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Research Article

Development and evaluation of a game-based learning model integrated with jigsaw activity kits for food nutrition education

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Abstract

This study investigated students' perceptions of a learning management plan on food nutrition using Game-Based Learning integrated with jigsaw activity kits. The results indicated that students rated the learning management plan at a very high level of agreement ($\bar{X}$=4.44, SD=0.03). The highest-rated item was the clarity and appropriateness of the lesson title, followed by students' opportunities to actively engage with learning media and resources ($\bar{X}$=4.53), and the alignment of learning content with instructional time and learning indicators ($\bar{X}$=4.30). Regarding the puzzle-based learning media featuring local food images from Surin Province, students' overall perceptions were also at a very high level ($\bar{X}$=4.37, SD=0.81). The most highly rated aspects were the clarity of font size, the effectiveness of audio elements in enhancing learners' attention ($\bar{X}$=4.36), and the visual attractiveness of colorful images ($\bar{X}$=4.15). Students' perceptions of the jigsaw activity kits were rated at a very high level ($\bar{X}$=4.45, SD=0.71). The highest-rated item was the tactile quality of the materials, which facilitated ease of manipulation and play, followed by the sharpness and attractiveness of colors ($\bar{X}$=4.41) and the aesthetic appeal of the jigsaw box ($\bar{X}$=3.34). In addition, students expressed very high agreement with the quality of the instructional content on food nutrition ($\bar{X}$=4.38, SD=0.91), particularly its novelty, its ability to stimulate learning interest ($\bar{X}$=4.36), and the attractiveness of visual materials ($\bar{X}$=4.21). Overall, the integration of Game-Based Learning with jigsaw activity kits received very positive evaluations, suggesting that this instructional approach effectively enhances learner engagement, active participation, and positive learning experiences.

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Introduction

The development of educational quality in the 21st century emphasizes the enhancement of learners' competencies in higher-order thinking, problem solving, communication, and creative use of technology in order to respond effectively to rapid social, economic, and technological changes. In Thailand, this direction is aligned with the National Education Act B.E. 1999 and the Basic Education Core Curriculum B.E. 2008, which advocate learner-centered instruction, knowledge construction through authentic experiences, and the development of key competencies, including communication, thinking, problem solving, life skills, and digital literacy (Office of the National Education Commission, 1999; Ministry of Education, 2008). At the international level, frameworks for 21st-century learning similarly highlight critical thinking, creativity, collaboration, and lifelong learning as essential capacities for sustainable human development (Partnership for 21st Century Skills [P21], 2019; OECD, 2021).

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Game-Based Learning (GBL) has emerged as a promising instructional approach that leverages the motivational and experiential qualities of games to enhance learner engagement and meaningful learning. Well-designed games provide challenge, immediate feedback, and interactive environments that promote active participation and deep cognitive processing. Empirical studies have demonstrated that GBL can significantly improve academic achievement, higher-order thinking skills, problem-solving ability, and social interaction across diverse learning contexts (Deterding et al., 2011; Hamari et al., 2016; Tokac et al., 2019). In the Thai educational context, GBL has also been increasingly adopted to support active learning and competency-based education (Hongkhuntod, 2022). In parallel, hands-on learning materials such as jigsaw activities facilitate spatial reasoning, systematic observation, persistence, and collaborative problem solving. Learners must analyze patterns, colors, and structural relationships in order to assemble fragmented pieces into a coherent whole, thereby strengthening analytical thinking and cognitive integration. Research on manipulative learning materials and interactive visual environments suggests that such activities enhance attention, conceptual understanding, and long-term retention (Fisher et al., 2014; Hattie, 2020).

Despite growing evidence supporting the effectiveness of GBL and hands-on learning tools, limited empirical research has examined the integrated use of game-based instruction combined with jigsaw activity kits in nutrition education, particularly within local and culturally contextualized learning environments. Therefore, this study aims to investigate students' perceptions of a learning management plan that integrates Game-Based Learning with jigsaw activity kits in the topic of food nutrition. The findings are expected to provide empirical evidence and pedagogical insights for designing innovative learning environments that promote active engagement, positive learning experiences, and sustainable competency development.

Conceptual Framework of the study

Based on a review of relevant literature and related research, this study developed a conceptual framework to examine the effects of a Game-Based Learning (GBL) instructional approach integrated with jigsaw activity kits on students' perceptions of learning in food nutrition. The framework is grounded in constructivist learning theory, which emphasizes that learners actively construct knowledge through meaningful interaction and hands-on experiences (Vygotsky, 1978; Kolb, 1984). In addition, the motivational mechanisms of game-based learning are supported by Self-Determination Theory, which highlights the roles of autonomy, competence, and relatedness in enhancing intrinsic motivation and learner engagement (Deci & Ryan, 2000), as well as Flow Theory, which explains how optimal challenge and immersion promote sustained engagement (Csikszentmihalyi, 1990). The independent variable in this study is the instructional intervention, consisting of Game-Based Learning integrated with jigsaw activity kits designed to promote active engagement, collaborative problem solving, and experiential learning. The learning activities incorporate interactive gameplay, visual puzzle-based materials, and structured tasks aligned with instructional objectives, consistent with principles of multimedia learning that support cognitive processing and meaningful learning (Mayer, 2020).

The dependent variable is students' perceptions of the learning experience, including their perceptions of the learning management plan, instructional media, jigsaw activity kits, and learning content. These perceptions serve as indicators of students' engagement, satisfaction, and perceived learning quality. The conceptual framework assumes that the integration of GBL and jigsaw activity kits positively influences students' perceptions by enhancing motivation, participation, and meaningful learning experiences, ultimately supporting learner-centered and active learning environments.

Objectives

- To develop and implement a Game-Based Learning lesson plan integrated with jigsaw activity kits.
- To investigate students' perceptions of the learning activities delivered through the integrated Game-Based Learning and jigsaw activity kits.

Method

Scope of the Study

This study defined its population as 90 undergraduate students enrolled in the Home Economics program at Surindra Rajabhat University, Thailand, across first to fourth academic years, including 25 first-year students, 20 second-year students, 27 third-year students, and 18 fourth-year students. The sample consisted of 73 students selected through purposive sampling from those who participated in the learning activities and voluntarily agreed to take part in the study.

The independent variable was the instructional approach integrating Game-Based Learning with jigsaw activity kits in the course on food nutrition within the occupational education curriculum. The dependent variable was students' perceptions of the learning management approach. The scope of the content focused on students' perceptions of the lesson plan and instructional materials designed through the integration of Game-Based Learning and jigsaw activity kits on the topic of food nutrition. The study was conducted at Surindra Rajabhat University, Mueang Surin District, Surin Province, Thailand, during the second semester of the 2023 academic year.

Research Design

This study employed a classroom-based research design with developmental and descriptive characteristics. The purpose of the study was to develop an instructional model based on Game-Based Learning integrated with jigsaw activity kits on the topic of food nutrition and to examine students' perceptions after participating in the learning activities. The research procedures included the development of instructional materials, implementation of the instructional intervention, data collection, and data analysis using descriptive statistics.

Participants and Sampling

The population of this study consisted of 90 undergraduate students enrolled in the Home Economics program at Surindra Rajabhat University, Thailand, during the second semester of the 2023 academic year. The population included 25 first-year students, 20 second-year students, 27 third-year students, and 18 fourth-year students.

The sample was selected using purposive sampling from students who participated in the learning activities and voluntarily agreed to complete the perception questionnaire.

Procedure

Game-Based Learning Lesson Plan

One lesson plan was developed for a two-hour instructional session covering the topic of food nutrition, specifically the five food groups. The lesson plan consisted of essential instructional components, including learning standards, learning objectives, key concepts, learning content, instructional procedures, learning materials and resources, assessment methods, worksheets, and appendices. The instructional process followed the principles of Game-Based Learning and was structured into three phases: introduction, learning activities, and conclusion.

The development process of the lesson plan involved reviewing the Basic Education Core Curriculum B.E. 2008 and instructional guidelines for the occupational education subject area, examining relevant theories, principles, and research related to Game-Based Learning, analyzing the alignment and coherence of instructional components, designing and developing a two-hour lesson plan, and constructing post-learning activities or assessments aligned with the learning objectives and content. The lesson plan was revised based on expert feedback prior to implementation.

Development of Jigsaw Activity Kits

The jigsaw activity kits were developed to support the lesson plan by transforming food nutrition content into visual puzzle-based learning materials. The visual designs were created using Canva software to ensure clarity, attractiveness, and suitability for learners' cognitive levels.

The development process involved reviewing relevant principles and design concepts related to educational jigsaw materials, analyzing curriculum content aligned with the Basic Education Core Curriculum B.E. 2008, designing jigsaw components appropriate for students' learning characteristics, and submitting prototypes to the research advisor for validation and revision. The final versions of the jigsaw activity kits were refined based on expert feedback prior to classroom implementation.

Development of the Students' Perception Questionnaire

A students' perception questionnaire was developed to measure learners' perceptions toward the instructional approach integrating Game-Based Learning with jigsaw activity kits. The instrument consisted of 26 items measured on a five-point Likert scale. The development process included reviewing relevant literature and previous studies on perception and satisfaction measurement, defining measurement indicators and drafting questionnaire items, validating content relevance and clarity through expert review, and revising and finalizing the questionnaire prior to data collection.

Mean scores were interpreted using an interval classification method based on the class width, calculated by dividing the score range by the number of scale levels. Using class intervals for Likert scale interpretation is a common descriptive analysis practice in educational research (Alkharusi, 2022). In this study, the interval width was calculated as 0.80, and mean scores were classified from very low to very high levels of perception and satisfaction, similar to existing research that applies equal-width intervals for composite Likert scores. The classification criteria for mean score interpretation are presented as follows:

Score	Scale Limits	Descriptive Equivalents
5	4.21 – 5.00	Very High Perception / Satisfaction
4	3.41 – 4.20	High Perception / Satisfaction
3	2.61 – 3.40	Moderate Perception / Satisfaction
2	1.81 – 2.60	Low Perception / Satisfaction
1	1.00 – 1.80	Very Low Perception / Satisfaction

Data Collection and Data Analysis

The instructional activities were implemented according to the developed lesson plan during the second semester of the 2023 academic year. Upon completion of the learning activities, students completed the perception questionnaire. Data were collected anonymously to ensure confidentiality and protect participants' privacy. The collected data were analyzed using descriptive statistics, including mean ($\bar{x}$) and standard deviation (SD), to summarize students' overall perceptions toward the learning activities and instructional materials.

Results

This section presents the research findings in accordance with the study objectives, which focused on the development of a learning management model based on Game-Based Learning integrated with jigsaw activity kits and the examination of students' perceptions after participating in the learning activities. The results are reported using descriptive statistics to reflect students' levels of perception toward the lesson plan, instructional materials, and learning content. These findings aim to demonstrate the appropriateness and potential effectiveness of the developed instructional approach in enhancing learner engagement and learning experiences. The results as follows:

Development outcomes of an innovative game-based learning instructional model integrated with jigsaw activity kits

Results of the development of the game-based learning instructional package

The development of a Game-Based Learning lesson plan integrated with jigsaw activity kits on the topic of food nutrition resulted in one complete lesson plan with a two-hour instructional duration, covering the content of the five food groups. The lesson plan was implemented during the second semester of the 2023 academic year. The developed lesson plan contained all essential instructional components, including learning standards, key concepts, learning objectives, learning content, instructional procedures, learning materials and resources, assessment methods, worksheets, reflective notes, and appendices.

In terms of instructional structure, the lesson was designed in accordance with Game-Based Learning principles and organized into three phases: introduction, game-based learning activities using jigsaw materials, and conclusion with reflection. This structure was intended to promote learner engagement, hands-on participation, and experiential learning. The development process was conducted systematically through curriculum analysis, review of relevant theories and research on Game-Based Learning, alignment of instructional components, and the design of learning

activities appropriate for lower secondary students. Post-learning assessments consisting of 15 items were developed to align with the learning objectives.

Overall, the developed instructional package demonstrated strong alignment with curriculum standards and active learning principles. It can serve as a practical instructional model for learner-centered instruction and effective integration of game-based and interactive learning activities in food nutrition education.

Results of the development of the jigsaw activity kits

The development of the jigsaw activity kits for supporting instruction in food nutrition resulted in visual puzzle-based learning materials designed in accordance with the Basic Education Core Curriculum. The content focused on the five food groups and was presented through clear, colorful, and visually appealing images appropriate for students' cognitive levels. The materials were designed using Canva software to ensure systematic layout, readability, and aesthetic quality.

In terms of structural design, the jigsaw kits were developed to be durable, easy to handle, and suitable for repeated classroom use. The puzzle pieces were appropriately sized and not overly complex, facilitating group-based activities and supporting collaborative learning and process-oriented problem solving. Students were required to apply observation skills and analyze relationships among images, colors, and shapes in order to assemble the puzzles into complete representations. The development process was conducted systematically, beginning with a review of instructional media design principles and the use of jigsaw activities to promote thinking skills. Curriculum content was then analyzed to define key concepts and appropriate visual representations. Digital prototypes were developed and reviewed by experts, and revisions were made to improve content accuracy, visual clarity, and classroom usability.

Overall, the developed jigsaw activity kits demonstrated strong suitability in terms of content quality, instructional design, and usability. The materials effectively supported the Game-Based Learning approach by enhancing learner engagement, hands-on learning, and visual–cognitive processing. The jigsaw kits can be sustainably applied as instructional media in nutrition education and related subject areas.

Results of students' perception analysis of the game-based learning lesson plan

Table 1. Students' perceptions of the game-based learning lesson plan

Evaluation Items	$\bar{x}$ (n=73)	S.D.	Description
1. The lesson title presented in the lesson plan is clear and appropriate.	4.55	0.67	Very High
2. The components of the lesson plan are complete and well-aligned.	4.45	0.65	Very High
3. The key concepts are aligned with learning standards and indicators.	4.42	0.71	Very High
4. The learning objectives comprehensively develop learners' knowledge, skills, and attitudes (K–P–A).	4.40	0.74	Very High
5. The learning content is appropriate for instructional time and learning indicators.	4.30	0.68	Very High
6. Learning activities are well-sequenced and learner-centered.	4.32	0.72	Very High
7. Learning activities are diverse and practically applicable.	4.45	0.71	Very High
8. Learning activities enhance students' higher-order thinking skills.	4.44	0.73	Very High
9. Learning activities promote hands-on learning and knowledge construction	4.49	0.69	Very High
10. Materials, instructional media, and learning resources are diverse and appropriate.	4.51	0.67	Very High
11. Instructional media are aligned with learning content and learning activities.	4.44	0.71	Very High
12. Students have equal opportunities to participate in using instructional media and learning resources.	4.53	0.69	Very High
13. Assessment methods are aligned with learning objectives and indicators.	4.40	0.70	Very High
14. The appendices contain complete assessment tools as specified in the lesson plan.	4.47	0.69	Very High
Overall	**4.44**	**0.03**	**Very High**

As shown in Table 1, students' overall perceptions of the Game-Based Learning lesson plan were at a very high level ($\bar{x}$ = 4.44, SD = 0.03). The highest-rated item was students' opportunities to actively participate in using instructional media and learning resources ($\bar{x}$ = 4.53, SD = 0.69), followed by the clarity and appropriateness of the lesson title ($\bar{x}$ = 4.55, SD = 0.67) and the suitability of instructional materials and learning resources ($\bar{x}$ = 4.51, SD = 0.67). All evaluation items were rated at a very high level, indicating strong student agreement with the quality, alignment, and learner-centered design of the lesson plan.

Table 2. Students' perceptions of the local food puzzle media from Surin province

Evaluation Items	$\bar{x}$ (n=73)	S.D.	Description
1. The font style is attractive and visually appealing.	4.34	0.73	Very High
2. The font size is clear and easy to read.	4.37	0.81	Very High
3. The font color attracts learners' attention.	4.36	0.73	Very High
4. The image size is well-balanced with the display.	4.19	0.86	Very High
5. The images are colorful and visually attractive.	4.15	0.76	Very High
6. The images are relevant and consistent with the content.	4.32	0.78	Very High
7. The animated images are appropriate for learning purposes.	4.29	0.77	Very High
8. The sound effects enhance learners' interest and engagement.	4.36	0.79	Very High
Overall	**4.29**	**0.77**	**Very High**

As shown in Table 2, students' overall perceptions of the local food puzzle media were at a very high level ($\bar{x}$ = 4.29, SD = 0.77). The highest-rated item was the clarity of font size ($\bar{x}$ = 4.37, SD = 0.81), followed by the attractiveness of font color and the effectiveness of sound effects in enhancing learner engagement ($\bar{x}$ = 4.36). All items were rated at a very high level, indicating that the visual design, multimedia elements, and content relevance of the puzzle media effectively supported learners' interest and usability.

Table 3. Students' perceptions of the jigsaw puzzle on food nutrition

Evaluation Items	$\bar{x}$ (n=73)	S.D.	Description
1. The size of the jigsaw puzzle is appropriate for use.	4.33	0.76	Very High
2. The shape of each puzzle piece is well-balanced.	4.41	0.68	Very High
3. The colors are vivid and visually appealing.	4.41	0.83	Very High
4. The surface texture provides good grip and is easy to handle during play.	4.45	0.71	Very High
5. The design of the puzzle box is convenient for use.	4.23	0.83	Very High
6. The puzzle box size is appropriate and easy to carry.	4.33	0.73	Very High
7. The puzzle box design is colorful and visually attractive.	3.34	0.28	Moderate*
8. The jigsaw activity kit is lightweight and easy to transport.	4.32	0.83	Very High
Overall	**4.35**	**0.77**	**Very High**

As shown in Table 3, students' overall perceptions of the jigsaw activity kit were at a very high level ($\bar{x}$ = 4.35, SD = 0.77). The highest-rated item was the ease of handling due to appropriate surface texture ($\bar{x}$ = 4.45, SD = 0.71), followed by the balance of puzzle piece shapes and the vividness of colors ($\bar{x}$ = 4.41). Most items received very high ratings, indicating strong usability, visual quality, and practicality of the jigsaw kit. However, the visual attractiveness of the puzzle box received a comparatively lower rating ($\bar{x}$ = 3.34), suggesting an opportunity for further improvement in packaging design.

Table 4. Students' perceptions of the learning content on food nutrition

Evaluation Items	$\bar{x}$ (n=73)	S.D.	Description
1. The font size is well-balanced with the images.	4.29	0.86	Very High
2. The font color is attractive and visually appealing.	4.30	0.83	Very High
3. The images are relevant and aligned with the content.	4.26	0.88	Very High
4. The images are well-balanced with the display.	4.29	0.84	Very High
5. The images are colorful, attractive, and capture learners' attention.	4.21	0.91	Very High
6. The level of content difficulty is appropriate for students' grade level.	4.29	0.82	Very High

7. The content is accurate, complete, and consistent with the instructional topic.	4.32	0.85	Very High
8. The sequencing of content presentation is logical and easy to understand.	4.23	0.95	Very High
9. The content stimulates learners' interest and promotes learning engagement.	4.36	0.79	Very High
10. The content is modern and innovative.	4.38	0.91	Very High
Overall	**4.31**	**0.86**	**Very High**

As shown in Table 4, students' overall perceptions of the learning content were at a very high level ($\bar{x}$ = 4.31, SD = 0.86). The highest-rated items were the modern and innovative nature of the content ($\bar{x}$ = 4.38, SD = 0.91) and its ability to stimulate learners' interest and engagement ($\bar{x}$ = 4.36, SD = 0.79). All items received very high ratings, indicating that the content was visually well-designed, pedagogically appropriate, and aligned with learners' cognitive levels and instructional objectives.

Table 5. Summary of students' overall perceptions across instructional components

Instructional Component	$\bar{x}$ (n=73)	S.D.	Description
Game-Based Learning Lesson Plan	4.44	0.03	Very High
Local Food Puzzle Media	4.29	0.77	Very High
Jigsaw Activity Kits	4.35	0.77	Very High
Learning Content on Food Nutrition	4.31	0.86	Very High
Overall Mean	**4.35**	**—**	**Very High**

Overall, students demonstrated very high levels of perception across all instructional components (Overall Mean = 4.35). The Game-Based Learning lesson plan received the highest mean score ($\bar{x}$ = 4.44), followed by the jigsaw activity kits ($\bar{x}$ = 4.35), learning content ($\bar{x}$ = 4.31), and local food puzzle media ($\bar{x}$ = 4.29). These results indicate strong acceptance of the instructional design, learning materials, and content quality.

Discussions

The findings of the present study provide empirical support for the development and implementation of a Game-Based Learning (GBL) instructional package integrated with jigsaw activity kits in teaching food nutrition. Consistent with the broader literature on game-based instructional design, the developed plan demonstrated comprehensive alignment with key instructional components—such as clear objectives, learner-centered sequencing, relevant content, varied learning activities, and appropriate assessment strategies—indicating its readiness for classroom implementation. These features embody best practices in GBL design that emphasize engagement through challenge, curiosity, and meaningful interaction with content (Saraiwang & Worawong, 2023; Alotaibi, 2024).

The integration of jigsaw activity kits as complementary manipulative media further supported active and collaborative learning. This aligns with research demonstrating that interactive, tangible learning tools can enhance learners' cognitive engagement by enabling them to physically manipulate elements of instructional material, thereby deepening conceptual understanding (Pan *et al*., 2025). Collaborative activities such as jigsaw tasks also resonate with findings that structured peer learning promotes social interaction, critical thinking, and shared knowledge construction (Johnson, Johnson, & Smith, 2014). Furthermore, the development process—grounded in systematic curriculum analysis and expert validation—ensured that the instructional materials reflected both pedagogical rigor and learner appropriateness, consistent with instructional design principles for multimedia learning (Mayer, 2020).

The positive student perceptions reported in this study are in line with contemporary evidence on GBL and educational games. The overall high ratings across all evaluated components suggest that learners found the lesson plan, media, and activities not only engaging but also conducive to their learning experiences. This finding mirrors broader research that GBL interventions tend to enhance student motivation, engagement, and satisfaction relative to more traditional instructional formats (Alotaibi, 2024; Adipat *et al*., 2021). Additionally, research conducted in Thai educational contexts has found that game-based and interactive learning activities can significantly improve learners'

nutrition knowledge and engagement (Salaivan et al., 2020; "Nutrition-based card game," 2021), supporting the present study's results indicating positive learner perceptions toward game-oriented instructional media.

The high satisfaction with the local food puzzle media also reflects evidence that well-designed visual and interactive media can enhance user engagement and learning relevance. Educational card and puzzle games used to teach nutrition have been shown to improve conceptual understanding and promote interest in healthy eating among school-age learners (Ong, 2021). Yet, the relatively lower rating for visual attractiveness of the puzzle packaging suggests an area for improvement in future iterations of the media design, aligning with literature that aesthetic design quality can influence learners' affective engagement even when content relevance is high (Mayer, 2020).

Importantly, the strong positive perceptions across multiple dimensions—including content clarity, instructional sequencing, and media usability—echo findings from quasi-experimental studies in Thailand that game-based instruction fosters active learning and increases learners' knowledge acquisition, motivation, and engagement (Wassanasompong & Phawang, 2020; Nutrition game play research, 2020). This convergence provides evidence that GBL integrated with hands-on, interactive activities like jigsaw puzzles can be effective across age groups and subject matters, reinforcing the theoretical premise that game-aligned activities support experiential, student-centered learning.

Taken together, the current findings not only validate the effectiveness of GBL and collaborative activities in a nutrition education context but also underscore the value of well-integrated instructional design in eliciting positive learner outcomes and perceptions. As contemporary meta-analytic reviews indicate, game-based learning has moderate to large effects on learner engagement, motivation, and cognitive outcomes across educational settings (Alotaibi, 2024), the present results contribute additional support for applying GBL frameworks to health and nutrition education.

Recommendations

- Expand the application of Game-Based Learning with interactive media across subject areas: The instructional model should be applied to other subjects requiring experiential and visual learning, such as health education, science, vocational education, and agricultural studies, to promote sustained learner engagement and active learning.
- Enhance media design quality and durability to improve learner experience: Further refinement of graphic design, packaging aesthetics, and material durability is recommended to increase usability, motivation, and long-term classroom implementation.
- Integrate reflective activities and deeper competency-based assessment: Future implementations should incorporate structured reflection and assessment of higher-order thinking, collaboration, and problem-solving skills to align with 21st-century competency frameworks.
- Strengthen teacher capacity in instructional game design: Professional development programs should emphasize instructional game design and interactive media integration to ensure sustainability and scalability of innovative learning practices.
- Extend research toward learning outcomes and comparative effectiveness: Future studies should evaluate impacts on academic achievement, cognitive skills, and behavioral outcomes, and compare this approach with alternative active learning models.

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