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Game Development for Fostering Smart Agricultural Innovators in Schools in Ban Phaeo District, Samut Sakhon Province

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Abstract

This research aimed to (1) develop educational games to cultivate smart agricultural innovators among secondary school students in Ban Phaeo District, Samut Sakhon Province, (2) assess the efficiency of these games in enhancing innovation in smart agriculture, and (3) evaluate students' innovative skills following game-based learning. The study involved four schools, targeting students aged 12–15, and employed the ADDIE Model with integrated Design Thinking to design two types of games: a digital game (Plug) and a board game (Farm Genius - Unplug).The findings revealed that both games demonstrated high efficiency in design and learning outcomes, with overall evaluation scores above 4.7 out of 5. After participation, students showed significant improvements in four key innovation skills: growth mindset, learning skills, financial literacy, and digital literacy. The average scores increased from 78.82 (Plug) to 95.94 (Farm Genius). These results highlight the games' effectiveness in promoting creativity, problem-solving, and technological application, thereby supporting the development of future innovators in smart agriculture.

Keywords: Game-based learning, Smart agriculture, Educational game development, Innovation skills, Secondary students

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Introduction

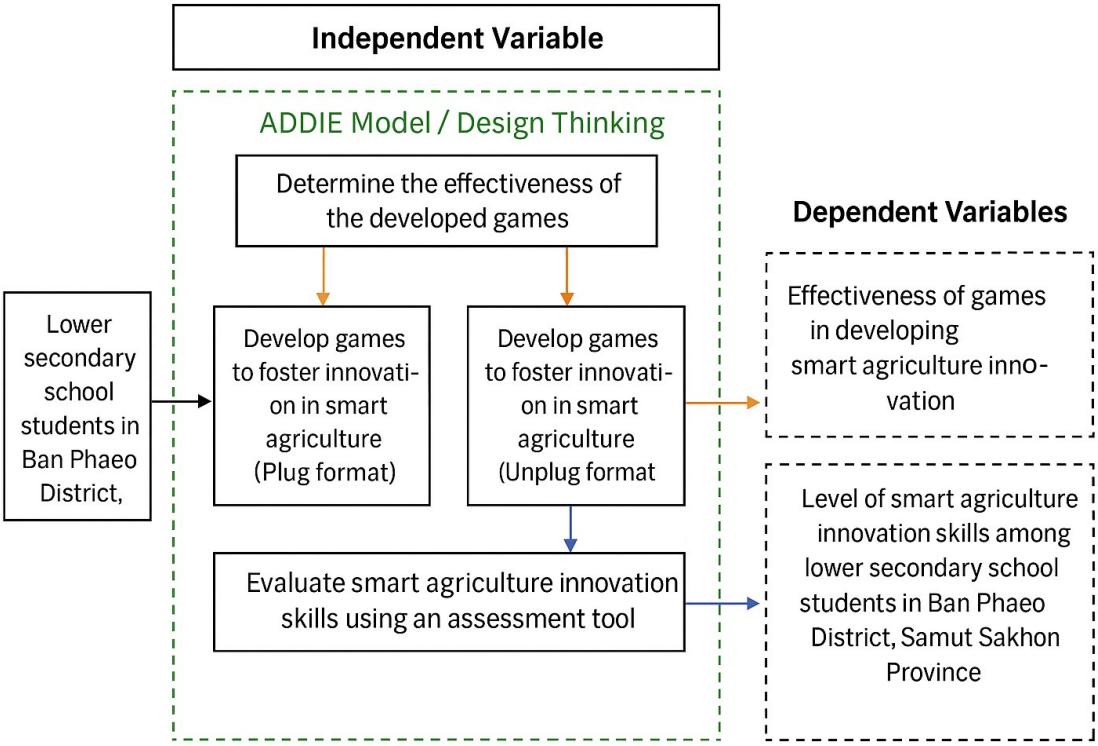
Ban Phaeo District in Samut Sakhon Province, located along the Damnoen Saduak Canal, is rich in agricultural resources, producing various crops, vegetables, and fruits. With 7,593 farmers and over 65,000 rai of farmland—about 72% of the province's agricultural area—the district emphasizes developing smart agriculture innovators by instilling innovation skills in secondary school students. This early development aims to transform traditional farming into smart agriculture, improving efficiency, income, and reducing farming risks.

Smart agriculture innovators are individuals who apply advanced technologies—such as IoT, AI, data analytics, and automation—to optimize farming, increase yields, minimize waste, and promote sustainability.

Using games in education is a proven method to make learning engaging, effective, and student-centered. Game-based learning enhances motivation, critical thinking, and hands-on experience. Research supports its role in boosting understanding and participation, especially when aligned with learners' interests and abilities.

This study aims to develop an educational game that promotes smart farming knowledge and skills, creating a new generation of innovators ready to drive agricultural advancement in Ban Phaeo District.

Conceptual Framework



Concepts, Theories, and Related Research

This chapter outlines the foundational concepts related to educational games, including their principles, classifications, and application in learning processes. It draws on educational guidelines from authoritative sources such as the Department of Academic Affairs (1997) and the Office of the National Primary Education Commission (1998), emphasizing that games can foster engagement, understanding, and positive learning behaviors in students.

Key principles include:

- Introducing unfamiliar games with step-by-step demonstrations
- Allowing independent or group-based play
- Providing teacher facilitation and feedback
- Encouraging tidy and respectful use of materials

The chapter also reviews criteria for designing educational games—such as alignment with natural phenomena, movement consistency, and use of realistic imagery and colors—to support cognitive development.

In addition, the chapter synthesizes relevant research findings that support game-based learning as an effective tool to enhance creativity, critical thinking, and problem-solving skills. Research indicates that well-designed games can improve student motivation, attention, and retention, especially in contexts such as smart agriculture, where innovation and technology integration are essential.

Research Methodology Summary

This study aimed to develop a game for promoting smart agricultural innovators among secondary school students in Ban Phaeo District, Samut Sakhon. The research followed these steps:

3.1 Population and Sample

The target population consisted of 685 students from four secondary schools. A specific group of 120 students aged 12–15 years was selected from four participating schools based on willingness to join the study.

3.2 Research Instruments

The tools included assessment forms for consistency with innovation skills, gameplay suitability, and student skill levels. Both computer-based and board games were developed.

3.3 Research Procedure

The study adopted the ADDIE Model and Design Thinking approach, involving:

1. **Needs Analysis** – Gathered data from stakeholders, reviewed relevant games, interviewed local farmers, and aligned with government policy.
2. **Game Design** – Defined target skills, identified problems, and collaborated with schools and farmers to create gameplay promoting four key skills:

    - Adaptability and resilience
    - Data analysis and creative problem-solving
    - Financial risk management
    - Digital technology application

3. **Prototyping** – Developed and tested board and computer game versions. Adjustments were made based on user experience and expert feedback.
4. **Implementation** – Students first played the board game, followed by the computer game. Skills were measured using rubric-based assessment post-game.
5. **Evaluation** – Expert panels assessed game quality using a Likert scale. A separate rubric assessed the four target skill areas.

3.4 Data Collection

Skill levels were assessed after gameplay in both plug (computer) and unplug (board) formats. Consent and participation were coordinated with schools.

3.5 Data Analysis

Basic statistics (mean, standard deviation) and content validity (IOC) were used to analyze results and tool effectiveness.

Research Results

This study aimed to develop educational games that promote smart agricultural innovation among secondary school students in Ban Phaeo District, Samut Sakhon Province. The results are summarized into three key areas:

1. Game Development Results

Two types of games were developed:

- **Board Game (Unplug: Farm Genius):** A farm management game focusing on crop cultivation, purchasing smart agricultural tools, and maximizing profits. Suitable for upper secondary students.

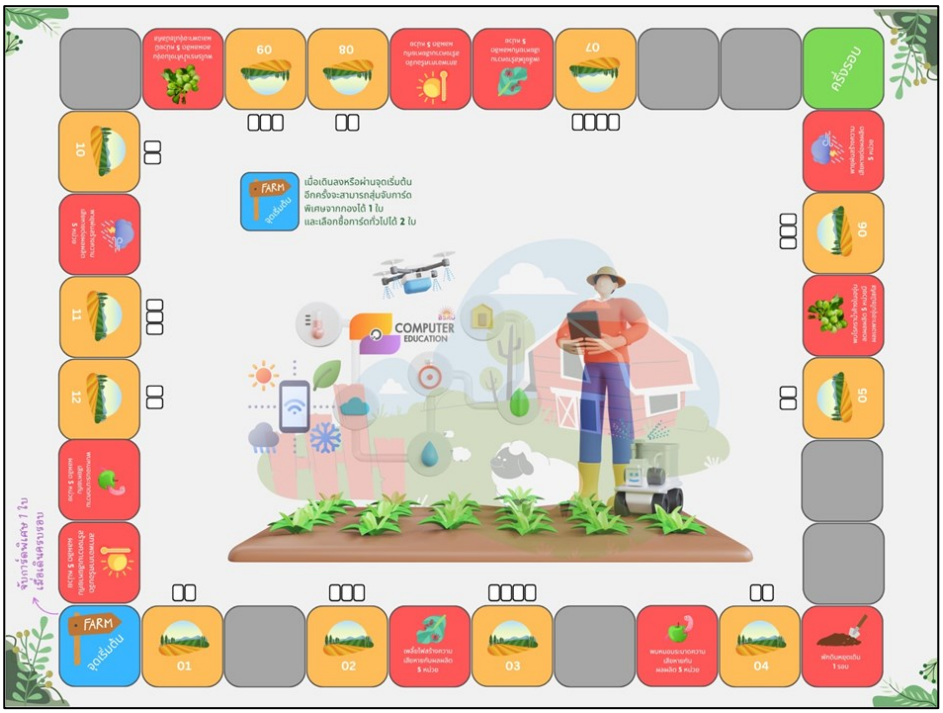


Figure 1.1 Game board Farm Genius

- **Computer Game (Plug):** A simulation game focused on cherry tomato farming. Players manage resources and apply smart farming tools to prevent crop damage from pests and weather conditions.

Figure 1.2 Home page for practice

2. Game Efficiency Evaluation

Expert evaluations of both games found them to be highly effective:

- Board Game: Received an average score of 4.75/5 in design and learning effectiveness.
- Computer Game: Received an average score of 4.73/5 for visual design, audio, content, and educational value.

3. Game Implementation and Skill Development

When tested with students:

- The board game significantly improved all areas of innovation skills, particularly in *growth mindset* and *financial literacy*, with an average score of 95.94/100.
- The computer game emphasized *learning skills* and *digital literacy*, with an average score of 78.82/100.
- Both games effectively promoted high to very high levels of smart agricultural innovation skills among learners.

Summary

1. Research Objectives

This research had three objectives:

1. To develop a game to foster smart agricultural innovators among secondary school students in Ban Phaeo District, Samut Sakhon Province.
2. To evaluate the effectiveness of the developed game.
3. To assess the level of smart agricultural innovation skills demonstrated by students using the developed games.

The sample consisted of four purposively selected schools that voluntarily participated in the study. Each school selected students aged between 12–15 years, a developmental stage considered appropriate for acquiring smart agricultural innovation skills through game-based learning. The participating schools were:

1. Wat Thamcharayaphirom School (30 students)
2. Wat Laksi Pipat Rat Uppatham School (30 students)
3. Lak Song Song Serm Witthaya School (30 students)
4. Wat Yokkrabat School (30 students)

2. Research Findings

The development of the games followed the ADDIE Model, incorporating the Design Thinking process. Game content was constructed using input from the Department of Agricultural Extension, local educational authorities, schools, and farmers. Two games were created:

- a computer game (Plug)
- a board game titled *Farm Genius: The Innovative Farmer* (Unplug)

The intervention was implemented over two phases within a two-week period: first, students played the computer game, followed by the board game.

Expert evaluations revealed high effectiveness:

- Computer Game:
  - Game design: 4.67
  - Learning effectiveness: 4.83
  - Overall: 4.73 (Very Good)
- Board Game:
  - Game design: 4.63
  - Learning effectiveness: 4.87
  - Overall: 4.75 (Very Good)

Student learning outcomes showed improvement:

- After the computer game (Phase 1): average score = 78.82 / 100
- After the board game (Phase 2): average score = 95.94 / 100

Rubric-based skill assessments indicated that students exhibited a high to very high level of smart agricultural innovation skills across four dimensions:

1. Growth Mindset & Anti-Fragile Thinking
2. Learning Skills (data analysis, critical thinking, problem-solving)
3. Financial Literacy
4. Digital Literacy

Average post-game scores:

- Computer game: 3.20 (High)
- Board game: 3.84 (Very High)

3. Discussion

The development of both games applied the ADDIE Model integrated with Design Thinking principles to cultivate future smart agricultural innovators in Ban Phaeo District. This aligns with research by Puri and Sahay (2003) on GIS utilization and by Vate-U-Lan, Quigley, and Masoyras (2017) on smart farming technology in Ontario, Canada. Both studies confirmed that smart agriculture improves quality and reduces costs.

The high effectiveness of the developed games also aligns with:

- Nilrat Kota et al. (2023), who demonstrated that educational games enhance basic thinking skills in early childhood.
- Tiprat Sithiwong (2020), who found that game-based learning effectively develops thinking skills in preschool children.

Furthermore, the increase in students' innovation skills after gameplay is consistent with Tipaluk Komonwanich (2024), who found that the SCAMPER card game significantly enhances creative and innovative thinking—core traits of an agricultural innovator. Activities promoting ideation, questioning, observation, interaction, and experimentation were key enablers of this growth.

4. Conclusion

Game-based learning is an effective tool for developing smart agricultural innovators. Sustained engagement with both computer and board games enhances students' skills progressively and measurably over time.

5. Recommendations

1. Recommendations Derived from the Study

1.1 Establishing collaboration with school teachers and forming a dedicated club or community of practice could contribute to the sustainable development and dissemination of knowledge.

1.2 In developing an educational board game with card-based mechanics, the content on each card should be concise, appropriate, and easily understandable. Overly lengthy or complex text may discourage players from reading and engaging with the information.

2. Recommendations for Future Research

2.1 The development of skill-based games should include testing to find a balance between the depth of skill training—which may increase complexity—and the simplicity of gameplay to enhance accessibility and enjoyment for players.

References

Department of Disease Control, Ministry of Public Health. (2020). Guidelines for the Prevention of Coronavirus Disease 2019 for the General Public and At-Risk Groups. Retrieved from https://dcc.moph.go.th.

Land Development Department. (2020). Geospatial Information System for Individual Farm Land Use Planning (LDD On Farm Land Use Planning). Retrieved from https://agri-map-online.moac.go.th

Land Development Department. (2021). Guidelines for Promoting Agriculture Based on the AgriMap Proactive Agricultural Map Database in Samut Sakhon Province [Map and Report]. Land Development Department.

Department of Curriculum, Ministry of Education. (1997). Pre-primary Education Curriculum B.E. 2540. Bangkok: Kurusapa Ladprao Printing Press.

Kingkan Lertanan. (1999). The Adaptation Process of Agricultural Communities in the Western Peri-Urban Area of Bangkok: A Case Study of Ban Phaeo District, Samut Sakhon Province (Master's thesis). Chulalongkorn University.

Jitima Wannsri. (2020). Innovation for School Development (3rd edition). Phitsanulok: Rattanasuwan Printing.

Tatsanawan Ramanarong. (2013). Flipped Classroom. Retrieved January 8, 2025, from http://www.gotoknow.org/posts/548870

Tiprat Sithiwong. (2021). The Effects of Using Board Game to Promote Learning for Undergraduate Students, Faculty of Education, Naresuan University. Journal of Education and Innovation, 23(4), 187–200.

Tipaluk Komonwanich. (2021). Development of "SCAMPER" Card Game for Innovative Thinking. Burapha Journal of Fine Arts, 24(2), 89–107.

Nitiwut Kaewraksa, Wisut Phongngern, Thipanet Yaemmanichai, & Phisit Tangpornprasert. (2024). Innovation in Art Learning Management Using Gamification and Digital Learning Technology to Promote Innovator Skills in Grade 12 Students. Silpakorn Educational Research Journal, 16(2), 1–18.

Nithikan Khwanboon. (2006). Development of Educational Games for Mathematical Readiness in Early Childhood. Silpakorn University/Bangkok. DOI:

https://doi.nrct.go.th/ListDoi/listDetail?Resolve_DOI=10.14457/SU.the.2006.86

Nilrat Kota, Kamonwan Thossachuey, Thaphat Kota, Ratchanon Srisangchan, & Wilailak Kota. (2023). Using Educational Game Activities to Develop Basic Thinking Abilities for 2nd Year Kindergarten Students. Journal of Research and Development Institute, Chaiyaphum Rajabhat University, 5(1), 25–37.

Patcharaporn Yuyuen, Apinya Phumiota, & Sira Sriyothin. (2017). Influencing Factors for Becoming Innovators: A Case Study of PUNN Product. Proceedings of the 4th National Conference on Public Affairs Management, Khon Kaen University.

Paitoon Sinlarat. (2018). Education 4.0 is More Than Education. Bangkok: Chulalongkorn University Press.

Phanon Khumsupa. (2019). New Generation Local Innovators and the Spread of Innovation to Communities. Journal of Business Communication DPU, Nakhon Pathom University, 13(2), 258–299.

The Royal Institute. (2011). Royal Institute Dictionary B.E. 2554. Bangkok: Nanmee Books Publications, 2013.

Wiwat Meesuwan. (2017). Factors Affecting the Attributes of Innovative Teachers in Educational Technology in Teaching Practice Schools, Naresuan University Network. Journal of Education, Naresuan University, 19(3), 50–62.

Salinee Udomphon. (2019). Area-Based Curriculum to Develop Innovators for Whole School Innovation Management Using a Community-Based Approach in Kanchanaburi Province (Doctoral dissertation). Silpakorn University, Bangkok.

Office of the National Primary Education Commission. (1998). Learning Reform: Student-Centered Learning. Bangkok: Kurusapa Ladprao Printing Press.

Anucha Somabut. (2013). Information, Media, and Technology Skills for 21st Century Learning. Retrieved October 25, 2024, from https://teacherweekly.wordpress.com/2013/09/25/information-media-andtechnology-skills/

Atchara Cheewaphan. (1988). Thai Language Teaching Manual: Learning Activities through Play (2nd ed.). Bangkok: Thai Wattana Panich.

Arnal, L. (2018). Creating Innovators. What Skills Does Innovation Require? Retrieved from https://www.linkedin.com/pulse/creating-innovators-what-skills-does-innovationrequire-luis-arnal/

Balafoutis, A. T., Beck, B., Fountas, S., Tsiropoulos, Z., Vangeyte, J., van der Wal, T., ... & Pedersen, S. M. (2017). Smart farming technologies–description, taxonomy and economic impact. Precision Agriculture: Technology and Economic Perspectives, 21–77.

Bournaris, T., & Papathanasiou, J. (2012). A DSS for planning the agricultural production. International Journal of Business Innovation and Research, 6(1), 117.

Dyer, A. G., Paulk, A. C., & Reser, D. H. (2011). Colour processing in complex environments: insights from the visual system of bees. Proceedings of the Royal Society B: Biological Sciences, 278(1707), 952–959.

Ekanayake, D., Roberts, J., Royal, A., Bennett, L., & Werner, A. (2015). Management zone delineation in arable crop systems. Retrieved July 24, 2019, from http://www.massey.ac.nz/~flrc/workshops/15/Manuscripts/Paper_Ekanayake_2015.pdf

Grisso, R. D., Alley, M. M., Thomason, W., Holshouser, D., & Roberson, O. T. (2011). Precision farming tools: Variable-rate application. Retrieved July 24, 2019, from https://www.researchgate.net/publication/309121121_Precision_farming_tools_Variable-rate_application

Horth, D. (2014). How to use innovation to lead effectively, work collaboratively, and drive results. N.P.: Center for Creative Leadership and Dan Buncher, Continuum.

Kieu, P. (2017). 8 Skills That Make a Successful Innovator. Retrieved from https://sociable.co/business/innovation-8-skills

Lee, C., & Benza, R. (2015). Teaching Innovation Skills: Application of Design Thinking in a Graduate Marketing Course. Business Education Innovation Journal, 7(1), 43–50.

Marks, G. (2010). Precision Irrigation: A Method to Save Water and Energy While Increasing Crop Yield—A Targeted Approach for California Agriculture. Retrieved July 24, 2019, from https://www.slideshare.net/GaryMarks/precisionirrigation-a-method-to-save-water-and-energy-while-increasing-crop-yield-a-targeted-approach-for-california-agriculture

Puri, S. K., & Sahay, S. (2003). Participation through communicative action: A case study of GIS for addressing land/water development in India. Information Technology for Development, 10(3), 179–200.

Sørensen, C., Fountas, S., Nash, E., Pesonen, L., Bochtis, D., & Pedersen, S. (2010). Conceptual model of a future farm management information system. Computers and Electronics in Agriculture, 72(1), 37–47.

Triandis, & Weick. (2010). Educational Administration: Theory, Research, and Practice (6th ed.). New York: McGraw-Hill.

Vate-U-Lan, P., Quigley, D., & Masoyras, P. (2017). Smart Dairy Farming through Internet of Things (IoT). Asian International Journal of Social Sciences, 17(3), 23–36. doi:10.29139/aijss.20170302