. *EDULEARN Proceedings*. https://doi.org/ 10.21125/edulearn.2019.1027

Mayer, R. (2009). *Cognitive Theory of Multimedia Learning.* https://dl.icdst.org/pdfs/files1/20f8ab74894c98baa44518a982cfa761.pdf

Orhani, S., Kolukaj, M., Saramati, F., & Saramati, E. (2023). ICT as a didactic tool to facilitate the learning process in the subject of Mathematics in combined classes. *InternationalJournal of Innovative Research in Multidisciplinary Education, 02*(05). https://doi.org/10.58806/ijirme.2023.v2i5n01

Portana, H. V., Fronda, J. G., Policarpio, D. G. T., Rigat, K. a. R. C., & Llames, G. A. (2021). Effectiveness and acceptability of instructional materials in the enhancement of students' academic achievement. *International Journal of Advanced Engineering, Management and Science*, *7*(1), 12–15. https://doi.org/10.22161/ijaems.71.2

Rahman, N. M. S., & Chavhan, N. D. R. (2022). 7E model: An effective instructional approach for teaching learning. *EPRA International Journal of Multidisciplinary Research*, 339–345. https://doi.org/10.36713/epra9431

Sadera, J. R. N., Torres, R. Y. S., & Rogayan, D. V., Jr. (2020). Challenges encountered by junior high school students in learning science: Basis for action plan. *Universal Journal of Educational Research*, *8*(12A), 7405–7414. https://doi.org/10.13189/ujer.2020.082524

Sujariati, S., & Wanci, R. (2023). Distance learning: The impact on teaching and learning process. *Al-Ishlah: Journal of Education*, *15*(2), 1740–1749. https://doi.org/10.35445/alishlah.v15i2.2301

Tenzin, S., Tendar, P., & Zangmo, N. (2022). Enhancing students' understanding of abstract concepts in Physics by integrating ICT in teaching-learning process. *Asian Journal of Education and Social Studies*, 68–80. https://doi.org/10.9734/ajess/2022/v26i230624