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Development and effectiveness of a 7Es-based interactive science pocket for grade 6 digestive system learning

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ABSTRACT

Despite the availability of various instructional resources, teaching abstract biological concepts like the human digestive system remains a challenge for elementary learners due to their developmental stage and the limitations of traditional textbooks. In response, this study aimed to develop and validate the 7Es Learning Pocket (LeaP), an innovative, portable instructional material anchored in the constructivist approach and structured around the 7Es instructional model—elicit, engage, explore, explain, elaborate, evaluate, and extend. The study adopted the 4D model (define, design, develop, and disseminate) and engaged 42 grade 6 students from a public elementary school, along with expert science teachers for validation. During the development phase, qualitative feedback from learners and expert validators guided iterative refinements of the LeaP, with experts rating it "very satisfactory" in content, format, organization, and information accuracy. Quantitative evaluation included paired samples t-test comparing pretest and posttest scores of 42 learners, revealing significant improvement from a mean of 7.12 to 16.79 ($t=18.36$, $p<0.001$). Additionally, 81-90% of learners demonstrated "very satisfactory" procedural knowledge across all 7Es activities. Learner perception data further affirmed high satisfaction, engagement, and perceived usefulness of the material. These findings confirm that the 7Es LeaP is a well-validated and effective instructional tool that enhances conceptual understanding and promotes active learning in elementary science education.

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1. INTRODUCTION

Teaching the digestive system to elementary students can be effectively achieved through a range of innovative strategies tailored to the unique learning needs of this age group. Kistiari and Ahmadi [1] demonstrated that demonstration methods significantly enhance students' understanding of digestive system concepts by providing practical, hands-on learning experiences. Such methods make the complex processes of digestion more comprehensible, which is crucial for learners' cognitive development at this stage. Additionally, the integration of multimedia resources, such as animations and interactive applications, further supports learning by transforming abstract content into concrete and engaging visual representations. For instance, Maftuhah [2] reported that interactive learning media like Anato-Smart Media effectively engage

students in exploring anatomy, including digestive organs and their functions. Likewise, virtual reality and interactive multimedia can create immersive learning experiences that clarify intricate biological processes, offering advantages over traditional textbook-based instruction [3]. These varied instructional approaches—demonstrative, multimedia-based, and interactive—collectively contribute to improved learning outcomes and a deeper conceptual understanding of the digestive system among elementary students.

Despite these advancements, learning about the human digestive system still poses considerable challenges for young learners due to the abstractness of the content and their cognitive developmental stage. Initial needs analysis in this study revealed that a significant portion of grade 6 learners had difficulty grasping digestion-related concepts, particularly those involving the mechanical and chemical processes of food breakdown. This was supported by teacher surveys, which noted that more than 70% of students performed below satisfactory levels in digestion-related assessments. Teachers also reported challenges in simplifying and contextualizing the lesson to match learners' comprehension levels.

Moreover, the needs analysis identified that the teaching aids currently used in classrooms are often outdated and limited to black-and-white textbook images or chalkboard diagrams. Traditional resources lack tactile and engaging features, which reduces their effectiveness in fostering active learning. While multimedia tools are recognized for their instructional potential, many public elementary schools face constraints in accessing such resources consistently due to infrastructural limitations, such as unreliable electricity, limited internet connectivity, or insufficient devices. This issue echoes the findings of Kusuma *et al.* [4], Marpelin *et al.* [5], and Aguirre *et al.* [6], who emphasize the digital and motivational gaps encountered in under-resourced classrooms.

Furthermore, while there is an abundance of interactive digital media available, there remains a lack of simple, physical instructional materials that are portable, cost-effective, and specifically designed based on the 7Es instructional model. No existing tool, as identified in this study, integrates the 7Es framework into a tangible, student-friendly format that allows for sequential, scaffolded learning aligned with the Department of Education's Most Essential Learning Competencies (MELCs). This gap underscores the need to develop a new product that bridges the accessibility of physical media with the pedagogical strength of constructivist approaches. These findings guided the define and design phases of the study.

One such promising approach is the use of the 7E instructional model—elicit, engage, explore, explain, elaborate, evaluate, and extend—which is grounded in constructivist learning theory. Research by Mekonnen *et al.* [7] demonstrated that this model enhances students' conceptual understanding and helps correct misconceptions through deep cognitive engagement. Supporting this, Kahyaoğlu and Torun [8] found that the use of the 7E model led to better academic performance compared to traditional teaching strategies. Hairini *et al.* [9] further emphasized its benefits in developing logical reasoning, problem-solving abilities, and promoting active student participation. The flexibility and responsiveness of the 7E model in incorporating diverse strategies foster an interactive learning environment, leading to more meaningful learning experiences and improved retention of complex content [10], [11].

Interactive learning environments also play a vital role in enhancing educational outcomes. García-Carrión *et al.* [12] demonstrated that such environments promote inclusivity and group cohesion, especially for students with disabilities. Similarly, Villardón-Gallego *et al.* [13] reported that interactive strategies can foster prosocial behaviors and strengthen classroom dynamics. Rachmawati [14] emphasized that classroom interaction encourages idea exchange and critical thinking, while Zhang *et al.* [15] noted that smart technologies supporting interactive learning increase student engagement and motivation. Altogether, these findings highlight the transformative potential of interactive learning pockets in promoting inclusivity, collaboration, and higher-order thinking skills.

Responding to these challenges and opportunities, this study aims to develop and validate the Learning Pocket (LeaP), an innovative instructional tool designed specifically for grade 6 learners studying the digestive system. Grounded in constructivist learning theory and structured around the 7Es instructional model, the LeaP utilizes a thematic approach enhanced with visually engaging content. Its compact, pocket-sized format addresses the practical limitations of traditional textbooks by offering a portable, lightweight, and easily accessible learning resource that students can use both inside and outside the classroom.

2. METHOD

This study utilized a qualitative-quantitative research design anchored on the 4D instructional model by Thiagarajan *et al.* [16], which served as the framework for developing the LeaP material. The 4D model comprises four progressive phases—define, design, develop, and disseminate—each playing a vital role in the structured formulation and validation of the instructional resource.

2.1. Participants

The participants comprised three distinct groups involved in evaluating and testing the 7Es LeaP. The first group consisted of two in-service science teachers with at least 5 years of experience teaching Biology who participated in the needs assessment survey. The second group included five expert in-service Science teachers who evaluated the developed 7Es LeaP based on their extensive experience. The third group comprised 42 grade 6 learners from Datu Batugan Elementary School in Saguiaran, Lanao Del Sur, who participated in the pilot testing. These students were purposely selected based on their willingness to participate and prior exposure to digestive system topics in their science curriculum.

2.2. Research procedure

2.2.1. Define phase

The define phase began with a thorough alignment of the instructional content to the Department of Education's K-12 MELCs for grade 6 science. Specifically, the topic "Describes the parts and functions of the digestive system" was selected due to its complexity and the high percentage of learners performing below mastery level based on teacher feedback and previous assessments. To clarify the focus of instruction, three learning objectives were formulated: i) identify the major organs involved in digestion; ii) describe their functions; and iii) explain the digestive process from ingestion to elimination. A needs assessment was then conducted through structured interviews and surveys involving two in-service science teachers, who confirmed the difficulty of delivering this topic using existing materials. Students reportedly struggled with visualizing and sequencing digestive processes due to abstract textbook content. A comprehensive literature review further identified common instructional challenges and best practices in teaching anatomy at the elementary level, laying the theoretical and empirical groundwork for designing the LeaP.

2.2.2. Design phase

In the design phase, the structure and content of the LeaP were carefully mapped out using the 7Es instructional model: elicit, engage, explore, explain, elaborate, evaluate, and extend. Each phase was supported by specific tasks designed to scaffold learners' conceptual development. Elicit activities involved short scenario-based prompts and vocabulary association tasks to activate prior knowledge. Engage activities introduced visually stimulating questions and hands-on tasks, such as using clay to simulate food breakdown. Explore activities allowed learners to independently label digestive diagrams and analyze food journey maps. Explain included illustrated concept sheets and guided peer-to-peer discussions. Elaborate activities encouraged application through assembling digestive system cutouts on blank anatomical figures. Evaluate was implemented through a 25-item teacher-made test assessing knowledge and understanding. Extend activities involved creating posters promoting digestive health, encouraging real-life application and transference of learning. Layouts, graphic designs, and instructional flow were prototyped during this phase using both printed and digital mock-ups.

2.2.3. Develop phase

The develop phase focused on producing the initial LeaP prototype and conducting multiple validation cycles. The prototype was first subjected to face validation by two science educators, who assessed clarity, language appropriateness, and alignment with student reading levels. After revisions, the material underwent expert validation by five in-service science teachers using the Department of Education's Learning Resources Management and Development System (LRMDS) evaluation tool. The assessment criteria included content accuracy, format, presentation and organization, and up-to-datedness of information. Quantitative ratings and qualitative comments were collected, with suggestions such as adding color-coded labels and improving the size of images for better visual clarity. Revisions were then implemented accordingly. Additionally, test instruments and learner activity sheets were reviewed for validity and reliability, ensuring alignment between instructional objectives and assessment tools.

2.2.4. Disseminate phase

In the disseminate phase, the finalized LeaP material was pilot-tested with 42 grade 6 learners from a public elementary school. Before implementation, informed consent was secured from both school administrators and parents. Learners first completed a pretest to establish baseline understanding. The LeaP was then integrated into classroom instruction across three science sessions, each covering distinct phases of the digestive process aligned with the 7Es activities. Learners actively engaged with the pocket material through guided and independent tasks. After the intervention, a posttest identical in structure to the pretest was administered to measure learning gains. Additionally, learners completed a perception questionnaire using a 4-point Likert scale to assess their satisfaction, perceived effectiveness, and enjoyment of the LeaP.

Classroom observations and student outputs, such as assembled digestive diagrams and health posters, were also documented to support qualitative evaluation.

2.3. Data collection

Data collection utilized multiple instruments, all subjected to rigorous validation to ensure reliability and alignment with the study's objectives. The teacher survey questionnaires used in the needs assessment were reviewed by two experienced science educators to confirm clarity, relevance, and appropriateness for in-service teachers, while expert evaluation forms followed the Department of Education's LRMDS standards for assessing instructional materials. The pretest and posttest, consisting of 25 multiple-choice items aligned with the K–12 MELCs for grade 6 science, were validated by two subject matter experts and pilot-tested with a non-participating group of students to determine item quality and make necessary revisions. Procedural knowledge assessment rubrics, designed from established performance criteria, were validated by two in-service science teachers to ensure clarity, consistency, and relevance to the learning outcomes. Additionally, learner perception questionnaires using a 4-point Likert scale were reviewed by educational measurement specialists for face validity and language suitability, then pilot-tested with a similar student group, with feedback incorporated into the final instrument before formal data collection.

2.4. Data analysis

Data analysis employed descriptive statistics, including mean calculations for teacher ratings, frequency distributions for learner performance, percentages for response analysis, Likert scale interpretation for perceptions, and a paired samples t-test for determining significant differences between pre-test and post-test scores.

a. Statistical tools used

- Mean: average scores of expert teacher ratings on the 7Es LeaP
- Frequency distribution: analysis of grade 6 learners' performance data
- Percentage: proportion of learners' responses regarding 7Es LeaP perceptions
- Likert scale: measurement of agreement levels with 7Es LeaP effectiveness statements
- Paired samples t-test: determination of significant differences between pre-test and post-test scores

b. Interpretation scales

- Expert validation ratings: very satisfactory (3.25-4.00); satisfactory (2.50-3.24); poor (1.75-2.49); and not satisfactory (1.00-1.54).
- Academic performance (DepEd Order No. 8, Series 2015): outstanding (84.00-100%); very satisfactory (76.00-83.99%); satisfactory (68.00-75.99%); fairly satisfactory (60.00-67.99%); and did not meet expectations (0.00-59.99%).
- Procedural knowledge assessment: very satisfactory (80-100%); satisfactory (60-79%); poor (40-59%); and not satisfactory (0-39%).
- Statistical significance: p-value<0.05 is significant difference and p-value≥ 0.05 is no significant difference.

2.5. Production cost

The estimated production cost for each LeaP is approximately ₱155. This amount includes ₱80 allocated for printing per pocket. The remaining ₱75 covers material expenses, including paper and binding costs.

3. RESULTS AND DISCUSSION

3.1. Development of 7Es LeaP using the 7Es model

The developed 7Es LeaP integrates all seven phases of the instructional model to enhance learners' understanding of the digestive system through interactive and competency-aligned strategies. The elicit phase activates prior knowledge by prompting students to share ideas about food processing, identifying misconceptions early. In the engage phase, students use clay and marbles to simulate food breakdown, sparking curiosity and deepening engagement. During the explore phase, learners independently investigate digestive system parts through diagram labelling, fostering analytical and critical thinking. The explain phase delivers structured content on digestive functions, supported by peer-to-peer discussions that reinforce comprehension and communication. In the elaborate phase, students apply their understanding by assembling digestive system cut-outs on blank figures, further motivating learning and addressing conceptual gaps. The evaluate phase features a 25-item multiple-choice test that assesses conceptual understanding and supports self-regulation through immediate feedback. Finally, the extend phase tasks students with designing posters

on digestive health tips, promoting the application of knowledge in real-world contexts and demonstrating effective knowledge transfer. Figure 1 shows the preliminary pages of the developed 7Es LeaP.

Figure 1. Preliminary pages of the developed 7Es LeaP

3.2. Expert validation of the 7Es LeaP

Table 1 presents the evaluation results from five expert science teachers, highlighting consistently high ratings across all four validation categories: content, format, presentation and organization, and accuracy of information. Among these, the "format" category received the highest mean score (3.90), indicating expert appreciation for the material's layout, clarity, and learner-centered design. The "content" category followed closely with a mean score of 3.77, with perfect scores on indicators related to promoting higher-order thinking, content neutrality, and alignment with the Department of Education's MELCs. All experts unanimously recommended the material for classroom use, confirming its overall quality and practical relevance.

Table 1. Overall expert validation ratings of the 7Es LeaP

Category	N	Overall means	Remarks
Content	5	3.77	Very satisfactory
Format	5	3.90	Very satisfactory
Presentation and organization	5	3.76	Very satisfactory
Accuracy and up-to-datedness of information	5	3.73	Very satisfactory

Note: very satisfactory=3.25-4.00; satisfactory=2.50-3.24; poor=1.75-2.49; and not satisfactory=1.00-1.54.

In support of these quantitative results, qualitative feedback from the validators provided deeper insights into the material's strengths. Experts noted that the 7Es LeaP effectively simplifies abstract biological concepts, particularly through the use of step-by-step visuals, structured activities, and tactile interaction. One expert commented that the LeaP "Successfully scaffolds the digestion process into manageable chunks that young learners can easily follow." Another pointed out that its integration of inquiry-based questions within each 7Es phase was "Essential in building critical thinking and reflection." Suggestions for refinement included enlarging some text portions for better readability and including more relatable food examples to strengthen contextual connections. These comments contributed to iterative revisions that further improved the tool's accessibility and instructional coherence.

The very satisfactory ratings across all criteria can be attributed to the deliberate design choices embedded in the LeaP. The use of the 7Es instructional model ensured a sequential and scaffolded learning experience, which may explain why experts highly rated its organization and cognitive alignment. Furthermore, its physical, low-tech design addresses equity concerns by eliminating the need for electronic devices. By providing an alternative to screen-based instruction, the LeaP promotes inclusivity while maintaining pedagogical rigor.

These findings do not merely align with previous research—they reflect a strategic response to well-documented limitations in conventional instructional materials. As Marsari and Rifma [17] emphasized, traditional resources often fail to support meaningful learning because they present abstract concepts without interactive or experiential anchors. Similarly, Aguirre *et al.* [6] noted that digital resources, although engaging, remain inaccessible to many learners due to economic and technological barriers. Lin *et al.* [18] also highlighted the need for structured, curriculum-aligned resource management, which physical tools like the LeaP can support even in digitally limited contexts. Therefore, the strong validation results, supported by both numerical ratings and expert commentary, affirm that the 7Es LeaP fills a critical gap in science education by offering an accessible, curriculum-aligned, and pedagogically sound alternative to traditional and digital-only resources. The positive expert consensus reinforces its suitability as a classroom resource that addresses not only conceptual learning but also student engagement and instructional equity.

3.3. Impact on learner performance and understanding

Table 2 shows that before the intervention, all students (100%) scored below 14 points in the pretest, indicating that none achieved the expected performance standards for grade 6 Science as set by Department of Education. Following the use of the 7Es LeaP, learners demonstrated notable improvement: 14% achieved an "outstanding" rating (21-25 points), 24% reached the "very satisfactory" range (19-20 points), and 38% performed within the "satisfactory" to "fairly satisfactory" levels (15-8 points). The average pretest score was 7.12 (SD=2.47), which increased to 16.79 (SD=3.81) in the posttest, with standard errors of 0.38 and 0.59, respectively. Results from a paired samples t-test revealed a significant difference ($t=18.36$, $p<0.001$), and the computed Cohen's d of 2.83 indicated a very large effect size, confirming both statistical and practical significance of the intervention. The remarkable improvement in performance can be attributed to key features of the LeaP material: its 7Es framework promoted conceptual change through structured, inquiry-based learning (IBL); its tactile and visual design helped learners grasp abstract biological concepts more concretely; and its pocket format allowed self-paced and flexible engagement, enhancing comprehension and retention. To ensure test validity and reliability, the 25-item pretest and posttest were developed based on the MELCs in grade 6 science and validated by two expert science educators for content accuracy, clarity, and cognitive alignment. A pilot test with non-participating students was also conducted to evaluate item difficulty and discrimination, yielding a reliability coefficient of KR-20=0.82, which confirmed internal consistency. These findings align with previous studies emphasizing the effectiveness of the 7Es instructional model. For instance, Aviyanti *et al.* [19] reported significant gains in science process skills using 7E-based instruction with PhET simulations, while Aloysius [20] found that the model promotes engagement and critical thinking. Similarly, Khairani *et al.* [21] and Mustika *et al.* [22] observed improvements in learners' ability to link theory with practice. The present study strengthens this body of evidence by showing that even a low-cost, hands-on instructional tool grounded in sound pedagogy can lead to substantial cognitive gains among elementary learners, particularly in complex science topics. Table 3 presents the statistical significance testing results.

Table 2. Comparison of pretest and posttest performance

Test	N	Std. Deviation	Mean	Description
Pretest	42	2.47	7.12	Did not meet expectations
Posttest	42	3.81	16.79	Very satisfactory

Note: outstanding=17.50-20.00; very satisfactory=15.00-17.49; satisfactory=12.50-14.99; fairly satisfactory=10.00-12.49; and did not meet expectations below 10.00.

Table 3 summarizes the results of the statistical significance test comparing the pretest and posttest scores of grades 6 learners. The findings show a notable mean score increase of 9.6667, with a t-value of 18.3604 and degrees of freedom (df=41). The p-value (<0.001), which is far below the 0.05 significance level, indicates a statistically significant improvement in learners' performance. Consequently, the null hypothesis is rejected, confirming that the 7Es LeaP intervention effectively enhanced students' conceptual understanding of the digestive system. These results are consistent with prior studies supporting the efficacy of IBL in improving academic achievement and cognitive skills. For instance, Worachak *et al.* [23] reported that IBL strengthens critical thinking by engaging learners in real-world problem-solving and independent decision-making. Suárez *et al.* [24] found that IBL fosters learner autonomy and motivation, leading to improved academic outcomes, while Rasis *et al.* [25] noted that open inquiry approaches help students connect learning to personal and environmental contexts, thereby increasing engagement and environmental awareness. Likewise, Burhan *et al.* [26] demonstrated that IBL strategies outperform traditional instruction in developing reading comprehension and analytical thinking—skills essential for higher-order cognition.

Collectively, these findings validate the positive impact of inquiry-based approaches like the 7Es LeaP on students' critical thinking, problem-solving, and academic performance.

Table 4 illustrates a progressive improvement in learners' performance across the 7Es activities, indicating steady growth in procedural knowledge. The percentage of learners achieving satisfactory or higher began at 81% in the "let's evoke" phase, rose to 86% in "let's do it", and peaked at 90% in "let's complete". The final activity, "my poster", maintained this strong performance with an 81% very satisfactory rating. This upward trend suggests that the structured implementation of the 7Es instructional model did not merely support knowledge acquisition but also systematically developed learners' science process skills over time.

Table 3. Statistical significance between pretest and posttest

Test	Mean difference	t-statistics	df	p-value	Interpretation
Pretest Posttest	9.6667	18.3604	41	0.001	Significant

Table 4. Learners' procedural knowledge performance

Activity	Score	Percentage range	Frequency	Percentage	Remark
Let's evoke	8-10	80-100	16	38	Very satisfactory
	6-7	60-79	18	43	Satisfactory
	3-5	40-59	8	19	Poor
	0-2	0-39	-	-	Not satisfactory
Let's do it	10-12	80-100	36	86	Very satisfactory
	7-9	60-79	6	14	Satisfactory
	4-6	40-59	-	-	Poor
	0-3	0-39	-	-	Not satisfactory
Let's examine	10-12	80-100	30	71	Very satisfactory
	7-9	60-79	12	29	Satisfactory
	4-6	40-59	-	-	Poor
	0-3	0-39	-	-	Not satisfactory
Let's complete	10-15	80-100	38	90	Very satisfactory
	7-9	60-79	4	10	Satisfactory
	4-6	40-59	-	-	Poor
	0-3	0-39	-	-	Not satisfactory
My poster	10-15	80-100	34	81	Very satisfactory
	7-9	60-79	8	19	Satisfactory
	4-6	40-59	-	-	Poor
	0-3	0-39	-	-	Not satisfactory

Note: very satisfactory=80-100; satisfactory=60-79; poor=40-59; and not satisfactory=0-39.

These improvements can be attributed to the sequential and scaffolded design of the 7Es phases, each of which targets specific components of scientific inquiry. The elicit phase ("let's evoke") activated learners' prior knowledge and encouraged prediction-making—critical for hypothesis formation. Although this phase showed the lowest "very satisfactory" percentage, this may reflect the initial unfamiliarity of students with inquiry-based tasks. As students moved into the engage and explore phases ("let's do it" and "let's examine"), they were encouraged to manipulate materials, model digestive processes, and independently investigate diagrammatic representations—activities that built observational, classification, and data interpretation skills. This hands-on exploration is a foundational aspect of procedural knowledge, and the increase in performance during these phases suggests that learners became more confident and competent in applying scientific methods.

The explain and elaborate phases guided learners in articulating their understanding, comparing their observations with established scientific explanations, and extending this knowledge to unfamiliar contexts. The "let's complete" activity—where students assembled a digestive system cutout—saw the highest performance, likely because it integrated both conceptual understanding and spatial reasoning. This phase supported the synthesis of ideas, reinforcing analytical thinking and procedural accuracy.

Finally, the extend phase ("my poster") asked learners to apply their knowledge creatively and communicate health-related information to others. Although slightly lower than the peak, the 81% very satisfactory rating still demonstrates the material's ability to promote transfer of learning and communication skills—two advanced components of scientific literacy.

The structure and content of each 7Es activity were deliberately aligned with targeted science process skills, which likely contributed to this incremental progression. Rather than relying on rote recall, the LeaP required learners to engage with real-world contexts, manipulate materials, reason logically, and reflect

on outcomes—all of which are key indicators of process skill development. This outcome supports Gonzaga-Leong-On's [27] findings, which showed that the 7E model enhances collaboration and inquiry through structured engagement. Similarly, Aviyanti *et al.* [19] confirmed that when paired with well-designed tasks, the model improves learners' ability to investigate and explain phenomena. Han *et al.* [28] also found that observational and analytical skills were significantly strengthened when instruction was scaffolded through the 7Es phases.

Table 5 reveals overwhelmingly positive perceptions of the 7Es LeaP, with 100% of learners strongly agreeing that they gained substantial knowledge about the digestive system. High satisfaction ratings were also recorded in terms of content clarity (97.6%), enjoyment (95.2%), perceived usefulness (90.5%), and willingness to share learning with others (83.3%). These results suggest that the material not only engaged students cognitively but also resonated with them affectively—promoting motivation and a sense of ownership in learning.

Table 5. Learners' perception of the developed 7Es LeaP

Statements	Strongly agree		Agree		Disagree		Strongly disagree	
	f	%	f	%	f	%	f	%
1. I learned a lot about the digestive system using the 7Es LeaP.	42	100	-	-	-	-	-	-
2. I am satisfied with the learning contents using the 7Es LeaP.	41	97.6	1	2.4	-	-	-	-
3. I enjoyed the 7Es LeaP.	40	95.2	2	4.8	-	-	-	-
4. I believe the developed 7Es LeaP on the digestive system is a useful learning tool.	38	90.5	4	9.5	-	-	-	-
5. I will share what I have learned with my classmates/friends.	35	83.3	6	14.3	-	-	1	2.4

Several factors may have contributed to these highly favorable perceptions. The colorful illustrations, tactile components, and gamified tasks embedded within each phase of the 7Es likely made the learning experience more accessible and enjoyable for young learners. As one student wrote in the feedback form, *"I like learning with LeaP more because it has interesting pictures and games. It helps me understand what happens to my food."* Such comments suggest that the material successfully bridged conceptual content with age-appropriate visual and interactive elements, leading to higher learner engagement. Additionally, the structure of the LeaP allowed for autonomy in learning, enabling students to review, manipulate, and complete tasks at their own pace—an important feature for fostering learner agency at the elementary level.

However, the overwhelmingly positive responses must also be interpreted with caution. Given that the data were collected through self-report questionnaires in a school setting, students may have felt inclined to provide favorable feedback out of politeness or a desire to please their teachers and the researchers. This type of social desirability bias is common in perception studies involving children. To minimize such bias, researchers took deliberate steps: i) ensuring that the feedback forms were anonymous; ii) using neutral language in all questionnaire prompts; and iii) emphasizing to students that there were no right or wrong answers and that their responses would not affect their grades or standing in class. Additionally, students were given the opportunity to write comments freely at the end of the form, and the inclusion of unsolicited quotes such as the one suggests that the positive feedback was, at least in part, genuine and unprompted.

These findings underscore the importance of prioritizing student needs when designing instructional materials. A student-centered or process-oriented approach—such as the one used in the LeaP—allows for the integration of diverse learning styles and preferences, resulting in educational experiences that are more resonant and impactful. Abdelmohsen [29] emphasizes the value of needs-oriented educational design, noting that addressing students' humanistic needs and preferred learning styles supports deeper learning and personal connection to the material. Similarly, Azizah *et al.* [30] highlight how the independent curriculum framework empowers educators to tailor content to student competencies and interests, making learning more relevant, enjoyable, and engaging. This flexibility not only supports differentiated instruction but also encourages creativity and innovation in teaching practices. Furthermore, Arifin *et al.* [31] stress the importance of bridging gaps between curriculum goals and learners' actual needs by aligning content with clear learning objectives, ensuring that educational materials fulfill both cognitive and motivational requirements.

4. CONCLUSION

The findings of this study affirm the effectiveness of the 7Es instructional model as a practical framework for implementing constructivist learning theory in elementary science education. The structured phases—elicit, engage, explore, explain, elaborate, evaluate, and extend—provided a scaffold that allowed

learners to actively build new knowledge upon prior understanding, engage in scientific inquiry, and apply their learning in meaningful contexts. The significant improvement in conceptual understanding and procedural knowledge illustrates how constructivist learning, when operationalized through the 7Es model, fosters not only cognitive development but also learner autonomy and motivation. This study contributes to the theoretical discourse by demonstrating that even in resource-constrained educational environments, constructivist principles can be effectively realized through well-designed, low-tech instructional tools like the 7Es LeaP.

Practically, the 7Es LeaP proved to be a valuable and engaging instructional material for teaching the digestive system to grade 6 learners. Expert validation confirmed its alignment with curriculum standards and pedagogical soundness, while learner feedback highlighted its clarity, relevance, and appeal. The portability and interactivity of the material enabled flexible use in various learning settings, promoting both guided instruction and independent learning. The LeaP is thus recommended as a supplementary resource for teachers seeking to implement inquiry-based science instruction, particularly in schools where access to digital media is limited. To extend its impact, future development efforts may adapt the format to other science topics and explore integration into diverse educational contexts.

This study is limited by its focus on a single science topic within a specific grade level and geographic setting, which may constrain the generalizability of the findings. Additionally, while the research captured cognitive and perceptual outcomes, longitudinal effects on learning retention and scientific attitudes remain unexplored. Future research should examine the long-term impact of 7Es-based physical instructional tools and investigate their adaptability across broader age groups, content areas, and instructional modalities. Moreover, integrating learner metacognition and teacher feedback in future validation cycles could further enhance the instructional value and responsiveness of the material.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors state no conflict of interest.

INFORMED CONSENT

Since the participants were underage, both parental consent and student assent were duly obtained.

ETHICAL APPROVAL

This study was conducted in accordance with ethical standards for research involving human participants. Approval was obtained from the appropriate institutional ethics committee.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [A-ISS], upon reasonable request.

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