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Designing educational projects for developing low-calorie dessert recipes in the learning process

Kateryna Sydorova,

Bachelor, Specialist, Owner, Pastry Chef-Decorator, Confectionery Shop «One love», Kherson, Ukraine, <https://orcid.org/0009-0009-0010-1163>

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***Abstract.** The study aims to develop a comprehensive theoretical justification for designing and integrating educational projects focusing on creating low-calorie dessert recipes within the secondary school curriculum. It addresses the identified gap in traditional biology and chemistry instruction, which often lacks practical application of nutritional principles. It seeks to foster subject-specific competencies in food science and broader key skills such as critical thinking, collaboration, and digital literacy among students. **Methods.** A systematic theoretical analysis was carried out of contemporary project-based learning (PBL) frameworks and healthy nutrition education approaches in a competency-based context. Core pedagogical principles, including constructivism, active learning, and inquiry-based instruction, were identified. These principles informed the conceptualization of methodological models for organizing school-based dessert projects. A structured conceptual model was then synthesized, detailing logical workflow, timeline, roles, resources, and assessment tools. Finally, a SWOT analysis evaluated the model's internal strengths and weaknesses and external opportunities and threats. **Results.** Findings*



*demonstrate that a phased PBL approach integrating laboratory experiments (e.g., ingredient analysis, caloric calculation) with digital tools (e.g., spreadsheets, simulation apps) effectively engages students in hands-on nutritional science. The model's logical structure and detailed calendar ensure clear progression through the initiation, planning, implementation, and reflection phases. Role distribution among teacher-facilitator, student researchers, and external experts enhances scientific rigor. The SWOT analysis revealed methodological integrity and multi-level support as strengths, resource intensity and project duration as weaknesses, state grants and partnership opportunities as external opportunities, and unstable financing and technical risks as threats to project implementation. **Conclusions.** The proposed conceptual model offers a robust framework for embedding low-calorie dessert projects into school programs. Adaptive resource planning, targeted teacher training, and continuous monitoring mechanisms are essential to ensure successful implementation. The study lays a theoretical foundation for subsequent empirical validation and provides actionable guidance for scaling and adapting the model across diverse educational contexts.*

***Keywords:** low-calorie desserts, project-based learning, Healthy nutrition, Interdisciplinary integration, Competency-based approach, Culinary technology education.*

Формування освітніх проєктів для розробки рецептів низькокалорійних десертів у навчальному процесі

Сидорова Катерина Олександрівна,

бакалавр, спеціаліст, власниця, кондитер-декоратор, кондитерський цех
«One love», м. Херсон, Україна, <https://orcid.org/0009-0009-0010-1163>



Анотація. *Метою* дослідження є розробка комплексного теоретичного обґрунтування створення та інтеграції освітніх проєктів із розробки рецептів низькокалорійних десертів у навчальну програму середньої школи. Робота спрямована на подолання розриву між традиційним викладанням біології й хімії та практичною нутриціологічною освітою, а також на формування в учнів як предметних компетентностей із харчової хімії, так і ключових навичок критичного мислення, командної взаємодії та цифрової грамотності. **Методи.** Здійснено системний теоретичний аналіз сучасних підходів проєктно-орієнтованого навчання в галузі здорового харчування в контексті компетентнісної парадигми. Визначено ключові педагогічні принципи (конструктивізм, активне та дослідницьке навчання) й концептуалізовано методичні моделі організації шкільних проєктів. На основі цих даних синтезовано структуру концептуальної моделі, що включає логіку роботи, календарний план, розподіл ролей, необхідні ресурси та інструменти оцінювання. Проведено SWOT-аналіз моделі освітнього проєкту для виявлення внутрішніх сильних і слабких сторін та зовнішніх можливостей і загроз. **Результати.** Дослідження засвідчили ефективність пофазного проєктно-орієнтованого підходу, який об'єднує лабораторні експерименти (аналіз інгредієнтів, розрахунок калорійності) з використанням цифрових засобів (електронні таблиці, симулятори рецептів). Логічна структура й детальний графік гарантують послідовність етапів: ініціація, планування, реалізація й рефлексія. Розподіл ролей між учителем-фасилітатором, учнями-дослідниками та зовнішніми експертами забезпечує наукову обґрунтованість і практичну підтримку проєкту. SWOT-аналіз виявив методичну цілісність та багаторівневу підтримку як сильні сторони; ресурсомісткість і тривалість проєкту – як слабкі; держгранти та партнерські можливості – як зовнішні шанси; а нестабільне фінансування й технічні ризики – як загрози реалізації



проєкту. **Висновки.** Запропонована концептуальна модель створює надійну методичну основу для впровадження проєктів із створення низькокалорійних десертів у шкільний освітній процес. Для її ефективною реалізації необхідні адаптивне планування ресурсів, цільове підвищення кваліфікації вчителів та безперервний моніторинг. Отримані результати закладають основу для подальшої емпіричної перевірки та масштабування моделі в різних навчальних закладах.

Ключові слова: низькокалорійні десерти, проєктно-орієнтоване навчання, здорове харчування, міждисциплінарна інтеграція, компетентнісний підхід, технології кулінарної освіти.

Problem statement. Modern teenagers are increasingly faced with the problems of unbalanced nutrition, which leads to an increase in excess body weight and related chronic diseases. At the same time, the traditional school curriculum in biology or chemistry does not provide students with sufficient practical experience in applying knowledge about the nutritional value of foods and methods for reducing the calorie content of dishes. The lack of interdisciplinary educational projects that would combine the theoretical foundations of healthy eating with the practice of developing recipes for low-calorie desserts reduces the motivation of schoolchildren to a healthy lifestyle. It does not form key competencies in nutrition and food technology.

Project-based learning (PBL) is a recognized tool for developing a wide range of subject and interdisciplinary skills; however, in the Ukrainian environment, there is no clear methodological model for integrating healthy eating in the format of creative school projects. Existing research on project activities mainly concerns general pedagogical approaches or individual aspects of cooking technology without focusing on low-calorie desserts as a special educational topic. This situation makes



it difficult for teachers to develop projects that are attractive to students, combining interdisciplinary knowledge with the practical creation of healthy desserts.

Therefore, there is an urgent need for theoretical justification and methodological support for educational projects to develop recipes for low-calorie desserts in secondary schools. Our study aims to analyze theoretical sources on the problems of PBL and healthy eating, identify pedagogical opportunities for such projects, outline practical approaches to their organization, propose a clear structure of the educational project and formulate expected results in the form of student competencies. Such a comprehensive approach will fill the methodological gap and increase schoolchildren's effectiveness in forming healthy eating habits and key project management skills.

Analysis of significant research and publications. The scientific literature has widely discussed the issue of using the project method in education. In particular, L. Bisovetska and I. Verkhova emphasize the role of the project method in the formation of a healthy lifestyle in students [1], and V. S. Nikulin, O. I. Kizilov and D. D. Yashkina investigate the social demand for healthy nutrition among schoolchildren using the example of the educational institutions of the Kharkiv region [2]. N. Pakhalchuk, T. Kryvosheia and A. Verbska highlight the model of forming a healthy lifestyle in senior preschool-age children, laying the theoretical foundations of the competency approach [3]. In a broader context, C. G. Campbell and G. Feldpausch consider the justification and practical application of the project in teaching nutrition and sustainable food systems, which became the basis for the development of educational projects in secondary school [4].

Y.-C. Chen, P.-L. Tsui, C.-C. Lee, M.-H. Chiang and B.-C. Lan demonstrates the integration of multimedia and computational thinking into a dessert-making course, opening up opportunities for digital support of student projects [5]. H. Derler, S. Berner, D. Grach, A. Posch and U. Seebacher examine a sustainable



food development case study in a trans-institutional PBL environment, highlighting key steps in initiating and implementing projects [6]. R. R. Di Prinzio et al. analyze a pilot implementation of a Total Worker Health® nutrition education program for healthcare professionals, illustrating the potential of an interdisciplinary approach to education [7].

G. Federici, V. Marcotrigiano, and E. Bino examine the Healthy Snack Project initiative aimed at improving healthy snack choices through interdisciplinary educational interventions, an example of the integration of food technology and pedagogy [8]. S. L. Hosseinipour, B. Ghanbarzadeh, V. Mofid, M. Soltani and H. Hosseini propose the optimization of the formulation of a low-calorie dairy dessert with pre-and probiotics, which provides a scientific basis for practical classes in food technology circles [9]. A. Jaleel et al. analyze an educational program on school gardens aimed at building nutritional knowledge among children in rural India [10]. G. Kendel-Jovanović, S. Janković and Ž.P. Pavičić study the impact of a nutrition and lifestyle education program on the knowledge and habits of schoolchildren in Croatia, confirming the effectiveness of an integrated approach [11].

S. S. Kim et al. conducted a cluster randomized trial of school nutrition education programs, showing significant changes in the diets of adolescent girls in Ethiopia [12]. In their review, S. Lavado-Anguera, P. Velasco-Quintana and M. Terrón-López argue that PBL as a methodology provides deep immersion of students in project activities, which can be adapted for secondary school [13]. S.- F. Liao, H.-M. Tseng, J.-D. Chen, C.-M. Chen and S.-C. Li implemented a pilot study of a school fruit and vegetable program, demonstrating the successful combination of students' theoretical knowledge and practical skills [14]. B. Mederer-Hengstl, P. Núñez-Delgado and A. Bueno-Cavanillas evaluate the experience of problem-based learning in health promotion in primary school, emphasizing the role



of reflection and evaluation of results [15]. L. Oliveira and E. L. Cardoso explore a project-based approach to stimulate innovation and academic entrepreneurship in a master's program in food engineering that can be scaled up to secondary school [16]. M. Sircar, S. Orr, C. Madis and S. DiMaria propose an initial conceptual model for supporting discipline-rich projects in STEM that can be adapted for developing interdisciplinary educational projects [17]. E. Szczepańska et al. analyze a pilot implementation of a Total Worker Health® nutrition education program for healthcare professionals, illustrating the potential of an interdisciplinary approach in education analyze the project «Colourful Means Healthy» as an example of integrating visual and practical educational activities to form healthy eating habits in schoolchildren [18].

Highlighting previously unresolved parts of the general problem. Despite numerous studies of the methodology of PBL and the problem of healthy eating, none of the works reveal the specifics of the formation of educational projects specifically for developing low-calorie dessert recipes in high school. Most publications focus on the general principles of PBL or the introduction of healthy treats without a precise algorithm for their creation and evaluation. The lack of a consistent theoretical basis that would combine the theory of nutrition, cooking technology, and pedagogical methodology does not allow teachers and methodologists to develop a single project model that is adequate to the specifics of school age and curricula. The methodological approaches described in the existing works do not detail the stages of organization, distribution of roles and construction of a system for assessing student results in the context of creating low-calorie desserts. No developed template would include resource planning, nutritional value calculation, testing of technological schemes and reflective assessment of acquired competencies. Such methodological gap complicates achieving the stated goals -



particularly the formation of students' subject and key competencies in healthy nutrition and project management.

Formulation of the objectives of the article (task statement). The article aims to theoretically substantiate the creation of educational projects aimed at developing recipes for low-calorie desserts in the educational process of secondary schools. The objectives of the study: to analyze modern theoretical approaches to project-oriented learning and education in the field of healthy eating in the context of a competency-based approach; to identify and conceptualize pedagogical principles and methodological models for organizing school projects for developing low-calorie desserts that ensure the formation of subject and key competencies; to synthesize the structure of the theoretical model of an educational project for developing a low-calorie dessert and conduct its SWOT analysis to assess strengths and weaknesses, opportunities and risks of implementation in the educational process.

Presentation of the primary research material. PBL acts not simply as a methodology for completing tasks but as a holistic pedagogical system in which students acquire competencies through long-term work on current problems. In the context of the competency approach, PBL integrates knowledge and skills, from data analysis to organizing experimental activities. Given this, H. Derler et al. emphasize that PBL models should contain clear stages of initiation, planning, implementation and evaluation, which allows students to see the final result of their activities and adjust the course of work based on the data obtained [6]. At the same time, the competency approach emphasizes «being able to learn»: the student not only receives knowledge but also masters strategies for applying it in new contexts. L. Bisovetska and I. Verkhova emphasize that in this model, the roles of the teacher and the student are reversed - the teacher becomes a facilitator, and the students independently generate ideas, justify decisions and reflect on mistakes [1, p. 85]. A



key component of the model is reflective assessment - students analyze their strategies and not just the finished product. As S. Lavado-Anguera et al. argue, this kind of feedback allows for forming project management competencies, from understanding roles in a team to presentation skills and reasoned discussion [13]. Awareness of the need for healthy eating in schoolchildren combines theoretical knowledge about nutrients with the practice of daily food choices. The Healthy Snack Project demonstrates that involving students in developing and analyzing healthy snacks leads to a significant reduction in the consumption of harmful foods and an increase in interest in vitamin alternatives [8]. A cluster randomized study by S. S. Kim et al. confirmed that consistent interactive lessons with elements of game tasks and group discussions contribute to an increase in the consumption of vegetables and fruits by an average of 25% compared to the control group [12, p. 686]. It indicates the importance of a systematic approach: not a one-time demonstration but regular project activities with clear student feedback. Multimedia lessons in the dessert preparation course allow students to model experimental recipes in a simulator and only proceed to real kitchen attempts, which increases motivation and reduces the risks of food losses in school laboratories [5].

Practical educational projects combine knowledge from different disciplines, creating conditions for a deep understanding of the topic. The multidisciplinary project “Nutrition Gardens” is a vivid example of the combination of botany (plant cultivation), nutrilogy (analysis of nutritional value) and sociology (study of food practices). This approach allowed students to master the entire chain - from seed to dish - and evaluate the impact of food choices on health [10].

The technological side of developing a low-calorie dessert requires knowledge of food chemistry and rheology. S. L. Hosseinipour and colleagues investigated the effect of different concentrations of prebiotics and sugar substitutes on the texture and stability of a dairy dessert, developing an optimal recipe with high



fiber and low energy value [9, p. 7829]. These data can become the basis for workshops in the school kitchen. Finally, the pedagogical component of the project ensures the integration of technical knowledge into the learning process. The project «Colourful Means Healthy» combines visual experiments (color pH indicators, mixing natural dyes) with work on desserts, which not only increases interest but also forms critical thinking about the composition of products and the environmental aspects of their production [18].

The first key principle of using projects is constructivism, in which students acquire knowledge and skills by actively constructing their own ideas about the world. In projects on the development of low-calorie desserts, students do not passively consume information about nutrients but independently investigate the composition of ingredients, conduct experiments with their combination and form their conclusions about the taste and technological properties of the product. The constructivist position allows us to consider each student's individual preferences and stimulate metacognitive processes - planning, monitoring and correction of the course of the project [1, p. 85].

Active learning involves a constant movement between theory and practice: students apply theoretical knowledge directly during the preparation of desserts, analyzing, for example, how replacing sugar with natural sweeteners affects texture and taste. This approach forms «learning by doing». It significantly increases motivation because the result of the activity - the finished product - serves as visual evidence of success or the need for recipe improvement [6]. Inquiry learning ensures the development of scientific thinking skills in students: formulating hypotheses (how will the consistency of the dessert change if a prebiotic is added?), planning an experiment, observing the results and conclusions. A project on low-calorie desserts may include students' contribution to choosing the optimal proportions of ingredients, conducting a quantitative analysis of the results, and writing conclusions



in the form of scientific reporting, which stimulates critical thinking and responsibility for the process [13].

The classic PBL model consists of four phases: initiation, planning, implementation, and reflection. At the initiation stage, the teacher presents the problem - the need to develop a low-calorie dessert with specific criteria - and students form groups and discuss possible approaches. The planning phase includes creating a logical map of the project, defining technological steps and resources (laboratory equipment, ingredients, IT tools), and assigning roles in the team [6]. During implementation, students conduct culinary and technological experiments: calculating nutritional value, testing various sugar substitutes, and monitoring the impact of changes on the structural and taste properties of the dessert. Tools can include spreadsheets for counting calories, mobile applications for collecting feedback, and digital laboratories for modeling recipes. The final reflection phase involves evaluating the results according to a pre-developed rubric that covers the recipe's scientific validity, the final product's quality, team interaction, and presentation skills. In peer assessment, students analyze the work of their colleagues, which contributes to the formation of constructive feedback skills.

While working on a low-calorie dessert, students acquire subject competencies in food chemistry and technology: they learn to calculate the balance of macro- and microelements and consider the properties of prebiotics and the texture of stabilizers. Using fundamental tools (laboratory scales, pH meters) turns the lesson into a mini-research to clarify scientific concepts of nutrition [9, p. 7829].

Key competencies formed during students' project work include critical thinking, communication and teamwork. During the discussion of the results of experiments, students learn to argue their proposals and make decisions by consensus. Information and digital competence are formed when developing and presenting a recipe, as participants use online resources to search for data, tools to



visualize results and create multimedia presentations. Personal and social competencies are developed through reflection: students analyze their actions, take responsibility for the results, and realize the role of healthy eating in community life. Thanks to the inclusive formatting of the project, students' social responsibility increases, and self-management skills and an ethical attitude toward resources are formed [1, p. 85].

The logical model of an educational project is its conceptual scheme, reflecting the relationship between investments (resources), activities, products and expected results. At the beginning of the project, educational materials on nutrition and confectionery technology, laboratory equipment, and IT platforms for calculating calorie content were selected. The activity includes researching ingredients, conducting technological experiments and analyzing the obtained data [7].

The work plan for a project to create a low-calorie dessert involves certain stages:

- familiarization with the theoretical foundations, formulating goals and preparing a logic map.
- experimental phase (research of ingredients, calculation of nutritional value, testing prototypes) with weekly reports.
- presentation of final recipes, summing up and reflection.

Such a phased approach makes it possible to track progress, adjust plans on time, and ensure the integration of the project into the school curriculum. Coordination of stages with the school year calendar is also necessary to avoid overlapping with control and vacation periods.

The success of an educational project largely depends on a precise distribution of roles. The teacher acts as a facilitator and coach: provides methodological recommendations, monitors the safety of experiments and coordinates



communication with experts. Students distribute roles among themselves: «researcher» is responsible for collecting information about ingredients; «analyst» - for calculating nutritional value; «technologist» - for conducting kitchen experiments; and «presenter» - for designing and defending results [1, p. 85]. Laboratory resources include scales with accuracy for the gram, pH meters, mixers, and thermostats to stabilize the texture of desserts. IT tools - spreadsheets for automated calorie calculation, mobile applications for collecting feedback and online recipe simulators [5]. The availability of such resources allows students to combine the practical and digital components of the experiment.

Expert support is an essential component of the project, which involves the involvement of a dietitian for nutritional consultations, a food technologist for recipe optimization, and a methodologist to support the evaluation. Collaboration with stakeholders (local catering establishments and higher education institutions) expands the possibilities of the educational project and adds realism to the students' tasks [8].

Subject outcomes of projects on the creation of low-calorie desserts include a deep understanding of nutrients and the ability to analyze the nutritional value of ingredients and calculate the energy value of dishes. During the project, students master theoretical concepts of food chemistry and technology for the production of low-calorie desserts, in particular, the properties of prebiotics and sweeteners [9, p. 7830]. Practical skills include recipe development, laboratory research, and data processing using digital tools. In addition, students master the basics of project management: task planning, calendar management, interpersonal communication, and presentation of results. Students' attitudes should be transformed from passive information consumers to responsible creators of valuable products. Positive values are formed - responsibility for one's health, environmental awareness of resource use, and willingness to share knowledge with peers and family [12].



As part of the final stage of our research, it is advisable to conduct a SWOT analysis of the conceptual model of an educational project to develop low-calorie desserts. This approach allows us to systematize the internal strengths and weaknesses of the model, as well as identify external opportunities and threats to its implementation. SWOT analysis serves as a transitional stage between the theoretical description of the model and practical recommendations, helping to visualize the key success factors and risks that will affect the effectiveness of the project implementation in real school conditions (table 1).

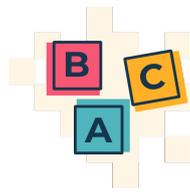
Table 1

SWOT analysis of the proposed conceptual model of an educational project

Strengths	Weaknesses	Opportunities	Threats
Clear structure and schedule	High resource intensity	Government grants and initiatives	Unstable funding
Laboratory + digital tools	Project duration (8 weeks)	Partnerships with universities	Equipment breakdown, internet
Facilitation + expert support	Dependence on teacher training	Participation in competitions and internships	Low student motivation

Source: created by the author

The strengths of the conceptual model lie in the combination of a clear, logical structure and a flexible calendar plan, which ensures the gradual and controlled development of project stages. Integrating laboratory and digital tools creates a comprehensive learning environment: students simultaneously gain experience working with real equipment and master digital platforms for calculations and analysis. In addition, multi-role support (facilitator teacher, student researchers, expert consultants) guarantees the scientific validity of the formulation and a high level of mentoring. The model's weaknesses are related to its resource intensity: the need for specialized equipment (pH meters, laboratory scales), licenses for IT



platforms and the involvement of external experts may exceed the budgetary capabilities of many schools. The long time (at least eight weeks) creates a risk of conflict with other subject courses and the curriculum, which requires additional coordination with the administration. Teachers' readiness levels can also cause particular difficulties: without proper methodological training, the implementation of the model can be reduced to the formal fulfillment of tasks.

Opportunities for implementing the model of an educational project for creating a dietary dessert are increasing due to the relevance of a healthy lifestyle and state support for STEM education. Participation in grant programs and scientific project competitions opens up additional financial resources and increases the school's prestige. Cooperation with higher education institutions and industrial enterprises makes organizing student internships and borrowing modern food industry technologies possible. In addition, successful project cases can become the basis for developing similar programs in other educational institutions.

Project risks are primarily associated with funding instability: a reduction in school program budgets can lead to the cessation of support for key stages of experimental activities. Technical risks include the absence or instability of Internet connection and equipment breakdowns, which can stop the work of groups and demotivate students. Finally, without systematic teacher training, the PBL approach may remain incompletely implemented, which will reduce the overall effectiveness of the educational project.

Thus, the SWOT analysis of the conceptual model demonstrates the balance between its methodological strength and organizational challenges and reflects external development opportunities and potential risks. The next step will be to adapt the recommendations, taking into account the identified factors, and develop a detailed manual for teachers to maximize the benefits and minimize the negative impacts during the practical implementation of the project.



As a result of the research of the theoretical foundations, methodological approaches and SWOT analysis of the proposed conceptual model of the educational project, it can be stated that it is internally coherent and, at the same time, needs to be adapted to the real conditions of the school environment. Structured stages, a combination of laboratory and digital tools, and multi-stage support from the teacher and experts create a solid basis for forming subject and key competencies in schoolchildren.

Conclusions. Analysis of modern theoretical approaches to healthy eating confirmed that the competency paradigm best meets the tasks of forming in students both subject knowledge in nutrition and interdisciplinary skills of critical thinking, independent planning and reflection.. In particular, the studies showed the effectiveness of the phased PBL approach, which integrates research methods with practical laboratory and digital exercises and allows students to directly experience changes in the sensory and technological characteristics of low-calorie products. The second stage identified and conceptualized key pedagogical principles and methodological models for organizing school projects on developing low-calorie desserts. The feasibility of using constructivism, active and research learning was substantiated, and mechanisms for facilitation and expert support were developed. These models provide for precise distribution of roles and self- and mutual assessment for comprehensive monitoring of students' progress.

Conducting a SWOT analysis of the synthesized conceptual model allowed us to assess its internal strengths and weaknesses and external opportunities and threats. The identified strengths - a holistic structure, a combination of laboratory and digital resources, and multi-stage support - lay a solid foundation for the implementation of the project. At the same time, resource intensity, time constraints, and dependence on teacher qualifications form weaknesses that require additional planning,



emphasizing the importance of developing mechanisms for external support and modular adaptability of the project.

Thus, the conceptual model of an educational project on creating dietary desserts has been formed as a reliable methodological platform for forming nutritional and project management competencies in schoolchildren. At the same time, for its successful implementation, it is necessary to develop adaptive financing schemes, provide technical support, and conduct training sessions for teachers. The results obtained create a basis for further empirical research and testing of the model in different regions and educational institutions.

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