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A Research Synthesis on Learning Management that Develops 21st Century Learning Skills by Meta-Analysis

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Abstract

The purpose of this research were: 1) to study the effect size of research studies on learning management that develops 21st century learning skills, 2) to study the characteristics of research studies influencing effect size of learning management that develops 21st century learning skills, publicized during 2008-2017, a total of 86 issues. The research instruments were quality evaluative forms and research characteristics coding forms. The data were analyzed by descriptive statistics, analysis of difference of means using forest plot and subgroup analysis.

The result of research synthesis were:

1. The research characteristics found that most research studies on learning management that develops 21st century learning skills were conducted by Chulalongkorn University (88.4 %) which was published in 2016 (17.4%). Most research studies were critical thinking skills and problem-solving skills (33.7%). Most innovation used teaching methods (91.9%). Most objectives were for research and development (61.1%). The instructional media were two-way instructional media (93.0%) and measurement and evaluation methods were testing (100%). The type of research hypothesis were mostly directional hypothesis (52.8%). The sample acquisition method was simple random sampling (100%). The research instrument was a test (100%). Most research studies collected data for 1-2 months (83.77%). Most statistic for data analysis was t-test (72.2%). The total quality of research reports was excellent ($M = 4.50$, $SD = 0.65$).

2. The key findings were as follows: 1) The total effect size of learning management that develops 21st century learning skills was 1.09. 2) The effect size of learning management that develops 21st century learning skills in each research had high heterogeneity with statistical significance at the .05 level ($Q(85) = 648.51$, $p < .0001$) 3) The characteristic of research influencing the effect size of learning management that develops 21st century learning skills was instruction.

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Introduction

21st century learning skills are necessary for students to keep with changes that occur throughout the global. Learning activities must be created and managed to develop knowledge for students. Learning management is necessary to develops 21st century learning skills and refers to the ability to use new knowledge in a creative way, which will lead to instruction that helps students prepare themselves to live their life in the real world. It mainly focuses on lifelong learning by being flexible in how we teach, stimulating and motivating students to become resourceful who continuously search information to gain knowledge even after graduation. Thus, preparing students for their life in the 21st century is necessary for educational institutions.

The traditional educational approaches cannot met the educational needs of the new society and do not recognize new learner characteristics of the 21st century, therefore it is better to modify instructional design principles (Sahin, 2009). Learning methods in the 21st century should be flexible, creative, challenging, and complex as well as offering new opportunities and possibilities (St George's College, 2013). In the development of 21st century learning skills for students, a large number of teachers, lecturers, and scholars have implemented research on this matter. The prior research studies have caused social changes in wide and deep directions. Without collection, systematization, and utilization of these research studies, it would be a pointless investment (Sukamolson, 1989). Synthesis of prior research studies will create immeasurable value to the total results of the research in terms of different findings because they were already tested and practiced. Thus, we will obtain a body of useful knowledge to develop instruction for students from research synthesis. Meta-analysis is very useful to create the body of knowledge. The expected benefits from meta-analysis are the development of quality research studies, complete statistical reports, printing quality, writing research reports, and theoretical development from meta-analysis. These imply the significance of meta-analysis for concrete development of different sciences.

Accordingly, to prevent loss of benefits for prior research studies and to utilize them for instructional management, the researcher was interested in research synthesis on the development of achievement and desirable characteristics by meta-analysis in order to obtain conclusions for learning management that can aid in developing 21st century learning skills by meta-analysis. This research and results focus on being highly objective and reliable. The research synthesis created new knowledge and findings from the conclusions will be useful for further utilization and instructional development in teachers/lecturers, administrators, and for others involved in education. Moreover, it can be a guideline on research implementation for those interested in learning management models because this study revealed gaps or missing pieces in several aspects.

Objectives

1. To study the effect size of research studies on learning management that develops 21st century learning skills.
2. To study the characteristics of research studies influencing effect size of learning management that develops 21st century learning skills.

Research methodology

Population and samples

The population included prior research studies on learning management that develops 21st century learning skills from 3,569 graduate thesis publicized in the database of TDC Thailis between 2008-2017.

The samples included research studies on learning management that develops 21st century learning skills from 67 graduate thesis publicized in the database of Thailis by the following selection criteria.

1. Research studies with keywords about learning management that develops 21st century learning skills.
2. Quasi-experimental research studies with dependent variables of learning management that develops 21st century learning skills.
3. Research studies with reports of basic statistics and other statistics sufficient for effect size calculation.

Then, the selection and exclusion were implemented. 49 research studies without effect size or which were not sufficient for effect size calculation were excluded. The other 3,404 research studies were excluded based on the following: 1) Research did not contain comparisons between control and treatment groups, 2) did not match the target, and 3) contained duplicate sources.

Publication bias analysis

According to the results of publication bias analysis from all 67 research studies, and the results from 86 research studies ($k = 86$) by analyzing egger' s regression intercept, statistical significance was found ($t = 7.96$, $df = 84$, $p < .0001$). This implied that effect size of learning management with achievement

depended on the size of research studies. It conformed to the results of analysis by funnel plot which indicated that most distribution of learning management in the 21st century was linear (Higgins & Green, 2008), as shown in Figure 1.

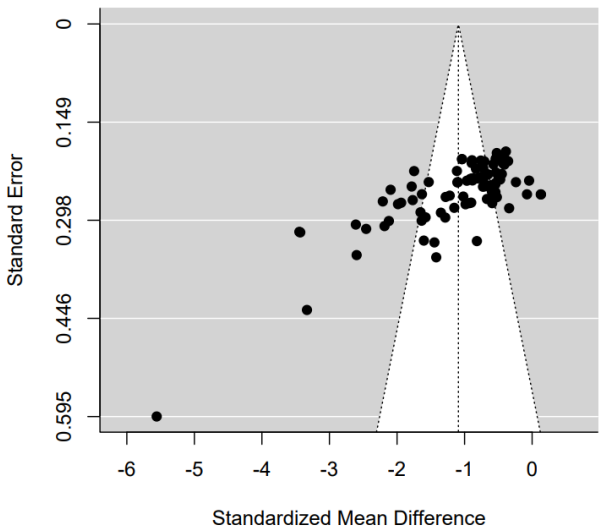


Figure 1 Funnel plot

Research instruments

The instruments in this research were used as follows.

1. Research quality assessment form: It contained a 5-rating scale, consisting of 2 parts, i.e., research quality assessment and assessment criteria. The form was developed as per the following process. 1) Research textbooks about research quality assessment were studied. 2) The research quality assessment form was developed, with 5-rating scale, 22 criteria, and the level of the assessment criteria in each item (Rubric). 3) The examined and improved assessment form from the experts was tested and assessment with 2 assessors. In regard to the qualifications of the assessors, they graduated with a master's degree and Ph.D. in Educational Research and Evaluation. A total of 3 assessors were involved, including the researcher. Inter-rater among the assessors was calculated by Intra-class Correlation (ICC) using SPSS. ICC was obtained at 0.802 with a 95% confidence level, implying good conformity among the multiple assessors.

2. Research characteristics record form was an instrument for data collection. The form was developed as per the following process. 1) Relevant textbooks, documents, and research papers were studied. 2) The research characteristics record form was developed as a checklist. 3) The form was examined by the expert for the ambiguity in data collection about the variables of research characteristics. 4) The improved record form was brought for record with the other 2 recorders, including the researcher. The 3 assessors, examined conformity by recording 3 research papers. The results revealed high conformity of the characteristics record for all of the 3 research papers at 78.57-85.57%.

Data analysis

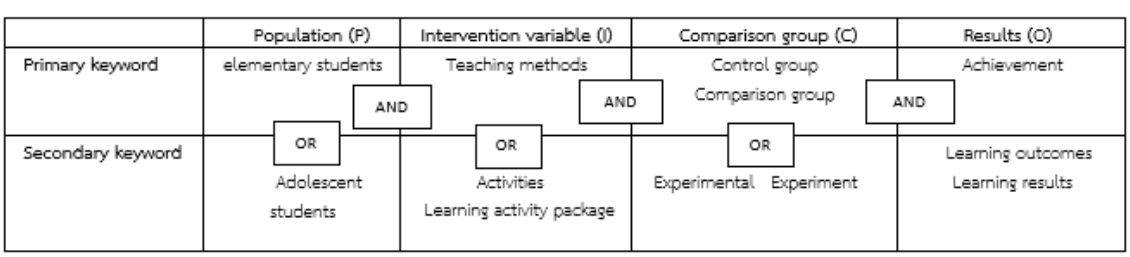
1. Quantitative data and primary data was analyzed, i.e., percentage, frequency of research characteristics as the nominal variables, mean, SD, skewness, kurtosis, and coefficient of variation (CV) to acknowledge the distribution of the variables of research characteristics as the nominal variables in all 4 aspects, i.e., primary data about general research characteristics, and details about research characteristics in terms of content and methodology, quality, and publication bias analysis by Egger's regression intercept.

2. Research characteristics influencing effect size were analyzed. The quantitative research was synthesized by meta-analysis. Cohen's d Formula for effect size was used(Cohen, 1988).

3. The difference between the total effect size and each paper was analyzed by forest plot. The difference of effect size in each paper was analyzed by subgroup analysis using the R program (version 3.6) (R Core Team, 2019).

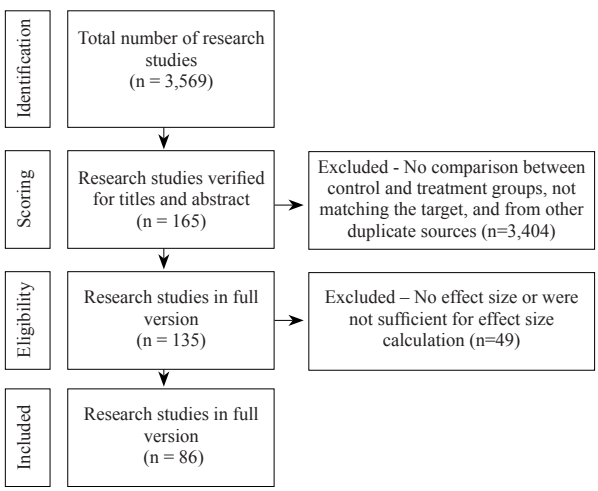
Research implementation and data collection

Searching strategies and research selection criteria



The first selection criteria was for research studies from between 2008-2017, that focused on learning management that develops 21st century learning skills. Then a search of the Thailis database was conducted based on PICO format and keywords.

The researcher selected "advance search" by keywords and viewing from the filter of data selection, title, subject, university/institution (All universities/institutions), type of documents, and thesis only between 2008-2017 with a retrieval of 135 research studies. Only the ones on elementary students were selected. Next, research studies were selected by process and report based on the principles of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The selection process included inclusion – exclusion criteria for further meta-analysis as follows.



Results

1. The analysis results of primary data of nominal variables of research characteristics.

For general research characteristics, in terms of thesis production institution, 76 research studies (88.4 %) were produced by Chulalongkorn University. In terms of publication year, most or 15 research studies (17.4%) were published in 2013. In terms of thesis level, 86 were graduate thesis (100%).

For content, 29 research studies (33.7%) were associated with critical thinking skills. In terms of innovation/solution methods, 27 research studies (91.9%) used teaching methods. In terms of objective, 22 research studies (61.1%) were for research & development. In terms of instructional media, 80 research studies (93.0%) were two-way communication. In terms of test and evaluation, 86 research studies (100%) used a test.

For research methods, in terms of hypothesis, 86 research studies (100%) used directional hypotheses. In terms of sample acquisition, 17 research studies (19.8%) obtained their samples by simple random sampling. In terms of sample size, 86 research studies (100%) included sample sizes over 30 rather than less than 30. In terms of data collection instrument, 86 research studies (100%) used a test. In terms of data collection duration/experiments, 46 research studies (53.5%) took 1-2 months. In term of statistics, 72 research studies (83.77%) used a t-test.

When considering distribution of continuous variables in some research studies, it was found that they included a sample size of 77, with SD = 17.20, maximum = 111 samples, and minimum = 40 samples. The distribution was right skewed. Sample size was mostly lower than the mean, with lower distribution than normal curve (Sk = 0.12, Ku = -0.71). For research assessment score, mean = 4.64, SD = 0.17, maximum = 4.91, and minimum = 4.05. The distribution was left skewed. For the research assessment score, it was mostly higher than the mean, with a higher distribution than normal curve (Sk =-1.38, Ku =3.23).

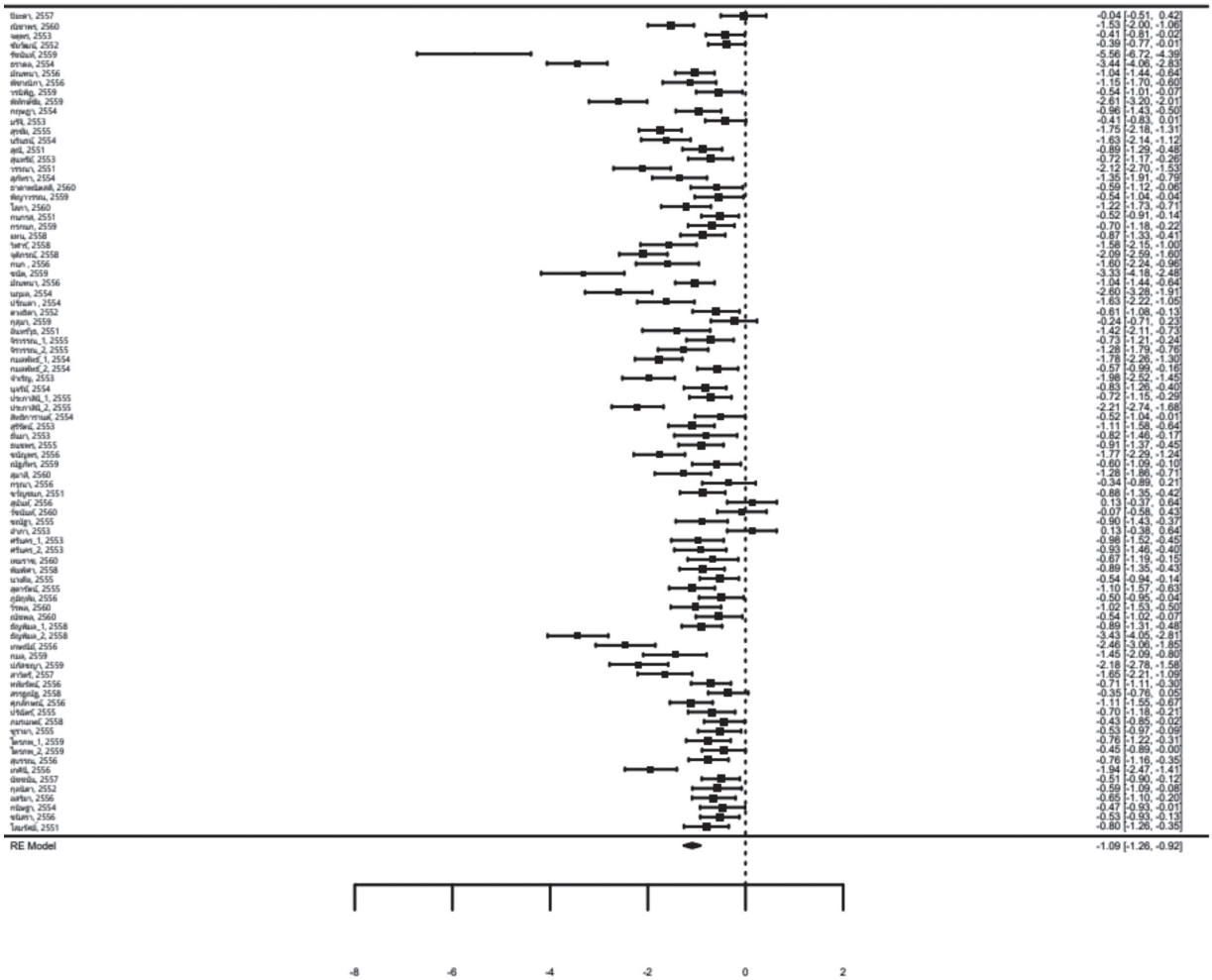
2. The analysis results of research studies influencing effect size of learning management that develops 21st century learning skills.

2.1 The analysis results of total effect of learning management that develops 21st century learning skills.

The analysis used Cohen's d Formula for effect size calculation. It was found that the total effect = -1.09, with a 95% confidence interval between 1.26 to - 0.92.

2.2 The analysis results of effect size of learning management that develops 21st century learning skills from each research study

Effect size of 86 research studies (k = 86) implied a significant difference of effect size variance ($p < .05$) ($Q(85) = 648.51$, $p < .0001$). Also, the result of statistical consideration ($I2) = 90.39\%$ implied that effect size of learning management that develops 21st century learning skills from each research study was highly different (heterogeneity). This conformed to the analysis results of difference of effect size by forest plot that displayed difference of effect size in each research study. This implied that such a difference finally led to subgroup analysis.



2.3 Moderator variable analysis

There were 2 moderator variables in this research, i.e., research characteristics in terms of contents, i.e., innovation or solution methods, and instructional media. The details of effect size analysis for each moderator variable are as follows.

1) For innovation or solution methods, there were 86 research studies (k = 86), classified into effect size from 79 research samples using innovation or solution methods in terms of teaching methods only, and 7 research samples using teaching methods with media/materials. According to the total analysis results of research studies using innovation or solution methods in terms of teaching methods only (Subgroup 1), statistical significance was found ($p < .05$) with SMD = 1.97 (CI 95% [1.75, 2.21]). According to the total effect of research studies using teaching methods with media/materials (Subgroup 3), statistical significance was found ($p < .05$) with SMD = 1.60 (CI 95% [0.97, 2.22]). According to the analysis results of the difference of SMD, no significant difference was found ($p > .05$) (SMD = 1.93, CI 95% [1.71, 2.15] p = .27). These analysis results implied that innovation or solution methods were not moderator variables influencing effect size of learning management in the 21st century, or when testing the difference of both subgroups, their effect size was not significantly different (Q (1) = 1.21, p = .27), as shown in Figure 3.

2) For instructional media, there were 86 research studies (k=86), classified into effect size from 2 research samples using one-way communication media, 80 research samples using two-way communication media, and 4 research samples using self-learning media. According to the total analysis results of research studies

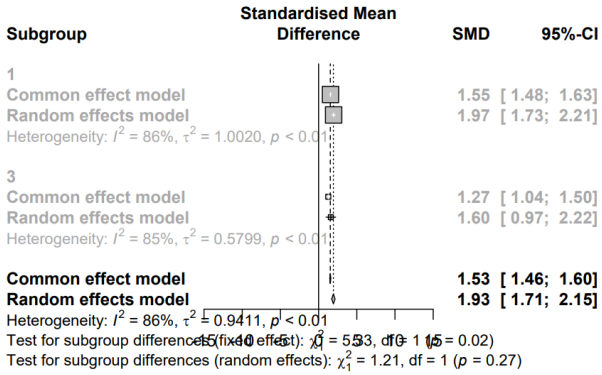


Figure 3 Subgroup analysis of innovation or solution methods

using one-way communication media (Subgroup 1), statistical significance was found (p < .05) with SMD = 1.00 (CI 95% [0.60, 1.39]). According to the total effect of research studies using two-way communication media (Subgroup 2), statistical significance was found (p < .05) with SMD = 1.97 (CI 95% [1.73, 2.20]). According to the total effect of research studies using self-learning media (Subgroup 3), statistical significance was found

(p < .05) with SMD = 1.86 (CI 95% [0.82, 2.91]). According to the analysis results of the difference of SMD, significant difference was found (p < .05) (SMD=1.93, CI 95% [1.71, 2.15] p <. 001). These analysis results implied that instructional media was a moderator variable influencing effect size of learning management in the 21st century. Or when testing the difference of both subgroups, their effect size was significantly different (Q(2)= 17.11, p<.001), as shown in Figure 4.

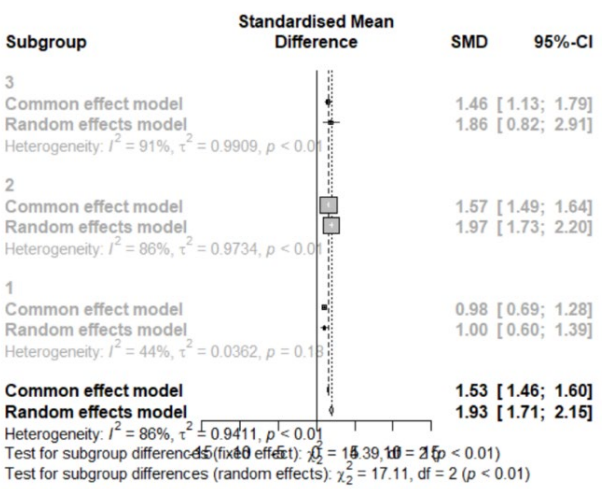


Figure 4 Subgroup analysis of instructional media

Discussion

1. According to the research results, it was found that innovation or solution methods were not moderator variables influencing effect size of learning management in the 21st century, or when testing the difference of both subgroups, their effect size was not significantly different. This could be due to the research studies using innovation or solution methods to develop 21st century learning skills that used teaching methods with instructional media/materials and guidelines or main procedures of similar teaching methods. To clarify, they focused on introduction, teaching, and conclusions. Instructional media were also used during teaching. Apart from this, it might also be because this research contained similar implementation features, i.e., experimental duration, innovation try-out duration, innovation creation process or solution methods in the development process. Thus, using innovation or solution methods made no difference to effect size of learning management skills in the 21st century.

2. According to the research results, it was found that instructional media was a moderator variable that caused significant difference of effect size of learning management in the 21st century, or when testing difference of both subgroups, effect size between the subgroups was significantly different. That was because different instructional media influenced different learning outcomes/results. For example, two-way media created interaction between students and teachers, resulting in better understanding than one-way media. In addition, there was also communication for information transfer between senders and receivers, with correspondences and feedbacks during instruction. This could motivate instruction for better teaching and cause different effect size. This conforms with the research of Udomkhun (2009), who synthesized her research and found that innovation influencing effect size most was various instructional media that focused on colorful motivation for learning and made instruction effective. The results also conformed to Komtomgsuk (2007), who synthesized her research on integrated learning management: Meta-analysis and content analysis. It was found that types of instructional media/material had different effect size.

Suggestions

Suggestions for utilization of research results

1. According to the results, it was found that effect size of learning management that develops 21st

century learning skills in each research study was different. The associated issues, e.g., teaching/learning management methods and test were necessary to difference of effect size. Therefore, teachers who would like to develop 21st century learning skills should focus on those associated variables to maximize the benefits for students, e.g., new and suitable teaching methods, creating instructional media that suits the age and interest of students, and suitable guidelines on testing that reflect real data of students.

2. According to the findings from this synthesis, it was found that instructional media was a moderator variable for effect size of developing 21st century learning management, or when effect size between two groups was different. As a result, instructional media influenced 21st century learning management. Thus, teachers in elementary schools who would like to develop 21st century learning skills should focus on two-way and self-learning instructional media to help develop students more efficiently.

Suggestions for future research implementation

1. There should be studies on the factors influencing 21st century learning management, century learning management for more practical benefits.

2. There are still a few issues in research synthesis when compared to other issues associated with 21st century learning skills. Thus, there should be further studies on cultural and paradigm understanding of skills for inclusive 21st century learning management.

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