

Empowering village health volunteers in Ubon Ratchathani Province through experiential learning models: Enhancing understanding of hyperglycemia and kidney health

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ABSTRACT

This study investigated the impact of integrating experiential learning activities into a physical learning model to enhance conceptual understanding of hyperglycemia and its effects on kidney function. Participants were local residents engaged through Village Health Volunteer (VHV) outreach, with limited prior knowledge of the topic. This study aims to explore participants' understanding and perceptions of the physical learning models after a brief, structured intervention. A mixed-methods approach was employed. Forty participants attended a one-hour training session incorporating experiential learning into the physical model. Pre- and post-tests measured conceptual understanding. Perceptions were gathered through a 5-point Likert-scale questionnaire, and semi-structured interviews were held to explore participants' learning experiences. The results show significant improvements in several core areas, particularly in understanding the *Signs of Diabetes Mellitus* ($p = 0.001$), *Kidney Structure and Function* ($p < 0.001$), and the *Effects of Chronic High Blood Sugar* ($p = 0.026$). Qualitative feedback linked these gains to the use of physical models that helped participants visualize internal structures. In contrast, no significant changes were observed in *Glucose Uptake* ($p = 0.248$) and *Diabetes Mellitus Risk* ($p = 0.564$). Qualitative data showed participants preferred practical information over complex details. Participants reported high levels of satisfaction with the learning activities, including perceived benefits (4.85 ± 0.43), interest (4.83 ± 0.46), and understanding of diabetic kidney disease (4.82 ± 0.44). Some concerns were raised about time constraints and applying knowledge in practice. Interviews confirmed improved foundational knowledge and an intent to apply the acquired learning in daily life. In conclusion, experiential learning with physical models enhanced understanding and engagement, even in a brief session. Limited time, however, constrained deeper exploration. Focusing on practical, easy-to-grasp content may boost engagement in complex areas. Moreover, scaling this approach may improve health education for underserved communities. Future research should assess its effectiveness across a range of topics and formats.

Keywords:

hyperglycemia, diabetes education, experiential learning, physical model, village health volunteers

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INTRODUCTION

Diabetes mellitus (DM) is a growing concern in Thailand, particularly among individuals with unhealthy lifestyles,¹ such as having poor eating habits and other harmful behaviors. According to a report by the International Diabetes Federation,² approximately 2.4 million people in Thailand are living with undiagnosed diabetes. Alarming, nearly 40% of individuals with diabetes are unaware of their condition. Nevertheless, understanding the mechanisms behind DM is essential for developing effective prevention and management strategies.^{3,4} Poorly managed DM significantly damages both the nervous system and blood vessels,⁵ leading to various adverse effects on multiple organs. One of the key indicators of DM is elevated blood glucose levels, known as hyperglycemia, and chronic hyperglycemia, which can result in numerous health complications.⁶⁻⁸ A notable complication is kidney damage caused by impaired small blood vessels in the kidneys, referred to as “Diabetic Kidney Disease (DKD).”⁸

Timely diabetes education has proven to be highly effective in managing blood sugar levels and reducing complications.⁹⁻¹² However, individuals with limited knowledge of DM and its consequences often struggle to maintain a healthy lifestyle.^{13,14} This highlights the crucial role of education in motivating and empowering people to take active responsibility for their daily dietary choices.¹⁵ A basic understanding of body systems, along with consistent self-management, is essential,³ especially for those at risk of Type 2 DM, who may remain undiagnosed until significant damage has already occurred.

This study focuses on individuals who received support or services from Village Health Volunteers (VHVs), referred to here as VHV visitors, as the primary target group. VHVs serve as a vital

bridge between healthcare providers and their communities, particularly in remote areas of Thailand where access to technology and healthcare facilities is limited. For more than four decades, VHVs have played a crucial role in delivering primary healthcare across the country, supported by a network of 1.04 million volunteers under the oversight of the Ministry of Public Health.¹⁶⁻¹⁸ As community health leaders, VHVs are instrumental in helping communities safeguard themselves from chronic diseases.¹⁸ For example, they support individuals at risk of diabetes by enhancing their self-management skills²⁰ and contribute to the efficacy of integrated care models designed to prevent and slow the progression of chronic kidney disease (CKD).²¹ Acting as conduits for knowledge and behavioral change, VHVs benefit both their families and the wider community.¹⁶ However, a recent study has highlighted the need for offline learning options to address infrastructure limitations in rural areas.¹⁹ The participants in this study, the VHV visitors, were local residents with limited prior knowledge of the subject, further emphasizing the essential role VHVs play in reaching and educating underserved populations.

Research objective

The objective of this study, therefore, is to explore the impact of experiential learning through a physical model on learners’ understanding of hyperglycemia and its effects on kidney function. This approach is well-suited to the participants’ educational needs as it provides a tangible, interactive method to grasp complex physiological processes, which can be challenging to comprehend through traditional didactic methods alone.²² This study also investigated learners’ perceptions of how effectively the physical model enhances their understanding, as well as the benefits and satisfaction they gain from the experience.

To achieve these objectives, we developed a kidney learning model integrated with educational activities grounded in Kolb's experiential learning theory.^{23,24} Rooted in John Dewey's concept of "learning by doing," the model is designed for use by local medical assistants, such as nurses and medical technicians, to educate villagers about the symptoms of Type 2 DM.

In addition to empowering the villagers, this study aims to contribute to community health education by improving the understanding of how health literacy develops in local communities. Insights into learners' perceptions help identify effective learning strategies and areas where comprehension is challenging. This information can inform educational approaches and improve the delivery of health education. Beyond rural Thailand, the findings from this study have the potential to inform health education efforts in other low-resource settings. The integration of experiential learning with a tangible physical model presents a scalable, cost-effective, and culturally adaptable strategy for enhancing health literacy, especially among populations with limited access to formal healthcare or digital learning resources. This model could inform future community health strategies and policy decisions aiming to reduce the global burden of chronic diseases like diabetes.

Research questions

Based on these justifications, this study investigated the educational impact of a physical learning model designed around experiential learning principles. To guide this investigation, the following research questions were developed:

Primary research question:

1. What is the effect of experiential learning through a physical learning model on learners' conceptual understanding of

hyperglycemia and its impact on kidney function?

Secondary research questions:

2. What do learners perceive about the incorporation of a physical learning model into the learning process?

3. What benefits and satisfaction do learners derive from their learning experience?

Operational definitions

To support the clarity and precision of this study, key terms used in the research questions are defined operationally. Clearly articulating these terms ensures consistency in data collection and analysis, and enhances the transparency of the research process.

- Conceptual understanding refers to learners' general comprehension of key concepts at an introductory level, including basic kidney components, their functions, and the effects of high blood sugar levels. The focus is on everyday understanding rather than clinical or technical accuracy, emphasizing the ability to explain these ideas in simple, relatable terms.

- Perceptions refer to learners' views, feelings, and judgments about the overall effectiveness of the physical learning model. These were gathered through semi-structured interviews to explore their level of engagement and the perceived relevance of the learning experience.

METHODS

Study design

This study employed both quantitative and qualitative research methods to gain a comprehensive understanding of participants' learning experiences with the physical model. Specifically, a convergent mixed methods design, which is a form of mixed methodology where both types of data are collected concurrently and analyzed

separately before integration, was used.²⁵ Quantitative data, including pre- and post-tests and a Likert-scale questionnaire, were used to assess changes in conceptual understanding and levels of satisfaction. At the same time, qualitative data were gathered through semi-structured interviews to explore participants' reflections, perceptions, and the perceived effectiveness of the learning experience. These datasets were analyzed separately and then integrated during interpretation to allow for triangulation and to capture both measurable learning outcomes and in-depth participant insights. Given the study's focus on both cognitive gains and learner experiences, this methodological approach was deemed most appropriate for addressing the multifaceted nature of the research questions.

Instructional design approach: Rapid prototyping

The research was conducted in Ubon Ratchathani Province, located in northeastern Thailand. Participants attended a one-hour workshop, facilitated by the researcher, to test the learning model prototype. While the duration may seem limited given the complexity of the topics, it was intentionally designed to align with the principles of rapid prototyping (RP), which emphasizes early detection of design flaws and swift iterative improvements in order to avoid costly revisions later.²⁶ In this context, RP was employed to support the quick development, testing, and refinement of the physical learning model and accompanying activities. Feedback from participants and facilitators was gathered with the aim of making immediate improvements to both content and delivery. The goal was not to induce long-term behavioral change, but to assess participants' immediate learning experience and foundational understanding of key concepts, such as hyperglycemia and kidney function. This flexible, user-

centered process enabled the research team to identify practical adjustments and enhance the educational tool's effectiveness within a short timeframe.²⁷

Additionally, keeping the session brief helped minimize disruption to participants' daily routines, which is particularly important in rural communities where individuals may have limited availability due to work and household responsibilities. Insights were gathered through pre- and post-assessments, interviews, and surveys. Within this focused timeframe, the study successfully captured actionable feedback to refine both the content and delivery of the learning model.²⁷

Instructional framework: Kolb's experiential learning cycle

The workshop was created to foster a "direct sense of experience"²³ and relate the learning to participants' daily lives. The learning process follows the four stages of Kolb's experiential learning cycle:^{23,24} concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). This approach should effectively meet the participants' educational needs by offering a hands-on, interactive way to understand physiological processes, which can be difficult to grasp through traditional lecture-based methods alone.²² The conceptual framework of learning instruction, integrated with the learning model, is summarized in Figure 1, which aligns each stage of Kolb's cycle with corresponding physical learning activities. These include interacting with the model to explore the structure of the kidney (CE), identifying and discussing nephron components (RO), simulating blood flow under varying sugar conditions (AC), and applying new knowledge by developing personal lifestyle adjustment plans (AE).

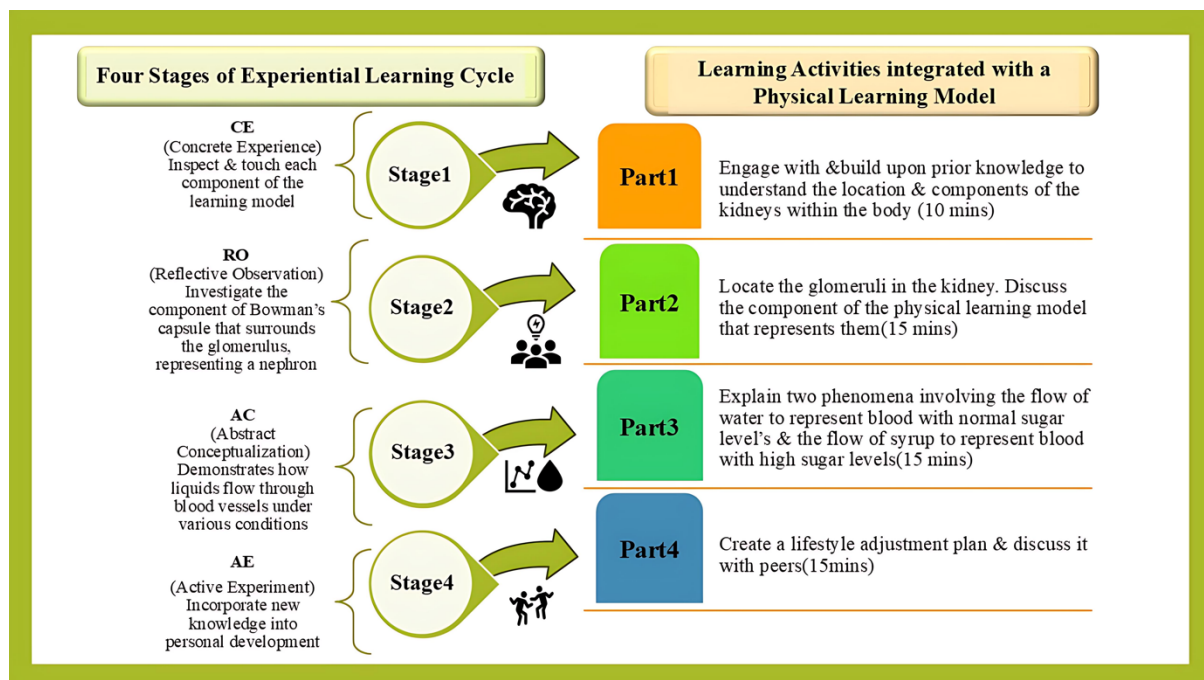


Figure 1. Integration of the experiential learning cycle with physical learning activities

The physical kidney model used in the workshop measured approximately 30 x 20 centimeters and was constructed from lightweight, durable plastic. It included detachable components representing key anatomical features such as the cortex, medulla, and renal pelvis, as well as magnified nephron units to support visibility. Colored water was used to simulate blood flow through the model, helping participants understand filtration processes. This tactile, visual format allowed learners to physically manipulate the model and observe simulated physiological changes, supporting abstract conceptual understanding through concrete experience. To ensure consistency in instruction, the facilitator used a structured teaching guide detailing activity sequences and timing aligned with Kolb's four-stage model. A pilot session was conducted with 10 graduate students at the Institute for Innovative Learning, Mahidol University, to refine the instructional script and ensure clear delivery. Although one facilitator

conducted all sessions, these measures helped maintain consistent content and pacing across participants.

In the CE phase, learners engaged in hands-on activities, allowing them to explore each component of the kidney model and identify its three main parts: 1) the outer layer or "cortex," 2) the innermost part or "medulla," and 3) an expanded funnel-shaped area known as the "renal pelvis." This phase supported the learning objective of helping learners accurately identify and name the kidney's components through tactile and visual exploration.

During the RO phase, participants shared their newly acquired knowledge and reflected on it, with discussions focusing on Bowman's capsule, a component of the nephron that surrounds the glomerulus. Figure 2 shows the learning models used in these two phases. This reflection phase aligned with the objective of reinforcing understanding of key kidney structures and their functions through discussion and peer learning.

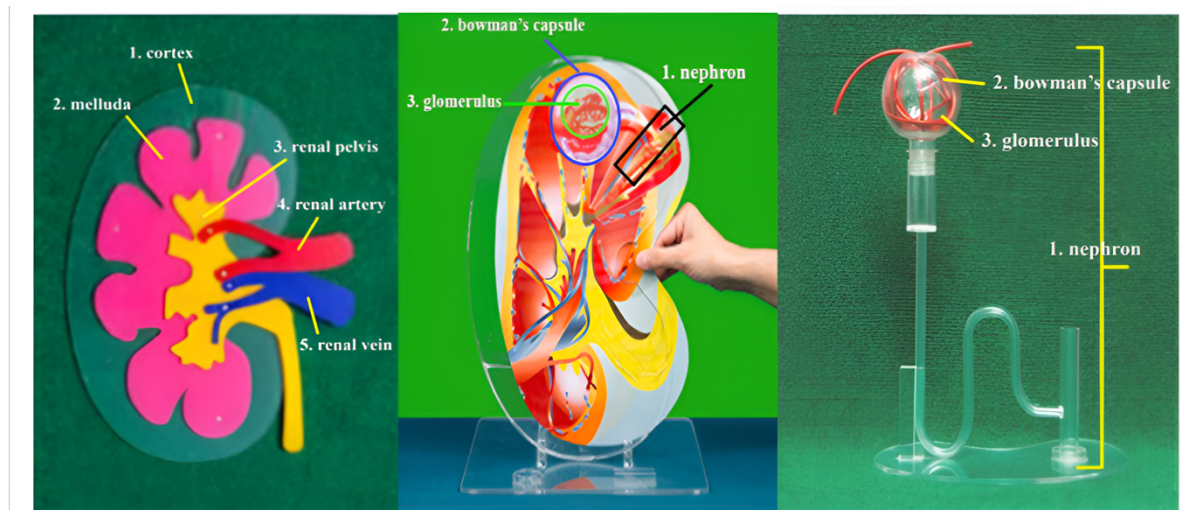


Figure 2. Physical learning models of the kidney

In the AC phase, learners explored analogies and examined the effects of excessive sugar in the blood vessels, which impairs the kidney's filtration function. The discussions focused on hyperglycemia and its role in the development of diabetic kidney disease, including narrowing and hardening of blood vessels, ultimately leading to a loss of the kidney's ability to filter waste in the glomeruli. Participants also learned that hypoglycemia which is caused by factors such as medication, alcohol consumption, or other health issues can potentially lead to kidney failure.²⁸ This stage addressed the learning objective of enabling participants to explain the relationship between blood sugar levels and kidney function, using real-world analogies.

The AE phase addressed the warning signs and symptoms that may indicate potential issues in individuals with hyperglycemia, a condition characterized by elevated blood sugar levels. These signs include dry lips and frequent urination. To encourage active engagement, learners were tasked with applying their conceptual understanding to real-life situations.^{29, 30} They used informational sheets to discuss actions related to risk and to develop plans to adjust their daily habits. This final stage aimed to support the learning objective of applying new knowledge to personal health

behaviors, particularly in preventing or managing diabetes-related complications.

Limitation: Control group

One limitation of the study is the absence of a control group. Without a comparison group, it is not possible to definitively attribute observed changes in conceptual understanding to the intervention alone. While the convergent mixed methods approach offers depth by integrating both quantitative and qualitative insights, the lack of a control group limits the ability to rule out alternative explanations such as test familiarity or placebo effects. This limitation was taken into consideration during both the design and interpretation stages.

Research participants

Participants were recruited through convenience sampling from individuals receiving services from the VHV in Ubon Ratchathani Province. Participants were required to meet the following criteria: 1) any age or gender; 2) a commitment to complete the study; and 3) generally good health, with stable health status for those with diabetes. While convenience sampling may introduce bias, as the sample might not fully represent the general population of VHV visitors, the study followed Cohen's (1988) guidelines:³¹ specifically, an effect

size of 0.5, a power of 0.80, and an alpha of 0.05 were selected to balance feasibility with the ability to detect meaningful differences in conceptual understanding, a primary outcome of interest. These parameters are commonly used in behavioral and educational research when prior data are limited, and they provide sufficient sensitivity to observe changes in small-scale intervention studies. Based on these criteria, a minimum of 30 participants was required. To account for a potential 20% dropout rate and to ensure more robust results and greater reliability, the final sample size was increased to 40 participants.

Ethical approval

This study was conducted following ethical guidelines to ensure the protection of participants' rights. This study received ethical approval from the Research Ethics Committee under the Faculty of Social Sciences and Humanities, Mahidol University (Approval No. COA.No.2013/348.2312, approved on 23 December 2013. Prior to data collection, participants were briefed on the objectives of the study, their right to discontinue participation at any point without penalty, and the steps taken to ensure the confidentiality and protection of their personal information. They were also notified that the ethical clearance had been granted by the Institutional Review Board (IRB), confirming adherence to ethical research practices and prioritizing participant well-being throughout the research process. Written informed consent was obtained from every participant.

To ensure confidentiality, all data were anonymized using participant codes, and no identifying information was included in the analysis or reporting. Audio recordings and transcripts from interviews were stored securely on password-protected devices accessible only to the

research team. These measures were taken to uphold privacy, maintain data security, and ensure compliance with ethical standards.

Research instruments and data collection

Data collection of this research comprised four phases, each employing different methodologies as follows:

Pre-test. The first phase involved administering a pre-test assessment to evaluate participants' initial conceptual understanding of hyperglycemia and its impact on kidney function. The pre-test consists of 20 true/false items, which were reviewed by two experts – a nephrologist and a hemodialysis nurse. Cronbach's alpha reliability coefficients³² for the pre-test were 0.76, indicating a satisfactory level of internal consistency. This value suggests that the items on the pre-test are reliably measuring the intended construct, enhancing the validity of the assessment.

While true/false questions may not capture deeper or more nuanced levels of conceptual understanding, this format was intentionally chosen for several reasons: it is accessible for participants with limited formal education, quick to administer within the one-hour workshop format, and aligned with the study's focus on introductory-level comprehension rather than clinical accuracy. The goal was to assess general understanding in a simple, time-efficient manner appropriate for the target population.

To illustrate the content and scope of the assessment, some sample items are provided below:

- Blood sugar level is an indicator of diabetes.
- People with diabetes will urinate more often at night.
- Kidneys are bean-shaped structures.

- The glomerulus is a small cluster of blood vessels in the kidney.
- All filtrates are left to flow out as urine.

In addition to assessing internal consistency using Cronbach's alpha, the validity of the test items was evaluated through expert review to ensure content relevance and alignment with the intended learning objectives. Three experts participated in the validation process:

- An education specialist from the Institute for Innovative Learning, Mahidol University, with expertise in instructional design and health education for adult learners.
- A nephrologist from a public hospital, specializing in chronic kidney disease and diabetic complications.
- A dialysis nurse from a public hospital, with clinical experience in patient education and kidney health management.

Each expert independently assessed the congruence between the test items and the learning objectives using the Item-Objective Congruence (IOC) method, rating each item on a scale from -1 (not congruent) to +1 (clearly congruent).³³ IOC scores were calculated by averaging the three ratings for each item. All 20 test items achieved IOC scores of 0.50 or higher, indicating acceptable content validity.

Post-test: In the second phase, participants completed a post-test to assess changes in their conceptual understanding after the learning intervention. The post-test, like the pre-test, consisted of 20 true-false items that were parallel to the pre-test questions. Cronbach's alpha reliability coefficient for the post-test was 0.81.

Semi-structured interview: The third phase involved semi-structured interviews to capture participants' reflections on their learning experiences. Four interviews were conducted, and the

data gathered were sufficient for the analysis, with no additional interviews required.³⁴ The principal investigator recorded and transcribed all interviews, which were analyzed to gain insights into the participants' perceptions and experiences.

Questionnaire. The final phase utilized a 5-point Likert scale questionnaire comprising 14 statements to measure participants' perceptions of experiential learning facilitated by the physical learning model. The questionnaire demonstrated a Cronbach's alpha reliability coefficient of 0.74, indicating satisfactory internal consistency. Representative items from the questionnaire include:

- The learning activities were interesting.
- The activities stimulated my thinking.
- During the learning process, I found myself thinking ahead and asking several questions.
- While learning, I reflected on the content, expressed my opinion, and shared ideas with other participants.

Data analyses

Data from the pre- and post-tests were assessed for normality using the Shapiro-Wilk test.³⁵ Results indicated that the data were not normally distributed, leading to employment of the Wilcoxon signed-rank test. This non-parametric method is well-suited for analyzing non-normally distributed data and is particularly effective for comparing two related samples under such conditions.³⁶

The pre- and post-test results were subsequently used to inform the analysis of interview data, allowing us to explore how significant or non-significant test results were mirrored in participants' learning experience. Our goal was to gain insight into participants' gradual development of conceptual understanding for each topic, detailing both their challenges and

achievements in grasping each concept. Interview transcriptions were analyzed using the three-phase method proposed by Miles and Huberman (1994)³⁷ including data condensation, data presentation, and deduction of conclusion.

Interview data were initially coded manually using a hybrid approach that combined both deductive coding (based on the study's conceptual framework and research questions) and inductive coding (to allow emergent themes to surface from participant narratives). Codes were reviewed and grouped into categories, which were then refined into overarching themes. To ensure trustworthiness, a second researcher independently reviewed a subset of the transcripts and coding decisions. Discrepancies were discussed and resolved through consensus, enhancing the credibility and dependability of the analysis. Although formal inter-rater reliability metrics (e.g., Cohen's Kappa) were not calculated due to the exploratory nature and limited size of the interview dataset, this collaborative process helped minimize subjective bias.

After that, themes were compared with pre- and post-test data to identify patterns of alignment or divergence. This triangulation between quantitative and

qualitative results strengthened the interpretive validity of the findings. Additionally, meaningful participant quotations were included to support each theme and preserve the voices of learners, particularly in relation to their learning experiences with the physical model. Finally, questionnaire data were examined and summarized using descriptive statistics in order to capture participants' views on the workshop's benefits and their overall satisfaction.

RESULTS

The demographic data, categorized by age range, educational background, and occupation, are presented in Table 1. The findings reveal that the largest age group is 50-59 years (45%). Additionally, most participants have an educational level lower than a bachelor's degree (67%), while 10% received non-formal education. The majority of participants' occupations are housekeepers/housewives (30%) and employees (27.5%), with equal representation from government officers (27.5%), and smaller proportions being merchants (15%).

Table 1. Demographic profile of study participants: Age, education, and occupation.

Demographic data	Percentage
Age range	
Under 30 years	5
30-39	5
40-49	10
50-59	45
60-69	17
Over 70 years	18
Total	100
Educational background	
Lower than bachelor's degree	67
Bachelor's degree	15
Master's degree	8
Non-formal education	10
Total	100

Demographic data	Percentage
Occupation	
Housekeepers/Housewives	30
Employees	27.5
Merchants	15
Government officers	27.5
Total	100

These characteristics may have influenced learning outcomes in meaningful ways. The high proportion of older adults and individuals with limited formal education suggests that the interactive and visual nature of the physical learning model was especially effective in promoting understanding. Many participants were likely more familiar with learning through experience than through written or lecture-based methods. Additionally, the variety of occupational backgrounds, most of which do not involve technical or scientific work, may have contributed to participants engaging more confidently with concrete, everyday concepts (e.g., symptoms and organ function) while finding abstract biological processes (e.g., glucose absorption) more difficult to grasp. These factors help explain the variation in learning gains observed across different concepts.

The following sections present findings according to the study's four data collection phases, each aligned with a specific research question.

Results from Phase 1 and Phase 2: Pre- and Post-Assessment

These assessments were designed to measure changes in participants' conceptual understanding, thereby addressing Research Question 1 – What is the effect of experiential learning through a physical learning model on learners' conceptual understanding of hyperglycemia and its impact on kidney function? Seven key concepts were assessed: (1) Diagnosis and nature of DM – understanding the medical guidelines used by professionals to diagnose diabetes; (2)

Signs of DM – recognizing common signs that may indicate diabetes-related issues; (3) Glucose uptake – understanding how the body absorbs glucose from the bloodstream for energy use; (4) DM risk – identifying conditions that increase an individual's likelihood of developing diabetes; (5) Kidney structure and function – understanding the components of the kidneys and their role in maintaining bodily function; (6) The role of glomeruli – understanding the essential role of these kidney structures in maintaining internal balance and waste elimination; and (7) Effects of chronic high blood sugar – awareness of long-term complications associated with persistent hyperglycemia.

The Wilcoxon signed-rank test revealed consistent results with varying levels of significance, with five concepts showing statistically significant improvements following the workshop. In contrast, no significant changes were observed for two concepts, as shown in Table 2. To further interpret the practical significance of these findings, Cohen's d^{36} was used to estimate the effect size, where values around 0.2 are considered small, around 0.5 are medium, and 0.8 or above are large. Among the concepts with significant improvements, most demonstrated small to medium effects, suggesting that the workshop had a noticeable, though varying, impact on participants' understanding. This helps to contextualize the impact of the intervention beyond just p -values, highlighting which conceptual areas were more strongly influenced by the workshop.

Table 2. Comparison of conceptual understanding scores before and after intervention using the Wilcoxon Signed-Rank Test. ($N = 39^1$)

Conceptual understanding (20 points)	Pre-test and post-test	N	Sum of ranks	Asymp. Sig. (2-tailed)	Cohen's d
1. Diagnosis and nature of DM	Negative Ranks	0	0		
	Positive Ranks	15	120	<0.001*	0.649
	Ties	24	-	-	-
	Total	39	-	-	-
2. Signs of DM	Negative Ranks	0	0		
	Positive Ranks	14	105	<0.001*	0.261
	Ties	25	-	-	-
	Total	39	-	-	-
3. Glucose uptake	Negative Ranks	4	26		
	Positive Ranks	8	52	0.2669	0.287
	Ties	27	-	-	-
	Total	39	-	-	-
4. DM risk:	Negative Ranks	1	2		
	Positive Ranks	2	4	0.5640	0.134
	Ties	36	-	-	-
	Total	39	-	-	-
5. Kidney structure and function	Negative Ranks	0	0		
	Positive Ranks	21	231	<0.001*	0.608
	Ties	18	-	-	-
	Total	39	-	-	-
6. The role of glomeruli	Negative Ranks	2	9		
	Positive Ranks	8	46	0.0460*	0.273
	Ties	29	-	-	-
	Total	39	-	-	-
7. Effects of chronic high blood sugar	Negative Ranks	2	9		
	Positive Ranks	9	57	0.0288*	0.366
	Ties	28	-	-	-
	Total	39	-	-	-

The three concepts showing the most notable improvement were *Diagnosis and Nature of DM* ($p < 0.001$, $d = 0.649$), *Signs of DM* ($p < 0.001$, $d = 0.261$), and *Kidney Structure and Function* ($p < 0.001$, $d = 0.608$), highlighting the intervention's strong effect on participants' understanding the kidney's role in maintaining bodily functions. The effect sizes for these concepts ranged from small to medium, with the largest effects observed in *Diagnosis and Nature of DM* and *Kidney*

Structure and Function, suggesting a meaningful educational impact.

Additionally, two other concepts, including *The Role of Glomeruli* ($p = 0.0460$, $d = 0.273$) and *Effects of Chronic High Blood Sugar* ($p = 0.0288$, $d = 0.366$), showed statistically significant improvement, accompanied by small to moderate effect sizes. This indicates that the intervention contributed positively to participants' comprehension of these topics, albeit to a lesser extent.

¹Negative Ranks: Post-test scores lower than pre-test scores; Positive Ranks: Post-test scores higher than pre-test scores; Ties: No change between pre- and post-test scores. Asymp. Sig. (2-tailed) indicates the p -value for the statistical test. A p -value ≤ 0.05 is considered statistically significant (marked with *). One participant's response was excluded from analysis due to incomplete data.

In contrast, no significant changes were observed in the concepts of *Glucose Uptake* ($p = 0.2669$, $d = 0.287$) and *DM Risk* ($p = 0.5640$, $d = 0.134$). The small effect sizes and lack of statistical significance suggest that these topics may have been more challenging to convey within the session's constraints or may not have been sufficiently emphasized in the instructional design. The lack of significant improvement could be due to several factors, such as the limited duration of the intervention, its content not being

specifically tailored to target these areas, or an inadequate number of assessment items to detect meaningful change.

Line charts were created to illustrate trends of each item of pre- and post-test assessments across seven key concepts. Overall, the findings suggest that the intervention was successful in enhancing understanding of areas where initial knowledge gaps were more prominent, while maintaining high performance in topics where participants were already well-informed, as shown in Figure 3.

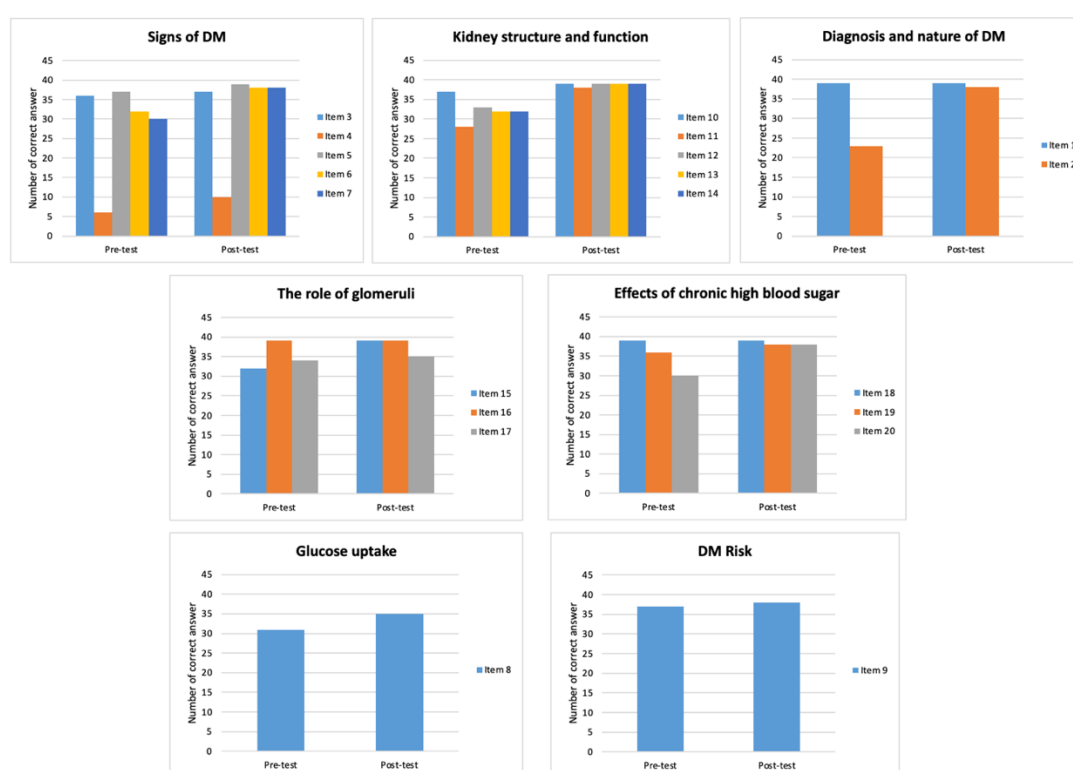


Figure 3. Pre- and Post-test Assessment Scores Across Seven Key Concepts

A consistent trend is observed, with many items showing notable improvement from pre-test to post-test. Among the concepts, *Signs of DM*, *Diagnosis and Nature of DM*, and *Kidney Structure and Function* demonstrated significant gains, as highlighted by the Wilcoxon analysis results. Almost all items under these topics showed a marked increase in scores. Notably, Item 4 in *Signs of DM*, which began with a much lower pre-test score compared to the others, exhibited

significant improvement in the post-test, emphasizing the effectiveness of the intervention in addressing areas with initial knowledge gaps.

Two concepts identified as having significant improvement from the Wilcoxon analysis, including *The Role of Glomeruli* and *Effects of Chronic High Blood Sugar*, exhibited high performance both pre- and post-tests, indicating that participants had strong baseline knowledge in these areas. Conversely, areas such as

Glucose uptake and *DM Risk*, which already had high pre-test scores, demonstrated smaller improvements, likely due to the participants' pre-existing understanding of these topics.

Taken together, these findings indicate that the intervention had a measurable impact on conceptual understanding in key areas, directly addressing Research Question 1.

Results from Phase 3: Semi-structured interviews

To address Research Question 2 – What do learners perceive about the

incorporation of a physical learning model into the learning process? – we analyzed interview data using the three-phase method by Miles and Huberman (1994): data condensation, data presentation, and conclusion drawing.³⁷ Relevant statements from transcripts were condensed to capture participants' thoughts and experiences, then organized to identify recurring patterns. Table 3 summarizes the steps taken during thematic analysis, including examples of data coding and theme development.

Table 3. Thematic analysis process based on Miles & Huberman (1994)

Stage	Description	Application in the study	Examples
Data Condensation	Selecting, simplifying, and transforming raw data into analyzable units.	Transcripts were reviewed and relevant excerpts were extracted and coded. Codes were grouped into categories and refined into themes.	- Original quote: <i>“Actually touching and seeing the model made it much clearer.”</i> → Code: <i>“tactile clarity”</i> - Original quote: <i>“I’d like to hear it explained more clearly and in greater depth.”</i> → Code: <i>“needs elaboration for abstract concepts”</i>
Data Display	Organizing data in a structured way to facilitate interpretation and pattern recognition.	Condensed codes were grouped into thematic matrices with supporting quotes. Visual charts and tables were used to display how themes corresponded to quantitative findings.	- Codes about touching/seeing the kidney model. → Potential theme: Experiencing Concepts Tangibly - Codes about the application of knowledge → Potential theme: Contextual Application of Knowledge - Codes about showing confusion with the abstract concept → Potential theme: Navigating Abstract Thinking

Stage	Description	Application in the study	Examples
Drawing & Verifying Conclusions	Interpreting data patterns and checking them against the broader dataset or existing knowledge.	Themes were compared to test results (Wilcoxon), participant demographics, and Likert ratings to ensure coherence and triangulation. Coding was verified by multiple researchers.	- Wilcoxon test showed no significant change for glucose uptake; interviews reflected confusion, confirming a weak conceptual grasp. - Participant quote: <i>“The image of the glomerulus made me feel fearful...”</i> validated moderate test gain and emotional impact. - Two coders reviewed and agreed on theme categorization after initial coding rounds.

In the high significance group, participants demonstrated strong engagement with the physical model, reflecting on their learning through the tangible representation. We labeled this theme *“Experiencing Concepts Tangibly.”* In the group showing no significant change, participants reflected an initial grasp of DM theoretical foundation, although they encountered challenges with complex concepts such as glucose uptake and DM risk. This theme is termed *“Navigating Abstract Thinking.”* In the moderate significance group, participants connected their new knowledge to real-world contexts, applying what they learned to their daily practice. We named this theme *“Contextual Application of Knowledge.”* To further illustrate these themes, the following quotations from the interview data highlight participants’ perspectives and experiences.

Theme 1: Experiencing concepts tangibly

Data from the interview showed that participants entered the workshop with a foundational understanding of DM, including knowledge about symptoms and blood sugar levels. This aligns with the Wilcoxon test results, which showed good performance on questions about signs of DM and kidney structure and function. This prior knowledge boosted their confidence in answering pre- and post-test questions,

as they felt comfortable with the general topic. One participant noted, *“At first, I didn’t really know much. I had some knowledge about [diabetes] ... and the symptoms, and blood sugar, so I could [do the test]. But when it came to deeper details about the kidneys ... actually touching and seeing the model made it much clearer.”* This excerpt also suggests that the participant recognized a progression in the workshop from basic concepts to more complex details.

Participants pointed out that the model-assisted method provided during the workshop allowed them to visualize and interact with representations of these internal structures. One participant shared, *“I have learned that the kidney is shaped like a bean, just as I learned a long time ago in school, and [the model had] many parts that I could physically touch.”* Furthermore, the data highlighted how tactile and visual interactions with the model reinforced their learning, making kidney structure and function more tangible and understandable. Another participant described it in this way: *“Seeing the twisted blood vessels flowing back upward makes everything so clear. It was a real ‘aha’ moment. Normally, when I think of kidney failure, I would imagine it as a [whole] bean-shaped organ ... I understand it more deeply.”* These insights underscore how physical models facilitated a shift from general knowledge to a more nuanced and

comprehensive understanding of kidney anatomy and its relation to DM complications.

Theme 2: Navigating abstract thinking

Although the physical model effectively illustrated the location and structure of internal organs, it has limitations in demonstrating dynamic processes, such as blood pressure regulation or the impact of high blood sugar on the body. Some bodily functions are abstract and challenging to understand through a physical model or prior knowledge alone. One participant reflected, *“For the demonstration about blood pressure, I’d like to skip this part quickly ... [and rather] talk about the concentration ... high [blood] sugar.”* This comment suggested that participants may struggle to stay engaged with complex details, expressing a preference for practical, straightforward information – particularly regarding DM risk and the influence of dietary habits.

Participants appeared to deprioritize focus on certain complex details, such as glucose uptake and DM risk. Results from the Wilcoxon analysis corroborate this observation, indicating that participants who did not concentrate on these concepts performed poorly on test questions about glucose uptake and DM risk concepts. Extending the duration of sessions and incorporating additional methods to clarify abstract concepts might enhance participants’ understanding and engagement with these complex topics. One participant remarked, *“I’d like to hear it explained more clearly and in greater depth. This session feels too short. I wish we could extend the time to enhance our knowledge and make it more comprehensive. Sometimes, people like us don’t pay much attention to our eating habits.”* This suggests that participants

spent more time grappling with abstract ideas during the workshop, which may have limited their ability to extract clear, practical meaning from the content.

Theme 3: Contextual application of knowledge

This theme highlights participants’ challenges and achievements during the workshop, emphasizing the importance of experiential learning for understanding DM. One participant demonstrated her conceptual understanding by explaining hyperglycemia’s effects; she explained: *“An example ... candied fruits. It shows that if there’s a lot of sugar in the fruit, it will become mushy ... helping to visualize that if blood sugar is high, the ‘netting’ here will start to loosen and spread apart.”* While not medically precise, her interpretation of the “loosening of the netting” illustrates her understanding of how high blood sugar damages small blood vessels and tissues.

Despite these successes, some participants requested additional clarification on complex topics. For example, one participant stated: *“I learned that the blood vessels coming from the heart also supply the kidneys. Actually, the blood leaves the heart and passes through the abdominal area before ... reaching the kidneys. This should be explained a bit more.”* This feedback highlights the need for more time or resources in order to deepen comprehension.

Many participants expressed intentions to adjust their behavior, such as avoiding sweets, eating healthier, exercising, and being more mindful of daily activities. Additionally, the learning model resonated emotionally with participants, reinforcing these intentions. One participant noted, *“The image of the glomerulus used for comparison made me feel fearful of this disease. It was very clear.”*

From this theme, participants recognized the importance of both conceptual clarity and behavioral change in managing DM. Their feedback and emotional responses underscore the value of practical, relatable teaching tools in fostering understanding and motivation. This is further supported by the results of the Wilcoxon analysis, which indicate moderate improvements in participants' understanding of the role of glomeruli and the effects of chronic high blood sugar.

In conclusion, data from semi-structured interviews showed a progression in participants' learning experiences, which aligned closely with their pre- and post-assessment outcomes. Participants described how the physical model enhanced their understanding of tangible

concepts such as kidney structure and symptoms of diabetes, while abstract concepts such as glucose uptake and disease risk remained more challenging. These qualitative insights offer rich perspectives on how learners engaged with the physical model and constructed meaning throughout the workshop, providing direct evidence in response to Research Question 2.

To further strengthen the integration of quantitative and qualitative findings, Table 4 presents a systematic comparison between participants' assessment scores and their reported experiences. This cross-analysis highlights areas of alignment and divergence, helping to explain the variation in learning gains across different diabetes-related concepts.

Table 4. Integration of Quantitative and Qualitative Findings with Thematic Sub-Themes

Qualitative Theme	Sub-Theme / Illustrative Quote	Integration Insight / Interpretation	Concept Area	Quantitative Outcome (Wilcoxon)
Theme 1: Experiencing Concepts Tangibly	<i>"Seeing the twisted blood vessels flowing ... it was a real 'aha' moment."</i>	Strong tactile-visual learning from the model helped participants deepen understanding, aligning with test improvements.	Kidney Structure & Function	Highly significant improvement ($p < 0.001$)
Theme 1: Experiencing Concepts Tangibly	<i>"I had some knowledge ... but touching and seeing the model made it clearer."</i>	Physical model reinforced pre-existing knowledge, enhanced recognition of content; increased confidence, improved post-test scores.	Signs of DM	Significant improvement ($p < 0.001$)
Theme 1: Experiencing Concepts Tangibly	<i>"I could [do the test] because I already had some knowledge about symptoms ..."</i>	Learning built upon prior knowledge; connecting new learning to personal experience, improved assessment outcomes.	Diagnosis & Nature of DM	Significant improvement ($p < 0.001$)
Theme 3: Contextual Application of Knowledge	<i>"Candied fruits ... show how sugar loosens the 'netting'."</i>	Metaphorical thinking helped participants conceptualize internal damage; reinforced by model visuals and test gains.	Role of Glomeruli	Significant improvement ($p = 0.0460$)
Theme 3: Contextual Application of Knowledge	<i>"The image ... made me feel fearful of this disease."</i>	Emotional impact and practical relevance enhanced memory and understanding, explaining score improvement.	Effects of Chronic High Blood Sugar	Significant improvement ($p = 0.0288$)

Qualitative Theme	Sub-Theme / Illustrative Quote	Integration Insight / Interpretation	Concept Area	Quantitative Outcome (Wilcoxon)
Theme 2: Navigating Abstract Thinking	"I'd like it explained more clearly and in greater depth."	Abstract concept not easily visualized with the model; confusion persisted, reflected in stagnant test scores.	Glucose Uptake	No significant change ($p = 0.2669$)
Theme 2: Navigating Abstract Thinking	"People like us don't pay much attention to our eating habits."	Lack of personal relevance and abstraction made risk harder to grasp or apply; less test improvement seen.	DM Risk	No significant change ($p = 0.5640$)

Results from Phase 4: 5-point Likert scale questionnaire

Following the integrated analysis of test performance and interview data, the final phase of data collection focused on participants' overall perceptions of the learning experience. To address Research Question 3 – What benefits and satisfaction do learners derive from their learning experience? – a 5-point Likert scale questionnaire was used to gather quantitative feedback on the perceived effectiveness, relevance, and emotional impact of the physical learning model and associated activities.

The results from the questionnaire indicated that the learning activities were

effective and well-received. The overall mean score (4.58) and low standard deviation (0.20) suggest consistently positive perceptions regarding both the benefits and satisfaction derived from the learning experience. Table 5 presents the mean scores (Mean) and standard deviations (S.D.) for participants' evaluations of the learning activities across two categories: *Benefits of the learning activities* and *Satisfaction toward the learning activities*. Each item reflects specific aspects of knowledge gained or satisfaction with the overall learning process.

Table 5. Mean scores and variability of participants' perceptions of learning activities ($N = 40$)

Item statement	Mean	S.D.
<i>Benefits of the learning activities</i>		
1. I gained knowledge about the effect of high blood sugar on kidney function from this activity	4.72	0.50
2. Doing and experiencing this learning unit made me understand the contents	4.53	0.68
3. The model made me understand the kidney's function	4.78	0.48
4. The model made me understand the deterioration of the kidney in the long-term of high blood sugar	4.82	0.44
5. This activity made me know what I should do to prevent high blood sugar	4.60	0.67
6. Everything they learned in this workshop can be applied in real life	4.48	0.75
<i>Satisfactions toward the learning activities</i>		
7. I have benefited from this activity	4.85	0.43
8. This activity was interesting	4.83	0.46
9. This activity stimulated me to think	4.60	0.59
10. This activity aroused curiosity	4.35	0.74
11. I had the opportunity to share the idea and discuss them with friends	4.50	0.67

Item statement	Mean	S.D.
12. Too little time for this activity	3.85	1.17
13. I am satisfied with this learning activity	4.78	0.42
14. This activity does not waste my time	4.48	0.60
Overall	4.58	0.20

Participants reported high levels of perceived benefits, with mean scores ranging from 4.48 to 4.82, indicating a strong consensus on gaining knowledge, understanding kidney function, and learning about the long-term effects of high blood sugar. The highest-rated item (4.82 ± 0.44) reflects participants' enhanced understanding of how high blood sugar contributes to kidney deterioration, providing direct evidence of improved conceptual understanding consistent with the operational definition used in this study.

Similarly, satisfaction levels were notably high, with mean scores between 3.85 and 4.85. The highest score (4.85 ± 0.43) highlights participants' overall benefit from the activity, while a slightly

lower score (3.85 ± 1.17) suggests that some participants felt the activity may have been too short. These quantitative findings complement the qualitative data and support the interpretation that the physical learning model and experiential activities provided meaningful educational value. Learners not only gained practical knowledge but also found the experience personally engaging and relevant, key indicators of both benefit and satisfaction as defined in the scope of this research. Figure 4 illustrates these findings.

The consistently high scores in both benefit and satisfaction items confirm the model's perceived value, providing a clear response to Research Question 3.

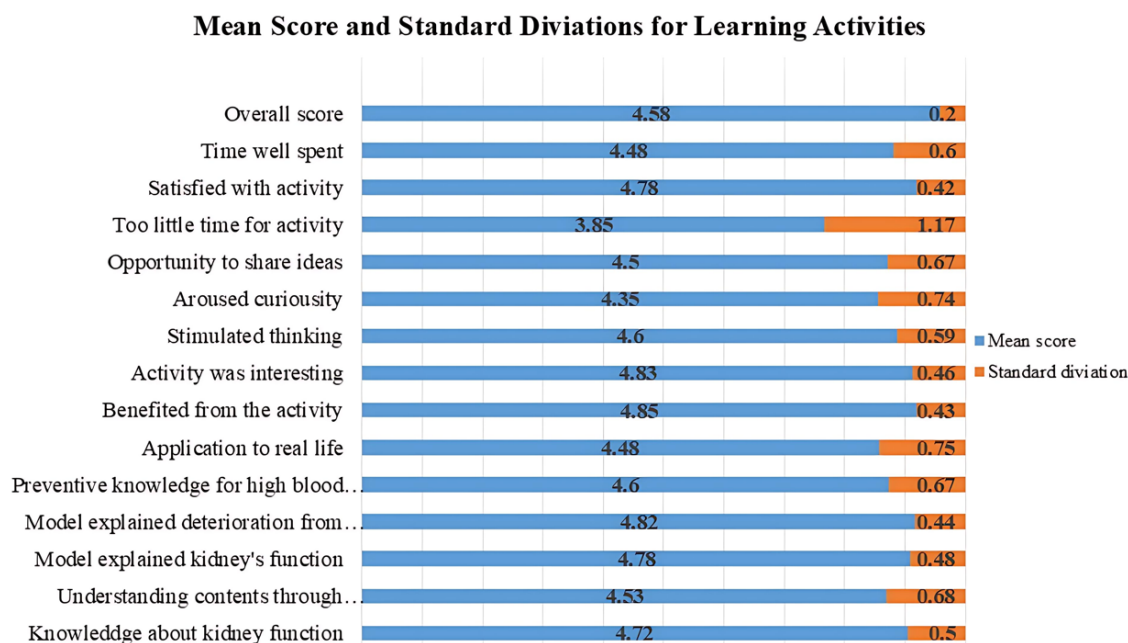


Figure 4. Participants' perceptions of learning activities

DISCUSSION

This section discusses how the use of a physical learning model influenced participants' understanding of hyperglycemia, addressing the central research question on its effectiveness in supporting conceptual learning in a community health context.

Improvement of understanding through physical engagement

This study's findings indicated that participants who engaged in an educational activity using a physical learning model demonstrated improved conceptual understanding of hyperglycemia and its effects across most topics, particularly during the concrete experience (CE) stage of experiential learning.^{23,24} Learning occurred through direct engagement with the subject matter³⁹ as participants interacted physically with the model to explore and connect with new information with their existing knowledge. The physical model acted as a bridge between abstract medical knowledge and practical understanding, especially in areas where participants previously had limited or superficial knowledge.

An interesting finding from the interview data suggested that participants were able to distinguish between surface-level understanding (e.g., general knowledge about diabetes and its symptoms) and deeper, more integrated knowledge (e.g., the role of glomeruli). In the interview, one participant reflected the transition from recognizing basic facts to grasping intricate details. This progression highlights the CE stage as a critical point where tactile and visual interactions with the model fostered deeper insights by emphasizing key structural and functional details. These findings align with previous research showing that physical models enhance learning by anchoring abstract concepts in tangible, memorable experiences, thereby

promoting a more profound understanding of complex topics.⁴⁰

Individual differences and learning trajectories

It is also important to consider that some participants may have entered the study with varying levels of pre-existing knowledge, which could have influenced their learning trajectories.⁴¹ For example, participants with prior exposure to diabetes education or personal experience managing the condition may have had a conceptual foundation that made integration of new information easier. Conversely, others with no such background might have perceived the same content as novel and more difficult to grasp. These differences may partly explain the variability in how deeply participants engaged with the model and retained information, beyond the learning design itself.

Nevertheless, data from the interviews revealed that not all complex concepts were easily understood through the physical model. Some participants expressed difficulty in staying engaged with certain topics and requested more training time. Others suggested skipping some concepts and focusing directly on practical information, such as dietary habits. While time constraints may have limited the depth of exploration, other factors could also have contributed to these challenges. For instance, differences in participants' educational backgrounds, health literacy levels, or prior exposure to medical information may have affected their ability to grasp certain abstract ideas such as blood pressure regulation. Additionally, participants who had limited personal or familial experience with diabetes-related complications may have struggled to relate to certain content, resulting in reduced engagement.

These responses suggest that certain abstract ideas, such as blood pressure, were

hard for participants to grasp. This learning process aligns with Kolb's reflective observation (RO) stage,^{23,24} where participants reflect on their experience and express their need for more relatable, actionable content. Moreover, Kolb's abstract conceptualization (AC) stage is also relevant here, as participants attempted to process these abstract ideas and connect them to their existing knowledge and experience. However, when these connections were weak or absent, learning appeared less effective, highlighting the importance of designing content that considers varying degrees of background knowledge and personal relevance.^{23,24}

Cultural context and community engagement

These findings contribute to broader global research on diabetes education involving community health workers. Studies in low- and middle-income countries have shown that hands-on, experiential approaches can empower community workers to deliver more relatable and effective health education, especially in underserved communities.^{42,43} In the Thai context, the strong role of Village Health Volunteers (VHVs) in local healthcare delivery may have enhanced participants' receptiveness to peer-led learning. Culturally, Thai communities often value interpersonal relationships, collective engagement, and respect for local health figures. This cultural alignment may have contributed to participants' willingness to engage with the learning activity and to consider lifestyle changes based on their new understanding.

Motivation and application to lifestyle changes

Interestingly, despite struggling with abstract concepts, participants expressed a strong desire to learn more about topics that could help them improve their lifestyle. This determination mirrors findings from a previous study on

experiential learning in Type 2 diabetes training programs, which showed that such approaches not only enhanced learners' understanding but also motivated them to actively engage in preventive activities.⁴⁴

In sum, participants' struggles with complex details highlight the need for diabetes education programs that balance abstract information with practical applications. Kolb's Active Experimentation (AE) stage^{23,24} is particularly relevant here, as it demonstrates how final-stage activities help participants focus on planning and committing to changes in behavior. Future diabetes education programs should emphasize practical problem-solving and purposeful inquiry in order to promote actionable outcomes.^{45,46} By actively applying new knowledge to real-life scenarios, participants are encouraged to turn their learning into meaningful lifestyle changes.

This approach is particularly relevant for preventing Diabetic Kidney Disease (DKD), a serious complication of hyperglycemia. Effective lifestyle adjustments, such as reducing sodium intake, losing weight and exercising, are vital for managing and preventing DKD.⁴⁷⁻⁵⁰ Furthermore, controlling blood glucose through a balanced diet and regular exercise is essential for preventing hyperglycemia.⁵¹ By adopting these lifestyle modifications, participants are taking proactive steps to lower their risks of developing DKD, thereby preserving kidney function and preventing further health complications. Additionally, this approach, focused on promoting sustainable lifestyle changes, could be scaled or adapted to address other health conditions, such as hypertension or cardiovascular disease, where similar behavioral modifications are crucial. Implementing such strategies in broader community settings, such as workplaces or local wellness programs, may further enhance public health outcomes by offering

accessible and practical prevention methods beyond diabetes care.

Additionally, peer support, particularly from VHV, plays a critical role in fostering long-term adherence to these health management strategies. Notably, a previous study has shown that VHV can motivate individuals with DM to manage their glycemic levels effectively.⁵² Equipping VHV with hands-on tools and knowledge enables them to actively support community members in adhering to health management plans. This ongoing support helps bridge gaps in areas where technological resources are limited, ensuring sustainable health outcomes within the community.

Limitations and theoretical implications

A limitation of this study is that the findings may not be applicable to wider populations due to the small sample size and lack of a control group, which limit rigorous statistical analysis and overall reliability. Additionally, the use of the convenience sampling method may also mean that the data do not accurately represent the entire target population. Another limitation is the short duration of the study, though this was intentional to allow for a rapid prototyping approach. This method was chosen to quickly test and refine the interventions, enabling iterative improvements based on early feedback.²⁷

Despite these limitations, the observed benefits of employing a physical learning model align with Kolb's theory of experiential learning. According to Kolb,^{23,24} active participation in experiential learning activities accommodates various learner preferences, including visual, auditory, kinesthetic, and tactile styles. These diverse learners integrate information during the questioning and reflection phases, fostering a deeper understanding of the material. Beyond reinforcing Kolb's four stage learning cycle

(CE, RO, AC, AE), the findings offer a contribution to the theory by highlighting the interplay between physical engagement and reflective processing in low-literacy populations. In particular, the CE and AE stages seemed to have the greatest impact, showing that hands-on activities and practical planning are especially important in community-based health education. Furthermore, the challenges some participants faced during the AC stage suggest that additional scaffolding or repetition may be required when introducing abstract content. These insights underscore the adaptability of experiential learning theory in real-world, culturally embedded educational settings and support its relevance beyond formal academic environments.

RECOMMENDATIONS

This study demonstrates the potential of experiential learning in healthcare education, particularly in diabetes management, by effectively enhancing conceptual understanding and encouraging behavioral change. However, to maximize its impact, the following targeted recommendations are proposed, organized by stakeholder group and prioritized for feasibility and impact.

For educators and curriculum developers, it is recommended that future diabetes education initiatives incorporate a more structured progression from concrete to abstract content. As the study revealed, participants struggled with understanding despite showing strong engagement with more tangible elements such as kidney structure and damage due to high blood sugar. To address this, teaching strategies should begin with hands-on, practical applications and gradually introduce more complex ideas using relatable analogies, visuals, or simplified narratives. Structured reflection and goal-setting activities can

also help learners integrate abstract content with their personal health contexts, in alignment with Kolb's Reflective Observation (RO) and Abstract Conceptualization (AC) stages.^{23,24}

Community health workers, particularly VHVs, play a vital role in supporting continued learning and behavior change beyond the initial activity. The experiential learning model used in this study could be adapted into portable, simplified toolkits that VHVs can use during household visits or community workshops. Training VHVs to use these models can bridge knowledge gaps in areas where literacy or access to digital tools may be limited. Given prior research highlighting VHVs' influence on glycemia control,²³ equipping them with physical models and context-appropriate instructional materials can further empower them as frontline educators in diabetes and kidney health management.

Healthcare administrators, who have a key role in implementation, should consider piloting experiential learning modules within existing community health outreach programs. Short-term implementation in targeted regions could help assess feasibility and participant receptivity. While the physical models can be developed at relatively low cost using locally available materials, successful integration will depend on sufficient training for facilitators and clear instructional guidelines. Developing a short certification course for facilitators, focused on learner-centered techniques and model usage, could support sustainable scale-up. Additionally, collecting data on cost-effectiveness, compared to conventional, educational methods would provide valuable insights for resource allocation and broader adoption. Gathering information on how cost-effective this approach is compared to traditional teaching methods could help decide how to use resources and whether to expand the program.

Nationally, policymakers are encouraged to integrate experiential learning strategies into national diabetes prevention frameworks and broader community health initiatives. The physical model approach may also be adaptable to other pressing health issues, such as hypertension, cardiovascular disease, or maternal health, where behavioral change is critical. For example, models illustrating salt intake and its impact on blood pressure, or maternal anatomy models for antenatal care education, could enhance understanding in similarly accessible ways. Involving local government units, schools, and community centers in these efforts can expand reach and promote intersectoral collaboration.

Future research should address methodological limitations identified in this study. The short duration, small sample size, and lack of a control group limited the ability to draw strong causal inferences. To improve rigor, future studies should adopt longer intervention periods and include follow-up assessments to evaluate retention and behavior change. Broader and more representative sampling strategies, including participants from different socio-economic, educational, and cultural backgrounds, will also improve generalizability.

Looking ahead, experiential learning approaches – such as the physical model used in this study – may offer a useful supplement to existing health education strategies, particularly for improving understanding of complex health topics at the community level. While the findings suggest the potential benefits, further research and careful adaptation are needed to determine their effectiveness across diverse settings and populations. With attention to practical implementation, including facilitator training and resource constraints, this model could contribute to more accessible and engaging health education in targeted areas of chronic disease prevention.

AUTHOR CONTRIBUTIONS

BW: Conceptualization, Methodology, Data curation, Writing – original draft. PJ: Conceptualization, Methodology, Supervision. PS: Data curation, Formal analysis, Writing – review & editing. SS: Conceptualization, Formal analysis, Writing – review & editing.

ETHICAL CONSIDERATION

This study received ethical approval from the Research Ethics Committee under the Faculty of Social Sciences and Humanities, Mahidol University (Approval No. COA.No.2013/348.2312, approved on 23 December 2013).

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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