The Effects of Deductive Learning Activities With Games on the Topic of "Single Variable Linear Equations" of Mathematics on Learning Achievement of 7th Grade Students

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Abstract

The purposes of the research were 1) to compare the scores of 7th grade students from deductive learning activitites managaement with games on the topic of "Single Variable Linear Equations" to the standardized criteria of 75%, 2) to compare the achievement of the 7th grade students before and after using the deductive learning activities with games, and 3) to study the satisfaction of the students with the deductive learning activities with games. The research samples were twenty-eight 7th grade students of class one at Triam Udomsaksa Patanakarn Roi-Et School in the second semester of 2021. They were selected by cluster random sampling method. The research instrument consisted of lesson plans, an achievement test, a questionnaire, a recording form after teaching and an observation form. The statistics used were mean, standard deviation, percentage, one-sample t-test and t-test for dependent. The research results indicated that compare the mean score of 7th grade students from deductive learning activitites managaement with games on the topic of "Single Variable Linear Equations" was higher than the standardized criteria of 75% at the .05 level of the statiscal significance. 2) The findings revealed that the mean postet score after using deductive learning activitites managaement with games was higher than that of the pre-test score at the .05 level of the statiscal significance. 3) The overall satisfaction of the student with the deductive learning activities with games was at a high level.

Keywords: deductive learning, games, Mathematics, achievement

1. Introduction

Mathematics takes the important role for learning achievement in the 21st century because Mathematics is able to provide human resource with creative thinking, reasonable thinking, systematical thinking and analytical thinking. The abilities in thinking assist human with appropriate and correct prediction, planning, decision and efficient practical application for daily life. Additionally, Mathematics is a major subject for study of science, technology and other sciences, which are necessary foundation of human resource development and economic development of the country. Therefore. Mathematics should be studied further and continuously for upgrading the country based on the current economic and social condition, including modernization of science and technology in the globalization era (Ministry of Education, 2017, p. 10)

In 2020–2021, Thailand encountered the COVID-19 pandemic and online learning method has been employed for instructional management of the teachers. The online learning management affected directly some students who were not accessible to the internet because they did not have computer, notebook and mobile phone. However, the students who were accessible to the internet, encountered the unstable internet and unclear online lesson. Most of the instruction focused on lecture without interesting teaching materials. As a result, most students have been interested in their lessons.

Kerras and Essayahi (2022) stated that the COVID-19 pandemic had the negative impact of many countries throughout the world. All human have encountered the emergency situation, online working and adapting their daily life. Moreover, online learning caused many problems about teaching management. For example, it is difficult to concentrate their lessons of students and there has been no response between teacher and students. Li (2022) asserted that the COVID-19 pandemic has caused mainly problems of the teachers about self-adaption, time management, annoyance of social media and difficulties in using technology. His study showed that 43% of the opinion of the students toward online learning was bored to the online lessons, 59% of annoyance from social

media and 58.5% of doing other activities during online learning.

The teachers have improved their teaching methods for solving the problems and increasing their interest in online learning of the students. Using games is one of the efficient and effective active learning strategies for building enjoyment and encouraging the students to follow the contents based on the appropriate lesson design, selecting games and planning for learning management relating the contents (Pornthadawit, 2018, p. 65). The previous research on using games with learning management showed that the learning activities with games affected the positive learning achievement of the students. White and McCoy (2019) showed that the learning activities with games improved the positive attitude toward learning Mathematics, interest in Mathematics lesson and the achievement of the students. Fitriyana et. al. (2021) indicated that hybrid learning with video conference and "chemondro-game" influenced on students' self-efficacy, self-regulated learning, and achievement toward Chemistry. The research results revealed that using technology, creating innovative learning strategies for instructional management in the 21st century affected greatly the abilities in learning perception and self-control of the students through integrating video conference with chemondro-game.

Mathematics is an abstract subject with rules theories and difficulties. Consequently, most of the students dislike learning Mathematics. It is obvious that the teachers usually organize learning activities by explaining rules to examples that is called deductive learning management. The teachers usually start explaining the rules to the students and the students understand the rules and conclude the lessons. The deductive learning method focuses on concepts and the abilities in applying rules for various and new situations (Niyoms, 2017, p. 144).

According to the COVID-19 pandemic and the importance of learning Mathematics, the online learning was employed for teaching Mathematics to the 7th grade students through giving lecture of the teachers. The disadvantage of the online teaching of the teachers was lack of stimulation for the interst of the students. It's obvious that the online learning through giving lecture of the teachers affected negatively and directly learning achiement and satisfaction of the students with learning Mathematics. Therefore, the author conducted the research on "The Effects of Deductive Learning Activities with Games on the Topic of "Single Variable Linear Equations" of Mathematics on Learning Achievement of 7th Grade Students". The research provided useful information to undergraduate teacher students and practical application of deductive learning activities with games.

2. The Aims of the Study

1) To compare the scores of 7th grade students from deductive learning activitites managaement with games on the topic of "Single Variable Linear Equations" to the standardized criteria of 75%.

2) To compare the achievement of the 7th grade students before and after using the deductive learning activities with games on the topic of "Single Variable Linear Equations" of Mathematics.

3) To study the satisfaction of the students with the deductive learning activities with games on the topic of "Single Variable Linear Equations".

3. Method

3.1 Samples

The research samples were twenty-six 7th grade students with low Mathematics achievement of class one at Triam Udomsaksa Patanakarn Roi-Et School, Nongwaeng Sub-district, Mueang District, Roi-Et Province under Office of the Basic Education Commission in the second semester of 2021. They were selected by cluster random sampling method.

3.2 Research Instrument

1) Twelve 12-hour lesson plans for the deductive learning activities with games on the topic of "Single Variable Linear Equations" of 7th Grade Mathematics. The appropriateness of the lesson plans assessed by three experts was at a very high level (Mean = 4.85). Each lesson plan was designed learning activities with game showed in Table 1.

Table 1. Contents and games on the topic of "Single Variable Linear Equations"

Hour No.	Lesson Plans	Games
1	Calculation of Algebraic Expression	- Calculate Algebraic Expression through ι Google Spreadsheet (Excel)
2	Writing Algebraic Expression	- Match the picture with the correct fruit.
3	Equations	- Online Game of Vonder Go on "Is the equation true?"
4	Answers of Equations	- Game Cards of "Is it true? with 3 seconds
5	Property of Equality	- PowerPoint "Show the Card of Picture and Guessing"
		- Picture Quiz Card Game
6	Solving Equations	- Mysterious Valley
		Picture Quiz Card Game
7–8	Single Variable Linear Equations	- PowerPoint "Show the Word Card and Guessing"
		- Woodwall "Match a Pair of Equations"
9	Writing Single Variable Linear Equations for a Situation	- Online Game of Vonder Go "Give the Correct Answer"
10–12	Solving Question of Single Variable Linear Equations	- Jigsaw of Equations
		- Mysterious Solving Game

Process for Deductive Learning Activity Management with Games.

The research was designed for deductive learning activity management with games of 7th grade Mathematics based on theories and concepts on "Single Variable Linear Equations", and the examples. Then they author design and selected games relating to the contents in both warm up activity and ongoing learning activities. The major aims of the deductive learning activity management with games were to provide enjoyment and goal achievement. The deductive learning activity management was divided into five steps as follows Moonkham & Moonkham (2003, p. 24).

Step 1 Problem Identification: The step aimed to present and identify the problems for encouraging the students to find appropriate problem solutions.

Step 2 Presentation and Explanation: The theories, principles and rules were presented and explained and then concluded the theories, principles and rules for teaching students.

Step 3 Application: The theories principles, rules and conclusions adopted from learning were applied for problem solutions.

Step 4 Examination and Conclusion: The students mainly examined and concluded the correct and appropriate practical application of theories for solving the problems.

Step 5 Practice: The students applied their previous knowledge for various new situations.

2) Thirty items of 4-multiple-achievement test on single variable linear equation for 7th grade students.

Content validity and index of item objective congruence (IOC) of the achievement test were assessed by three experts. The appropriateness of the test regarding the criteria of Tayraukham (2009, p. 101) 0.05 and more was at a very high level (IOC = 1.00).

3) Ten items of a questionnaire on the satisfaction of 7th grade students with the deductive learning activity management with games. The questionnaire was presented to three experts for assessing the index of consistency (IOC). The appropriateness of the test regarding the criteria of Tayraukham (2009, p. 107) 0.05 and the IOC of the questionnaire was 1.00.

4) A recording form after teaching

5) An observation form of activity participation in classroom

6) An observation form of responsibilities for the tasks assigned by the teachers

3.3 Research Design.

The experimental research design was employed for the study. The major aim of the research was to compare the pre-test score and post-test score of the 7th grade students after using deductive learning activitites managaement with games on the topic of "Single Variable Linear Equations". One Group Pretest–Posttest Design was employed for the experimental research design (Warakham, 2016).

Pre-test	Experiment	Post-test
T_1	X	T_2

Symbols of experimental research design

E refers to experimental group

T_1 refers to pre-test

X refers to deductive learning activity management with games

T_2 refers to post-test

3.4 Data Collection

1) The 7th grade students did the pre-test on single variable linear equation before using the deductive learning activity management with games.

2) The author conducted the experimental research based on the research planning on the deductive learning activity management with games in the second semester of 2021 for twelve hours. Learning activity management was recorded by an observation form after teaching twelve lesson plans. The activity participation and responsibilities of the students were collected by an observation form during twelve learning activities.

3) The satisfaction of the students with the deductive learning activity management with games was conducted by a questionnaire after using twelve lesion plans.

4) The 7th grade students did the post-test on single variable linear equation after using the deductive learning activity management with games.

3.5 Data Analysis

The author examined the accuracy of data and analyze the data as follows.

1) The scores of 7th grade students adopted from ongoing assessment and tasks of the deductive learning activity management with games consisted of quantitative data and qualitative data. The data was analyzed as follows.

① The score of the students from using the deductive learning activitites managaement with games on the topic of "Single Variable Linear Equations was compared to the extablished critetia of 75%. One-sample t-test was used to analyze the data.

② The qualitative data was adopted from a recording form after teaching, an observation form of learning activity participation in class, and the descriptive analysis was employed for data analysis.

2) The pre-test score of the students for learning achievement was compared with the post-test score after using the deductive learning activity management with games by using t-test for dependent.

3) The overall satisfaction of the students with the deductive learning activity management with games was analyzed by mean and standard deviation. The data was interpreted by using the criteria of Srisa-ard (2010, p. 121) as follows.

Mean		Degree of Satisfaction
4.51–5.00	=	Very high
3.51–4.50	=	High
2.51–3.50	=	Moderate
1.51–2.50	=	Low
1.00–1.50	=	Very low

4. Results

1) The research results of the ongoing learning activities

The results indicated that the mean score of the 7th grade students from the deductive learning activity management with games was higher than the established criteria of 75% at the .05 level of the statistical significance as shown in Table 2.

Table 2. Comparison of the score from ongoing activities with the established criteria of 75%

Topics	Total Score	Mean	SD	Mean Differences	t-test	Prob
Process	140	125.19	4.04	20.19	9.85	0.00

The score of the students for ongoing assessment was 125.19 points, or 89.42% which was higher than the

established criteria of 75%. The mean score of nine topics was higher than the established criteria of 75%. The two high rated scores of the topics were property of equality (94.62%) and Calculation of Algebraic Expression (78.46%) as shown in Table 3.

Table 3. Scores, mean, standard deviation and percentage of the results from ongoing assessment of the deductive learning activity management with games

Topics	Lesson Plan No.	Total Score	Mean	SD	Percent
Calculation of Algebraic Expression	1	10	7.85	1.57	78.46
Writing Algebraic Expression	2	20	18.81	2.19	94.04
Equations	3	10	9.35	0.94	93.46
Answers of Equations	4	10	9.27	0.96	92.69
Property of Equality	5	10	9.46	0.76	94.62
Solving Equations	6	20	18.46	1.70	92.31
Single Variable Linear Equations	7–8	20	16.96	1.15	84.81
Writing Single Variable Linear Equations for a Situation	9	10	9.00	1.17	90.00
Solving Question of Single Variable Linear Equations	10–12	30	26.04	2.29	86.79
Total	-	140	125.19	4.04	89.42

The results of classroom activities participation and responsibilities for assigned tasks of the students were low because of the COVID-19 pandemic. After the author used the deductive learning activity management with games focusing on creating various learning activities such as games, photo cards, video clips relating to the contents, the findings showed that the students had more interests and responsibilities for assigned tasks.

2) The research findings indicated that the post-test score of the students after using the deductive learning activity management with games was higher than that of the pre-test score at the .05 level of the statistical significance as shown in Table 4.

Table 4. Results of pre-test score and post-test score of the students after using the deductive learning activity management with games

Test	n	Mean	SD	Percent	Paired Differences		t-test	Prob
					Mean	SD		
Pretest	26	8.19	2.14	27.31	9.62	32.05	11.55	0.00
Posttest	26	17.81	5.18	59.36				

3) The overall satisfaction of the students with the deductive learning activity management with games was at a high level (Mean = 4.21). Regarding nine items of their satisfaction, the findings showed that there were one very high item, seven high items and two moderate items. The three highest rated items of their satisfaction were acceptance of other opinions (Mean = 4.65), teaching materials and positive attitude toward Mathematics (Mean = 4.50) and appropriate and interesting teaching materials (Mean = 4.46) respectively as shown in Table 5.

Table 5. Satisfaction of the 7th grade students with the deductive learning activity management with games on the topic of "Single Variable Linear Equation"

No	Items of Assessment	Mean	SD	Degree of Satisfaction
1	Students understood the contents precisely.	4.12	0.92	high
2	Students were able to plan for solving the problems by themselves.	3.88	0.79	moderate
3	Teaching materials assisted the students to understand the contents precisely.	4.50	0.64	high
4	Students improved the interaction with friends in classroom.	4.00	0.96	high
5	Students shared the idea with their friends in class.	4.12	0.82	high
6	Students were able to present their work in front of their ir friends in class.	3.65	1.16	moderate
7	Students accepted other opinions.	4.65	0.76	very high
8	Teaching materials used by the teachers were appropriate and interesting.	4.46	0.89	high
9	Students were able to apply their knowledge for their daily life.	4.23	1.19	high
10	Students had positive attitude toward Mathematics.	4.50	1.17	high
	Total	4.21	0.99	high

5. Conclusions and Discussions

The effects of the deductive learning activity management with games on the topic of "Single Variable Linear Equation" on learning achievement of the students were discussed as follows.

1) The mean score of the 7th grade students from the deductive learning activity management with games was higher than the established criteria of 75% at the .05 level of the statistical significance. The results may be caused by the systematical process for presenting contents, rules, theories, concepts and followed by the examples based on the deductive learning activities management with gemes. Sankpanya (2018, p. 65) states that the efficient learning management consists of quality of instruction. The major components of quality of instruction consists of appropriate lessons, systematical presentation for the contents, relating to previous knowledge of the students, giving examples, using photo and diagram. Additionally, the author used games with learning activities to encourage their interest in learning, enjoyment and participation in learning activities. Kamanee (2014) asserts that the advantage of teaching with games is to enhance the students to participate in learning by doing from meaningful learning activities and their learning retention. Haibin and Tingting (2021) state that the COVID-19 pandemic has affected all educational levels throughout the world. Therefore, online learning has been necessary for instructional management. The contents and technique should be analyzed and designed appropriately for efficient online learning. One of the important strategies for the efficient online learning is applying electronic blackboard to online deductive and linking theory to practice for better understanding of knowledge. Sun et al. (2021) claim that using games for learning Mathematics of the students improves their knowledge, attitude, motivation and behaviors. The teachers are able to integrate games with learning activities for efficient learning of the students.

2) The post-test score of the students after using the deductive learning activity management with games was higher than that of the pre-test score at the .05 level of the statistical significance. The results may be caused by three steps of the deductive learning activity management with games. The teaching steps of the deductive learning activity management with games. Consisted of 1) presentation, 2) checking and concluding the rules and 3) practice. The teaching steps encouraged the students to get knowledge and enjoyment. As a result, the posttest score of the students for Mathematics achievement was higher than that of the pre-test score. Malangtupthong et. al. (2015) claim that the effects of the deductive and inductive learning activities affect the Mathematic achievement, reasonable thinking and communication of the 10th grade students. The post-test score of the students after using the deductive and inductive learning activities was higher than the standardized criteria of 70% at the .01 level of the statistical significance. Kerddee (2014) asserted that the post-test score of the students for Mathematics achievement after using the deductive learning activities was higher than that of the pre-test score at the .05 level of the statistical significance. Ekasart (2017) stated that the post-test score of the 11th grade students for Mathematics achievement after using the deductive learning activities was higher than that of the pre-test score at the .05 level of the statistical significance. Nuhoglu (2020, pp. 118–119) asserted that the problem-solving skill of the 7th grade students after using deductive methods improved than before using the deductive methods at the .05 level of the statistical significance.

3) The overall satisfaction of the student with the deductive learning activities with games on the topic of "Single Variable Linear Equations" was at a high level. The results may be caused by appropriate lesson plan design based on the abilities and interest of the students. Moreover, the deductive learning management focuses on rules, theories and conclusion based on the learning objectives. The teachers provide the examples and encourage the students to apply their previous knowledge for new situations and share their learning experiences with their friends during doing tasks or learning activities. Singh et al. (2021) had developed the card game of Math Zap for improving matjematical number calciation skills of the primary school students at the age of 12–13 years old. The research findings indicated that the numeral skills in fraction, percent and decimal number by using games were significantly higher than those of the skills and aptitude before using games. Bilgin (2021) stated that using games was able to decrease the anxiety of the students in learning Mathematics and improve the positive attitude toward Mathematics. Nur (2022) interviewed five 12–13-year-old primary school students about the deductive approaches. The study showed that they were really satisfied with the deductive approaches because the approached provided them to understand the lesson and interaction between teachers and students.

6. Suggestions

6.1 Practical Suggestions

The teachers should explain the deductive learning activities clearly because the deductive learning activities are new for them. Additionally, the teachers should select simple, appropriate and clear learning activities for them.

Problem identification is the first step of deductive learning activities. Therefore, the teachers should select the

problems concerned with their daily life and their interest. Moreover, the teachers should encourage the students to find problem solutions.

The teachers should use appropriate teaching materials in case of no internet network during doing learning activities.

Time management should be sufficient and appropriate for the contents and learning activities in class.

6.2 Suggestions for Further Study

The deductive learning management with games should be employed for further study of

the different contents and classes of Mathematics.

TPACK Model or Active Learning Model should be employed for further research on Mathematics learning improvement and retemtion of the students.

Acknowledgments

References

Bilgin, E. A. (2021). A Mobile Educational Game Design for Eliminating Math Anxiety of Middle School Students Enes. *The Asian Institute of Research Education Quarterly Reviews*, *4*(1), 354−361. https://doi.org/10.31014/aior.1993.04.02.251

Ekasart, K. (2017). *The Effects of Deductive Teaching Method in the Topic of Trigonometric Ratios on Mathematics Learning Achievement of Mathayom Suksa V Students at Surathampitak School in Nakhon Ratchasima Province*. Degree: Master of Education (Curriculum and instruction). Independent Study. Bankkok: Sukhothai Thammathirat Open University.

Fitriyana, N., Wiyarsi, A., Sugiyarto, K. H., & Ikhsan, J. (2021). The Influences of Hybrid Learning with Video Conference and "Chemondro-Game" on Students' Self-Efficacy, Self-Regulated Learning, and Achievement toward Chemistry. *Journal of Turkish Science Education*, *18*(2), 233−248. https://doi.org/10.36681/tused.2021.62

Haibin, S., & Tingting, L. (2011). Student-Centered Online Teaching Practices in Theoretical Mechanics. *Higher Education Studies*, *11*(2), 233−239. https://doi.org/10.5539/hes.v11n2p233

Kamanee, T. (2014). *Teaching Science: Cognitively for organizing effective learning processes*. Bankkok: Publisher of Chulalongkorn University.

Kerddee, W. (2014). *The Comparison of Learning Achievement and the Attitude towards the Topic Entitled 'Pythagorean Theory' Mathematics Learning Substance Group of Mathayomsuksa 2 Students using Induction and Deductive*. Degree: Master of Education (Curriculum and instruction).

Kerras, N., & Essayahi, M. L. B. (2022). Education and COVID-19: Learning Arabic Language and Perspectives. *The Electronic Journal of e-Learning*, *20*(1), 36−52. https://doi.org/10.34190/ejel.20.1.1976

Li, D. (2022). The Shift to Online Classes during the Covid-19 pandemic: Benefits, Challenges, and Required Improvements from the Students' Perspective. *The Electronic Journal of e-Learning*, *20*(1), 1−18. https://doi.org/10.34190/ejel.20.1.2106

Malangtupthong, P., Angganapattarakajorn, V., & Nualpang, K. (2015). The effects of organizing inductive and deductive learning on mathematical reasoning and written communication abilities in numbers theory of Mathayomsuksa four students. *Journal of Education* (Burapha University), *26*(2), 102−113. Retrieved from http://dspace.lib.buu.ac.th/xmlui/handle/1234567890/2933

Ministry of Education. (2017). *Indicators and Core Learning Materials Mathematics Learning Materials based on the Core Course of Basic Education Buddhist Era 2008* (Revised Version 2017). Bankkok: Office of Academic Affairs and Educational Standards, Office of the Basic Education Commission, Ministry of Education.

Moonkham, S., & Moonkham, O. (2003). *19 Ways to Manage Learning: To Improve Knowledge and Skills*. Bankkok: pap print.

Niyoms, N. (2017). *Basic knowledge on instruction*. Nakhon Pathom: Silpakorn University.

Nuhoglu, H. (2020). The Effect of Deductive and Induction Methods Used in Modelling Current Environmental Issues with System Dynamics Approach in Science Education. *Participatory Educational Research*, *7*(1),

111−126, March. https://doi.org/10.17275/per.20.7.7.1

Nur, S. (2022). Students' Perception Toward the Use of Deductive and Inductive Approaches in Teaching English Grammar. *TESOL International Journal*, *15*(1), 6−19. Retrieved from https://files.eric.ed.gov/fulltext/EJ1257213.pdf

Pornthadawit, N. (2018). *Active learning management* (2nd ed.). Bankkok: triple Education.

Sankpanya, V. (2018). *Teaching Psychology*. Bankkok: Publisher of Chulalongkorn University.

Singh, P., Hoon, T. S., Nasir, A. M., Ramly, A. M., Rasid, S. M., & Meng, C. C. (2021). Card game as a pedagogical tool for numeracy skills development. *International Journal of Evaluation and Research in Education* (IJERE), *10*(2), June, 693−705. https://doi.org/10.11591/ijere.v10i2.20722

Srisa-ard, B. (2010). *Basic Research* (8th ed.). Bankkok: Suviriya Epistle.

Sun, L., Chen, X., & Ruokamo, H. (2021). Digital game-based pedagogical activities in primary education: A review of ten years' studies. *International Journal of Technology in Teaching and Learning*, *16*(2), 78−92. https://doi.org/10.37120/ijttl.2020.16.2.02

Tayraukham, S. (2009). *Research Methodology for Social Sciences and Jumanities* (3rd ed). Maha Sarakham: Mahasarakham University Print.

Warakham, P. (2016). *Educational Research* (8th ed.). Maha Sarakham: Tukkasila kanpim.

White, K., & McCoy, L. P. (2019). Effects of Game-Based Learning on Attitude and Achievement in Elementary Mathematics. *Networks: An Online Journal for Teacher Research*, *21*(1). https://doi.org/10.4148/2470-6353.1259