ICMR2024

Proceedings of the 1ˢᵗ International Conference on Multidisciplinary Research : ICMR

"Multidisciplinary Research on Sustainable Development"

MULTIDISCIPLINARY RESEARCH ON
SUSTAINABLE DEVELOPMENT

16 MAY
2024

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SHINAWATRA UNIVERSITY

Proceedings of the 1st International Conference on Multidisciplinary Research : ICMR

"Multidisciplinary Research on Sustainable Development"

Schedule
The 1st International Conference on Multidisciplinary Research 2024
16th May 2024, Online Conference (ICMR)
Via Internet (Zoom meeting)

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09.00 a.m.-09.10 a.m.　　**Opening Ceremony of the International Conference**

By　President of Shinawatra University

Associate Professor Zhou Fei

09.10 a.m.-11.00 a.m.　　**Keynote Speakers:**

- Neckband for LinkNet-34 for Surgical Instrument and Abdominal

Adipose Tissue Segmentation

By　Assoc.Prof.Dr. Manoj Gupta

- Creating a win-win situation the role of education in achieving the

sustainable development goals

Dr. Sipnarong Kanchanawongpaisan

- Scopus and Web of Science Standard as Framework for Determining

the Quality of Publishable Paper

By　Dr. Rommel V. Tabula

- Innovations Driving the Future of Healthcare

By　Dr. Veena Chantarasompoch

- Nurturing innovation via Arts and Culture for Sustainable

Community Progress

By　Dr. Chanyanan Somthawinpongsai

11.00 a.m.-11.05 a.m.　　**Group Photo Session**

11.05a.m.-12.00a.m.　　**Research Presentations**

(maximum 20 minutes per/ presentation, including 5 minutes for Q&A)

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EFFECT OF SURFACE TREATMENTS ON PREPARED SHORT FIBER-REINFORCED RESIN COMPOSITE TO SHEAR BOND STRENGTH AND BOND DURABILITY WHEN USING RESIN CEMENT

Mullika Hongsangiam, Sitthikorn Kunawarote

EFFECT OF SURFACE TREATMENTS ON PREPARED SHORT FIBER-REINFORCED RESIN COMPOSITE TO SHEAR BOND STRENGTH AND BOND DURABILITY WHEN USING RESIN CEMENT

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ABSTRACT

Introduction: The short fiber-reinforced resin composite (SFRCs) has been used as core build up in severely damaged teeth. SFRCs were presented the denuded fiber exposure and no oxygen inhibited layer after tooth preparation process of indirect restoration, that might inhibit adhesion to resin cement. There's no evidence about SFRCs bonding capacity to resin cement after tooth preparation. The purpose of this study was to evaluate the effect of surface treatment on prepared SFRCs to shear bond strength (SBS) and bond durability when using self-adhesive resin cement.

Methods: 20 conventional resin composites blocks (filtek[TM]Z350XT,FT) and 80 SFRCs blocks (everX posterior[TM],EV), size 5mm diameter and 4mm height, were cross section at middle for prepared to 200 resin composite specimens (5mm diameter, 2mm height) that embedded with epoxy resin by uncovered cutting surface then polished surface and then stored in distilled water at 37°C for 7 days. The 40 FT specimens were used as control group and 160 EV specimens were randomly divided into 4 groups according to surface treatments methods: no treatment(EV1), silanization(EV2), sandblasting(EV3) and sandblasting with silanization(EV4). Specimens were cemented with resin composite rods (3mm diameter, 2mm height) to the self-adhesive resin cement (RelyX[TM]Unicem) then divided into 2 subgroups, water storage for 24 hours and thermocycling 10,000 cycles. Specimens were subjected to SBS test. Data were analyzed by Two-way ANOVA and Tukey's test. Modes of failure were observed by stereomicroscope.

Result: The SBS of EV was significantly higher than FT (p<0.05). After thermocycling, The SBS was significantly decreased in all group except EV2 (p<0.05). Failure mode analysis showed predominantly mixed failure in EV2,EV3,EV4 and adhesive failure in FT,EV1.

Conclusion: SFRCs presented higher SBS than conventional resin composite. All of surface treatments of SFRCs were effective in increasing SBS to self-adhesive resin cement. The silanization of prepared SFRCs presented highest bond durability.

Keywords: short fiber-reinforced resin composite; core build up material; shear bond strength

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1. Introduction

Nowadays, biomimetics dentistry approach plays a crucial role in developing the dental restorative materials which mimic natural ones including mechanical, physical and optical properties [1]. In 2013, the short fiber-reinforced resin composite (SFRCs) has been introduced for direct restoration as dentin replacing materials [2]. The empirical academic evidence approved that the SFRCs show the physical properties such as the modulus of elasticity comparable to dentin, higher flexural strength, and fracture toughness when comparable to bulk-fill resin composite. The fiber reinforcement can stop crack propagation. The fibers that are oriented in transverse and perpendicular to fracture line can absorb stress and stop crack propagation. According to the crack propagation preventive properties, the failure of restoration almost presents in restorable failure. Moreover, SFRCs not only present good bonding capacity with the tooth substrate and the next layer of convention resin composite but also present low polymerization shrinkage stress when comparable to other resin composite [3-5].

2. Literature Reviews

The fiber-reinforced composite (FRCs) are composite materials with three different components: the matrix (continuous phase), the fibers (dispersed phase), and the zone in between (interphase) [6]. The use of FRCs in dental applications has been discussed in the literature since the early 1960s [7]. The FRCs have been became an effective material of choice in restorative dentistry such as an indirect resin composite, an inlay-retained fixed partial denture, and a fiber prefabricated post, etc. for a long time and continuous development.

The SFRCs were developed from FRCs for use as a direct restoration, dentin replacing materials and core build up materials. SFRCs consists of a combination of a resin matrix, short or nano fibers, inorganic particulate fillers, and the interface. There are many products of SFRCs such as Alert® (Pentron, Wallingford, CT, USA), NovaPro™ flow (Nanova, Columbia, MO, USA), NovaPro™ fill (Nanova, Columbia, MO, USA), EverX Flow™ (GC, Tokyo, Japan), EverX posterior™ (GC, Tokyo, Japan), Build-It™ FR (Kerr Corp., Orange, CA, USA), etc. [5]. The critical fiber length was around 50-150 times the diameter; this fiber length is the shortest length that allows tensile failure of the fiber and reduces the likelihood of shear failure in the matrix at the interface [8]. The short fiber orientation within the resin-based composite was discontinuous in random or unidirectional orientation. Garoushi et al., 2006 demonstrated that a high aspect ratio glass fiber-reinforced composite was a notable improvement in flexural strength when compared to a non-fiber filled resin composite [9]**.** Other reports confirmed these properties and showed improvements in the physical properties of resin composite [10]**.**

In Thailand, there are two available commercial products of SFRCs (everX posterior™ and everX Flow™) from GC, Tokyo, Japan. These products comprise short E-glass fibers and particulate barium glass fillers. The average fiber diameter is 17 µm and the length ranges from 1,300–2,000 µm for everX posterior™, and 200–300 µm with a diameter of 6 µm for everX Flow™ [3,4,11]. The resin matrix of everX posterior™ contains bisphenol-A-diglycidyl-dimethacrylate (bis-GMA), triethylene glycol dimethacrylate (TEDGMA), and linear polymethylmethacrylate (PMMA), forming a matrix called semi-interpenetrating polymer network (semi-IPN) during polymerization, that provides enhanced bonding properties for repairs and improves the toughness of the polymer matrix [12,13,14]. The short glass fibers incorporated into the resin matrix are millimeter-scale, discontinuous and in high aspect ratio, which provide enhanced mechanical properties that aim to be close to natural tooth tissues [15,16,17].

The SFRCs were used as core build up material in clinics [2,18,19]. Generally, the tooth preparation procedure; grinding and cutting by dental burs, for making the core build up that proper crown foundation, caused to remove oxygen inhibited layer, present in less residual monomer. Moreover, the denuded fiber exposure at the surface is possible to degradation after aging. There is no evidence about the properties of SFRCs after preparation and the surface treatment of SFRCs before cementation to indirect restoration. The purpose of this study is to evaluate the effect of surface treatment on prepared SFRCs to shear bond strength and bond durability when using self-adhesive resin cement.

3. Methodology

This study was an experimental study. The main materials in this study were shown in table 1. One-hundred resin composite blocks, size 5 mm in diameter and 4 mm in height were cross section at the middle to two-hundred resin composite specimens, size 5 mm in diameter and 2 mm in height by

using low-speed cutting machine (Isomet™ Low speed, Buehler Co., Illinois, USA). All of resin composite specimens were embedded with epoxy resin into the center of cylindrical plastic ring by facing up with uncovered cutting surface. The surface of specimens was polished by silicone carbide abrasive papers then stored in distilled water at 37°C for 7 days. The forty conventional resin composite (filtek™Z350XT, FT) specimens were used as control group and the one-hundred and sixty SFRCs (everX posterior™, EV) specimens were randomly divided into 4 groups according to surface treatments methods; no treatment (EV1), silanization (EV2), sandblasting (EV3) and sandblasting with silanization (EV4), as shown in figure 1.

    FT   Group : filtek™Z350XT + no surface treatment.

    EV1 Group : everX posterior™ + no surface treatment.

    EV2 Group : everX posterior™ + silanization with Rely™X ceramic primer 1min and air-dried.

    EV3 Group : everX posterior™ + sandblasting with 50µm Aluminum Oxide, 15 sec, 2.8 bar, 10mm distance.

    EV4 Group : everX posterior™ + sandblasting with 50µm Aluminum Oxide, 15 sec, 2.8 bar, 10mm distance + silanization with Rely™X ceramic primer 1 min and air-dried.

Table 1 Materials in this study

Materials	Composition
EverX posterior™	Resin matrix : Bis-GMA, TEGDMA, PMMA Filler : Barium borosilicate glass filler and E-glass fibers 74.2%wt, 57%vol
Filtek™Z350XT	Resin matrix : Bis-GMA, UDMA, TEGDMA Bis-EMA Filler : silica, zirconia (translucent shade; 72.5%wt 55.6vol%, other shade; 78.5%wt, 63.3%vol)
Rely™X Unicem applicap	Base : Methacrylate monomers containing acid groups, methacrylate monomers, silanated fillers, initiator components, stabilizer Catalyst : Methacrylate monomer, alkaline fillers, silanated fillers, initiator components
Rely™X ceramic primer	Silane in ethanol 70-80% water 20-30% solution
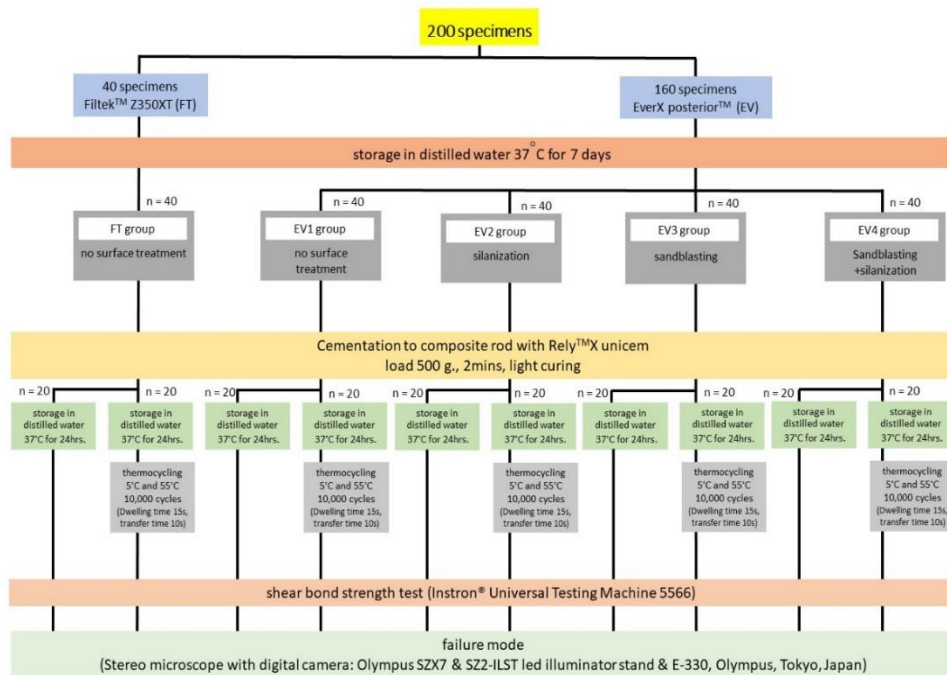
Figure 1 Experimental group of this study

All of specimens were cemented to resin composite rods (Filtek™Z350XT) size 3mm in diameter and 2mm in height by using self-adhesive resin cement (Rely™ X Unicem) according to the manufacturer's instructions. After cementation, the specimens were randomly divided into 2 subgroups (n=20), the first subgroup was stored in distilled water at 37°C for 24 hours, the second subgroup was stored in distilled water at 37°C for 24 hours then thermocycling (model B332R CWB332R TC301, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand) at 5°C and 55°C for 10,000 cycles (Dwelling time 20 sec, transfer time 5 sec).

Shear bond strength test and Mode of failure.

All of specimens from each subgroup were tested for shear bond strength by Instron Universal Testing machine (UTM; Instron® 5566 universal testing machine, Instron Engineering Corporation, Massachusetts, USA) with 1 mm/min cross head speed at the interface of specimen and resin cement.

Data of shear bond strength before and after thermocycling were collected and converted into megapascal (MPa) then analyzed by two-way ANOVA, followed by Tukey's test at significant level of 95% confidence interval. Modes of failure were observed under stereomicroscope and categorized into 4 groups, cohesive failure within the resin cement, cohesive failure within material in specimens, adhesive failure, and mixed failure.

Surface morphology examination.

Surface morphology examination after surface treatments of each group (FT group, EV1 group, EV2 group, EV3 group, and EV4 group) was done by using a Scanning Electron Microscopes (SEM, JSM-5910LV, JOEL Ltd., Japan) at X500, X1000, X10000, and X20000 magnification.

4. Results

The mean SBS value and standard deviations of each group are shown in table 2. The FT group presented the lowest mean SBS while the EV4 group presented the highest mean SBS. According to Two-way ANOVA, there were statistically significant difference ($p<0.05$) between FT group and all EV groups, both before and after thermocycling. The SBS at 24-hours bond of different surface treatment methods of all EV groups was no statistically significant difference ($p<0.05$) except between EV1 group and EV3 group.

The surface morphology of different surface treatment methods showed different characteristics as shown in figure 2. The FT group presented the homogenous nanofiller particles. The EV1 and EV2 groups were presented in 2 parts, the composite, and the fibers. The composite part showed mixed sized filler and the fibers part present in cylinder and ellipse shape in difference size and randomly direction. The EV3 and EV4 showed irregular surface and black holes at the fiber area.

Table 2 Mean shear bond strength and standard deviation of each group (Mean ± SD, MPa)

Groups		Shear bond strength (MPa)	
		24-hours bond	**Thermocycling 10,000 cycles**
Filtek™Z350XT + no treatment	FT	13.85 ± 3.12 B	8.22 ± 2.52 A
EverX posterior™ + no treatment	EV1	26.57 ± 2.28 DE	19.52 ± 3.81 C
EverX posterior™ + Silanization	EV2	27.42 ± 3.45 DEF	24.23 ± 4.78 D
EverX posterior™ + sandblasting	EV3	30.85 ± 3.36 F	24.68 ± 4.30 D
EverX posterior™ + sandblasting + silanization	EV4	29.95 ± 3.35 EF	25.86 ± 3.33 D

 Different superscript letters indicate statistical differences. ($p<0.05$)
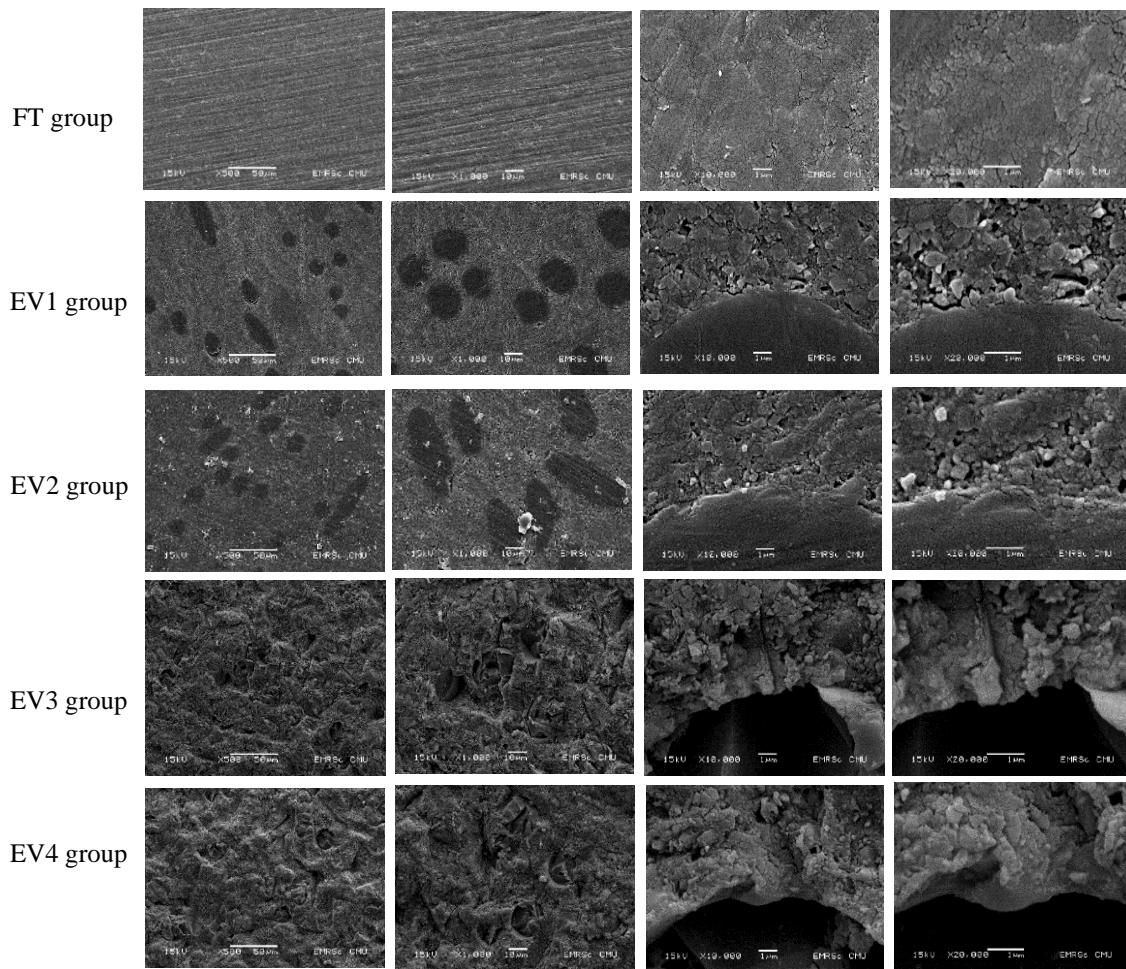
Figure 2 Surface morphology of each group

Mode of failure analysis showed predominantly adhesive failure in FT and EV1 and mixed failure in EV2 and EV3 and EV4, both before and after thermocycling, shown in figure 3.
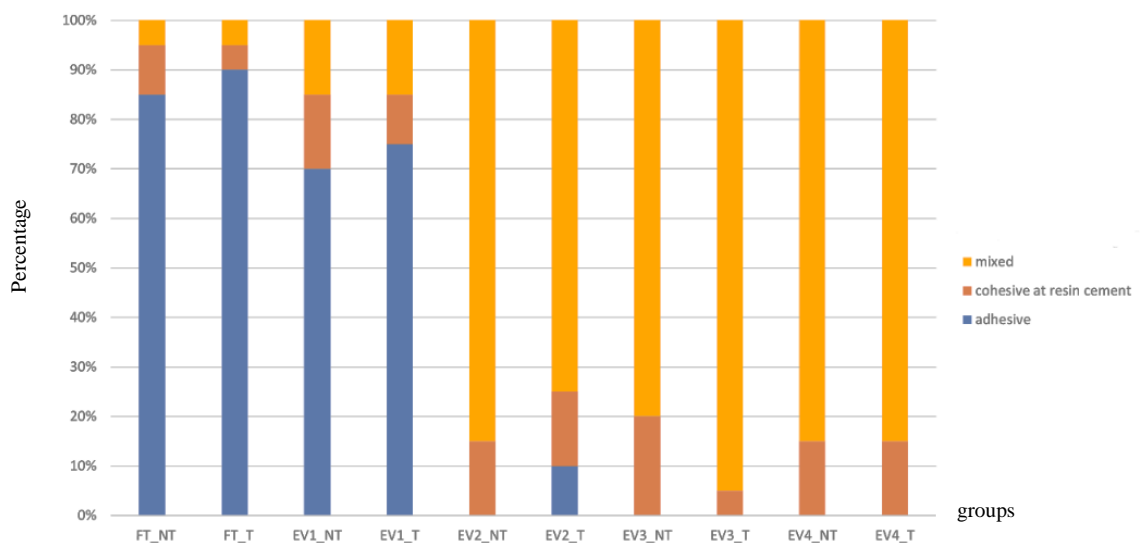
*FT_NT : FT group & Non-thermocycling, FT_T : FT group & Thermocycling, EV1_NT : EV1 group & Non-thermocycling, EV1_T : EV1 group & Thermocycling, EV2_NT : EV2 group & Non-thermocycling, EV2_T : EV2 group & Thermocycling, EV3_NT : EV3 group & Non-thermocycling, EV3_T : EV3 group & Thermocycling, EV4_NT : EV4 group & Non-thermocycling, and EV4_T : EV4 group & Thermocycling

Figure 3 Percentage of failure mode of specimens

5. Conclusion and Recommendation

In the process of tooth preparation for indirect restoration in case of severely damaged tooth was restored with core build up materials, the SFRCs were materials of choice. Clinically, the process of indirect restoration fabrication was spending times for 7 days or more. After tooth preparation, in part of core build up materials was presented in less residual monomer and no oxygen inhibited layer that cause to decreasing the bond strength to resin cement. Moreover, the denuded fiber exposure can cause degradation after aging. This study was simulated for finding the proper surface treatment after preparation procedure that gains the bond strength to the self-adhesive resin cement.

According to the results of this study, the mean SBS value of EV groups were higher than FT group with statistically significant difference ($p<0.05$) which can concluded the SFRCs present strong bond strength compared to conventional resin composite even though no extra surface treatment was performed. According to figure 2, the EV group had irregular surface from the fiber and resin matrix more than FT group, that possible to promote the high bond strength. And the SFRCs (everX posterior^{TM}) is a semi-IPN polymer which can strongly bond to the resin cement or the next layer of resin composite result in high SBS [13,14,20].

The silanization was increasing bond strength in chemically. Silane acts as adhesion promoters between resin cement and silica on resin composite surface. This molecule has two functional groups: the silanol group binds to silica on resin composite surface and the organic group blinds to methacrylate in resin cement [21,22]. However, silica is a main component in E glass fiber of everX posterior^{TM} [23,24]. By this reason, the mean SBS value of EV2 was higher than EV1.

The effect of sandblasting with aluminium oxide particle is increasing the surface roughness that not only enhances mechanical interlock but also promotes surface energy and wettability for resin cement [25]. The mean SBS value of EV3 and EV4 were higher than the other groups might cause from the irregular surface that observed in SEM, the 50µm aluminium oxide particles were affect all part of everX posterior^{TM}. The EV4 group was treated by both sandblasting and silanization that increase both mechanical and chemical bond strength. However, the mean SBS value of EV4 was higher EV3 but no statistically significant difference ($p<0.05$).

Thermocycling procedure stimulated the environment in oral cavity. The result shown the mean SBS value was decreased with statistically significant difference ($p<0.05$) after thermocycling in all groups except EV2 group. Possible to the silanization between silica and resin cement was strong to resist hydrolysis [26].

Conclusion: Base on this study,
1. The SFRCs present higher SBS than conventional resin composite.
2. All of surface treatments of SFRCs were effective to increasing SBS between the SFRCs to self-adhesive resin cement.
3. The SBS of SFRCs to resin cement was decreased with statistically significant difference ($p<0.05$) after thermocycling in all group of specimens except silanization group (EV2), so the silanization group present highest bond durability.

Acknowledgement

6. References

[1] D. S. Goswami and D. R. Ahmed, "Biomimetic dentistry," *Journal of Oral Research and Review,* vol. 10, no. 1, pp. 28-32, 2018.
[2] P. Vallittu and M. Özcan, Fillings and core build-ups (Book Chapter). In: Vallittu P, Ozcan M, editors. A clinical guide to principles of fibre reinforced composites (FRCs) in dentistry. 1st ed., Duxford: Woodhead Publishing, 2017.
[3] S. Garoushi, E. Säilynoja, P. K. Vallittu and L. Lassila, "Physical properties and depth of cure of a new short fiber reinforced composite," *Dental Materials,* vol. 29, no. 8, pp. 835-841, 2013.
[4] L. Lassila, E. Säilynoja, R. Prinssi, P. Vallittu and S. Garoushi, "Characterization of a new fiber-reinforced flowable composite," *Odontology,* vol. 107, no. 3, pp. 342-352, 2019.
[5] S. Garoushi, P. K. Vallittu and L. V. J. Lassila, "Fracture resistance of short, randomly oriented, glass fiber-reinforced composite premolar crowns," *Acta Biomater,* vol. 3, pp. 779-784, 2007.

[6] A. Scribante, P. K. Vallittu and M. Özcan, "Fiber-Reinforced Composites for Dental Applications (Editorial)," *BioMed Research International,* 2018.

[7] P. K. Vallittu, "Fiber-reinforced composites and their anisotropic properties," *Dental Materials,* vol. 31, no. 1, pp. 1-7, 2015.

[8] P. K. Vallittu, "High-aspect ratio fillers: Fiber-reinforced composites and their anisotropic properties," *Dent Mater,* vol. 31, no. 1, pp. 1-7, 2015.

[9] S. Garoushi, L. V. J. Lassila, A. Tezvergil and P. K. Vallittu, "Load bearing capacity of fibre-reinforced and particulate filler composite resin combination," *Journal of Dentistry,* vol. 34, no. 3, pp. 179-184, 2006.

[10] S. Garoushi, P. K. Vallittu and L. V. J. Lassila, "Fracture resistance of short, randomly oriented, glass fiber-reinforced composite premolar crowns," *Acta Biomater,* vol. 3, pp. 779-784, 2007.

[11] A. Tsujimoto, W. W. Barkmeier, T. Takamizawa, M. A. Latta and M. Miyazaki, "Mechanical properties, volumetric shrinkage and depth of cure of short fiber-reinforced resin composite," *Dental Materials Journal,* vol. 35, pp. 418-424, 2016.

[12] F. Keulemans, S. Garoushi and L. Lassila, Fillings and core build-ups (Book Chapter). In: Vallittu P, Özcan M, eds. A Clinical Guide to Principles of Fibre Reinforced Composites (FRCs) in Dentistry, Duxford: Woodhead Publishing; 2017, 2017.

[13] T. Akimasa, B. Wayne, T. Toshiki, L. Mark and M. Masashi, "Mechanical properties, volumetric shrinkage and depth of cure of short fiber-reinforced resin composite," *Dental Materials Journal,* vol. 35, pp. 418-424, 2016.

[14] J. Bijelic-Donova, S. Garoushi, P. K. Vallittu and L. V. J. Lassila, "Mechanical properties, fracture resistance, and fatigue limits of short fiber reinforced dental composite resin," *The Journal of Prosthetic Dentistry,* vol. 115, no. 1, pp. 95-102, 2016.

[15] J. Bijelic-Donova, S. Garoushi, L. V. J. Lassila, F. Keulemans and P. K. Vallittu, "Mechanical and structural characterization of discontinuous fiber-reinforced dental resin composite," *Journal of Dentistry,* vol. 52, pp. 70-78, 2016.

[16] S. Garoushi, L. V. J. Lassila and P. K. Vallittu, "The effect of span length of flexural testing on properties of short fiber reinforced composite," *Journal of Materials Science: Materials in Medicine,* vol. 23, no. 2, pp. 325-328, 2012.

[17] A. Alshabib, N. Silikas and D. C. Watts, "Hardness and fracture toughness of resin-composite materials with and without fibers," *Dental Materials,* vol. 35, no. 8, pp. 1194-1203, 2019.

[18] A. M. Eapen, L. V. Amirtharaj, K. Sanjeev and S. Mahalaxmi, "Fracture resistance of endodontically treated teeth restored with 2 different fiber-reinforced composite and 2 conventional composite resin core build up materials: an in vitro study," *Journal of Endodontics,* vol. 43, no. 9, pp. 1449-1504, 2017.

[19] M. Fráter and A. Forster, "A. New generation of short-fiber reinforced composite restorations of the posterior dentition," *International Dentistry - African Edition,* vol. 9, no. 5, pp. 7-8, 2018.

[20] F. Mannocci, T. F. Watson and P. K. Vallittu, "Penetration of bonding resins into fibre-reinforced composite posts: A confocal microscopic study," *International Endodontic Journal,* vol. 38, no. 1, pp. 46-51, 2005.

[21] M. Sakai, Y. Taira and T. Sawase, "Silane primers rather than heat treatment contribute to adhesive bonding between tri-n-butylborane resin and a machinable leucite-reinforced ceramic," *Dental Materials Journal,* vol. 30, no. 6, pp. 854-860, 2011.

[22] C. Y. K. Lung and J. P. Matinlinna, "Aspects of silane coupling agents and surface conditioning in dentistry: an overview," *Dental Materials,* vol. 28, pp. 467-477, 2012.

[23] A. S. Khan, M. T. Azam, M. Khan, S. A. Mian and I. U. Rehman, "An update on glass fiber dental restorative composites: a systematic review," *Materials Science and Engineering C-Materials for Biological Applications,* vol. 47, pp. 26-39, 2015.

[24] GC.dental, "A world of proof discover the power of fibres [Internet]. GC Europe," 2020. [Online]. Available: https://www.gc.dental/europe/sites/europe.gc.dental/files/products/downloads/everxflow/reference/REF_World_of_Proof_-_Study_Compilation.pdf [Accessed 9 March 2024].

[25] O. M. Orhan, B. Marja, O. Edward, B. Melih, O. I. Hamdi and O. N. Kartal, "The role of free oxygen radicals in the aetiopathogenesis of rosacea," *Clinical and Experimental Dermatology,* vol. 28, no. 2, pp. 188-192, 2003.

[26] X. Haifeng, L. Qiao, Z. Feimin, L. Yi, F. R. Tay, M. Qian and C. Chen, "Comparison of resin bonding improvements to Zirconia between one-bottle universal adhesive and tribochemical silica coating, which is better?," *Dental materials,* vol. 32, no. 3, pp. 403-411, 2016.

A HIGH-DIMENSIONAL VARIABLE SELECTION UNDER MULTICOLLINEARITY VIA WHITENING ELASTIC NET

Naphat Kanjanaphan, Vitara Pungpapong

A HIGH-DIMENSIONAL VARIABLE SELECTION UNDER MULTICOLLINEARITY VIA WHITENING ELASTIC NET

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ABSTRACT

For high-dimensional data such as genomics data, identifying predictors in highly correlated covariates poses significant challenges especially when employing regularization methods. Elastic Net is a well-known regularized method to deal with correlated covariates. Later on, WLasso (Whitening Lasso) was recently proposed to handle highly correlated settings by transforming predictors to mitigate correlation and applying generalized Lasso. Our aim is to enhance WLasso performance by adapting it to the Generalized Elastic Net framework, resulting in Whitening Elastic Net. Leveraging the transformation process of WLasso, we integrate it into the Generalized Elastic Net and utilizing the 'genlasso' package for computation. We evaluate the performance of Whitening Elastic Net alongside Lasso, Elastic Net, and WLasso through simulation study. However, our findings indicate that Whitening Elastic Net underperforms, exhibiting a high rate of incorrectly selected relevant predictors compared to other regularization methods. While WLasso struggles with a small number of predictors, its performance improves as the number of predictors increases. Thus, while Whitening Elastic Net requires further refinement, Wlasso shows promise for variable selection in high-dimensional and highly correlated settings.

Keywords: Regularization Techniques; Multicollinearity; Variable selection; High-dimensional data; Generalized Elastic Net; Whitening Lasso; Whitening Elastic Net

1. Introduction

High-dimensional regression has emerged as an active research area in statistical modeling, to deal with larger numbers of predictor variables than the number of observations. However, a common challenge that affects high-dimensional regression is multicollinearity. Multicollinearity refers to the strong correlation between predictor variables, in which it creates significant challenges when selecting the right variables and interpreting the results of a statistical model [1]. To address this problem, the Lasso (Least Absolute Shrinkage and Selection Operator) method was introduced. Lasso is a regularization method that imposes L_1 penalties on regression coefficients, result in sparsity in the model [2].

To address both variable selection and multicollinearity problems, Elastic Net (EN), an extension of Lasso, was developed to address some of the limitations of Lasso in handling multicollinearity. EN combines both L_1 (Lasso) and L_2 (Ridge) penalties to balance between variable selection and regularization [3]. While Elastic Net (EN) can address multicollinearity problems, it may not always be the optimal solution, especially when dealing with highly correlated predictors in high-dimensional data.

We have discovered a method that effectively addresses both variable selection and multicollinearity problems, particularly in high-dimensional data. This method, known as Whitening Lasso (WLasso), was developed by Zhu et al., and it will be a central focus of our research. WLasso offers a unique approach to variable selection in the presence of multicollinearity, making it suitable for high-dimensional data analysis. Through a data transformation that reduces multicollinearity, WLasso enhances the robustness and precision of variable selection, resulting in improved model stability and interpretability [4].

As we embark on this research, WLasso represents a powerful solution for addressing multicollinearity in high-dimensional data. However, we envision the potential for further advancements. Our research aims to extend the capabilities of WLasso by exploring the integration of the Generalized Elastic Net (GEN EN), developed by [5]. In our research, we draw inspiration from this original work, with the aim of extending the reach of WLasso. Our research tries to adapt the solutions provided by WLasso to the Generalized Elastic Net framework, by using the strengths of both methods to better address the challenges posed by highly correlated predictors in high-dimensional data. We anticipate uncovering a novel solution that can significantly enhance the precision of variable selection, model stability, and interpretability.

2. Literature Review

In a high-dimensional setting, the number of predictors (p) is much larger than the number of observations (n) which challenges the traditional statistical analysis and modeling. In this situation, conventional regression methods may face overfitting, lack of statistical power, and difficulty in variable selection problems due to the curse of dimensionality. Therefore, many literatures introduced a specialized term which called a "penalty term" or "L_p norm" that can alleviate these challenges. The high-dimensional regression is aimed to minimize the squared Euclidean norm and the penalty term, as shown in equation (1):

$$minimize_\beta: \|y - X\beta\|_2^2 + \lambda R(\beta) \tag{1}$$

, where λ represents the regularization parameter that controls the strength of regularization and $R(\beta)$ represents a penalty term. Regularization methods, such as Lasso, Ridge, and Elastic Net, have gained popularity in the high-dimensional settings. These methods introduce penalties or constraints on the model parameters to encourage sparsity, shrinkage, or a combination of both. As a result, they achieve variable selection, dimensionality reduction, and improving predictive performance.

2.1 Lasso Regression

Lasso (Least Absolute Shrinkage and Selection Operator) is a powerful tool in high-dimensional data analysis. Lasso achieves sparsity in the coefficient estimates by imposing an L_1 penalty on the regression model. The sparsity property of Lasso makes it particularly useful in situations where there are more predictors than observations, as it helps identify the most important predictors and reduces the risk of overfitting [2]. The objective of Lasso regression is to minimize both the squared Euclidean norm and the L_1 penalty term, as shown in equation (2):

$$minimize_\beta: \|y - X\beta\|_2^2 + \lambda\|\beta\|_1 \tag{2}$$

Where $\|\beta\|_1$ represents $L_1\ norm$ or $L_1\ penalty$ (Lasso). Applying an L_1 penalty in Lasso regularization encourages sparsity by driving many coefficients toward zero, the regularization parameter λ play a crucial role in controlling the level of sparsity in the model. Increasing λ leads to higher sparsity, as it strengthens the penalty on the coefficients, resulting in more coefficients becoming exactly zero.

2.2 Elastic Net Regression

Elastic Net is a technique that addresses the limitations of Lasso and improves upon it. It combines automatic variable selection with continuous shrinkage, allowing for the selection of correlated variable groups. It can be thought of as a stretchable fishing net that captures 'all the big fish'. Simulation studies and real data examples have demonstrated that Elastic Net often outperforms Lasso in terms of prediction accuracy [3]. The objective of Elastic Net is to minimize the squared Euclidean norm with the L_1 and L_2 penalty terms, as shown in equation (3):

$$minimize_\beta: \|y - X\beta\|_2^2 + \lambda_1\|\beta\|_1 + \lambda_2\|\beta\|_2^2 \tag{3}$$

Where, λ_1 represents the parameter that controls the strength of $L_1\ penalty$ regularization, λ_2 represents the parameter that controls the strength of $L_2\ penalty$ regularization, $\|\beta\|_1$ represents the $L_1\ penalty$ (Lasso), and $\|\beta\|_2^2$ represents the $L_2\ penalty$ (Ridge).

Elastic Net is a technique that addresses some limitations of Lasso regularization and offers improved performance in high-dimensional settings. It combines both L_1 and L_2 penalties to achieve simultaneous variable selection and continuous shrinkage. The Elastic Net regularization term is formulated as in (3), where the L_1 penalty term promotes sparsity by driving many coefficients towards zero, resulting in the selection of a subset of important variables. Meanwhile, the L_2 penalty term encourages shrinkage of the coefficient estimates, effectively controlling the magnitudes of the non-zero coefficients. By adjusting the values of λ_1 and λ_2, the Elastic Net can achieve varying degrees of sparsity and shrinkage[3].

2.3 Whitening Lasso Regression

Whitening Lasso (WLasso) is a method that incorporates potential correlations among predictors. This approach involves removing the existing correlations between the predictors (X) to "whiten" the data and then applying the generalized Lasso. Let $\Sigma^{-1/2} = UD^{-1/2}U^T$ where U and D are the matrices obtained from the spectral decomposition of the matrix Σ given by $\Sigma = UDU^T$[4]. Then, we transform the predictors denoted as $\tilde{X} = X\Sigma^{-1/2}$, which we can then substitute into equation (4):

$$y = \tilde{X}\tilde{\beta} + \epsilon, \tag{4}$$

where $\tilde{\beta} = \Sigma^{1/2}\beta = UD^{1/2}U^T$ while keeping the error term (ϵ) unchanged to prevent noise inflation. After the transformation, a correlation matrix of $\tilde{X}$ is the identity matrix. In other words, this transformation eliminates correlations among the predictors, enabling us to treat them as independent variables in the analysis [4].

Variable selection is performed using the generalized Lasso criterion proposed by [6]. Starting, from model (4), the WLasso regression objective involves minimizing the squared Euclidean norm with the transformation of X, as shown in equation (5):

$$minimize_{\tilde{\beta}}: \left\|y - \tilde{X}\tilde{\beta}\right\|_2^2 + \lambda\left\|\Sigma^{-1/2}\tilde{\beta}\right\|_1 \tag{5}$$

Thus, we obtain,

$$\hat{\hat{\beta}}_0 = argmin_{\tilde{\beta}} L_{\lambda}^{gen}(\tilde{\beta}).$$

For the $\hat{\hat{\beta}}_0$ mentioned above, we can now conduct variable selection by encouraging many coefficients to become exactly zero. To estimate the coefficient of β, we consider the estimated coefficient $\widehat{\beta_0} = \Sigma^{-1/2}\hat{\hat{\beta}}$. This step involves data whitening to eliminate correlations between predictors.

Unlike the original method, which employs thresholding techniques to select top coefficients based on certain criteria, we choose to ignore complexity in our implementation. We attempt to maintain fairness in our comparative analysis of regularization methods. To avoiding thresholding criteria, we aimed to ensure that the performance of each method could fairly evaluate without biases by use simple cutoff which is less than 0.01 is set to zero.

The WLasso method offers a comprehensive solution to the challenges posed by multicollinearity and variable selection in high-dimensional data. By integration the whitening transformation and customized variable selection strategies, WLasso provides improved modeling accuracy and effectively manages the correlation structure among predictors, making it a valuable tool in diverse domains [4].

2.4 Whitening Elastic Net Regression

Recently, [5] proposed Generalized Elastic Net method, which is tailored for regression problems where feature vectors are associated with vertices of a given graph, and the underlying signal is presumed to exhibit smoothness or piecewise constancy based on this graph. In our work, we aim to adapt certain aspects of their approach to our study by replacing a specific step in the Generalized Lasso or WLasso method. This adjustment aims to enhance comparison efficiency by incorporating this new technique in terms of prediction and variable selection. Our adaptation focuses on the transformation of WLasso, where we endeavor to estimate $\tilde{\beta}$ by minimize $\tilde{\beta}$ in equation (5), so we will adapt the Generalized Elastic Net into this step as follows.

$$minimize_{\beta} := argmin \frac{1}{2}\|y - X\beta\|_2^2 + \lambda_1\left\|\Sigma^{-1/2}\beta\right\|_1 + \lambda_2\left\|\Sigma^{-1/2}\beta\right\|_2^2 \tag{6}$$

Let $\tilde{y} := \begin{pmatrix} Y \\ 0 \end{pmatrix} \in \mathbb{R}^{n+p}$, $\tilde{X} := \begin{pmatrix} X \\ \sqrt{2\lambda_2}\Sigma^{-1/2} \end{pmatrix} \in \mathbb{R}^{(n+p)\times p}$ so that we can write,

$$minimize_{\beta}: argmin \frac{1}{2}\left\|\tilde{y} - \tilde{X}\beta\right\|_2^2 + \lambda_1\left\|\Sigma^{-1/2}\beta\right\|_1 \tag{7}$$

Now, we will implement the Generalized Elastic Net with the WLasso method. To do this, we need to fix λ_2 for regularization. We will set 10 values of λ_2, ranging from 0.5 to 5 in increments of 0.5, and determine the best λ_2 value through cross-validation. We will utilize the 'genlasso' package to perform WLasso. This package allows flexibility in adding custom penalty functions, such as the whitening transformation, to handle correlated predictors.

3. Methodology

This research will study a new technique that adapted from WLasso called Whitening Elastic. In this simulation study, we will try to simulate an environment that is as close to real-world data as possible in order to be useful to People who come to study this research. In our simulation study, we began by setting the sample size to 100 observations, then we generated the simulation dataset using model (1) where X was generated from multivariate normal with a correlation matrix equal to Σ, represented as $X \sim MVN(0, \Sigma)$, where Σ consider as block-wise correlation structure. Subsequently, we generated error term (ϵ) from standard Gaussian random vector that is independent of X, denoted as $\epsilon \sim N(0, \sigma^2)$ where σ^2 depends on the signal-to-noise ratio, which the level of signal-to-noise ratio are set to 1 and 10. We chose first 20 coefficients to be nonzero among the p coefficients of β, which consider as true relevant predictors for testing the variable selection of the Whitening Elastic net along with the other regularization. Moreover, the number of predictors (p) is equal to 500, 1500, and 3000 for covering low number of p to high number of p. In this simulation study, we chose to use 100 replicates for each simulation to ensure the reliability of the evaluation metrics. This number of

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replicates provides a solid foundation for assessing the robustness and consistency of our results across different settings.

Our methodology begins with the generation of data, as previously described, with adjustments made to the parameters p and SNR. Subsequently, for each simulation, we estimate the coefficients β using four different regularization methods. We use 'glmnet' package in R for Lasso and Elastic Net, which we perform grid search in Elastic Net to find tune the parameter of λ_1 and λ_2. For the WLasso and Whitening Elastic Net, we use 'genlasso' package for performed. The results from each of these algorithms are then averaged across 100 replications. Following this, we assess the performance of the simulation using four evaluation metrics: True Positive Rate (TPR), False Positive Rate (FPR), False Negative Rate (FNR), which serve to evaluate the accuracy of model outcomes. Additionally, Mean Squared Error (MSE) is employed to gauge the predictive performance of the model.

3.1 The choice of signal-to-noise ratio (SNR)

The signal-to-noise ratio (SNR) is a metric that quantifies how much stronger or clearer a signal is compared to the background noise. SNR can be defined as:

$$SNR = \frac{\beta^T \Sigma \beta}{\sigma^2}$$

Once we determine the value of SNR and obtain σ^2, we have the ε term, which allows us to consider different levels of signal-to-noise ratios. Consequently, we decided to consider two cases for SNR: SNR = 1 and SNR = 10. Where a higher SNR indicates that the signal is more distinguishable from the noise, which is typically desirable in data analysis. Conversely, a low SNR indicates that the data contend with high levels of noise compared to the signal. In this case, the model may struggle to capture the true signal due to the overwhelming noise.

3.2 The choice of number of predictors (p)

We have chosen three scenarios for p, where p is equal to 500, 1500, and 3000. These different levels of p present distinct challenges and opportunities for regularization techniques. Our study aims to study how regularization methods respond to these varying p levels. We will systematically evaluate the methods performance, assessing their ability to accurately estimate coefficients, select relevant predictors, and control overfitting, by considering p as a critical parameter.

3.3 The choice of Σ

The correlation matrix of X or Σ plays a crucial role in data analysis. Block-wise correlation structure can illustrate as:

$$\Sigma = \begin{bmatrix} \Sigma_{11} & \Sigma_{12} \\ \Sigma_{12}^T & \Sigma_{22} \end{bmatrix}$$

- Σ_{11} is the correlation matrix among nonzero coefficients, where any two nonzero coefficient predictors are correlated with correlation coefficients ρ_1
- Σ_{12} is the correlation matrix between zero coefficients and nonzero coefficients, where any zero predictors and nonzero predictors are correlated with correlation coefficients ρ_2
- Σ_{22} is the correlation matrix among zero coefficients, where any two zero coefficient predictors are correlated with correlation coefficients ρ_3

3.4 Evaluation Metrics

After performing selecting variables in each regularization, we are using 4 evaluation metrics, which True Positive rate (TPR), False Positive Rate (FPR), and False Negative Rate (FNR) are metrics that aim to check the accuracy of model outcomes. While MSE that we use is aimed to evaluate predictive performance of the model.

4. Results

In our analysis, we have obtained a total of six sets of results, each corresponding to different evaluation metrics. These metrics are crucial for assessing distinct aspects of the model performance. To facilitate a clear and comprehensive understanding, we will present and discuss these results separately for each metric.

However, we encountered an issue with the computation of Whitening Elastic Net using the 'genlasso' package, resulting in some replicates being unable to compute and throwing "Error in La.svd(x, nu, nv) : error code 1 from Lapack routine 'dgesdd'" errors. In this research, we chose to skip the error replicates and collect as much data as possible.

Table 1: Mean and standard deviation (in parenthesis) of True Positive Rate (TPR) and False Positive Rate (FPR) of the Lasso, Elastic Net, WLasso, and Whitening Elastic Net of all simulation.

Simulation Setting	Lasso		Elastic Net		WLasso		Whitening Elastic Net	
	TPR	FPR	TPR	FPR	TPR	FPR	TPR	FPR
(p, SNR) (500, 1)	0.4485 (0.1395)	**0.0203** **(0.0239)**	0.5615 (0.1566)	0.0846 (0.0683)	0.8030 (0.1651)	0.4717 (0.3234)	**0.9600** **(0.0595)**	0.8713 (0.1539)
(p, SNR) (1500, 1)	0.4040 (0.1585)	**0.0063** **(0.0056)**	0.5240 (0.1572)	0.0329 (0.0294)	0.6410 (0.1280)	0.0763 (0.0231)	**0.9330** **(0.0817)**	0.7819 (0.2162)
(p, SNR) (3000, 1)	0.4100 (0.1569)	**0.0049** **(0.0065)**	0.5125 (0.1834)	0.0277 (0.0331)	0.5820 (0.1093)	0.0339 (0.0064)	**0.8890** **(0.0902)***	0.5301 (0.1327)*
(p, SNR) (500, 10)	0.8430 (0.0885)	**0.0277** **(0.0203)**	0.8760 (0.0910)	0.0778 (0.0552)	0.8835 (0.0788)	0.2881 (0.1523)	**0.9805** **(0.0410)**	0.8115 (0.2217)
(p, SNR) (1500, 10)	0.8265 (0.0750)	**0.0128** **(0.0100)**	0.8500 (0.0693)	0.0345 (0.0277)	0.7840 (0.1005)	0.0613 (0.0107)	**0.9680** **(0.0441)**	0.6776 (0.3005)
(p, SNR) (3000, 10)	0.8075 (0.0645)	**0.0064** **(0.0053)**	0.8355 (0.0675)	0.0193 (0.0178)	0.7275 (0.1389)	0.0296 (0.0028)	**0.9574** **(0.0475)***	0.4617 (0.1657)*

*Remark: * means that simulation did not complete 100 simulations. The bold number means the best value in this table of each criterion. A number in a parenthesis is standard deviation (sd).*

4.1 Comparison of the regularization variable selection performance in p = 500 and SNR = 1

The results indicate that the Whitening Elastic Net achieves the highest True Positive Rate (TPR); however, it also exhibits a substantial False Positive Rate (FPR), which is not suitable for variable selection in this simulation. Similarly, WLasso demonstrates a high FPR, further indicating its limitations in effectively selecting relevant variables. Conversely, traditional regularization methods like Lasso and Elastic Net demonstrate lower TPR than WLasso and Whitening Elastic Net, but they perform better in terms of FPR. Therefore, for variable selection in this simulation, traditional regularization methods tend to outperform both WLasso and Whitening Elastic Net.

4.2 Comparison of the regularization variable selection performance in p = 1500 and SNR = 1

The results indicate that the Whitening Elastic Net achieves the highest True Positive Rate (TPR); however, it also exhibits a substantial False Positive Rate (FPR), which is not suitable for variable selection in this simulation. In this simulation, WLasso shows significant improvement as p increases, exhibiting the highest TPR (excluding Whitening Elastic Net), while its FPR decreases to nearly the same level as Elastic Net. Although both traditional regularization methods have lower FPRs than WLasso, WLasso maintains a higher TPR.

4.3 Comparison of the regularization variable selection performance in p = 3000 and SNR = 1

The results indicate that the Whitening Elastic Net achieves the highest True Positive Rate (TPR); however, it also exhibits a substantial False Positive Rate (FPR), which is not suitable for variable selection in this simulation. As p increases, the TPR of WLasso decreases, unlike traditional regularization methods where the TPR remains relatively unchanged. However, WLasso still outperforms traditional regularization in terms of TPR. Regarding FPR, WLasso shows improvement from p = 1500 onwards, with its TPR now nearly matching that of Elastic Net. Therefore, for variable selection in this simulation, WLasso methods tend to outperform both traditional regularization methods.

4.4 Comparison of the regularization variable selection performance in p = 500 and SNR = 10

The results indicate that the Whitening Elastic Net achieves the highest True Positive Rate (TPR); however, it also exhibits a substantial False Positive Rate (FPR), which is not suitable for variable selection in this simulation. Despite showing improvement over 4.1 in this simulation; however, it remains unsuitable for selecting relevant variables. Conversely, traditional regularization methods like Lasso and Elastic Net demonstrate lower TPR than WLasso and Whitening Elastic Net, but they perform better in terms of FPR. Therefore, for variable selection in this simulation, traditional regularization methods tend to outperform both WLasso and Whitening Elastic Net.

4.5 Comparison of the regularization variable selection performance in p = 1500 and SNR = 10

The results indicate that the Whitening Elastic Net achieves the highest True Positive Rate (TPR); however, it also exhibits a substantial False Positive Rate (FPR), which is not suitable for variable selection in this simulation. In this simulation, both Lasso and Elastic Net outperform WLasso and Whitening Elastic Net in terms of both TPR and FPR. Particularly in simulations with a high signal-to-noise ratio (SNR) or less noise in the dataset, traditional regularization methods tend to outperform WLasso and Whitening Elastic Net. In conclusion, both Lasso and Elastic Net prove to be suitable for variable selection in this simulation.

4.6 Comparison of the regularization variable selection performance in p = 3000 and SNR = 10

The results indicate that the Whitening Elastic Net achieves the highest True Positive Rate (TPR); however, it also exhibits a substantial False Positive Rate (FPR), which is not suitable for variable selection in this simulation. In this simulation, both Lasso and Elastic Net still outperform WLasso and Whitening Elastic Net in terms of both TPR and FPR. In scenarios where the signal-to-noise ratio (SNR) is high or there is less noise in the dataset, the performance of WLasso and Whitening Elastic Net diminishes, even with an increase in p from 1500 to 3000. In conclusion, both Lasso and Elastic Net prove to be suitable for variable selection in this simulation.

Table 2: Mean and standard deviation (in parenthesis) of Mean Square Error (MSE) of the Lasso, Elastic Net, WLasso, and Whitening Elastic Net of all simulation.

Simulation Setting	MSE			
	Lasso	Elastic Net	WLasso	Whitening Elastic Net
(p, SNR) (500, 1)	317.8106 (47.79672)	**311.506** **(41.57504)**	1047.746 (161.9652)	610.3183 (77.74337)
(p, SNR) (1500, 1)	303.3021 (47.30865)	**298.8581** **(47.16598)**	1074.809 (140.9152)	568.2753 (70.07619)
(p, SNR) (3000, 1)	307.6462 (46.0702)	**301.8062** **(45.00832)**	1015.712 (129.7659)	534.3533 (74.95887)*
(p, SNR) (500, 10)	36.82764 (6.754754)	**36.09791** **(6.049833)**	558.5234 (82.55882)	323.622 (44.3684)
(p, SNR) (1500, 10)	36.83605 (5.837283)	**36.64463** **(5.931304)**	573.3382 (88.1353)	305.1229 (39.80965)
(p, SNR) (3000, 10)	37.34966 (6.639297)	**37.13999** **(6.413391)**	581.149 (97.30114)	303.7573 (41.77521)*

*Remark: * means that simulation did not complete 100 simulations. The bold number means the best value in this table of each criterion. A number in a parenthesis is standard deviation (sd).*

4.6 Comparison of the regularization predictive performance

The results suggest that WLasso and Whitening Elastic Net exhibit poor predictive performance, as evidenced by their high Mean Squared Error (MSE), particularly in the case of WLasso. In contrast, traditional regularization methods such as Lasso and Elastic Net demonstrate similar MSE values, indicating their suitability for predictive tasks. Interestingly, changes in p appear to have little effect on altering MSE, while higher SNR values considerably facilitate the identification of relevant predictors compared to lower SNR scenarios.

5.   Conclusion and Recommendations

5.1 Finding

Based on all simulations conducted, Whitening Elastic Net emerges as unsuitable for variable selection due to its notably high False Positive Rate (FPR), indicating a propensity for false discoveries. However, WLasso demonstrates a notable capability for variable selection. Although it performs inefficiently in a low number of predictors, its effectiveness increases as the number of predictors grows. Notably, when the predictors exceed 1500, WLasso achieves a satisfactory False Positive Rate (FPR) and a higher True Positive Rate (TPR) compared to traditional regularization methods such as Lasso and Elastic Net. With the increase of predictors to 3000, the FPR of WLasso continues to improve. Despite the simplifications made in this research, WLasso has consistently shown promising outcomes in variable selection. Moreover, in terms of predictive performance, both WLasso and Whitening Elastic Net perform worse than traditional regularization such as Lasso and Elastic Net due to their very high Mean Square Error (MSE) values.

In conclusion, for these settings that we simulate, Whitening Elastic Net is not efficient in both variable selection and predictive performance. One possible reason for these bad results may lie in the lack of sparsity in Whitening Elastic Net solutions. To address this issue, a simple threshold was imposed in the research, considering coefficients below 0.01 as insignificant for interpretation. However, this thresholding approach may not be optimal, suggesting the need for better criteria to select a more appropriate threshold. Alternatively, reverting to the original WLasso, which inherently provides the appropriate threshold, could be considered.

5.2 Recommendations

Try to revert to using the original WLasso methodology for adaptation with the Generalized Elastic Net, as the authors of WLasso have demonstrated its practical applicability. The full process of the original WLasso may be more adaptable to integrate with the Generalized Elastic Net framework.

Explore other Generalized Elastic Net methods that may be more suitable for adaptation with WLasso. There could be alternative approaches that align better with the WLasso methodology and provide enhanced compatibility and performance.

Expanding the scope of the simulation to include scenarios with a higher number of predictors, such as beyond 3000, could provide valuable insights. Additionally, exploring different settings with block-wise correlation or varying signal-to-noise ratios may offer further understanding and potentially lead to different conclusions, especially regarding the suitability of Whitening Elastic Net for variable selection.

Acknowledgement

6. References

[1]   J. I. Daoud, "Multicollinearity and regression analysis," in *Journal of Physics: Conference Series*, 2017, vol. 949, no. 1: IOP Publishing, p. 012009.

[2]   R. Tibshirani, "Regression shrinkage and selection via the lasso," *Journal of the Royal Statistical Society Series B: Statistical Methodology,* vol. 58, no. 1, pp. 267-288, 1996.

[3]   H. Zou and T. Hastie, "Regularization and variable selection via the elastic net," *Journal of the Royal Statistical Society Series B: Statistical Methodology,* vol. 67, no. 2, pp. 301-320, 2005.

[4]   W. Zhu, C. Lévy-Leduc, and N. Ternès, "A variable selection approach for highly correlated predictors in high-dimensional genomic data," *Bioinformatics,* vol. 37, no. 16, pp. 2238-2244, 2021.

[5]   H. Tran, S. Wei, and C. Donnat, "The Generalized Elastic Net for least squares regression with network-aligned signal and correlated design," *arXiv preprint arXiv:2211.00292,* 2022.

[6]   R. J. Tibshirani, *The solution path of the generalized lasso*. Stanford University, 2011.

UTILIZATION OF WATER HYACINTH AND BAGASSE TO PRODUCE SOUND-REDUCING SMART BOARD WALLS

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Utilization of water hyacinth and bagasse to produce sound-reducing smart board walls

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ABSTRACT

This research was an experimental research using aquatic weeds that cause water pollution such as water hyacinth and bagasse which were agricultural waste. Used in the production of smart board walls. By taking water hyacinth and bagasse to dry in the sun, then cutting them to the size of 0.5 inches and mixing them with plaster, clean water, and latex. The ingredients are classified into 4 formulas. The ratio were in grams. Formula 1: plaster: clean water: latex: water hyacinth: bagasse, Formula 1: 1000:500:25:20:10. Formula 2: 1000:500:25:25:15. Formula 3: 1000: 500:25:30:20 and formula number 4 had the ratio 1000:500:25:0:0 , Pour all ingredients into a block size 1 2 0 X 2 5 0 X0.8 cm. Put it in the sun to dry and baked to remove moisture at a temperature of 65 degrees Celsius for 24 hours, made into sheets and then tested for sound reduction properties in a sound test room size 35 x25 0 x 35 centimeters at an extinguishing level of 85 dB(A).

The results found that Using water hyacinth and bagasse, formula number 3 ingredients plaster: clean water: latex, water hyacinth: bagasse in the ratio 1000:500:25:30:20. Makes the Smart board wall strong and not easily broken. It had the best sound reduction efficiency of 10.5 dB(A). The formula 2, formula 1, and formula 4, which have a ratio of 1000:500:25:25:15 , 1000:500:25:20:10 and 1000:500:25:0:0 respectively.

Keywords: Smart board wall, water hyacinth, bagasse, sound reduction

1. Research problem

Water hyacinths are the fastest growing aquatic weed. The area coverage can be expanded to double every 2 months or increase the number to 600,000 trees within 8 months. Sugarcanes are an economic crop. That increases the planting area and feeds more into the factory as well. As a result, there are bagasse in the amount of almost 50% of the sugarcanes that are entered into the production process. It is expected that there will be more than 50 million tons of bagasse (Office of the Cane and Sugar Board. 2023) Thailand encounters problems in managing water hyacinths and bagasse. It affects the use of water sources, agriculture, and transportation and have become a national problem. As a result, resources, budgets, and manpower have to be wasted in solving this problem continuously.

The physical characteristics of water hyacinth and bagasse, it was found that There are outstanding features: Toughness, softness, and light weight. This research therefore has an idea to use water hyacinth and bagasse, which are waste materials, to produce gypsum board ceiling panels as sound insulation panels.

2. Research objectives

1.Study the appropriate ratio for producing smart board walls from water hyacinth mixed with bagasse.
2.Study the sound reduction efficiency of smart board walls made from water hyacinth mixed with bagasse

3. Scope of research

1.Scope of sampling:

Water hyacinth and bagasse samples were collected. Sankhaburi District Chainat Province and find the most suitable ratio of water hyacinth and bagasse, that produces smart board walls and tested the physical properties of the smart board wall made from a mixture of water hyacinth and bagasse.
2.Experimental scope

The sound test room is divided into two rooms for testing, size width 35 centimeters, length 250 centimeters, height 35 centimeters, in a horizontal position.

4. Method

Instrument and material

1. Raw materials : water hyacinth, bagasse, clean water, latex and plaster.
2. Testing tools : sound measuring devices CEL - 600 series sound level meter
3. Various equipment :drying cabinets, digital scales Test chamber size 35 X 250 X 35 centimeters

Figure 1 material

Steps for preparing materials

1. Take only the stem of water hyacinth and bagasse, because it have more fiber than other parts. Cut into pieces about 0.5 inches in size so that the fineness of the fibers adheres together. The porosity of the materials are moderate which suitable properties for forming sound-absorbing panels.
2. Water hyacinth and bagasse were mixed with sodium hydroxide (NaOH) solution and boiled for 2 hours. After that the structure of water hyacinths were transformed into fiber and wash the fibers with clean water 3-4 times.

Steps for making a smart board wall

Mix together water hyacinth, bagasse, clean water, latex and plaster. Then pour it into a mold with a width 28 x length 37 centimeters and decorate the surface of the smart board wall smoothly. It should take no more than 5 minutes because the mixture will begin to harden. Then baked in a hot air dryer at a temperature of 65 °C for 24 hours, as shown in **Figure 2**
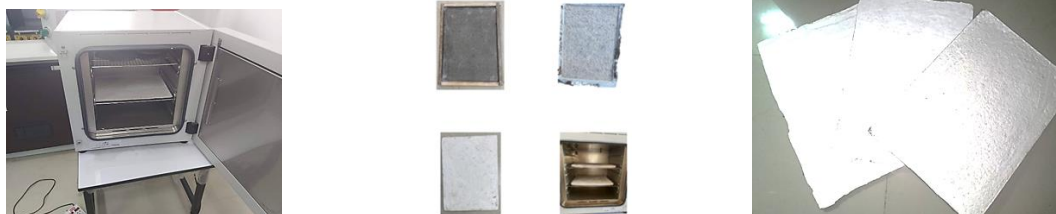
Figure 2 Smart board wall

Steps for testing noise reduction

Build the 35 x 250 x 35 centimeter laboratory model from a smart wall board with the ratio of water hyacinth and bagasse is different (1000:500:25:20:10, 1000:500:25:25:15 1000:500:25:30:20 and 1000:500:25:0:0 grams). Turn on the sound generator with a loudness of 85 dB(A). Measure the sound pressure in the laboratory at distances of 30, 60 and 90 cm. and compare the sound reduction of the smart wall board with the ratio of broken water hyacinth and sugarcane bagasse. different, as shown in **Figure 3**

Figure 3 Sound measurement laboratory and Sound Level Meter

5. Research results

Results of the experiment measuring sound pressure at distances of 30, 60 and 90 cm. compared to Smart board walls mixed with water hyacinth and bagasse, Formula 3 plaster: clean water: latex: water hyacinth: bagasse The ratio of 1000:500:30:20 grams at a distance of 90 cm. can reduce the sound loudness by a maximum of 10.5 dB(A) as shown in **Table 1.**

Table 1 Compares the sound pressure through the smart board wall with different formula

distance cm.	Formula 1 1000:500:25:20:10 dB(A)	Formula 2 1000:500:25:25:15 dB(A)	Formula 3 1000:500:25:30:20 dB(A)	Formula 4 1000:500:25:0:0 dB(A)
30	75.5	75.1	**74.8**	80.5
60	75.6	74.9	**74.7**	80.2
90	75.6	74.8	**74.5**	80.7
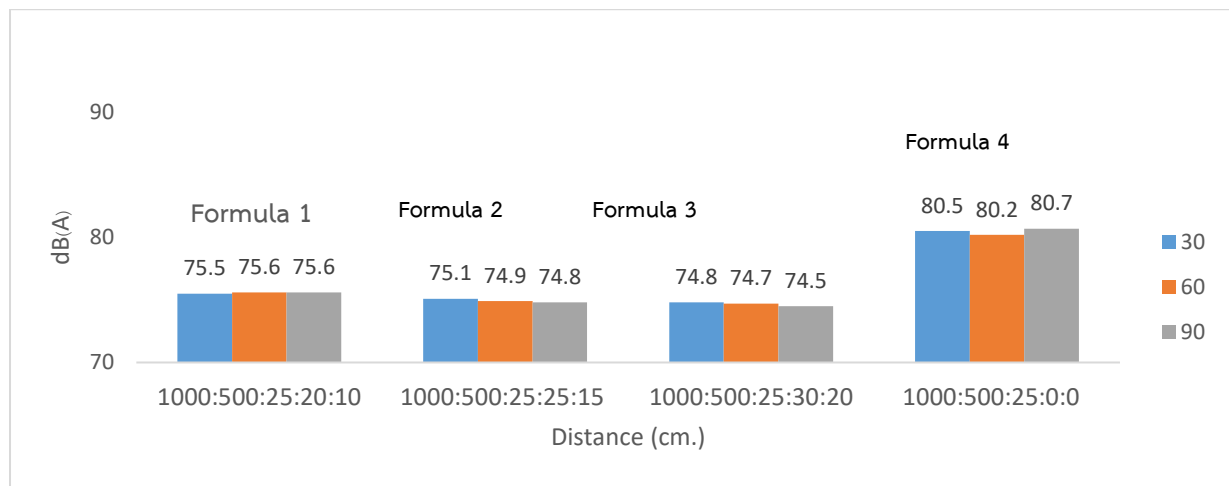
Figure 4 Comparison of sound pressure through the smart board wall water hyacinth and Bagasse various ratio

6. Summary

The researcher conducted the experiment by bringing together various research studies It is a guideline for experimenting with the ratios for producing smart board walls mixed with water hyacinth and bagasse in the ratios 1000:500:25:20:10, 1000:500:25:25:15 1000:500:25:30: 20 and 1000:500:25:0:0 grams, which the process produces smart board walls can be formed using a molding method, By the size of smart board wall production which width of 120 cm, length of 250 cm. and thickness of 0.8 cm.

Results from testing to determine the sound reduction value of smart board walls in each ratio found that gypsum board in the mixed ratio 1000:500:30:20 , It is more effective in reducing sound than smart board walls in other mixtures which is most effective in reducing sound within a distance of 90 cm. with a sound reduction test result of 74.5 dB(A)

Experimental results show that when increasing the amount of fiber mixture, the internal structure of the Smart board wall becomes porous air pockets. Absorbs and reduces sound better according to the amount of water hyacinth fiber mixed with bagasse, because of the amount of water hyacinth fiber mixed with bagasse .There is a lot of material. This makes the material very porous, latex molecular chain can move easily consistent with the study Prasan Chumjaihan et al. (2018) increased the ability to reduce sound loudness. To lead the production of this gypsum board To be used further in the industrial sector Using a small investment Along with reducing water pollution caused by water hyacinth.

7. Suggestions

1.The results of using water hyacinth mixed with bagasse should be studied together with other waste materials to reduce costs even more, material costs and value.

2.This research is a laboratory experiment only. It has not been implemented yet. If you want to use the results of this study to further develop, methods for testing other properties should be considered as well, such as density, water absorption rate.

8. Reference

[1] Kittiphan Boontositrakul, Pramote Weeranukul, Wihan Deepanya, and Kittiphan Suweero. (2021). Development of gypsum boards from water hyacinth for community enterprises. Pathum Thani : Engineering Journal Rajamangala University of Technology Thanyaburi.

[2] Nipawan Kolsuwan, and Apiluk Iaduea. (2017). Ceiling heat-insulating material from nanocomposite materials between natural kaolin clay and carbon. Bangkok : Kasetsart University Kamphaeng Saen Campus and King Mongkut's Institute of Technology Ladkrabang.

[3] Prasan Chumjaihan, Patcharapruek Phapho, Phutthipong Wongbundit, and Watchara Noimala. (2018). Study of reflective properties and strength of sound absorbing walls from biomaterials. Bangkok: King Mongkut's Institute of Technology Ladkrabang.

[4] Report on sugarcane planting area for production year. (2023).Office of the Cane and Sugar Board. <http://www.ocsb.go.th/upload/journal/fileupload/923-9193.pdf.

[5] Lawan Khankaset. (2022). Finding the mixing ratio of water hyacinth to develop into a ceiling. Bangkok: King Mongkut's Institute of Technology Ladkrabang.

[6] Athiphan Loymuangklang, and Akara Sembun. (2021). Development of ceiling panels from wood fiber mixed with gypsum powder that has heat insulating properties. Buriram: Buriram Rajabhat University.

[7] Erni Setyowati, Gagoek Hardiman, Purwanto Khusnan. (2019). Tailoring Acoustic Performances of Resin Reinforced Biomass Fiber-Based Panel with Single and Multiple Tailed Cavity Inclusions for Interior Work.

[8] E. Setyowati, G. Hardiman, Nur Farida Grafiana. (2021). The Acoustical Performance of Water Hyacinth Based Porous-Ceramic Compared to the Biomass Fiber Composites for Architecture Application.

[9] Muhammad Rahmatullah Amin, Sefri Wahyu Fernando Gultom, Fitrisia Krisa Bella, Putri Lynna Adelinna Luthan. (2019). Using Water Hyacinth Fiber (Eichhornia Crassipes) as Heat Absorbers Media In Wall.

[10] S.Sulardjaka , N.Iskandar , SriNugroho , A.Alamsyah. (2022). The characterization of unidirectional and woven water hyacinth fiber reinforced with epoxy resin composites.

DENGUE HEMORRHAGIC FEVER PREVENTION BEHAVIOR OF PEOPLE IN KHLONG BANG KAEO NOI COMMUNITY, BANG PHLI YAI SUBDISTRICT, BANG PHLI DISTRICT, SAMUT PRAKAN PROVINCE

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Dengue Hemorrhagic Fever Prevention Behavior of People in Khlong Bang Kaeo Noi Community, Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province

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ABSTRACT

This research is a cross-sectional descriptive study with the objective of studying the behavior aimed at preventing dengue hemorrhagic fever among the people of the Khlong Bang Kaeo Noi community. In Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province, the sample group consists of 275 people from the Khlong Bang Kaeo Noi community, selected using the Krejci and Morgan formula. A specific random sample was then chosen. Data collection involved the sample responding to questionnaires containing personal information, leading factors, enabling factors, additional factors, and protective behaviors related to dengue hemorrhagic fever. Content validity and appropriateness of content and language were checked. The IOC consistency index was 0.83, the difficulty value was 0.39, the discriminatory power was 0.54, and the reliability of the entire instrument was 0.72. Descriptive statistics were used to analyze the data, along with the analysis of relationships among existing factors. The relationship with dengue hemorrhagic fever prevention behavior was assessed using the Chi-square test and Pearson correlation coefficient statistics.

The results of the study indicate that most people have a moderate level of knowledge about dengue hemorrhagic fever, and their behavior to prevent it is at a good level. The analysis of the relationship between factors and dengue hemorrhagic fever prevention behavior revealed that knowledge about the disease was significantly associated with prevention behavior at the 0.05 level. Additionally, perceived benefits in preventing dengue hemorrhagic fever, perception of its severity, perception of the risk, access to health resources, and receiving advice from public health personnel were significantly associated with prevention behavior at the 0.01 level.

Relevant public health agencies should support the public with correct and appropriate knowledge. To have good behaviors to prevent dengue hemorrhagic fever Including encouraging communities to join together in campaigning to prevent dengue hemorrhagic fever.
Keywords: Behavior; Prevention; Dengue hemorrhagic fever

1. Introduction

Dengue hemorrhagic fever (DHF) is a contagious disease caused by infection with the dengue virus, which spreads into the human body from the bite of female Aedes mosquitoes, specifically the Aedes aegypti, the vector of the disease. Dengue hemorrhagic fever is most common during the rainy season from May to September, when stagnant water in various containers becomes breeding grounds for Aedes mosquito larvae, such as water jars, car tires, and containers with standing water in households [1]. Symptoms or dangerous signs of dengue hemorrhagic fever include a fever higher than 38.5 degrees Celsius, loss of appetite, fatigue, headache, muscle pain, bone pain, and a flushed face. Additionally, some patients may experience nosebleeds, gum bleeding, and spots of bleeding under the skin on the arms, legs, joints, and skin. Symptoms of dengue hemorrhagic fever may worsen between days 3 to 7 of the illness, potentially leading to shock and death [2].

Dengue hemorrhagic fever is a significant cause of morbidity and mortality in Thailand. According to the 2022 report on the situation of dengue hemorrhagic fever in Thailand, 1,952 patients were identified, resulting in 2 deaths. The age group with the highest number of cases was 5-14 years old, followed by 15-24 years old. In 2023, the number of dengue hemorrhagic fever patients surged to 158,705 with a morbidity rate of 239.86 per 100,000 people, marking a 3.5-fold increase from 2022.

Additionally, there were 181 deaths calculated as a case fatality rate of 0.11 percent, with the highest mortality rate observed in the 25-34 year age group, primarily among individuals with chronic illnesses and obesity. Laboratory tests on the deceased revealed all four strains of the dengue virus, with DENV-2 being the most prevalent, followed by DENV-1, DENV-3, and DENV-4. Data from the epidemiological disease surveillance report (506) by the Samut Prakan Provincial Public Health Office indicated a continuous increase in dengue hemorrhagic fever patients, with 982 cases Calculated as a morbidity rate of 68.91 per 100,000 population. Which it reported from January 1 to August 8, 2023. Despite the implementation of policies and measures in Samut Prakan Province, such as disseminating knowledge in villages, conducting training campaigns on dengue hemorrhagic fever, mosquito spraying, and distributing sand to eliminate mosquito larvae, patients continue to emerge due to incomplete coverage of solutions and a lack of effective dengue prevention behaviors among the population [3]. Factors contributing to dengue hemorrhagic fever outbreaks include age group, immunity, previous exposure to infection, dengue virus type prevalent in the area, abundance of Aedes mosquito larvae, community density, urban or rural characteristics, and climatic factors such as water, rain, humidity, and temperature. Efforts to address dengue hemorrhagic fever should prioritize disease prevention by promoting household cleanliness, waste disposal, and proper water container management to prevent mosquito breeding. Educating the public, fostering a positive attitude towards self-defense, instilling correct health beliefs, and seeking advice from public health professionals is crucial for promoting sustained behavioral changes to prevent dengue hemorrhagic fever, aligning with the Health Promotion Model (PRECEDE – PROCEED Model) [4], which categorizes health behavior into predisposing, enabling, and reinforcing factors.

Given the aforementioned problem situation, researchers recognized the importance of employing the concept of Health Promotion Models in a study aimed at understanding the preventive behavior regarding dengue hemorrhagic fever among the people of Khlong Bang Kaeo Noi community, Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province. This study was intended to provide essential information for planning and determining strategies for implementing health education to induce behavioral change among the population. Furthermore, this model can elucidate individual behavior influenced by various factors. Such insights are invaluable and can serve as a framework for controlling and preventing dengue hemorrhagic fever in the future.

Research objectives

1. To study the behavior of preventing dengue hemorrhagic fever among people in the Khlong Bang Kaeo Noi community, located in the Bang Phli Yai Subdistrict of Bang Phli District, Samut Prakan Province

2. To investigate the relationship between personal factors, such as gender, age, marital status, education level, occupation, income, and exposure to news, and factors contributing to health promotion. These factors encompass knowledge about dengue hemorrhagic fever, attitudes towards prevention, perception of risk, perceived barriers, perceived benefits, and severity perception. Additionally, factors facilitating health promotion include access to healthcare resources. Furthermore, receiving advice from public health personnel and encouragement from family members regarding preventive behaviors against dengue hemorrhagic fever among the residents of the Khlong Bang Kaeo Noi community, located in the Bang Phli Yai Subdistrict of Bang Phli District, Samut Prakan Province.

Research plan

This research is a cross-sectional descriptive study aimed at investigating the preventive behavior against dengue hemorrhagic fever among the residents of the Khlong Bang Kaeo Noi community, located in the Bang Phli Yai Subdistrict of Bang Phli District, Samut Prakan Province. The study examines factors associated with this behavior and employs a conceptual framework based on the health promotion model (PRECEDE – PROCEED Model), which consists of three main factors: predisposing factors, enabling factors, and reinforcing factors. Data were collected using a questionnaire from June 1st to July 31st, 2023.

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│ 1. Demographic information     │
│     1.1 sex                    │
│     1.2 age                    │
│     1.3 Marital status         │
│     1.4 Education level        │
│     1.5 Occupation             │
│     1.6 Average monthly income │
└────────────────────────────────┘

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│ 2. Leading factors             │
│     2.1 Knowledge about dengue hemorrhagic fever    │
│     2.2 Attitudes about dengue hemorrhagic fever    │
│     2.3 Perception of the severity of dengue        │
│ hemorrhagic fever                                   │
│     2.4 Perception of the risk of dengue hemorrhagic│
│ fever                                               │
│     2.5 Perceived benefits in preventing dengue fever│
│     2.6 Perceived barriers to dengue hemorrhagic    │
│ fever prevention                                    │
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│ 3. Conducive factors           │
│     3.1 Access to health resources │
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│ 4. Additional factors          │
│     4.1 Receiving advice from public health │
│ personnel                                   │
│     4.2 Prompting from family members       │
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│ Dengue hemorrhagic fever       │
│ prevention behavior of people in the │
│ Khlong Bang Kaeo Noi community │
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Figure 1 Conceptual framework used in research

2. Literature Reviews

1. Patawee Puakpromma, Alisa Nititham and Nutthakritta Sirisopon. (2022). Factors Relating to Dengue Hemorrhagic Fever (DHF) Preventive Behaviors of People at Bang Krachao Mueang District in Samut Sakhon Province. The results indicated that the sample behaviors were at a moderate level. The correlation analysis revealed that bio-social factors, particularly age, were significantly associated with dengue hemorrhagic fever (DHF) preventive behaviors among the subjects at the 0.05 level. Furthermore, internal factors such as knowledge, attitude, perceived susceptibility, perceived severity, and perceived benefit were also significantly correlated with dengue hemorrhagic fever (DHF) preventive behaviors among the subjects at the 0.05 level. Additionally, external factors including receiving recommendations from family members, health professionals, and obtaining information were found to be significantly related to dengue hemorrhagic fever (DHF) preventive behaviors among the subjects at the 0.05 level [5].

2. The PRECEDE – PROCEED Model is applied to plan and evaluate health promotion and health education projects. Specifically, the PRECEDE Model serves as a framework for planning health education for volunteers and engaging target groups to foster desired health behaviors. Health and health risks result from multiple factors, and efforts to promote health necessitate behavioral, environmental, and societal changes, which must be approached from various perspectives. Additionally, behavior change is closely linked to the level of engagement of the target group. The health promotion model consists of 3 main factors: leading factors, facilitating factors, and auxiliary factors (PRECEDE – PROCEED Model).

3. Methodology

Population and sample studied

The population is people living in Khlong Bang Kaeo Noi community, Village No. 2, Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province, totaling 820 people.

The sample group is calculated using the formula of Krejci and Morgan. By setting the proportion of the trait of interest in the population to be equal to 0.5, the tolerance level being 5%, the confidence level being 95%, and increasing the sample size by 5% to prevent loss of the sample, resulting in a sample size of 275 people. Then select a purposive random sample. The inclusion criteria were people aged 18 years and over, both female and male. Volunteer to participate in the research study and be fully informed about the research study. And the exclusion criteria were people under 18 years of age and not living in the Khlong Bang Kaeo Noi community area, Village No. 2, Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province.

Research process

1. The tool utilized in the study was a questionnaire developed by the researcher based on concepts, theories, and related research. It comprised five parts, which are as follows:

Part 1: General information questionnaire, encompassing gender, age, marital status, education level, occupation, income, and news exposure. It featured multiple-choice answers (Checklist) and open-ended responses, totaling seven questions.

Part 2: Questionnaire on factors contributing to promoting personal health, categorized into five sections:

1. Knowledge about dengue hemorrhagic fever consists of 10 questions, with a yes/no answer format. The scoring criteria are as follows: Correct answers are awarded 1 point, while incorrect answers receive 0 points. The interpretation of scores is based on Bloom's criteria (1971) [6]. which divides scores into three levels: High-level knowledge, scoring 80 percent or higher; Moderate knowledge, scoring between 60 and 79.9 percent; and Low-level knowledge, receiving a score lower than 60 percent.

2. Attitudes about dengue hemorrhagic fever consist of 10 items. The questionnaire employs a 4-level rating scale: strongly agree, agree, disagree, and strongly disagree. Scoring criteria for the questions are as follows: Positive statements receive scores of 4, 3, 2, and 1 respectively, while negative statements are scored in reverse order, i.e., 1, 2, 3, and 4 respectively. The criteria for categorizing the average score into three levels are as follows: A low-level attitude corresponds to an average score between 1.00 and 2.00, a medium-level attitude ranges from 2.01 to 3.00, and a high-level attitude falls between 3.01 and 4.00 (Best, 1977) [7].

3. Perception about dengue hemorrhagic fever includes perception of the risk, perceived barriers to prevention, perceived benefits in preventing, and perception of the severity of dengue hemorrhagic fever, totaling 20 items. The questionnaire adopts a 4-level rating scale: strongly agree, agree, disagree, and strongly disagree. Scoring criteria for the questions are as follows: Positive statements receive scores of 4, 3, 2, and 1 respectively, while negative statements are scored inversely, i.e., 1, 2, 3, and 4 respectively. The criteria for classifying the average scores are divided into three levels as follows: A low-level awareness corresponds to an average score between 1.00 and 2.00, a medium-level awareness ranges from 2.01 to 3.00, and a high-level awareness falls between 3.01 and 4.00 (Best, 1977).

Part 2: Factors conducive to promoting one's own health include access to health resources. There are a total of 10 items in the questionnaire. It utilizes a 5-level rating scale: the most, more, moderate, less, and the least. Scoring criteria for the questions are as follows: Positive statements receive scores of 5, 4, 3, 2, and 1, respectively, while negative statements are scored inversely, i.e., 1, 2, 3, 4, and 5 respectively. Criteria for classifying the average score into three levels are as follows: A low level corresponds to an average score between 1.00 and 2.33, a moderate level ranges from 2.34 to 3.66, and a high level falls between 3.67 and 5.00 (Best, 1977).

Part 3: Additional factors for promoting one's own health include receiving advice from public health personnel and receiving encouragement from family members, totaling 20 items. The questionnaire employs a 5-level rating scale, namely the most, a lot, moderate, a little, and the least. Scoring criteria for the questions are as follows: Positive statements are assigned scores of 5, 4, 3, 2, and 1 respectively, while negative messages receive scores in reverse order, i.e., 1, 2, 3, 4, and 5 respectively. Criteria for classifying the average score into three levels are as follows: A low level corresponds to an average score between 1.00 and 2.33, a moderate level ranges from 2.34 to 3.66, and a high level falls between 3.67 and 5.00 (Best, 1977)

Part 4: Self-health promotion behavior to prevent dengue hemorrhagic fever consists of 10 items in total. The questionnaire employs a 4-level rating scale: practice regularly, practice frequently, practice sometimes, and I don't practice at all. Scoring criteria for the questions are as follows: Positive statements receive scores of 4, 3, 2, and 1 respectively, while negative statements receive scores in reverse order, i.e., 1, 2, 3, and 4 respectively. Criteria for classifying the average score into three levels are as follows: A low level of protective behavior corresponds to an average score between 1.00 and 2.00, a moderate level ranges from 2.01 to 3.00, and a high level falls between 3.01 and 4.00 (Best, 1977).

2. Procedures for creating and checking the quality of research instruments

2.1 Study documents, including academic books and related research, then use them as guidelines for creating a questionnaire.

2.2 Review documents, textbooks, journals, and information on dengue hemorrhagic fever and health promotion concepts, such as health promotion models (PRECEDE – PROCEED Model)

2.3 Develop a questionnaire to address the research objectives, serving as a data collection tool. The questionnaire consists of various question types divided into five sections.

2.4 Assess content validity by presenting the questionnaire to three experts and calculating the consistency index (Index of Item Objective Congruence: IOC). Next, conduct a trial run (Try Out) with a population similar to the planned sample size of 30 individuals to evaluate questionnaire reliability. Employ the alpha coefficient formula, as proposed by Cronbach (1974), to determine the Alpha Coefficient.

3. Data analysis

The data from the complete questionnaire, all 4 parts, were analyzed using a ready-made computerized form, setting the level of statistical significance at the .05 level to test the hypotheses for this research and proceed with the following steps.

3.1 Descriptive statistics, including frequency, percentage, mean, and standard deviation, were employed to analyze general personal information, leading factors, contributing factors, additional factors, and behaviors aimed at preventing dengue hemorrhagic fever.

3.2 Inferential statistics, such as the Chi-square test and Pearson correlation coefficient, were utilized to analyze factors related to dengue hemorrhagic fever prevention behavior.

4. Results

4.1 Results of analysis of general personal information, leading factors, contributing factors, additional factors, and behaviors to prevent dengue hemorrhagic fever .

Quantity analysis results and the percentage of personal data of the population living in the Khlong Bang Kaeo Noi community area Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province, found that the majority of the sample were female, accounting for 53.5 percent and male, accounting for 46.5 percent, with an average age of 43.3 years. Most of them were in a couple, accounting for 64.7 percent, followed by being single, accounting for 21.8 percent. Most had a primary education level, accounting for 43.3 percent, followed by a lower secondary school level, accounting for 32.8 percent. Most have private sector employees, accounting for 57.1 percent, followed by general contractors, accounting for 26.9 percent. Most have an average monthly income of 10,001 - 20,000 baht, accounting for 61.5 percent, followed by less than 10,000 baht, accounting for hundreds. 31.6 each (Table 1)

Table 1 Number and percentage of general personal information of the people of Khlong Bang Kaeo Noi community Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province (n=275)

Demographic information	Number	Percentage
sex		
man	128	46.5
female	147	53.5
Age $\overline{X}$ = 43.3, S.D.=12.4, Max=78, Min=20		
Marital status		
single	60	21.8
Married	178	64.7
Widowed/divorced/separated	37	13.5

Education level		
Not studying	5	1.8
Primary education	119	43.3
Junior high school	90	32.8
Senior High School/Vocational Certificate	41	14.9
Associate's Degree/ Diploma Vocational Certificate	10	3.6
Bachelor's degree	10	3.6
Occupation		
agriculture	5	1.8
trade	20	7.3
general employee	74	26.9
service	8	2.9
Private employee	157	57.1
housekeeper	11	4.0
Average monthly income		
Less than 10,000 baht	87	31.6
10,001 – 20,000 baht	169	61.5
20,001 – 30,000 baht	16	5.8
More than 30,001 baht	3	1.1

Results of the analysis of numbers and percentages regarding the knowledge level about dengue hemorrhagic fever among people in the Khlong Bang Kaeo Noi community area, Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province. Classified by level, it was found that the majority had a moderate level of knowledge about dengue hemorrhagic fever, with 166 people representing 60.4 percent, followed by a poor level of knowledge, with 73 people accounting for 26.5 percent.

Results of the analysis of numbers and percentages regarding the knowledge level about dengue hemorrhagic fever among people in the Khlong Bang Kaeo Noi community area, Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province. Classified by level, it was found that the majority had a moderate level of knowledge about dengue hemorrhagic fever, with 166 people representing 60.4 percent, followed by a poor level of knowledge, with 73 people accounting for 26.5 percent.

The results of the analysis of numbers and percentages regarding the perception of the risk of dengue hemorrhagic fever, perception of barriers to dengue hemorrhagic fever prevention, perceived benefits in preventing dengue hemorrhagic fever, and perception of the severity of dengue hemorrhagic fever among people in the Khlong Bang Kaeo Noi community area, Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province. Classified by level, it was found that the perception of the risk of dengue hemorrhagic fever was mostly at a high level, with 243 people, accounting for 88.4 percent, followed by a moderate level with 22 people, accounting for 8.0 percent. Prevention of dengue hemorrhagic fever was mostly at the moderate level, with 161 people, accounting for 58.5 percent, followed by the high level, with 77 people, accounting for 28.0 percent. Perceived benefits in preventing dengue hemorrhagic fever were mostly at a high level, numbering 224 people, calculated as 81.5 percent, followed by 45 people at the moderate level, accounting for 16.3 percent. Perception of the severity of dengue hemorrhagic fever was mostly at a high level, with 207 people, accounting for 75.3 percent, followed by 64 people at a moderate level, accounting for 23.2 percent

The results of the analysis of numbers and percentages regarding access to public health resources in the Khlong Bang Kaeo Noi community area, Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province. Categorized by level, it was found that the majority had access to public health resources. Specifically, 230 people were at the high level, accounting for 83.7 percent, followed by 38 people at the moderate level, accounting for 13.8 percent.

The results of the analysis of numbers and percentages regarding receiving advice from public health personnel and receiving encouragement from family members of people in the Khlong Bang Kaeo Noi community area, Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province, classified by level, found that receiving advice from public health personnel was mostly at a high level, with 229 people, accounting for 83.3 percent. This was followed by 34 people at the moderate level,

accounting for 12.3 percent. In contrast, receiving encouragement from family members was mostly at the moderate level, with 173 people, accounting for 62.9 percent, followed by the low level, with 68 people, accounting for 24.7 percent.

The results of the analysis of numbers and percentages regarding dengue hemorrhagic fever prevention behavior of people in the Khlong Bang Kaeo Noi community area, Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province. Categorized by level, it was found that the majority of people's dengue hemorrhagic fever prevention behaviors were at a good level, with 179 people, accounting for 65.1 percent, followed by the moderate level, with 78 people, accounting for 28.4 percent.

4.2 Results of the analysis of the relationship between personal factors and dengue hemorrhagic fever prevention behavior.

The analysis of the relationship between factors and dengue hemorrhagic fever prevention behavior among people in the Khlong Bang Kaeo Noi community area, Bang Phli Yai Subdistrict, Bang Phli District, Samut Prakan Province, revealed that knowledge about dengue hemorrhagic fever was significantly related to behavior to prevent dengue hemorrhagic fever at the 0.05 level. Additionally, perceived benefits in preventing dengue hemorrhagic fever, perception of the severity of dengue hemorrhagic fever, perception of the risk of infectious diseases, access to health resources, and receiving advice from public health personnel were significantly associated with dengue hemorrhagic fever prevention behavior at the 0.01 level. However, factors such as gender, status, occupation, income, education level, age, perceived barriers to dengue hemorrhagic fever prevention, and encouragement from family members were not related to people's dengue hemorrhagic fever prevention behavior. (Table 2)

Table 2 Correlation coefficient between factors and dengue hemorrhagic fever prevention behavior

factor	Behavior to prevent dengue hemorrhagic fever	
	Pearson correlation coefficient (r)	**p-value**
age	0.086	0.093
Knowledge about dengue hemorrhagic fever	0.193	0.015*
Attitudes about dengue hemorrhagic fever	0.074	0.177
Perception of the severity of dengue hemorrhagic fever	0.657	<0.0001**
Perception of the risk of dengue hemorrhagic fever	0.084	<0.0001**
Perceived benefits in preventing dengue hemorrhagic fever	0.156	<0.0001**
Perceived barriers to dengue hemorrhagic fever prevention	0.029	0.085
Access to health resources	0.320	<0.0001**
Receiving advice from publichealth personnel	0.325	<0.0001**
Prompting from family members	0.081	0.238

* Statistically significant at the level .05

** Statistically significant at the level .001

5. Conclusion and Recommendation

The results of the analysis of the level of knowledge about dengue hemorrhagic fever among people in the Khlong Bang Kaeo Noi community area found that the majority had a moderate level of knowledge about dengue hemorrhagic fever, accounting for 60.4 percent. This could be attributed to the fact that many people in Samut Prakan Province work as private employees in industrial factories, often leading to irregular working hours. As a result, when public health personnel provide knowledge about dengue hemorrhagic fever prevention, such as through door-to-door visits, radio broadcasts, or community meetings, individuals may not always be available to receive this information.

Consequently, they may not receive various information regarding dengue hemorrhagic fever prevention correctly. This finding is consistent with the study conducted by Puttipong Boonchu (2022) on factors related to prevention and control behavior of dengue hemorrhagic fever in Nampud Sub-district, Mueang District, Trang Province. The study suggested that in the endemic village, there was a moderate level of knowledge and good prevention and control behavior [8].

The analysis of dengue hemorrhagic fever prevention behavior among people in the Khlong Bang Kaeo Noi community revealed that the majority exhibited good prevention behavior, accounting for 65.1 percent. This suggests that people possess correct dengue prevention practices to safeguard themselves and their community members. This inclination towards proper prevention behavior can be attributed to the widespread awareness of the severity of dengue hemorrhagic fever, coupled with a high perception of the associated risks and benefits of prevention measures. These findings align with a study by Pratumrat Sittichai (2020), which focused on the knowledge of dengue hemorrhagic fever and preventive behaviors among Police Non-Commissioned Officer Students in Provincial Police Training Center Region 9. The study concluded that the dengue hemorrhagic fever prevention behaviors were generally good [9].

The results of the analysis of the relationship between factors and dengue hemorrhagic fever prevention behavior among people in the Khlong Bang Kaeo Noi community revealed that knowledge about dengue hemorrhagic fever was significantly associated with dengue hemorrhagic fever prevention behavior at the 0.05 level, consistent with the findings of Pratumrat Sittichai (2020). The results suggest that knowledge about DHF was statistically significantly associated with DHF preventive behaviors at the 0.05 level. Furthermore, the analysis found that access to health resources and receiving advice from public health personnel were significantly associated with dengue hemorrhagic fever prevention behavior at the 0.01 level. This underscores the importance of knowledge and understanding about dengue hemorrhagic fever, perceived benefits, severity, and risk of infectious diseases. Access to health resources and advice from public health personnel contribute to correct and appropriate dengue hemorrhagic fever prevention behavior. Knowledge and awareness play crucial roles in driving individuals to adopt protective behaviors. Therefore, public health personnel should prioritize both knowledge dissemination and provision of adequate supplies and equipment to prevent dengue hemorrhagic fever, leading to improved prevention behavior. These findings are consistent with the study conducted by Prayom Sirima (2023). Factors influencing the dengue fever prevention behavior of the people in Lalai Subdistrict, Kantharalak District, Sisaket Province. Results suggest that perceived risk of dengue fever, perceived severity of dengue fever, perceived benefits of dengue fever prevention and knowledge about dengue fever, and can explain the variance of factor influencing the dengue fever prevention behavior of the people in Lalai Subdistrict, Kantharalak District, Sisaket Provinceat 43.80percent ($R2=0.438$)statistically significant at 0.05 level. Consequently, community health teams should encourage people's participation in DHF prevention in the community [10].

6. References

[1] Boonprajuk Junwin. **Relationship between Perception and Prevention Behavior of Dengue Hemorrhagic Fever Among People in the Districts with High-morbidity Rate, Nakhon Si Thammarat Province**. Academic Journal of Community Public Health, 2022, p.p. 141-156.

[2] Department of Disease Control. **Forecasting the dengue hemorrhagic fever situation in 2023**. Ministry of Public Health. Nonthaburi, 2023. Thailand

[3] Division of Vector borne Diseases. **Dengue fever situation 2023**. Epidemiology Division. Department of Diseases Controls, Ministry of Public Health, Nonthaburi, 2023. Thailand

[4] Green L. W. & Kreuter M. W. **Health Program Planning: an Educational and Ecological Approach**. New York: McGrawHill, 2005.

[5] Patawee Puakpromma, Alisa Nititham and Nutthakritta Sirisopon. **Factors Relating to Dengue Hemorrhagic Fever (DHF) Preventive Behaviors of People at Bang Krachao Mueang District in Samut Sakhon Province**. Journal of The Royal Thai Army Nurses. 23(2), 2022, p.p. 68-77

[6] Bloom, B. S. **Mastery learning. In J. H. Block (Ed.),** Mastery learning: Theory and practice. New York: Holt, Rinehart & Winston, 1971.

[7] Best, J. W. **Research in Education. (3ⁿᵈed)**. Englewod Cliffs: Prentice-Hall, 1977.

[8] Puttipong Boonchu. (2022). **Factors Related to Prevention and Control Behavior on DengueHemorrhagic Fever: Comparative Study between Epidemic Village andNon-incidence Village in Nampud Sub-district, Mueang District,Trang Province**. Thai Journal of Public Health and Health Sciences. 3(3), 2020, p.p. 79-94.

[9] Pratumrat Sittichai. **The Knowledge of Dengue Hemorrhagic Fever on Preventative Behavior of Dengue Hemorrhagic Fever of Police Non-Commissioned Officer Student in Provincial Police Training Center Region 9**. Thai Journal of Public Health and Health Sciences. 3(2), 2020, p.p. 110-123.

[10] Prayom Sirima (2023). **Factors influencing the dengue fever prevention behavior of the people in Lalai Subdistrict, Kantharalak District, Sisaket Province**. Sisaket Journal of Research and Health Development. 2(2), 2023, p.p. 112-124

FACTORS AFFECTING THE SUCCESS OF SMART CITY DEVELOPMENT IN TERMS OF TRAVELING AND TRANSPORTATION (SMART MOBILITY) AT AMPHOR MOUNG KHONKAEN, KHONKAEN PROVINCE

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Factors Affecting the Success of Smart City Development in Terms of Traveling and Transportation (Smart Mobility) at Amphor Moung Khonkaen, Khonkaen Province

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Abstract

The rapid urbanization and technological advancements have propelled the concept of smart cities to the forefront of urban development. The population of Amphor Mueang Khon Kaen, which consists of 387,279 people, the sample size is determined using Taro Yamane's formula, which consists of 399.59 individuals. This study aims to evaluate the critical success factors of smart city development in the context of travel and transportation (Smart Mobility) in Mueang Khon Kaen District, Khon Kaen Province, focusing on the influence of personal factors. The study surveyed Mueang Khon Kaen District residents using a quantitative research methodology to assess their perceptions of the critical success factors. The findings indicate that personal factors, specifically gender, age, and education level, significantly impact the perceptions of these success factors. Notably, differences were observed between males, females, and alternative genders, with females and alternative genders sharing similar viewpoints. Age groups exhibited varying opinions, with those aged 31-35 years, 36-40 years, and above 41 years having similar perspectives. Additionally, education level influenced perceptions, with distinct differences between respondents with high school education, bachelor's degrees, and higher education levels. However, income and marital status did not significantly affect the opinions on the critical success factors. These results highlight the importance of considering diverse demographic factors in the planning and implementing of innovative city initiatives, particularly in Smart Mobility, to ensure their effectiveness and inclusivity.

Keywords: Smart Mobility, travel and transportation, personal factor

Introduction

Thailand's development began with the implementation of the Thailand 1.0 model. The government sector prioritizes stimulating investment in the agriculture industry. Furthermore, it steps into the Thailand 2.0 model, explicitly targeting the automotive sector by capitalizing on job opportunities and a favorable labor market. The emphasis is placed on local production by harnessing the country's natural resources as alternatives to importing goods from other countries. Simultaneously, Thailand has embraced the concept of Thailand 3.0 and has prioritized the development of heavy industries by using cutting-edge technology. Facilitate the export of goods by enabling the participation of foreign investors in investing. Establish Thailand as a manufacturing hub

for global exports. In order to transition into the Thailand 4.0 era (Warisara Inthasan, 2019). To attain progress and fulfill current requirements. In order to stay abreast of advancing digital technology, the nation is on the verge of entering the Thailand 4.0 era, which involves the use of contemporary technology and innovative management practices—and ensuring comprehensive access to facilities and services that promote the overall well-being and health of individuals across all age groups, in preparation for their transition into the senior population and promoting engagement in all sectors to use alternative energy sources, such as clean and renewable energy. The collaboration between the public and private sectors aims to establish links and foster corporate cooperation while also using innovation to drive the development and transformation of enterprises. The objective is to establish a smart city that will enhance the overall well-being of its residents. The source of this information is the Digital Economy Promotion Agency in the year 2021. The government has actively advocated for and substantially assisted in developing smart cities. The chosen target regions have been established as prototypes for intelligent cities. In 2018-2019, 10 smart cities were identified in 7 provinces, including Bangkok, Chiang Mai, Phuket, Khon Kaen, Chonburi, Rayong, and Chachoengsao (Chuliporn Aramnet, 2024).

Khon Kaen Province is the 4th most populous province in the country, with a total population of 1,790,055 people, accounting for 576,964 households, accounting for 387,279 people residing in the Mueang District area as of 2020 (Khon Kaen Municipality, 2020) It is also the center of travel and intelligent transportation and the economy of the northeastern region. It is making this Province become a city center in many dimensions. However, the rapid growth of cities also causes other problems, such as pollution problems. Inequality in society and the traffic problem of the public transportation system being insufficient to meet demand (Chuliporn Aramnet, 2024). The development of smart cities in terms of travel and intelligent transportation is an important matter that the government sector is recognizing. Development must be accelerated to enable transportation. Travel of people in this city is efficient for achieving communication and transportation connections, and traveling in the future will be convenient and fast. Also, in the future, a High-speed rail project to connect with transportation from China will be a critical city that acts as a center for trade, goods transportation, and tourist transit. Therefore, developing intelligent travel and transportation is a matter for the government and public sectors to accelerate and understand in order to develop to their full potential.

Therefore, the researcher studied the success of the smart city in Khon Kaen Province by explicitly studying the area of intelligent travel and intelligent transportation according to the proposal of the brilliant city development plan, area 5, which is the area of travel and transportation (Smart mobility), by studying the opinions of the people. Classified according to personal factors that can affect the success of innovative city development in Khon Kaen Province, the results of the study and the knowledge gained will be able to be used for knowledge, policy planning, and planning for urban development in the form of smart cities. Of Mueang Khon Kaen District Khon Kaen Province To use as a model for innovative city development for other provinces.

Research Objective

To evaluate different perspectives of the critical success factors of smart city development in travel and transportation (Smart Mobility) at Mueang Khon Kaen District, Khon Kaen Province is classified by personal factors.

Methodology

Population and sample

In this study, the researcher examines the population of Amphor moung Khon Kaen, which consists of 387,279 people (Khonkaen Provincial Adminisrative Organization, 2021). The sample size is determined using Taro Yamane's formula (Yamane, 1973), resulting in a calculated sample size of 399.59 individuals with a confidence level of 95%. Stratified random sampling is used for sample selection.

Content validity

1) Take the questionnaire to 3 experts to consider and check its content validity and then revise it appropriately. as well as check the quality of the tools by finding the consistency index value between questions and objectives (Item – objective congruence index: IOC) Questions with an IOC value of 0.60-1.00 show that they are measured according to their intended purpose. Questions that can be used Questions with an IOC value lower than 0.60 indicate that they are not measurable for their intended purpose and should, therefore, be considered to be eliminated or improved.

2) After receiving the complete questionnaire, the researcher tested its reliability with the general public in Mueang Khon Kaen District, Khon Kaen Province, who were not in the sample of 30 sets. (Reliability) of the questionnaire by analyzing the alpha coefficient (Cronbach's alpha) with a confidence level value equal to more than 0.7 and above, considered to have a relatively high reliability value (Cronbach, 1951).

Data Analysis

The researcher has classified the data analysis issues according to the study objectives by using data from studying documents, research, interviews, and various electronic media related to domestic and international sources related to the city's success. Transportation Smart City Leader Potential Technology and Innovation Management and Smart City Development According to the conceptual framework obtained from the literature review, statistics were used to analyze the data as follows.

1) Descriptive statistics by finding frequencies, percentages, averages, and standard deviations. To describe the characteristics of the respondents. Moreover, the distribution characteristics of the variables by using descriptive statistics such as frequency values and percentage values of the observed variables that are variables. Continuing and analyzing percentage values for the canonical variables that are the data of the preliminary sample. And present data with tables and captions

2) Conduct a factor-level analysis by having criteria for determining the level of opinions of the respondents. The questionnaire measures data in the same unit and has a score level according to the affective scale using a Likert scale. Respondents give a level of score based on their being. TRUE According to the list of questions in each category in terms of opinions, with a score of 1-5, give a score of 1, meaning the question item is the least accurate to reality, and give a score of 5, a score of 5, the question item is the most accurate to reality.

3) Statistics used in this research are $\bar{x}$, S.D. and F-test (One-way ANOVA) to compare the different perspectives of respondents

Result

Table 1 The demographic of respondents

Demographic	Frequency	Percent
Gender		
Male	181	45.25
Female	213	53.25
Alternative	6	1.51
Age		
25-30 years	48	12.01
31-35 years	238	59.5
36-40 years	76	19.02
41 years above	38	9.53
Education		
High school	190	47.51
Bachelor's degree	195	48.89
Higher than bachelor	15	3.80
Income		
Lower than 25,000 baths	304	76.01
25,001 - 30,000 baths	81	20.32
30,001 – 40,000 baths	10	2.54
40,001 baths or above	5	1.31
Marital Status		
Single	109	27.31
Married	278	69.54
Divorced/widowed	13	3.33
Total of respondents	**400**	**100**

Table 2 Comparison of respondents

Dependent variable	Gender		Age		Education		Income		Marital Status	
	F	Sig	F	Sig	F	Sig	F	Sig	F	Sig
Success factors of smart city development	34.30	.00*	0.82	.00*	113.57	.00*	1.31	.26	3.64	.02*

*Significant level at .05

Table 2 presents the comparison of respondents classified by personal factors. I found that different genders, ages, and education levels are different. However, the opinions of income and marital status are not different from the critical success factors of smart city development in travel and transportation (Smart Mobility) at Mueang Khon Kaen District, Khon Kaen Province, with a statistically significant level of .05

Table 3 Comparison of respondents classified by gender

Gender	Male	Female	Alternative
$\bar{x}$	4.38	4.70	4.66
Male		.31	.27
		(.00*)	(.07)
Female			.03
			(.95)

*Significant level at .05

Table 3 presents the comparison of respondents classified by gender. It was found that the differences among males, females, and alternative genders are different. However, females and alternative genders have no different opinions on the critical success factors of smart city development in travel and transportation (Smart Mobility) in Mueang Khon Kaen District, Khon Kaen Province. With a statistically significant level of .05

Table 4 Comparison of respondents classified by Age

Age	25-30 years	31-35 years	36-40 years	41 years above
$\bar{x}$	4.26	4.43	4.56	4.50
25-30 years		.16	.29	.24
		(.00*)	(.00*)	(.00*)
31-35 years			.12	.07
			(.01*)	(.59)
36-40 years				.05
				(.84)

*Significant level at .05

Table 4 presents the comparison of respondents classified by age. It was found that the differences among 25-30 years, 31-35 years, 36-40 years, and 41 years above are different. However, 31-35 years, 36-40 years, and 41 years above have no different opinions on the critical success factors of smart city development in travel and transportation (Smart Mobility) in Mueang Khon Kaen District, Khon Kaen Province. With a statistically significant level of .05

Table 5 Comparison of Respondents Classified by Education

Education	High school	Bachelor's degree	Higher Bachelor
$\bar{x}$	4.26	4.43	4.56
High school		.36	.51
		(.00*)	(.00*)
Bachelor's degree			.15
			(.08*)

*Significant level at .05

Table 5 presents the comparison of respondents classified by education. It was found that High school, bachelor's degree, and higher bachelor's degree are different. However, 31-35 bachelor's and higher bachelor's degrees have no different opinions on the critical success factors of smart city development in travel and transportation (Smart Mobility) in Mueang Khon Kaen District, Khon Kaen Province. With a statistically significant level of .05

Conclusion

The findings of the study Factors Affecting the Success of Smart City Development in Terms of Traveling and Transportation (Smart Mobility) at Amphor Moung Khonkaen, Khonkaen Province, can be concluded that personal Factors Influence Opinions of the research indicate such as gender, age, and education level significantly influence the perceptions of critical success factors for smart city development in travel and transportation (Smart Mobility) in Mueang Khon Kaen District, Khon Kaen Province. There is a notable difference in opinions between males and females and alternative genders regarding the critical success factors. However, females and alternative genders share similar viewpoints on these factors. Respondents from different age groups (25-30 years, 31-35 years, 36-40 years, and 41 years above) have varying opinions on the success factors. Nevertheless, individuals aged 31-35, 36-40, and above 41 years tend to have similar perspectives. The level of education, ranging from high school to higher bachelor's degrees, affects the perceptions of the critical success factors. However, respondents with a bachelor's degree and those with higher education levels do not differ significantly in their opinions. The study found that income and marital status do not significantly impact the opinions on the critical success factors of smart city development in travel and transportation.

In conclusion, the success of smart city development in terms of Smart Mobility in Mueang Khon Kaen District, Khon Kaen Province, is influenced by various personal factors, particularly gender, age, and education level. These findings underscore the importance of considering diverse perspectives in planning and implementing smart city initiatives to ensure their effectiveness and inclusivity.

Discussion

The findings of this study reveal that personal factors, such as gender, age, and education level, play a significant role in shaping the perceptions of the critical success factors for innovative city development in the context of travel and transportation (Smart Mobility) in Mueang Khon Kaen District, Khon Kaen Province. These results align with the work of Chen (2023), who also found that demographic factors influence attitudes toward smart city initiatives. In terms of gender, the study indicates a difference in opinions between males, females, and alternative genders, which is consistent with the findings of Jiet al. (2021). However, females and alternative genders exhibited similar perspectives on the critical success factors, suggesting a potential alignment in their views toward smart mobility solutions. This observation could be explored further in future research to understand the underlying reasons for this alignment. Age also emerged as a significant factor, with distinct differences in opinions among various age groups. The similarity in views among respondents aged 31-35, 36-40, and above 41 may indicate a shared understanding or experience of smart mobility solutions among these age groups. This finding aligns with the research conducted by Dirsehan and van Zoonen (2022), which highlighted the impact of age on the acceptance of smart city technologies. The influence of education level on the perceptions of success factors was evident, with differences noted between respondents with high school education, bachelor's degrees,

and higher education levels. However, there was no significant difference in opinions between those with a bachelor's degree and higher education levels. This suggests that individuals may have similar views on smart mobility beyond a certain level of education. Interestingly, income and marital status did not significantly affect the opinions on the critical success factors.

Suggestions

1. Urban planners and policymakers should consider the diverse perspectives of different demographic groups, including gender, age, and education level, in the planning and implementation of Smart Mobility initiatives. This will ensure that the needs and preferences of all community members are addressed, enhancing the overall success of smart city development.

2. Develop communication strategies that cater to the specific characteristics of each demographic group to disseminate information about Smart Mobility solutions and their benefits effectively. This could involve using different platforms or messaging styles that resonate with various age groups, genders, and educational backgrounds.

3. The education institutes should conduct educational programs and awareness campaigns to bridge the knowledge gap between different educational levels and promote a better understanding of Smart Mobility technologies and their advantages. This could lead to increased acceptance and support for smart city initiatives.

4. Given the differences in opinions between genders, it is crucial to incorporate gender-sensitive design principles in developing Smart Mobility solutions. This will ensure that the transportation needs of both males and females and alternative genders are adequately addressed.

5. Develop age-friendly Smart Mobility solutions catering to different age groups' needs and preferences. For example, older adults may require more user-friendly interfaces or additional safety features.

Further Research

Further research is needed to explore the underlying reasons for the observed differences in opinions among different demographic groups. This can provide deeper insights into how to tailor Smart Mobility initiatives to better meet the needs of diverse populations.

References

Chen, Z. (2023). Smart cities and quality of life: a quantitative analysis of citizens' support for smart city development. *Information Technology & People, 36*(1), 263–285. doi:https://doi.org/10.1108/ITP-07-2021-0577

Chuliporn Aramnet. (2024). *Bangkok Business*. Retrieved April 8, 2024, from Bangkok Biz news: https://www.bangkokbiznews.com/tech/innovation/1039597

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*, 297–334.

Dirsehan, T., & van Zoonen, L. (2022). Smart city technologies from the perspective of technology acceptance. *4*(1), 197–210. doi:https://doi.org/10.1049/smc2.12040

Ji, T., Chen, J.-H., Wei, H.-H., & Su, Y.-C. (2021). Towards people-centric intelligent city development: Investigating the citizens' preferences and perceptions about smart-city services in Taiwan. *Sustainable Cities and Society, 67*(1), 1–14.

Khon Kaen Municipality. (2020). *Statistical of population*. Retrieved February 10, 2024, from Khon Kaen Municipality: https://www.kkmuni.go.th

Khonkaen Provincial Administrative Organization. (2021). *Database Development*. Retrieved April 8, 2024, from E–PlanData: https://kkpao.go.th/E-PlanData/?mod=index&file=datacat2-2

Warisara Inthasan. (2019). Development of the elderly society model for happiness. In the Thailand 4.0 era. *Silpakorn University*, 1–15.

Yamane, T. (1973). *Statistics: An Introductory Analysis.* London: John Weather Hill, Inc.

DETERMINING THE ANTHOCYANIN CONTENT AND DEVELOPING A CONCENTRATED FACE EMULSION UTILIZING PULP AND PEEL EXTRACT FROM SYZYGIUM CUMINI (L.)

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DETERMINING THE ANTHOCYANIN CONTENT AND DEVELOPING A CONCENTRATED FACE EMULSION UTILIZING PULP AND PEEL EXTRACT FROM *SYZYGIUM CUMINI* (L.)

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ABSTRACT

The objectives of this research were 4 items: 1) to study the anthocyanin content in *Syzygium cumini* (L.) extract by using pH Differential Method 2) to study the antioxidant capacity of *Syzygium cumini* (L.) extract 3) to study and Develop a formulation of concentrated emulsion for facial care from flesh and bark extracts and 4) to test the efficacy and satisfaction of the concentrated emulsion from *Syzygium cumini* (L.) extract. The extracts from the *Syzygium cumini* (L.) were extracted by using 0.1% hydrochloric acid in ethanol. Next, the extract's anthocyanin content was determined using the pH differential technique. DPPH free-radicals scavenging test compared to standardized vitamin E. Phenolic was analyzed from standard gallic curves using Folin–Ciocalteu reagent method. Three concentrated emulsion facial care products were developed at concentrations 0%, 3%, and 6%. Physical stability was tested. Heating-Cooling cycle test Method. Closed patch test and product satisfaction were tested in 15 volunteers. The statistics used in the data analysis were frequency, percentage, mean, standard deviation (SD). One -way ANOVA when the difference was found compared to the pair mean by Duncan Multiple Range Test method. The antioxidant activity of the pulp and peel extract was found to have an IC_{50}, which was 1.204. $\pm$ 0.629 µg/mL. *Syzygium cumini* (L.) extract had total phenolic value of 7.35 µg/mL. Concentrated emulsion for facial care from 3 formulas of *Syzygium cumini* (L.) extract found that the pH of all were equal to 6. After testing the stability of the 3 concentrated emulsion formulations, it was found that the pH , texture, color and odor of the product did not change. There is no allergy to all 3 formulas from the product satisfaction test. It was discovered that the respondents' mean values for formulas 3, 2, and 1 were 4.95 $\pm$ 0.21, 4.65 $\pm$ 0.58, and 4.28 $\pm$ 0.20, respectively, revealing that the requirements were satisfied in decreasing order. The three formulations were discovered to differ statistically significantly at the 0.05 level.

Keywords: concentrated emulsion, anthocyanin, *Syzygium cumini* (L.)

1. Introduction

People have been interested in reducing aging from prehistoric times to the present. This is a result of the aging process of human skin. The conditions that lead to wrinkles are signs of skin degeneration, which occurs as we age due to internal mechanisms known as intrinsic skin aging. Skin cells lose their ability to function as other systems do, which throws off the delicate equilibrium between skin cell development and breakdown. Then, the skin starts to degrade and wrinkles appear. Scientists have found that there are distinct ways by which each component contributes to aging. The epidermis, dermis, and subcutaneous layer (hypodermis) are the constituent layers of skin. Collagen and elastin, two types of protein fiber connective tissue, constitute the dermis. The main component is collagen, which is weaved into huge collections of fibers. serves as a support to keep the epidermis's structure flexible. The skin in the area that has been damaged will often heal itself by generating new collagen to replace the damaged tissue. However, the various functions that skin cells activity appear to decline with age[1]. Alternatively, there may be other reasons why the balance in these repairs is decreasing. In other words, the body will be beginning generating less collagen. At the same time, the generation of enzymes capable of breaking down collagen will take position resulting in the slicing of the collagen strands. When there is insufficient support for the skin, it becomes less elastic and wrinkled. A further factor that increases the synthesis of MMPs enzymes is UV radiation. Additionally, it quickens the breakdown of cells via a process known as photoreactivity. Reactive oxygen species, or ROS, are free oxygen radicals [2]. The tropical fruit lukwa (*Syzygium cumini* (L.) Skeels. found from Africa to Southeast Asia. May and June are the seasons that produces fruit. It tastes slightly astringent, sour, and sweet. It has essential minerals and nutrients. The fruit of *Syzygium cumini* (L.) is high in phenolic compounds, vitamin C, and anthocyanins. Vitamin C is categorized as a biologically active molecule that aids in the fight against free radicals. Anthocyanin is the pigment or colorant that gives objects their red, purple, and blue hues. Meals are given a natural hue by it. Nutraceutical properties are present in Anthocyanin In Vitro. As an antioxidant, a nutraceutical reduces blood coagulation, which decreases the risk of heart attack and stroke and assists in reducing down the aging of cells, reduced the rate of ocular degradation and helped guard against food poisoning and diarrhea brought on by the *Escherichia coli* bacteria (*E. Coli*). It came out from the aforementioned literature study that anthocyanins assist in preventing the aging process. Furthermore, studies on *Syzygium cumini* (L.) fruit have shown that it possesses an interesting anthocyanin content. The fruit *Syzygium cumini* (L.) has antioxidant qualities that the researcher is interested in investigating [3]. Specifically, the researcher wants to find out the amount of anthocyanin is in the extract and then develop a concentrated emulsion product formulation that uses the extract to nourish the skin on the face.

2. Literature Reviews

A prominent commercial plant species often found in Southeast Asia, especially in Thailand, is the black plum (*Syzygium cumini* (L.) Skeels, a member of the Myrtaceae Family. The species cumini was widely used to apply for medical and health benefits, according to a number of earlier reports. According to Bhandary (1995) [4], Jagetia and Baliga (2002) [5], Veigas et al. (2007) [6], Gopu et al. (2015) [7], and other studies, it may be able to treat sore throat, chronic diarrhea, diabetes, antidiuretic, and lessen DNA damage in human peripheral blood. This is because it is made up of several significant antioxidants, particularly polyphenolic components like oxalic acid, gallic acid, and tannins, as well as anthocyanins.

According to Tavares et al. (2017) [8], *Syzygium cumini* (L.) Skeels has a high quantity of phenolic compounds and strong antioxidant activity, both of which have a protective effect on food. According to Dannenberg et al. (2016) [9], antioxidants can act as metal chelators occasionally as well as radical hijackers to postpone the oxidation of various substrates. Furthermore, the antioxidants might have antibacterial properties as well. Further research has shown the advantageous properties of jambolan, including its antioxidant and antibacterial properties [10], employing leaves, bark, essential oils, fruits, and seeds.

Anthocyanins are water-soluble pigments that are produced as secondary plant metabolites. They are classified as polyphenolic constituents and belong to the flavonoid family of bioactive compounds, which is responsible for the distinctive red, blue, and purple colors of fruits, vegetables, and flowers [11] [12]. Although the distinct colorful appearance that anthocyanins impart to various plant parts is more well-known, their primary function is to scavenge free radicals and exhibit strong antioxidant activity, which protects against DNA damage.

The evaluation of anthocyanin content. There are various methods to determine the total anthocyanin content, consisting of measuring the absorbance at specific wavelengths. addition pH-differential technique While evaluating the absorbance value, The absorbance of the extract was determined at its broadest wavelength. The highest wavelength at which anthocyanin can be absorbed is between 490 and 550 nm, which is significantly longer than the range at which other phenolic compounds can be absorbed, which is between 260 and 320 nm. Separate evaluations were made for anthocyanins and phenolic compounds. This method does have some limitations, though, as substances like melanoidin and other components that generate as anthocyanin breaks down can absorb light in the same spectrum as anthocyanin, which can result in values that are not accurate. Consequently, the remedy to that issue led to a development of the pH-differential technique. At this point in time, it is the method that is most commonly used to determine anthocyanin content. The ability of transforming the structure of anthocyanins encouraged the development of the pH-differential technique. The light absorbance of anthocyanins changes in accordance with the change in pH value[13].

3. Methodology

Preparatin Of Plant Extracts

Fresh *Syzygium cumini* (L.) obtained from Ban Khlong Yee-Poon, Bang Len Subdistrict, Lat Bua Pak Tha District. Nakhon Pathom Province, Thailand. Separate the seeds and the pulp and peel. Use only the pulp and peel, then chop them finely and then was macerated in 0.1 % hydrochloric acid in ethanol for 24 hours then filtered through Whatman® No.4 paper. The supernatant was evaporated under rotary evaporator. The extracts were kept at 4°C until used [3].

Determination of total anthocyanin content

A pH-differential method was adopted for total anthocyanin content determination. Briefly, the extracts were weighed and dissolved in distilled water; 1 mL of the sample was mixed with 9 mL of potassium chloride pH = 1.0) and 9 mL of sodium acetate (pH = 4.5), then incubated with aluminum foil wrapping for 20 min at room temperature. Then, the absorbance of the mixtures was measured at 320 and 700 nm. The total anthocyanin content, expressed as milligram cyanidin-3-glucoside equivalents per liter, was calculated as follows

$$\text{Anthocyanins content (mg/l)} = \Delta A \times MW \times DF \times 1000 / \varepsilon \times l$$

Where $\Delta A = (A_{320} - A_{700})\ pH1.0 - (A_{320} - A_{700})\ pH4.5$, MW is the molecular weight of cyanidin-3-glucoside (449.2), DF is the dilution factor, ε is the molar absorptivity (26900), and l is cell path length (usually 1 cm) [13].

Determination Of Total Phenolic Content

The total phenolic content was determined by the Folin-Ciocalteu method. The extracts were dissolved in methanol at various concentrations (0.1- 5.0 mg/ml), then the extract solution (0.5 ml) was mixed with the Folin-Ciocalteu reagent (0.25 ml) and 20% sodium carbonate (1.25 ml). After mixing and standing at room temperature for 30 min, the absorbance was measured at 765 nm. The total phenolic content was expressed as mg gallic acid equivalent/g dried extract [3].

Determination Of DPPH Radical Scavenging Activity

Determination of DPPH radical scavenging activity [14]. The free radical scavenging activity was determined by the method. The extract was dissolved in methanol at various concentrations (0.1-5 mg/ml), then 2.8 ml of each extract solution was mixed with 0.2 ml of DPPH solution (1 mM in methanol). After incubation at room temperature for 30 min, the absorbance was measured at 517 nm. The negative (methanol) and positive (vitamin C) controls were run in parallel. The scavenging activity was calculated using the formula,

$$\% \text{ scavenging} = [(A_{517}\text{control} - A_{515}\text{sample})/A_{517}\text{control}] \times 100.$$

Formulation the *Syzygium cumini* (L.) extract may be used in a of facial concentrated emulsion, the composition of which is as follows Table1

Table 1 : Formulation of facial concentrated emulsion from *Syzygium cumini* (L.) extract may be used in a of facial concentrated emulsion

Ingrredients	Formulaton		
	Control	1	2
Deionized water	60.6	57.6	53.6
Hydroxyetyl Cellulose	0.6	0.6	0.6
Butylene Glycol	10.0	10.0	10.0
Octyldodecanol	3.0	3.0	3.0
Oleth-5	6.0	6.0	6.0
Ceteary alcohol, Ceteareth 20	3.0	3.0	3.0
Pentacythrity Distearate	1.0	1.0	1.0
Myritol 318	1.0	1.0	1.0
Sodium Hyaluronate 1%	10.0	10.0	10.0
สารสกัดลูกหว้า	0.0	3.0	6.0
Bifida Ferment Lysate	2.0	2.0	2.0
Vitamin E Acetate	0.5	0.5	0.5
Ethylhexylglycerin,Propannediol	1.0	1.0	1.0
Sodium Metabisulfite	0.2	0.2	0.2
fragrance	0.1	0.1	0.1

Evaluation of facial concentrated emulsion from *Syzygium cumini* (L.) extract

Hypoallergenic Test
The formula that is stable and has good antioxidation test for allergies in the arm area of 15 subjects by Closed Patch Test method. Sheet 1 contains controlled substances (saline), and another sheet is a serum formulation used. Test sample on the inner upper arm for 24 hours. After 24 hours, remove the patch and notice if irritation occurs and record the results [15].

Assessing Product Satisfaction
A total of 15 volunteers were selected for the age of 35-55. All volunteers were given samples. The 1st bottle was a controlled bottle without extract and the 2nd, 3rd bottle contains a formula extract. The volunteers use it for 2 weeks and then observe the changes. After that, a satisfaction questionnaire was obtained from using the serum containing *Syzygium cumini* (L.) extract.

4. Results
By comparing the pH 1 KCl-HCl buffer solution with the pH 4.5 acetate buffer solution, the experiment results have been examined to determine the amount of anthocyanin by the pH Differential method. It was determined that the *Syzygium cumini* (L.) fruit extract contained 150.54 mg/L of malvidin-3,5-diglucoside and 167.44 mg/L of pelargonidin-3-glucoside anthocyanin.

According to an experiment comparing the antioxidant activity of standard compounds containing vitamin E, it was found that pulp and fruit peel extracts had an effective antioxidant activity with an IC_{50} value of $1.204 \pm 0.629 \, \mu g/mL$. The IC_{50} value of vitamin E is $66.35 \pm 1.97 \, \mu g/mL$. Compared to vitamin E, it has a 55-fold higher antioxidant potency. The fruit extract has a total phenolic value of $7.35 \, \mu g/mL$ in relation to the gallic acid standard.

Three formulae were developed from the investigation and development of concentrated emulsion solutions for facial skin care using *Syzygium cumini* (L.) fruit extract: one with a controlled formula that included no additional extracts, Formula 1 with 3% *Syzygium cumini* (L.) fruit extract, and Formular 2 with 6% *Syzygium cumini* (L.) fruit extract.

These are the outcomes: Control group concentrated emulsion product for nourishing facial skin, with a pH of 6, thick, white liquid texture, and mild scent. pH-valued concentrated emulsion product for nourishing face skin: Formula 1. has a viscous, thick feel and is equal to 6. The second concentrated face emulsion solution has a thick liquid texture, a pH of 6, and a mild smell. It is light yellow in color. It has a pale golden hue. The scent is mild.

From evaluating the product's stability at room temperature, 4 ℃, 50 ℃ and Heat-Cool Cycle. It was found that the three formula products had the same pH level and a thick liquid consistency without any layer separation. Both the color and scent are the same.

From the close patch test of 15 volunteers for 24 hours by covering the plaster sheet with all formulas in the upper arm area, it was found that after removing the test sheet, no irritation occurred. Redness and swelling in volunteers.

According to the evaluation results, Formula 2 had the highest mean value of 4.95 ± 0.21, followed by Formula 1 at 4.65 ± 0.58 and the Control Formula at 4.28 ± 0.20, which indicated the participants' overall level of satisfaction.

5. Conclusion and Recommendation

This study established that concentrated emulsion face skin care products made from *Syzygium cumini* (L.) fruit extract addition to having the potential to develop into an industrial-scale cosmetic, the item that is manufactured could serve as a model for future cosmetics that incorporate *Syzygium cumini* (L.) fruit extract.

Concentrated emulsion made of water extract used as a facial skin care treatment. They might result in allergic responses. On delicate skin due to the properties of concentrated emulsion face skin care products developed from water lily extracts, middle-aged persons can benefit from by implementing them. However, allergic reactions to the extracts and components of the product should be investigated in volunteers with sensitive skin before trial usage. Because of its extremely concentrated texture, it works well for those whose skin is drying out, dehydrated, or degrading.

Acknowledgement

6. References

[1] Papaccio F, D Arino A, Caputo S, Bellei B. **Focus on the Contribution of Oxidative Stress in Skin Aging. Antioxidants (Basel)**. 2022 Jun 6;11(6):1121.

[2] Liang Y, Su W, Wang F. **Skin Ageing: A Progressive, Multi-Factorial Condition Demanding an Integrated, Multilayer-Targeted Remedy.** Clin Cosmet Investig Dermatol. 2023 May 9;16:1215-1229.

[3] Rawinipa Srimoon. **Changes of anthocyanins, total phenolic contents and antioxidant activity in black plum (Syzygium cumini Skeels) juice, during local can processing.** Journal of Agricultural Technology. 2016. 12(6):1153-1164.

[4] Bhandary, M.J., Chandrashekar, K.R. and Kaveriappa, K.M. **Medical ethnobotany of the Siddis of Uttara Kannada district, Karnataka, India.** Journal of Ethnophamacology. 1995. 47: p.p 149-158.

[5] Jagetia, G.C. and Baliga, M.S. *Syzygium cumini* **(Janum) reduces the radiation-induced DNA damage in the cultured human peripheral blood lymphocytes: a preliminary study.** Toxicology Letters. 2002. 132:19-25.

[6] Veigas, J.M., Narayan, M.S., Laxman, P.M. and Neelwarne, B. **Chemical nature, stability and bioefficacies of anthocyanins from fruit peel of** *Syzygium cumini* **Skeels.** Food Chemistry. 2007. 105: 619-627.

[7] Gopu, V., Kothandapani, S. and Shetty, P.H. **Quorum quenching activity of** *Syzygium cumini* **(L.) Skeels and its anthocyanin malvidin against Klebsiella pneumonia**. Microbial Pathogenesis. 2015. 79:61-69.

[8] Tavares, I. M. C. C., Nogueira, T. Y. K. N., Mauro, M. A., Gómez-Alonso, S., Gomes, E., Da-Silva, R., et al. **Dehydration of jambolan [***Syzygium cumini* **(L.)] juice during foam matdrying: quantitative and qualitative changes of the phenolic compounds.** Food Res. Int. 2017. 102:2–42.

[9] Dannenberg, G. S., Funck, G. D., Mattei, F. J., Silva, W. P., and Fiorentini, ÂM. **Antimicrobial and antioxidant activity of essential oil from pink pepper tree (***Schinus terebinthifolius* **Raddi) in vitro and in cheese experimentally contaminated with Listeria monocytogenes**. Innov. Food Sci. Emerg. 2016. 36:120–127.

[10] Singh, J. P., Kaur, A., Singh, N., Nim, L., Shevkani, K., Kaur, H., et al. **In vitro antioxidant and antimicrobial properties of jambolan (*Syzygium cumini*) fruit polyphenols**. LWT Food Sci. Technol. 2016. 65:1025–1030.

[11] Dixon, R.A. and G.M. Pasinetti. **Flavonoids and isoflavonoids: from plant biology to agriculture and neuroscience.** Plant Physiol. 2010. 154:453-457.

[12] Santos, D.T., P.C. Veggi and M.A.A. Meireles. **Extraction of antioxidant compounds from jabuticaba (Myrciaria cauliflora) skins: yield, composition and economical evaluation**. J. Food Eng. 2010. 101: 23-31.

[13] Lee, J., R.W. Durst and R.E. Wrolstad. **Determination of total monomeric anthocyanin pigment content of fruit juices, beverages, natural colorants, and wines by the pH differential method: Collaborative study.** J AOAC Int. 2005. 88:1269-1278.

[14] Sudjaroen, Y., Kakatum, N., & Thongmuang, P. **Evaluation of rice bran oil from riceberry rice (Oryza sativa L.) as active ingredient in skincare application.** Journal of Pharmaceutical Negative Results. 2022. 13(3):121-127.

[15] Nuengruetai Srichaipor, Padcha Pongcharoen, Puritat Kanokkangsada and Arunporn Itharat. **Skin Irritation and Allergic Testing of Thai Herbal Extracts (Ha-Rak with Turmeric) in Healthy Volunteers**. 2020. 20(2):165-174

CHINESE MEDICINE FOR THE TREATMENT OF TRIGGER FINGER

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Chinese Medicine for the Treatment of Trigger Finger

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ABSTRACT

In the severe level, trigger finger can be a hindrance in day-to-day activities and employment. Tendon damage (伤筋) or tendon injury (筋痹) is the reason according to Chinese Medicine. Pain closing disease (痹症) is the classification for it result in discomfort manifested as a blocked meridian. The body's interior organs degrade because to blood clots and Qi stagnation. Skin, blood, and Qi are all drained, and cold depletes bones and tendons of vital nutrients. The destruction of disease is frequently caused by external forces including wind, cold, and humidity. Shut down the meridians. There are five stages to the disease's symptoms, which include pain, numbness, and blood congestion that is cleared by Qi. Level zero: soreness in the fingers when bending. Inflammation is the first level, followed by Triggering, Locking, and Flexion in the second, third, and fourth levels. Tui Na massage, Acupuncture, Poultices, Chinese medicine Steaming, and Gua Sha are all part of the traditional Chinese Medicine therapy. Points that are often utilized comprising of He Gu points (合谷穴), Yang Xi points (阳溪穴), Da Ling points (大陵穴), pain points (阿是穴), and muscle relaxation points. Blood circulation and Qi can ease discomfort.

Keywords: *CHINESE MEDICINE TREATMENT; TRIGGER FINGER; LITERATURE REVIEW*

1. Introduction

One of the prevalent issues in today's world is trigger finger. It's causing by hours of nonstop smartphone gaming make tensing in the finger muscles. These days, apart from using smartphone people utilize their fingers for tasks like typing, weaving, and using computers.[1]

Thus, trigger finger is a common symptom that exists in all age groups and genders. When trigger finger is severe stage, it can make daily tasks and work more difficult. Trigger finger is an illness prevents the hand from bending or stretching naturally. It can happen in one finger or more fingers. According to Chinese medicine, Tendon damage (伤筋) and tendon injury (筋痹) are the causes.

In Chinese medicine, trigger finger symptoms organize in a Pain closing disease (痹症). This is discomfort in the form of a trapped sensation brought on by blood and Qi trapped inside the body's organs as physical deterioration; bones and tendons are lacking function, lacking nutrients and cold inside [3] it also skin and blood circulation. Wind, cold, and humidity—three external illness factors—often cause destruction of Qi; Qi is blocking blood circulation causing numbness, discomfort etc.

2. Literature Reviews

Causes of trigger finger disease

The cause is friction of the tendons used to bend the fingers and the tendon sheath that binds surrounding the tendons. Normally, the function is to hold the tendon close to the bone. As using our finger work hard repeatedly tendons in the fingers are pulled against the tendon sheath making friction that causes the thick tendon sheath to harden. Loss of flexibility this makes the tendon unable to pass through the tendon sheath. It is caused by excessive use of the hands and fingers or use it for long period of time people who regularly have to work by clenching their hands tightly, causing inflammation of the tendon sheath at the base of the finger. Common types of work such as office workers who type continuously for several hours in a row. [3] Additionally, this is typically the case for those who wash, wring, twist clothes, do laundry, and handle large shopping bags that need a firm grasp. Athletes who need to hold equipment firmly, such as tennis, badminton, etc., or even people who like to play with cell phones or laptops that use their hands to hold their phones firmly in their hands. In Chinese medicine, a tear to the muscle tendons is the cause of trigger finger. This results from overuse that becomes hurt. Additionally, the combination of humidity and cold acts to obstruct the meridians, trapping blood and qi. Reduced circulation as a result of the tendons and muscles not being able to receive blood or qi. Resulting in discomfort.

Symptoms of trigger finger

Five phases of symptoms can be characterized in five levels: level zero is characterized by bending finger pain; levels one is inflammation, level two is triggering, level three is locking, and level four is flexion contracture.

Level 0: Finger hurts while bending

At the base of the fingers, there is pain. There will be more pain if you apply pressure to the base of the front finger. Still, no indications of stumbling are there. Especially in the morning, using hands for a while.

Level 1: Inflammation

Having trouble leaning over make loud noises when extend your fingers. However, there's still no obvious indication that the fingers are stumbling. The A1pulley area of the MC head of that finger, which corresponds to the palm area, was painful for the patient. An examination by a physician found that the area was sore. The patient's finger will feel less smooth even with light pressure, and it will become more so when they are asked to bend or stretch it. However, no obvious indication of stumbling (uneven flexion) is seen.

Level 2: Triggering

The sheath of the A1 pulley tendon thickens with increasing chronicity of the condition, making the tendon responsible for finger flexion more noticeable to move. Along with the pain in the A1 pulley area as they experienced in the first phase, the patient also exhibited stumbling (triggering, snapping) when

requested to bend and stretch the affected finger. The patient can still independently extend their finger, though. Have the examiner lightly press on the patient's A1 pulley with a finger in situations where the stumbling symptom is not evident increasing the visibility of stumbling signs.

Level 3: Locking
Further impediment to tendon mobility occurs until the lock is activated. Put another way, a patient who has their finger completely bent will not be able to release the bend by themselves. To extend (passive extension), one must utilize the opposite hand. Certain individuals may have a medical history wherein they have had extreme discomfort, inability to bend the finger downward, or both.

Level 4: Flexion Contracture
The patient feels excruciating agony as he moves his fingers as the pathology worsens. Adhesions develop in the tendon of the flexor digitorum superficialis when it is utilized. It puts the proximal interphalangeal joint (PIPJ) in a bent posture and prevents it from using the other hand to help straighten the finger out. It is located adjacent to the A1 pulley tendon sheath.

Trigger finger disease in Chinese medicine
"Trigger finger disease" is the term used in Chinese medicine to describe trigger finger illness. The tendon damage (伤筋) which is brought on by overuse. There's also the matter of humidity and cold preventing the meridians from moving consequently, Qi and blood get trapped and are unable to flow freely. When blood and qi are unable to support the tendons and muscles, pain occurs.

Mechanisms of trigger finger disease according to Chinese medicine
Tendons are associated with the liver, wood, eyes, and anger. Thus, if you are in a really angry state of mind and spend a lot of time staring at a computer or smartphone, may harm liver function send to the tendon functions may then be impacted by this. When a tendon is malnourished for an extended length of time, blood and qi circulation become difficult. In places that are frequently used, blood clots or malnourishment may arise. Similar to how sparks can be produced by dry wood rubbing against one another or thirst-stricken trees can dry up and die. That can cause tendon tension develops.[7]

3. Results

3.1 Chinese medicine treatment for trigger finger
The application of Tui Na massage, acupuncture, poultices, and Chinese medicine steaming are recommended forms of treatment in traditional Chinese medicine.

Tui Na Massage: helping stimulation of blood circulation. As a result, the muscles receive more oxygen. Relieve tiredness release the fascia's constriction keeps joints pliable minimize the chance of experiencing discomfort, contractions, or agony.

Acupuncture: can reducing edema, pain and assisting fingers in returning to normal function are achieved by stimulating blood circulation. Pain point (阿是穴), base of finger (A1-pulley), is one of the often use sites. Press the finger's base (A1-pulley) to locate it. Pain will be felt when pressed firmly utilized for dissolving fascia and relaxing muscles. Located on the back of the hand is He Gu point (合谷穴). Pinching the thumb and index finger together will allow you to locate it in the center of the second metacarpal bone, somewhere between the first and second metacarpal bones. The point where the protruding muscle between the two fingers is the highest. Properties: penetrating the meridian, Yang Xi point (阳溪穴), behind the wrist, lowers toothache, and reduces pain throughout the body. Thumbs up when making a fist this point is located at the thumb side dent. Properties: capable of causing muscular relaxation. Promotes blood circulation and Qi, and eases discomfort middle of the inner wrist is where you'll find the Da Ling Point (大陵穴). Properties: Modifies the flow of Qi.

Poultice

It involves applying herbal remedies to the areas of pain. Reducing swelling, relieving pain (消肿止痛) relaxing tendons, and reducing blood circulation are the main goals of treatment eases discomfort and dissipates congestion used for individuals experiencing discomfort, edema, redness, heat, stiffness in the joints, and muscle soreness.

Rapeutic

It is to increase blood flow and relieve congestion. Pain relief through meridians penetration (活血散瘀, 通络止痛) Ideal for: alleviating pain, relaxing muscles. Stop using right away and get medical attention if you experience adverse reactions, itching, or redness.

Traditional Chinese medicine Gua Sha

Adapt the body's temperature to maintain equilibrium. Numerous studies currently indicate that Gua Sha can widen capillaries. Boost the pore-to-sweat ratio. It gets cells to start working, stimulates the blood circulation system, which increases blood flow to the nerves and surrounding muscles, cells, and tissues have the ability to lessen nerve root swelling and irritation. Reduce the rate at which the joints accumulate calcium. Whites are more helpful at reducing muscle tension. This will aid in boosting the immunological system of the body. In order to locate poisons and latent illnesses in different body areas, the skin is swept or scraped. Toxin exposure causes red pigmentation in humans. Or a deep purple hue on the skin. It is a crimson area that promotes blood flow. And encourage the body to breathe more freely. It is capable of dissipating heat. Eliminate poisons from the organism coordinating the functions of internal organs among the pearls of Chinese Medicine is " **Gua Sha**." That has been inherited from ancient times and is highly well-liked. Chinese medicine holds that the tenets of Gua Sha are the meridians are opened. Induce respiration and blood circulation It is going to dissipate body heat.

3.1 Related research

Kang Zhiqiang [8] treated 79 patients of carpal tunnel syndrome with a combination of Chinese herbal cleansing and Tui Na massage therapy. Tendon function was adjusted by the therapy approach. Blockage in the drain by applying the meridian theory's pressing and stimulating rolling moreover, use Vaseline cream outside. 1 treatment period, consisting of 1–5 treatment periods at a time, is equal to 1 treatment time each day for 10 days. Treatment effectiveness: patients make a full recovery. 77% 100% improvement in treatment outcomes.

Ma wen long et al. [6] Professor Cheng Chunsheng's experience in treating stenosing tenosynovitis of the flexor tendon through syndrome differentiation. Under the guidance of Pingle's bone-setting "Balance Theory" and "Muscle Stagnation and Bone Fault Theory ", Master Cheng: a famous Traditional Chinese Medicine doctor in Henan Province, emphasizes the use of Traditional Chinese Medicine fumigation and washing as the main external treatment, followed by minimally invasive surgery. Treatment, and finally combined with massage techniques to treat stenosing tenosynovitis of the flexor tendon (hereinafter referred to as stenosing tenosynovitis) based on syndrome differentiation in stages, has a significant and definite effect.

Wang Sailong and Zhou Changlin [10] Treatment of stenosing tenosynovitis of the flexor tendon 42 cases (42 fingers) were collected and randomly divided into two groups, each treated for 2 weeks. The treatment group (n=21) was treated with "mild moxibustion combined with Ruyi Jinhuang Ointment", and the control group (n =21) is treated with "Flurbiprofen Babu Cream". Compare the local pain and functional improvement of each group of patients before and after treatment, and perform statistical analysis on the treatment results. Results After 2 weeks of treatment, the local pain of all patients was effectively improved, and the symptoms of functional limitation were also improved. At the same time, the improvement of the treatment group was significantly better than that of the control group. The total effective rate of the treatment group was 90.5%, and the total effectiveness of the control group was 90.5%. The effective rate was 85.7%. Statistical analysis showed that $P < 0.05$ showed that the difference between the two groups was statistically significant.

4. Conclusion and Recommendation

In the severe level, trigger finger can be a hindrance in day-to-day activities and employment. Tendon damage (伤筋) or tendon injury (筋痹) is the reason according to Chinese Medicine. Pain closing disease (痹症) is the classification for it result in discomfort manifested as a blocked meridian. The body's interior organs degrade because to blood clots and Qi stagnation. Skin, blood, and Qi are all drained, and cold depletes bones and tendons of vital nutrients. The destruction of disease is frequently caused by external forces including wind, cold, and humidity. Shut down the meridians. There are five stages to the disease's symptoms, which include pain, numbness, and blood congestion that is cleared by qi. Level zero: soreness in the fingers when bending. Inflammation is the first level, followed by Triggering, Locking, and Flexion in the second, third, and fourth levels. Tui Na massage, acupuncture, poultices, Chinese medicine steaming, and Gua Sha are all part of the traditional Chinese Medicine Therapy. Points that are often utilized comprising of He Gu points (合谷穴), Yang Xi points (阳溪穴), Da Ling points (大陵穴), pain points (阿是穴), and muscle relaxation points. Blood circulation and Qi can ease discomfort.

5. References

[1] A book with sick hands If you use too much. (2017) Retrieved from: https://www.thaihealth.or.th/?p=230027

[2] Chen Weiliang, Zhong Guangling, Yuan Richeng, etc. Standards for diagnosis and efficacy of TCM diseases and syndromes [M]. Nanjing: Nanjing University Press. 1994.

[3] Department of Development of Thai Traditional and Alternative Medicine. (2011) Acupuncture – Moxibustion Volume 3 (Acupuncture treats pain), Volume 3, page 65: [10] A book with sick hands If you use toomuch. (2017) Retrieved from: https://www.thaihealth.or.th/?p=230027

[4] Kanchanat Kongkhanoi,Ong-at Sirikulphisut. (2019) Division of Alternative Medicine, Thai Traditional Medicine Committee and alternative medicine Ministry of Public Health. Retrieved from https://thaicam.go.th.

[5] Ma Wen long et al. Professor Cheng Chunsheng's experience in treating stenosing tenosynovitis of the flexor tendon through syndrome differentiation(M). Modern Journal of Integrated Traditional Chinese and Western Medicine. 2021, (12).

[6] Nattawut Sukkrom. Comparative study of treatment results for trigger finger between percutaneous surgery alone and percutaneous surgery combined with steroid injections. In Kamalasai Hospital. Retrieved from the Journal of Health and Environmental Studies, Year 8, Issue 1.

[7] Sun Kang, Tang Xin. Prospective study on the clinical treatment of stenosing tenosynovitis [J]. Chinese Journal of Orthopedics, 1999, 7 (6): 49.

[8] Teera Aree. (2023) Trigger Finger Disease. Retrieved from: https://www.huachiewtcm.com/

[9] Wang Guoqiang, Traditional Chinese Medicine Medical Technology Manual [M], Beijing: Traditional Chinese Medicine Medical Technology Collaboration Group of the State Administration of Traditional Chinese Medicine: 118-122.

[10] Wang Sailong and Zhou Changlin. Treatment of flexor tendon stenosing tenosynovitis with moxibustion and Ruyi Jinhuang ointment(M). World Latest Medicine Information. 2019, (49)

APPROACHES TO DEVELOP WASTE SORTING AT SOURCE OF THE PIPE MANUFACTURING INDUSTRY IN NA MAI SUB-DISTRICT, LAT LUM KAEO DISTRICT, PATHUM THANI PROVINCE

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Approaches to develop waste sorting at source of the pipe manufacturing industry
In Na Mai Sub-district, Lat Lum Kaeo District, Pathum Thani Province

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ABSTRACT

The objective of this study is to find the approaches to develop knowledge on sorting each type of waste and appropriate approaches to encourage employees to understand waste sorting in the waste sorting area of a company's factory. The misunderstanding is possibly caused by the language barrier. The Burmese language has been added to labels indicating types of garbage and training is also provided to educate employees. According to the waste capture rate results and the contamination rate in all 6 types of trash bins, it was found that the capture rate of each type of garbage after adding the Burmese language to the label indicating the type of garbage increased for glass bottles, aluminum cans, plastic bottles, and contaminated containers. After the employees are trained, these values have been increased compared to adding only Burmese language to aluminum cans, plastic bottles, general garbage, contaminated materials, and contaminated containers. Only the value of glass bottle reduces. After adding the Burmese language to the sign, contamination in glass bottle trash cans, aluminum cans, plastic bottle bucket, and general trash cans reduces after training and educating employees when comparing with the addition of Burmese language only. Such values in aluminum cans, plastic bottle bucket, and general trash cans decrease. From statistical testing with ANOVA, significant differences were found in the capture rate of glass bottles (p=0.0618) and the contamination rate in glass bottle bins (p=0.0908) at a significance level of 10 percent. The findings in this research can be further developed in other areas or departments in the factory so that it can be developed more comprehensively. It can also be the tool for developing waste management for related agencies in the future in order to achieve sustainable development goals.

Keywords: Development of knowledge on waste sorting, label indicating type of waste, training to educate employees

1. Introduction

Because garbage or garbage refers to waste that is in solid form. which may have moisture mixed in Garbage generated from residential buildings Industrial factory locations will have different quantities and characteristics. Usually objects That is thrown away in the form of waste will contain both organic and inorganic substances. Some of these various substances can be decomposed by microorganisms in a short time. Especially food scraps and vegetable scraps, but some types cannot be decomposed at all, such as plastic and broken glass. Wastes cause an impact on the environment and human health, including waste that is thrown away and collected inefficiently. Solid waste, hazardous waste If there is a lack of proper management or if it is left in an industrial factory area, when it rains, it will lead to dirt, germs, and toxins from garbage flowing into water sources. Cause water sources to become polluted. And in addition, garbage also affects the quality of the soil. If the garbage contains the remains of batteries, it will have a negative effect on the soil ecosystem, causing an acidic condition in the soil. Waste that is discarded and collected inefficiently can easily cause impacts on public health, such as gastrointestinal diseases caused by bacteria carried by flies or exposure to toxins that come from hazardous waste. Therefore, this independent study project has studied guidelines for developing the separation of each type of waste in the company. By studying appropriate ways to encourage employees in the company to correctly sort waste in order to collect and dispose of it properly. Helps reduce environmental impacts that may occur in the future. It also contributes to achieving the Sustainable Development Goals (SDGs) in Goals 3, 6, 8, and 12 through effective waste management (Fatimah et al., 2020).

2. Literature Reviews

Jantarat Buwadkhuntod and Chalalwa Sayamit, in 2015, conducted a study on waste segregation behavior among employees of Diaries Rubber (Thailand) Company Limited, Uthai District, Phra Nakhon Si Ayutthaya Province. The study population comprised employees of Diaries Rubber (Thailand) Company Limited, Uthai District, Phra Nakhon Si Ayutthaya Province, totaling 191 individuals. The research tool used was a questionnaire developed by the researchers and validated for quality. The tool's reliability, tested using Cronbach's alpha coefficient method, was 0.89. The researchers collected data themselves and analyzed it using descriptive statistics, percentages, and standard deviations.

The research findings revealed that employees of Diaries Rubber (Thailand) Company Limited had a low level of knowledge and understanding of waste segregation, accounting for 73.30%. Their attitudes toward waste segregation before disposal were at a moderate level, accounting for 79.60%, while their behavior of segregating waste before disposal was also at a moderate level, accounting for 76.40%.

Suphak Tharapithakwong and colleagues, in 2019, studied guidelines for enhancing the efficiency of comprehensive waste management with environmentally friendly processes in Pa Pae Subdistrict, Mae Taeng District, Chiang Mai Province. The objectives were to develop and enhance the potential and capabilities in waste management of the Pa Pae community towards sustainable development. This was a research and development project using a participatory action research approach involving community members as the study population. Two groups were studied: the community members in Pa Pae Subdistrict, totaling 6,157 individuals, and the officials responsible for waste management in the community, including public health agencies.

The researchers conducted community analysis activities to identify issues related to enhancing sustainable waste management practices under environmentally friendly concepts. The research findings focused on promoting the development of knowledge in waste management and appropriate waste management technologies, as well as fostering community participation in developing comprehensive waste management plans with environmentally friendly processes in the Pa Pae Subdistrict. The emphasis was on community involvement in waste management using the A-I-C principles to create opportunities for everyone to participate in expressing common goals for problem-solving and sustainable development planning to achieve lasting change.

The data analysis revealed that the correlation coefficients within each variable ranged from -0.093 to 0.354. Community participation in waste management behavior had a positive correlation with environmental consciousness in waste management, the application of technology and knowledge in community waste management, and waste management by the Pa Pae Subdistrict (r = $0.354, 0.273$, and 0.156, respectively, in order of significance). Environmental consciousness in waste management had the strongest correlation.

Behavioral environmental consciousness in waste management had a positive correlation with the application of technology and knowledge in community waste management (r = 0.293), which was statistically significant at the 0.01 level. The waste management by the Pa Pae Subdistrict had a positive correlation with community participation in waste management behavior and environmental consciousness in waste management (r = 0.156 and 0.261, respectively, in order of significance), both statistically significant at the 0.01 level. However, it had a negative correlation with the application of technology and knowledge in community waste management (r = -0.093), which was not statistically significant at the 0.01 level.

Praewarada Photchanachan, in 2019, conducted a study on the management model of soft plastic packaging waste in household kitchens in the Nivej Charoenmueang community, Nonthaburi Province. The objectives were to examine the quantity and components of soft plastic packaging waste generated in the community, as well as the waste management system. The study aimed to assess knowledge, awareness, practices, and development needs regarding the management of soft plastic packaging waste among household representatives. It also aimed to develop a household-level management model for this type of waste and evaluate the quality of the model before and after implementation. This research and development project took place in Nonthaburi Province, which comprises 13 communities, including urban municipalities, municipal subdistricts, and subdistrict municipalities. There were three target groups: 1) households producing waste (26 households), 2) household representatives (400 individuals), and 3) community leaders, experts, and professionals in waste management (52 individuals). Data collection tools included surveys, tests, questionnaires, discussion points, and recording forms.
The research findings revealed:

1）Soft plastic packaging waste was produced at a rate of 0.56 kilograms per person per day, primarily consisting of plastics such as PP, HDPE, PET, and LDPE. The waste management system for this type of waste was only at the household level.

2）The sample groups exhibited a high level of knowledge about soft plastic packaging waste, moderate awareness of waste management, and occasional waste management practices, which were statistically significant at the 0.05 level.

3）The waste management model used by household representatives, employing the environmental study process known as the 3 TRIANGLE: SRUD MODEL, comprised:

(1) Source Management, including packaging selection (TRIANGLE 3 S),

(2) Intermediate Management, including separation and utilization (TRIANGLE 3 RU), and

(3）End Management, including littering and disposal (TRIANGLE 3 D). The evaluation results indicated that the model was of the highest quality.

4）The implementation of the waste management model for soft plastic packaging waste using the environmental study process led to a reduction in waste generation at the household level and an increase in knowledge, awareness, and practices among household representatives. These changes were statistically significant at the 0.05 level.

3. Methodology

A study was conducted to find ways to improve waste sorting at the waste sorting point of a company in Na Mai Sub-district, Lat Lum Kaeo District, Pathum Thani Province. The study was conducted as follows:

3.1 Surveying the waste sorting area to identify suitable locations for sample collection.

3.2 Selecting strategies to address issues in waste sorting. Currently, the company has signs indicating the types of waste in both Thai and English languages, along with corresponding images on the waste receptacles. This research aims to provide additional strategies for improvement, such as:

3.2.1 Designing to add Burmese language to the waste type signage. An example is shown in Figure 1.

Figure 1: Design adding Burmese language to the signage.

3.2.2 Train employees to increase knowledge.

3.3 Collect waste samples by weighing the weight of each waste type.

3.4 Analyze and evaluate the quality of the data obtained from weighing, including the capture rate and contamination rate in the waste bin, as shown in Equations 1 and 2.

$$capture\ rate = \frac{\text{The correct weight of each type of waste according to its category.}}{\text{The weight of each type of waste in each bin.}} x 100\% \qquad (1)$$

$$contamination\ rate = \frac{\text{The weight of waste that has been improperly disposed of according to its respective waste type.}}{\text{Total weight of garbage in that bin}} x 100\% \qquad (2)$$

3.5 Utilize statistics in the research.

   3.5.1 The ANOVA statistical method is employed to analyze significant differences within the dataset, with a significance level set at 10%. If significant differences are found, further analysis is conducted using a post-hoc test.

      - If $p < 0.1$, it indicates significance or a statistically significant difference or relationship.

      - If $p > 0.1$, it indicates non-significance or no statistically significant difference or relationship.

4. Results

From the collection of waste samples by weighing each type of waste, the details are as follows:

   1. Condition 1 refers to having signage indicating the type of waste in both Thai and English languages, along with pictorial representations.

   2. Condition 2 refers to having signage indicating the type of waste in both Thai and English languages, pictorial representations, and adding the Burmese language.

   3. Condition 3 refers to having signage indicating the type of waste in both Thai and English languages, pictorial representations, the Burmese language, and providing training for employees.

The analysis of the capture rate of each type of waste after adding the Burmese language to the waste type signage resulted in an increased capture efficiency of glass bottles by 1.95%, aluminum cans by 30.12%, plastic bottles by 12.31%, and contaminated containers by 1.36%. However, the efficiency decreased for glass bottles by 0.45%, aluminum cans increased by 17.79%, plastic bottles increased by 9.89%, general waste increased by 1.07%, and contaminated materials increased by 14.64%. Nevertheless, statistical testing using ANOVA revealed a significant difference in the capture rate of glass bottles ($p=0.0618$) only at a significance level of 10%. Therefore, from the designed and developed waste separation system, it can be concluded that there is a significant improvement in the capture efficiency of glass bottles.
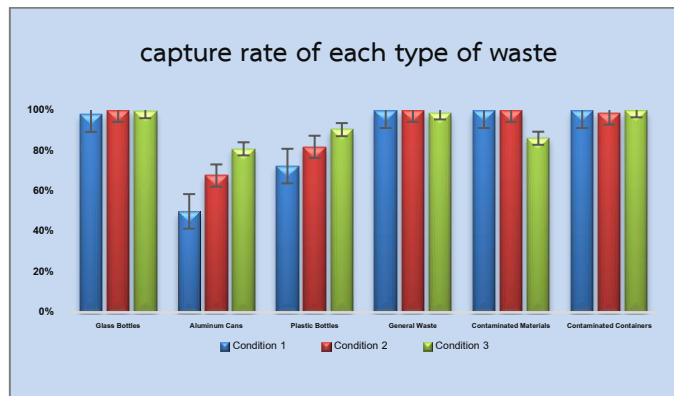
Figure 2: capture rate of each type of waste

The analysis of the contamination rate of each type of waste after adding the Burmese language to the waste type signage showed an increased efficiency for glass bottles by 200%, aluminum cans by 54.27%, plastic bottles by 32.79%, and general waste by 96.56%. Furthermore, the efficiency increased after training the employees for aluminum cans by 200%, plastic bottles by 83.40%, and general waste by 63.06%, respectively. However, statistical testing using ANOVA found a significant difference in the contamination rate in the glass bottle bins ($p=0.0908$) at a significance level of 10%. Therefore, this waste separation and management system's design and development can significantly reduce the contamination rate in glass bottle bins.
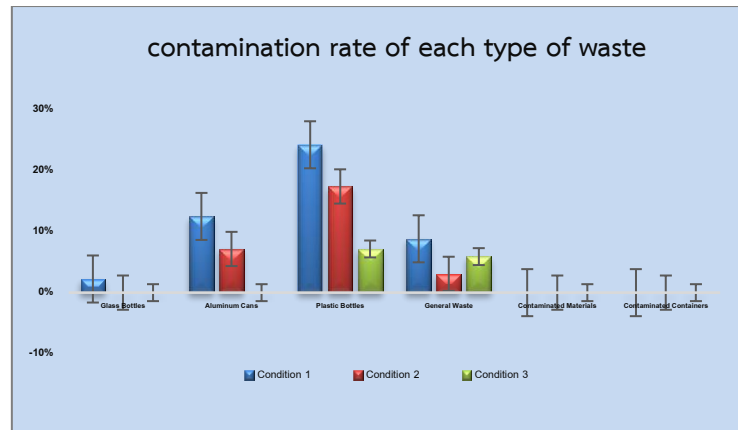
Figure 3: contamination rate of each type of waste

5. Conclusion and Recommendation

The study in this instance highlights a pathway for improving waste segregation efficiency in factory employees by enhancing clear communication. This includes adding the Burmese language to waste type signage and providing training to employees. As a result, employees have gained a more effective understanding of waste segregation, notably for glass bottles. Therefore, the strategies used in this research to improve waste segregation can be further developed and implemented in other areas or departments within the factory to achieve more comprehensive improvements. Moreover, these strategies can serve as tools for waste management development for relevant organizations in the future, aiming to achieve sustainable development goals.

Acknowledgement

In this independent research endeavor, I extend my heartfelt gratitude to Dr. Nattapon Leeabai, my academic advisor, for providing invaluable guidance and support throughout the study, from its inception to its completion, including feedback and additional recommendations.

I would also like to express my deepest appreciation to my parents for their unwavering support and encouragement in my educational pursuits over the years.

Furthermore, I am grateful to the faculty members and staff of the Environmental Engineering Department, especially those in the Special Program, for their assistance and guidance during the course of this study. Last but not least, I extend my thanks to my fellow graduate students in the Environmental Engineering Special Program for their contributions and willingness to provide information for this independent research endeavor.

6. References

[1] Prajaporn Kaewsuksa. (2006). A Study for Waste Management Guideline of Srinakharinwirot University. Ongkharak.

[2] Jantarat Buwattan, Thien Thongsis, & Chalawa Sayamit. (2015). A Study of Waste Separation Behavior of Employees at Dai A Resin (Thailand) Company Limited, Uthai District, Ayutthaya Province.

[3] Tosawat Aparanpong. (2016). A Study of Factors Affecting Waste Management of People in Nang Rong Municipality, Nang Rong District, Buri Ram Province.

[4] Metinee Isriyanan. (2017). A Qualitative Research to Review the Problem of Establishing Hazardous Waste Treatment Plants in the Past and Study the Expansion of Hazardous Waste Problems from Industrial Plants in Chachoengsao Province.

[5] Wipanee Uchupach. (2018). A Study of Knowledge and Waste Management Behavior of the Public and Service Quality in Waste Management of Sub-district Administrative Organization of Laoyao, Ban Hong District, Lamphun Province.

[6] Phatcharaphon Tachakan. (2019). A Study of Waste Management in the Agricultural Community of Ban Komwong, Umong Subdistrict, Mueang District, Lamphun Province.

[7] Supaporn Tharapitakwong & colleagues. (2019). A Study on the Development of Efficiency in Integrated Waste Management Processes Friendly to the Environment by the Community of Pa Pae Subdistrict, Mae Taeng District, Chiang Mai Province.

[8] Weerawat Kaewboonchu. (2019). A Study of Factors Affecting Vermicomposting Waste Separation Behavior in Household.

[9] Pavawradha Potchanjan. (2019). Waste Management Patterns of Soft Plastic Packaging Waste in Urban Communities of Nivescharn-Cha Muang, Nonthaburi Province. [1 0] Weisheng Lu, Junjie Chen. Computer vision for solid waste sorting: A critical review of academic research, 2022

LEADERSHIP OF SECONDARY SCHOOL ADMINISTRATORS IN THE 21ST CENTURY: A CASE STUDY OF SCHOOLS UNDER THE SECONDARY EDUCATIONAL SERVICE AREA OFFICE 29 IN MUNICIPALITY MUANG DISTRICT, UBON RATCHATHANI PROVINCE

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Leadership of Secondary School Administrators in the 21st Century: A Case Study of Schools Under the Secondary Educational Service Area Office 29 in Municipality Muang District, Ubon Ratchathani Province

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ABSTRACT

The purpose of this research was to study teachers' opinions on the leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province by gender, age, education level, position and teaching experience. The population used in this research were 436 teachers under the Secondary Educational Service Area Office 29 from 6 schools. The sample group consisted of 209 respondents based on random sampling from the population. The sample size was determined according to the calculation from Taro Yamane's formula. The research tool was a 3-part questionnaire with a reliability (Cronbach's alpha) value of 0.84. Data analysis was processed by computer to calculate frequency, percentage, mean, standard deviation, t-test, and F-test.

The research results summary found that teachers' opinions on the leadership of secondary school administrators were at a high level overall and in every aspect. When considering each aspect, the one with the highest average was communication ability, while the aspect with the lowest average was commitment to work success. Comparing the differences in opinions of teachers classified by gender, age, education level, job position, and work experience, it was found that there were no differences overall and in each aspect.

Keywords: Leadership; School Administrators

1. Background

Currently, well-managed organizations require competent and efficient personnel with leadership who are committed to their work and able to communicate effectively both within and between organizations. At the same time, they must be able to willingly build relationships from working together (Participation Cooperation) to lead the organization towards progress and reduce conflicts in coordinating with people around them. Therefore, to be successful, modern leaders must continually seek knowledge to keep up with the constantly pressing changes in both economic and social conditions. Effective leaders must be able to make their co-workers perform with quality and to their full potential. In a world of change, administrators must be leaders who can solve problems that may arise in the future by motivating others to believe in and accept their working methods. Thongchai Santiwong. (2007: 156). Leaders should also facilitate the work of group members for success, help co-workers, eliminate various problems and obstacles, coordinate work to achieve goals efficiently by using accepted power. Lussier R.N. and Achua C.F. (2009: 260) create motivation for workers to perform successfully, which will happen when the leader has leadership. For this reason, leaders and leadership are related. Bryman A. (2007: 330). Leadership can be learned, practiced and built. Eden D. and Shani A.B. (2004: 7). It is also the heart of success in every organization.

Leadership is considered an internal trait or a special personality that can command others by using authority from position and power that exists within oneself. It is also a tool that can influence subordinates to believe in, cooperate with, or accept them, whether it is personality, leadership characteristics, ability, initiative, creativity, decision-making in order to achieve the goals of the group or organization effectively and efficiently. Consistent with Pichetvanich Kakachon. (2010: 40), who explains the meaning of leadership as the art that is necessary and very important for administrators to lead the organization to success. Leaders are decision-makers, problem-definers, planners and responsible for the survival or development of the organization. Leadership is a process that has influence

over others by stimulating colleagues to cooperate or work according to the leader with faith and willingness in a coordinated manner until successfully achieving the group's goals with great efficiency.

Therefore, organizational leaders or department heads must have behaviors and characteristics that are accepted by the group or society in some way according to the culture of each organization. They must also be supported, have the art of using people, have the ability to improve the organization, know how to solve immediate problems and build morale until they can win over those around them. The leader is like a central point for improvement, amendment and the organization of work to be consistent and coordinated. Leaders must know how to use leadership to guide and manage in order to influence and motivate colleagues to understand the work, be enthusiastic to work to achieve goals, be a guide for operations and activities. Leaders must constantly learn in order to create appropriate changes to the environment that will make the organization progress. Veerrawat Pannitamai (2006: 51). In the current situation, the world is rapidly changing in all aspects. Leadership must also be adjusted to change, which is a challenge for leaders in successfully leading the organization to its goals. The paradigm of viewing leadership as an individual or a process is not broad and deep enough to develop leaders to keep up with change. As Avolio (1999: 4) suggests, we need to start thinking that leadership has a systemic characteristic, which will allow us to view leadership broadly and deeply enough to develop leadership effectively and efficiently. Good leaders should have good visionary leadership, good creativity, develop themselves to gain the faith of followers, stimulate followers to solve problems with new, intelligent methods, give importance to followers thoroughly, develop leaders and followers in all parts of the organization.

Meanwhile, Thai educational institutions have reflected the urgent need for educational administrators or leaders with clarity in both policy and administration. Regarding the success and progress of each educational institution, major changes, initiation of new things, and pioneering of new knowledge, it is found that one factor behind success is the ability of school administrators to manage, followed by academic progress and being a source of producing exemplary students who, after graduating from secondary school, can pass exams to study in good fields at leading higher education institutions in the country in large numbers. They can also go on to pursue suitable careers for themselves and play an important role in national development.

From the important roles of leadership for school administrators that are necessary to have as an indicator of the quality of administration and management of both public and private schools, to what extent they meet the standards, the researcher is interested in studying the leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District, Ubon Ratchathani Province, to see at what level their leadership is in 6 different aspects, namely being visionary, being committed to work success, having communication skills, having self-confidence, having problem-solving abilities, and having good governance principles, in order to reflect the facts and be a guideline for developing the personality of administrators of schools under the Secondary Educational Service Area Office 29 in the future.

2. Research Questions

1. What should the leadership of secondary school administrators in the 21st century look like: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province?

2. Do the respondents with different personal factors have different opinions on the leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province?

Research Objectives

1. To study the opinions of teaching staff on the leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province.

2. To compare the opinions of teaching staff on the leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province.

Scope of the Research

In the research on the leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province, the researcher has defined the following research scope:

1) Content scope

The content scope of leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province consists of 6 aspects, namely being visionary, being committed to work success, having communication skills, having self-confidence, having problem-solving abilities, and having good governance principles.

2) Population and sample scope

2.1. Population includes 436 teaching staff under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province from 6 schools (Source: Registration control of teacher appointments and dismissals, Secondary Educational Service Area Office 26, April 20, 2020).

2.2 The sample group of 209 respondents was obtained from random sampling of the population. The sample size was determined according to the calculation from Taro Yamane's formula. Simple random sampling was used to select the subjects for the study.

3) Variables studied

3.1. Independent variables are basic personal factors, including:

3.1.1. Gender

3.1.2. Age

3.1.3. Education level

3.1.4. Job position

3.1.5. Experience

3.2. Dependent variables are the opinions of educational personnel on the leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province in 6 aspects:

1. Vision

2. Commitment to work success

3. Communication skills

4. Self-confidence

5. Problem-solving ability

6. Good governance

Research Conceptual Framework

In the research on the leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province, the researcher studied relevant concepts and theories from many academic experts who own the theories, including Stogdill (1985), Gary Yukl (2010), Wailwarren Bennis (1985), DuBrin (1998) and many others that will be mentioned in Chapter 2. The researcher synthesized and analyzed the concepts and theories about leadership from many experts to define the conceptual framework for this research as follows:

Basic Personal Factors   **Dependent Variable**

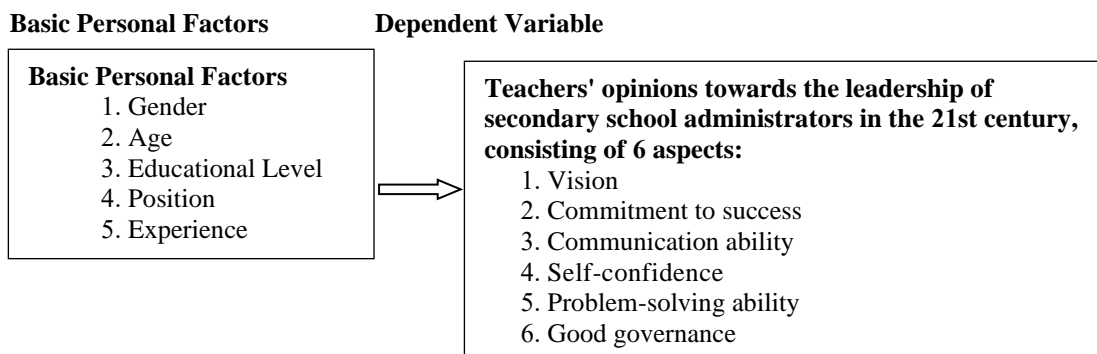| Basic Personal Factors	Teachers' opinions towards the leadership of secondary school administrators in the 21st century, consisting of 6 aspects:
1. Gender 2. Age 3. Educational Level 4. Position 5. Experience	1. Vision 2. Commitment to success 3. Communication ability 4. Self-confidence 5. Problem-solving ability 6. Good governance

Figure 1 Conceptual framework used in the research

Research Hypotheses

1. Teachers with different genders have different opinions on the leadership of secondary school administrators in the 21st century.

2. Teachers with different ages have different opinions on the leadership of secondary school administrators in the 21st century.

3. Teachers with different education levels have different opinions on the leadership of secondary school administrators in the 21st century.

4. Teachers with different job positions have different opinions on the leadership of secondary school administrators in the 21st century.

5. Teachers with different work experiences have different opinions on the leadership of secondary school administrators in the 21st century.

Benefits of the Research

1. The study reveals the opinions of teachers on the leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province.

2. The results of the study will be a guideline for utilization and promotion of the leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province.

Research Instruments

The tool used for data collection is a Rating Scale Questionnaire consisting of 2 parts as follows:

Part 1 is a questionnaire about general information of the respondents, who are teachers in secondary schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province, from a total of 6 schools. It is a check-list to determine the status of the respondents.

Part 2 is a questionnaire about the opinions of teachers on the leadership of school administrators under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province, from a total of 6 schools. It is a 5-level rating scale: the highest, high, moderate, low, and lowest levels of opinion. The scoring criteria are as follows:

5 means having the opinion at the highest level.
4 means having the opinion at a high level.
3 means having the opinion at a moderate level.
2 means having the opinion at a low level.
1 means having the opinion at the lowest level.
Creation and Efficiency Testing of the Instruments

The researcher created the instruments according to the following steps:

1. Study documents and research related to the leadership of school administrators under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province.

2. Create a questionnaire about leadership covering all 6 aspects: 1. Vision 2. Commitment to work success 3. Communication skills 4. Self-confidence 5. Problem-solving ability 6. Good governance

3. Request assistance from experts in research instrument development to help check the content validity and reliability of the questionnaire, and have them respond to the questionnaire.

4. Analyze the quality of the instrument from the responses of the 3 experts by finding the IOC (Index of Congruence) value, which was 0.89.

5. Try out the consistent and usable questionnaire with 30 teachers from schools under the Secondary Educational Service Area Office 28, Sisaket Province, who were not the research subjects. Then find the reliability using Cronbach's Alpha Coefficient method. The reliability test of the survey resulted in a reliability value of 0.84.

6. Use the reliable instrument to collect data from teachers of schools under the Secondary Educational Service Area Office 29.

Data Collection

1. The researcher sent a letter requesting cooperation for data collection to the administrators of the schools under the Secondary Educational Service Area Office 29 in all 6 schools.

2. The researcher scheduled an appointment to collect the questionnaires and compile the data within 30 days.

3. Check the completeness of the answers from the respondents.

4. Categorize the data for further analysis.

Data Analysis Criteria

The researcher used Best's criteria (1970) for interpretation:

4.50-5.00 means the respondents' opinion on the administrators' leadership is at the highest level.

3.50-4.49 means the respondents' opinion on the administrators' leadership is at a high level.

2.50-3.49 means the respondents' opinion on the administrators' leadership is at a moderate level.

1.50-2.49 means the respondents' opinion on the administrators' leadership is at a low level.

1.00-1.49 means the respondents' opinion on the administrators' leadership is at the lowest level.

3. Data Analysis

1. Use percentage to analyze the personal status of the respondents, including gender, age, education level, job position, and work experience (according to independent variables).

2. Use arithmetic mean ($\bar{X}$) and standard deviation (SD) to analyze the opinions of the respondents on the leadership of secondary school administrators under the Secondary Educational Service Area Office 29 in 6 aspects: 1. Vision 2. Commitment to work success 3. Communication skills 4. Self-confidence 5. Problem-solving ability 6. Good governance

3. Use t-test and F-test to analyze the differences between two or more groups, as the case may be, by computer program, in terms of gender, age, education level, job position, and work experience.

Statistics Used in Data Analysis

1. Basic statistics (Boonchom Srisa-ard. 2002: 99)

    1.1 Percentage

    1.2 Mean $\bar{X}$ using the formula (Boonchom Srisa-ard. 2002: 104)

    1.3 Standard Deviation (Educational Research Division 2002: 83)

2. Statistics used for finding the quality of the instrument. Determining the reliability of the questionnaire using Cronbach's Alpha Coefficient method. (Cronbach, unpaged) (Educational Research Division 2002: 83)

3. Statistics for hypothesis testing use t-test to test the difference between two means and F-test to test the difference between three means (One-Way ANOVA).

Research Results Summary

The results of the research on the leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province can be summarized as follows:

1. The leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province was at a high level overall and in every aspect. When considering each aspect of leadership in descending order of mean scores, they were: communication skills, problem-solving ability, self-confidence, good governance, vision, and commitment to work success.

    1.1 In terms of vision, it was at a high level overall and for each item. When considering each item, it was found that the one with the highest mean was always preparing annual work plans, while the item with the lowest mean was always thinking outside the box.

    1.2 In terms of commitment to work success, it was at a high level overall and for each item. When considering each item, it was found that the one with the highest mean was knowing how to encourage subordinates appropriately according to time and place, while the item with the lowest mean was not showing discouragement when facing obstacles.

    1.3 In terms of communication skills, it was at a high level overall and for each item. When considering each item, it was found that the one with the highest mean was having friendly speech, while the item with the lowest mean was firmly keeping one's word.

1.4 In terms of self-confidence, it was at a high level overall and for each item. When considering each item, it was found that the one with the highest mean was daring to make decisions even in risky situations, while the item with the lowest mean was always being a leader in various tasks.

1.5 In terms of problem-solving ability, it was at a high level overall and for each item. When considering each item, it was found that the one with the highest mean was being able to solve problems sustainably, while the item with the lowest mean was understanding win-win problem-solving methods.

1.6 In terms of good governance, it was at a high level overall and for each item. When considering each item, it was found that the one with the highest mean was managing by adhering to the rule of law, while the item with the lowest mean was emphasizing transparency in management and being ready for audits.

2. The results of the comparative analysis of the leadership level of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province.

2.1 The opinions of teaching staff in schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province, classified by gender, found that there were no differences in opinions overall and in each aspect.

2.2 The opinions of teaching staff in schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province, classified by age, found that there were no differences in opinions overall and in each aspect.

2.3 The opinions of teaching staff in schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province, classified by education level, found that there were no differences in opinions overall and in each aspect.

2.4 The opinions of teaching staff in schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province, classified by job position, found that there were no differences in opinions overall and in each aspect.

2.5 The opinions of teaching staff in schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province, classified by work experience, found that there were no differences in opinions overall and in each aspect.

4. Discussion

The opinions of teaching staff in 6 schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province, with a total population of 436 people and a sample group of 209 respondents based on random sampling from the population, were at a high level overall and for each item. The reason for this result may be because most administrators have leadership knowledge and understanding of management principles by using leadership principles as the main approach in managing their schools, such as in the aspects of vision, commitment to work success, communication skills, self-confidence, problem-solving ability, and good governance. Having school administrators with high leadership will result in successful management in any aspect because the administrators will gain acceptance from their subordinates. When the subordinates, in this case referring to the teaching staff in schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province, have faith in the leadership of the administrators, it will lead to dedication to teaching and learning to the best of their ability, which will positively affect the good learning outcomes of the students.

When considering each aspect, it was found that the one with the highest mean was communication skills, which was at a high level overall and for each item. When considering each item, it was found that the one with the highest mean was having friendly speech, while the item with the lowest mean was firmly keeping one's word. This is consistent with the research of Kelley Robeh (2005), who studied the relationship between leadership and school climate management. The study found that leaders in educational institutions need to see the needs of teachers and educational personnel and must provide opportunities for them to express opinions and visions fully in a way that empowers them. Importantly, they must be able to lead them to jointly create a good atmosphere for educational institutions creatively.

In terms of vision, it was at a high level overall and for each item. When considering each item, it was found that the one with the highest mean was always preparing annual work plans, while the item with the lowest mean was always thinking outside the box. This is consistent with the research of

Boone (1992), who studied the leadership of rural district educational officers to find the factors for success in restructuring groups of rural schools in Texas and Oklahoma. The research results found that the rural district educational officers' leadership had 4 common characteristics:

1. Vision and alertness by accessing the quality of education and recognizing the need for change.

2. Creating a shared vision by giving importance to communication with the committee in jointly setting goals and strategies for operations.

3. Building trust in school principals, teachers, school committees and the community.

4. Monitoring and following up to ensure that the work done to cause change has been carried out to achieve the goals to what extent. The characteristics of district educational officers must therefore be creative, supportive of innovative change, and seek new innovations to develop learning for effective performance of duties.

In terms of commitment to work success, it was found that overall and each item was at a high level. When considering each item, it was found that the one with the highest mean was knowing how to appropriately encourage subordinates according to time and place, while the item with the lowest mean was not showing discouragement when facing obstacles. This is consistent with the research of Kitkarn Patipan (2012: abstract), who studied and compared the level of expression of creative leadership and factors influencing the creative leadership of vocational education institution administrators, classified by gender, age and experience as an administrator, to examine the consistency of the developed structural equation model of creative leadership with empirical data and the influence of each factor. The sample group was 684 vocational education institution administrators under the Office of the Vocational Education Commission. The research results were as follows:

1. Vocational education institution administrators had the highest level of expression of creative leadership. Administrators of different genders had no difference in the level of creative leadership, and administrators of different ages with different experiences as administrators had significantly different levels of creative leadership.

2. The factors influencing the creative leadership of vocational education institution administrators were at a high level in all three factors: internal motivation, open environment, and profound knowledge. When comparing in terms of gender, age, and experience as an administrator, it was found that there were no differences.

3. The developed structural equation model of creative leadership of vocational education institution administrators was consistent with the empirical data.

4. Regarding the factors influencing the creative leadership of vocational education institution administrators, it was found that the internal motivation factor had the highest total influence on creative leadership, followed by the open environment factor having a total influential weight on creative leadership, and the profound knowledge factor having a total and direct influential weight on creative leadership. The three causal factors together explained the creative leadership of vocational education institution administrators.

In terms of communication skills, it was found that overall and each item was at a high level. When considering each item, it was found that the one with the highest mean was having friendly speech, while the item with the lowest mean was firmly keeping one's word. This is consistent with the research of Kelley Robeh (2005), who studied the relationship between leadership and school climate management. The study found that leaders in educational institutions need to see the needs of teachers and educational personnel and must provide opportunities for them to express opinions and visions fully in a way that empowers them. Importantly, they must be able to lead them to jointly create a good atmosphere for educational institutions creatively.

In terms of self-confidence, it was found that overall and each item was at a high level. When considering each item, it was found that the one with the highest mean was daring to make decisions even in risky situations, while the item with the lowest mean was always being a leader in various tasks. This is consistent with the research of Nipa Ampaivan, Poonsuk Hongkanon, and Pakorn Prajanbarn (2011), who studied the relationship between leadership behavior and motivation building of head nurses as perceived by professional nurses at Buddhachinaraj Phitsanulok Hospital. The research results found that the level of leadership behavior of head nurses overall and in each aspect was at a high level. The aspect with the highest mean score was the initiator leadership behavior, while the aspect with the lowest mean score was the rule-abiding leadership behavior. The level of motivation building of head nurses overall and in each aspect was at a high level. The aspect with the highest mean score was job characteristics, while the aspect with the lowest mean score was salary and compensation. The leadership

behavior of head nurses at Buddhachinaraj Phitsanulok Hospital as perceived by professional nurses had a statistically significant positive correlation with motivator factor motivation building (r = .443, p < .01) and had a statistically significant positive correlation with hygiene factor motivation building (r = .539, p < .01). The leadership behavior of head nurses at Buddhachinaraj Phitsanulok Hospital as perceived by professional nurses had a statistically significant positive correlation with overall motivation building (r = .751, p < .01).

In terms of problem-solving ability, it was found that overall and each item was at a high level. When considering each item, it was found that the one with the highest mean was being able to solve problems sustainably, while the item with the lowest mean was understanding win-win problem-solving methods. This is consistent with the research that is in agreement with the concept of McCall and Lombardo (Manit Boonprasert et al. 2006: 11-12, citing McCall and Lombardo, 1983), who studied the characteristics that will make leaders successful or fail, consisting of 4 characteristics: 1) emotional and personality stability, including calmness, especially in stressful situations, 2) accepting responsibility when there are mistakes and starting over, 3) good communication skills, which is the ability to persuade and communicate to others to agree with opinions without using threatening power, and 4) intelligence, ability to understand various things more broadly than knowing only one thing deeply and being narrow-minded.

In terms of good governance, it was found that overall and each item was at a high level. When considering each item, it was found that the one with the highest mean was managing by adhering to the rule of law, while the item with the lowest mean was emphasizing transparency in management and being ready for audits. This is consistent with the research of Charinrat Paengdee (2008: abstract), who studied the presentation of a model of administration with good governance principles of administrators in Bueng Pimpa Samakkhi School Network Group, Nakhon Sawan Educational Service Area Office 2. It was found that the administrators had very few problems in administration with 3 good governance principles: (1) The rule of law, with the most common problem being the preparation of an outdated asset register, followed by a lack of consideration for the rights and freedoms of personnel in the school. (2) Morality, with the most common problem being the lack of fair supervision, monitoring and evaluation, followed by unfairness in assigning work to personnel and the inability to create a moral network system among schools in the group. (3) Transparency, with the most common problem being the lack of a consistent database of learning resources, educational environment and local wisdom for dissemination, followed by the lack of continuous monitoring and evaluation of the use of technology media and the lack of disclosure of personnel performance evaluation in the school. The problems in administration with 3 good governance principles were at a fair level: the accountability principle, with the most common problem being the inability to have personnel be responsible for quality assurance, followed by assigning personnel to be responsible for work that does not match their potential and the inability create a sense of responsibility for the performers. There was also the inability to build relationships with the community to jointly develop the school and the inability to build morale for personnel to jointly take responsibility for performing their duties with sacrifice and dedication. The good governance principle with moderate problems was the participation principle, with the most common problem being the inability to develop a curriculum that truly meets the needs of learners and the local area, followed by the inability to promote educational management with public participation in education and personnel not participating in jointly determining evaluation criteria. The last problem at a moderate level was the value for money principle, with the most common problem being the inability to control the disbursement of various projects cost-effectively and efficiently, followed by the inability to control the use of media and equipment for maximum cost-effectiveness and the inability to manage for students to be able to use various laboratories regularly.

5. Suggestions

From the research results on the leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province, the researcher has the following suggestions:

1. The research results found that the leadership of secondary school administrators in the 21st century: A case study of schools under the Secondary Educational Service Area Office 29 in Mueang District Municipality, Ubon Ratchathani Province was at a high level in every aspect overall. When considering each aspect, it was found that the aspect that should be developed or improved is commitment

to work success. Although the score was at a high level, there should be improvements in not showing discouragement when facing obstacles and having more consistent work commitment.

2. In terms of vision, leaders should think and do things more for the future than before.

3. In terms of communication skills, leaders should know how to stimulate others to express themselves sincerely to make it clearer to subordinates.

4. In terms of problem-solving ability, leaders should be able to distinguish what the causes of accumulated problems are and solve them more at the root causes.

5. In terms of good governance, although leaders have high responsibility for the work they perform or direct, they should manage by adhering more to moral principles.

Suggestions for Further Research

1. There should be research studies on the components of other types of leadership that can be related to school administration competency.

2. There should be qualitative research studies on the leadership of school administrators under the Secondary Educational Service Area Office 29 in order to obtain in-depth knowledge to compare with quantitative research.

3. There should be studies or research in schools under other Secondary Educational Service Area Offices to compare the results and see how they are, in order to be a guideline for policy formulation and problem-solving for success in the future.

6. References

[1] Adam, J.A. (1993). Human Memory. New York: McGraw-Hill Books.

[2] Allen, Michael. (1988). The Goals of Universities. Stony Stratford: SRHE & Open University Press.

[3] American Federation of Teachers. (2002). Accountability in Higher Education. Washington, D.C. AFT.

[4] Amnuckmanee Apiradee. (2002). Demographic Influences on the Leadership Practices of Chief Faculty Officers during the Period of Reform (Thailand). D.B.A. in Business Administration. Nova Southeastern University. USA.

[5] Aree Panmanee. (2010). Modern leaders stepping towards internationalization. Bangkok: Yaimai Creative Group Company Limited.

[6] Avolio, J. & Bernard M. (1999). Transformational leadership, charisma, and beyond. In J.G., Hunt et al. (Eds.) Emerging Leadership vistas, 29-50. Lexington Books.

[7] Barnett, Ronald. (1990). The Idea of Higher Education. Buckingham: SRHE & Open University Press.

[8] Bassi & Chenny. (1997). Benchmarking the best. Training and Development. 51(11): 60-64.

[9] Bass, B.M. (1985). Leadership and Performance Beyond Expectations. New York: Free Press.

[10] Bass, B.M. (1990). Bass & Stogdill's Handbook of Leadership: Theory, Research, & Managerial Applications. 3rd ed. New York: Free Press.

[11] Bass, B.M. & B.J. Avolio. (1997). Full range leadership development. Manual for The Multifactor Leadership Questionnaire. Redwood City: Mind Garden Inc.

[12] Bennis & Nanus. (1998). Leadership: The Strategies for Taking Charge. New York: Harper & Row.

[13] Berbay. (2002). A Theory of Leadership Effectiveness. New York: McGraw-Hill.

[14] Blake and Mouton. (1991). Managing Inter-Group Conflict in Industry. Houston: Gulf Publishing Co.

[15] Boworn Srisaard and others. (2006). Report on the research titled Development of Leadership in Higher Education. Bangkok: Office of the Education Council.

[16] Bryman, A. (2007). Charismatic & Leadership in Organizations. London: SAGE Publications.

[17] Chai-anan Samudavanija. (2008). Educational reform-political reform. Bangkok: Chulalongkorn University Book Center.

[18] Chamroen Jitjirajanya. (2009). "Concepts of quality assurance of teaching and learning in higher education," in Academic Journal of the Association of Private Higher Education Institutions of Thailand. 15(1) May 2009: 131-159.

[19] Chamroen Juejan. (2007). "Concepts of knowledge management in higher education," in Academic Journal, Vongchavalitkul University. November 2006-February 2007 Issue: 16-33.

[20] Charat Suwannavela. (2005). Think, do, think. Bangkok: Publisher of Chulalongkorn University.

[21] Charat Suwannavela. (2008). University autonomy. Bangkok: Publisher of Chulalongkorn University.

[22] Charinrat Paengdee. (2008). Presentation of a model of administration with good governance principles of administrators in Bueng Pimpa Samakkhi School Network Group, Nakhon Sawan Educational Service Area Office 2. Master of Education Thesis, Graduate School, Nakhon Sawan Rajabhat University.

[23] Charoen Winyurak. (2000, December). "Good governance for building a good system of governance and society" Productivity Journal. 39(2): 3.

[24] Chaweewan Janmeng. (2009). Transformational leadership of administrators affecting learner standards of basic education institutions under Nakhon Pathom Educational Service Area Office 1. Thesis, Educational Administration. Silpakorn University.

[25] Cheaupalakit, Panpim. (2002). The Leadership Styles of Male and Female Higher Education Administrators in Thailand. Ph.D. in Education Administration. Illinois State University. USA.

[26] Chinrat Somsueb. (2006). People's participation in rural development. Bangkok: Sukhothai Thammathirat Open University.

[27] Chuphong Panjamawat. (2008). Human relations: The art of working together. 3rd edition. Bangkok: S.D. Press.

[28] Conger, J.A. and Kanungo, R.N. (2001). A behavioral attribute measure of Charismatic Leadership. Working paper, Faculty of Management, McGill University.

[29] Dilok Thuekla. (2004). Personnel management. "Comparing the concepts of Principle-Centered Leadership and Managerial Grid" page 71 Bangkok: Serm Witthaya.

[30] Duangsamon Klincharoen. (2002. July-September). Leaders: Creativity, development, technical education. Bangkok: Otien.

[31] Independence in the administration of Thai universities: Past, present and future trends (2009) Report of the Annual Academic Conference 2009. National Institute of Development Administration. Bangkok: National Institute of Development Administration.

[32] Janthanee Sanguannam. (2008). Theories and practices in educational administration. 2nd edition, Bangkok: Book Point Company Limited.

[33] Jomkwan Laophet. (2002, June). Are you a manager or a leader? Industrial Technology Review. 8(97): 149-151.

[34] Jumphon Himmapanich et al. (2009). Academic and professional freedom in higher education. Bangkok: Ministry of University Affairs.

[35] Kamolwan Thippanet. (2012) Structural Equation Model of Spiritual Leadership. Thesis (Educational Administration). Khon Kaen: Khon Kaen Graduate School. Photocopy.

[36] Kanlaya Vanichbuncha. (2006). Statistics for research. 2nd edition. Bangkok: Publisher of Chulalongkorn University.

[37] Kaosak Phuangsomjit. (2008). Leadership of administrators affecting the administration of Buddhist schools. Thesis, Educational Administration. Silpakorn University.

[38] King Prajadhipok's Institute; Office of the National Economic and Social Development Board and Thailand Development Research Institute Foundation. (2008). Summary of discussion points "National Good Governance". Bangkok: Office of the Secretary-General of the House of Representatives.

[39] Kitkarn Patipan. (2012). Creative Leadership. Bangkok: Manfa.

[40] Kulaya Tantiphalachiva. (1999, December 2000, March). Human relations in working together: Problems of administrators. Journal of Nursing Education. 10(3): 6-12.

[41] Kunlaphon Pholwan. (2008). Research report, the National Education Act, academic freedom issue. Bangkok: Office of the National Education Commission.

[42] Mallika Tonson. (2001). Organizational behavior. Bangkok: Dansuttha Printing Company Limited.

[43] Meeting of the Presidents of University Faculty Senates Nationwide and the Chulalongkorn University Faculty Senate. (2010). Good governance in Thai universities. Bangkok: Chulalongkorn University Press.

[44] Ministry of University Affairs. (1992). Two decades of the Ministry of University Affairs: Commemorative book on the 20th anniversary of the establishment of the Ministry of University Affairs. Bangkok: Chulalongkorn University Press.

[45] Nakrop Suwanchakorn. (2003). Leadership characteristics. Bangkok: Thai Wattana Panich.

[46] National Institute of Development Administration. (2009). Independence in the administration of Thai universities: Past, present and future trends. Report of the Annual Academic Conference 2009. Bangkok: National Institute of Development Administration.

[47] Nipa Ampaiwan, Poonsuk Hongkanon, and Pakorn Prajanbarn. (2011). Relationship between leadership behavior and motivation building of head nurses as perceived by professional nurses at Buddhachinaraj Hospital, Phitsanulok. Journal of Nursing and Health, 5(3), 65-79.

[48] Nit Summanaphan. (2003). Leadership: The driving force of the organization towards excellence. Bangkok: Innograph Fix.

[49] Nitima Tientong. (2003). Leadership of educational service area administrators in the next decade. Master of Education Thesis, Educational Administration Program, Graduate School, Chonburi: Burapha University, Abstract.

[50] Nonglak Wiratchai. (2005). Setting higher education standards. Bangkok: Office of the Higher Education Commission.

[51] Noppadol Chenaksorn. (2003). Methods of quantitative environment and community analysis. In Compilation of Professional Experience Course, Graduate Diploma in Educational Administration. Teaching materials, Units 1-5. Bangkok: Sukhothai Thammathirat Open University.

[52] Ruangchai Sapnirundorn. (2009, December). Matichon Weekend. Rajabhat Universities: Problems with administrative positions. Pages 24-30. Bangkok: Matichon.

[53] Rungsan Prasertsri. (2011). Leadership. Bangkok: Thanatuch Printing Company Limited.

[54] Sakthai Surakijborworn. (2002, January). Effectiveness of leadership of educational administrators and school administrators: Important characteristics of administrators in the globalization era. Academic Journal. 5(1): 9.

[55] Sirichai Kanchanawasi. (2010). Evaluation theory. 5th edition. Bangkok: Chulalongkorn University Press.

[56] Siriporn Pongsriroj. (1997). Organization and management. 7th edition. Bangkok: Technique 19.

[57] Sirivan Sereerat and others. (2008). Organizational behavior. 2nd edition. Bangkok: Theerafilm.

[58] Somchai Thepsaeng. (2003). Quality leaders: The key to creating educational quality. Academic Journal. 6(5): 12.

[59] Somkid Bangmo. (2004). Organization and management. 4th edition. Bangkok: June Publishing.

[60] Sommai Phromthong. (2002). Literature review on leaders. Thesis M.Ed. (Educational Administration). Bangkok: Graduate School, Srinakharinwirot University. Photocopy.

[61] Somwang Pitiyanuwat. (2006). External evaluation of higher education institutions. Bangkok: Office for National Education Standards and Quality Assessment (Public Organization).

[62] Tawan Ratworaphutthiphong. (2002). University administrative autonomy. "University autonomy in academic and general administration" Bangkok: Office of the Permanent Secretary, Ministry of University Affairs.

[63] Thamonwan Meehomhae. (2011). Servant leadership, spirituality in an organization affecting a lower-level executive of a food industry business in Bangkok. King Mongkut's University of Technology North Bangkok Academic Journal.

[64] Thepphom Muangman and Sawing Suwan. (1997). Organizational behavior. 2nd edition. Bangkok: Thai Wattana Panich.

[65] Thirayuth Boonmee. (2004, December 3-9). Matichon Weekend. Thailand's 'Peace' Strategy 2005. 25(1268): 28-29.

[66] Thongchai Santiwong. (2007). Organizational behavior: The study of administrative organizational behavior. 5th edition. Bangkok: Thai Wattana Panich.

[67] Tin Prachayapruet. (2010). Leadership and participation, teaching material for the course Human Behavior in Organizations, Unit 11. Nonthaburi: Sukhothai Thammathirat Open University.

[68] Vanchai Sirichana. (2007). Higher Education Reform in Thailand. Thailand' higher education reform in the past decade (1996-2006). A paper presented at the Regional Seminar on Higher Education in Southeast Asian Countries: A Current Update. organized by SEAMEO RIHED. 24-25 May 2007. Bangkok.

[69] Weerawat Pannitamai. (2006). Leader of change. Bangkok: Thana Press & Graphic.

[70] Weerawut Mekhasaranan. (2010). Developing visionary leadership. 5th edition. Bangkok: Expertnet Company Limited.

[71] Wichai Utasahajit. (2003). Leadership development. Bangkok: Academic Service Center, National Institute of Development Administration.

[72] Wilapa Thephasutin Na Ayutthaya. (2010). Higher education. (Teaching materials). Bangkok: Faculty of Education, Chulalongkorn University. Photocopied document.

[73] Wiphada Khuptanon. (2001). Organization and management. Bangkok: Rangsit University Press.

[74] Wiroon Tangcharoen. (2008). Educational vision. Bangkok: Srinakharinwirot University Printing Center.

[75] Worapat Totanakasem. (2008, April). Political reform "Building Good Governance in the Private Sector" Bangkok: Office of the Prime Minister.

THE DEVELOPMENT OF LEARNING MANAGEMENT STRATEGY BY COMBINING METACOGNITIVE STRATEGY AND SYNECTICS MODEL TO ENHANCE THAI READING FOR MAIN IDEA AND CREATIVE WRITING ABILITIES OF PRIMARY SCHOOL STUDENTS

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The Development of Learning Management Strategy by Combining Metacognitive Strategy and Synectics Model to Enhance Thai Reading for Main Idea and Creative Writing Abilities of Primary School Students

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ABSTRACT

The objectives of this research are: 1) Develop a learning management strategy by combining the strategies of Metacognition and Synectics to enhance reading comprehension and creative writing in Thai. For elementary school students 6) Study the results of using learning management strategies by combining the strategies of compassion and synectics to enhance reading comprehension and learning skills. Write creative Thai for primary school students, including studying and comparing the reading comprehension abilities of Grade 6 students between before and after the experiment. and study and compare the creative Thai writing abilities of Grade 6 students between before and after the experiment. Develop learning management strategies By studying basic information Related concepts and theories Use the data from the study to create a learning management strategy and then test it with a sample group of Grade 6 students at Sawang Daen Din Kindergarten School. Sakon Nakhon Province, 34 people, experimental period 15 weeks, measuring the results of the strategy experiment. It measures reading comprehension ability and creative writing in Thai. Before and after the experiment, the statistics used were percentage, mean, and standard deviation. and independent t-test statistics.

The research results found that

1. Developing a learning management strategy by combining the strategies of Mettacognition and Synectics to enhance reading comprehension and creative writing in Thai for elementary school students. Study That the researcher developed has elements of the strategy in 2 areas: 1) The learning management process consists of 6 learning management steps: Step 1, stimulating and motivating the lesson, Step 2, reading, Step 3 Step 4: Controlling reading. Step 4: Imagining. Step 5: Arranging the introduction of knowledge. Step 6: Summarizing the content. 2) Factors supporting the learning process have 2 sides: 1st, setting up the environment. 2) Books promoting reading by Evaluation results from experts in both areas
at the highest level with averages of 4.51 and 4.61, respectively

2. Results of using learning management strategies found that

2.1 Thai language learning results Reading comprehension Students who learn by combining the strategies of Mettacognition and Synectics have better reading comprehension skills. Higher than the 80% threshold and students' ability to read comprehension after the experiment was higher than before. Statistically significant at the .01 level.

2.2 Thai language learning results for creative writing Students who learned using the combination of the Metacognition and Synectics strategies had creative writing ability above the 80% threshold, and their creative writing ability after the experiment was higher than before. Statistically significant at the .01 level.

Keywords: Mettacognition; Synectics

1. Background

The modern world has continuously evolved since ancient times. Humans, therefore, need to seek knowledge to continually modernize themselves. Education is both a crucial tool and process for developing knowledge, thinking skills, abilities, behaviors, attitudes, values, and virtues in individuals from the foundation of life through all ages, continuously throughout life. The ability to adapt to rapidly changing times involves various methods. One effective method is reading and writing because they help follow global progress and develop one's intelligence, increasing knowledge and experience (Tasanee Supameti, 1999: 24-25).

To provide students with knowledge, skills, and efficiency, the Thai language subject is essential for Thais as a tool for seeking knowledge to develop themselves. Reading and writing are important skills and play a role in learning. Reading is the heart of all student learning activities. Therefore, teachers emphasize reading and promote better reading comprehension among children. Simultaneously, writing is essential and needs to be taught alongside reading because incorrect writing can lead to miscommunication of the writer's intentions. For students to be fluent readers and writers, they must learn language rules and have precise reading and writing skills. Thus, practicing accurate reading and writing skills forms the foundation for effective reading and writing (Kanjana Naksakul, 2007: 3).

Developing reading and writing skills is crucial in primary education. Student success in various subjects depends on their reading ability and ability to express thoughts and expand on what they read, describe, and apply knowledge from reading combined with their thoughts to further develop their knowledge and abilities (Kannikar Phuangkasem, 2004: 1). Creative writing at the primary level lays the groundwork for learning and self-development. Creative writing demonstrates unique ideas with elegant language, providing both knowledge and enjoyment to the readers (Thapanee Nakornthon, 2001: 24). The Department of Academic Affairs (2004: Introduction) emphasized the importance of creative writing in the Thai Language Teacher's Guide for the second educational level, stating that creative writing ability should be instilled and promoted in Thai youth, who will be the future developers of the country.

Teacher management significantly affects student learning outcomes. Synthesizing research on teaching methods and models found that teaching reading and writing at the primary level is a major challenge for teachers, especially organizing reading and writing learning activities, which are somewhat abstract and difficult for young children to understand or remember (Department of Academic Affairs, 2000: 11). This finding aligns with the study of Phadung Arayawinyoo (2001: 16-17), which found common problems among primary school students, including skills in listening, speaking, reading, writing, arithmetic, learning skills, language perception, social and emotional issues, and reasoning problems. If not addressed, these issues may lead to misbehavior in secondary education. Interviews with school administrators and teachers revealed that students lack reading and writing skills and proper vocabulary use due to a focus on lecturing, explaining, and exercises without teaching reading, writing, and thinking skills.

From studying concepts and teaching models, it was found that using metacognitive strategies can address reading comprehension problems, while the synectics model can promote creative writing. Metacognitive strategies involve linking new knowledge with existing knowledge, carefully selecting thinking strategies, planning, monitoring, and evaluating thinking processes. Flavell (1985) mentioned metacognitive knowledge, metacognitive experience, goals or tasks to be achieved, and actions or strategies, all interacting with each other. Reading involves skills and thinking processes, requiring significant use of metacognitive strategies. Learners must focus on reading, prepare, plan, evaluate reading, and summarize steps for further reading and writing practice (Tisana Khaemmanee et al., 2001: 8-9). Metacognitive strategies, a dimension of thinking, lead to reading and writing, enabling control and evaluation of one's thinking processes. They are essential for effective learning and good learning (Tisana Khaemmanee et al., 2001: 4).

The Synectics Instructional Model is a teaching method used to develop creative thinking. Joyce and Weil (1992: 217-239) stated that synectics is an interesting method for developing creative thinking. Gordon (1992: 12) believed that creative thinking occurs regularly and is crucial for daily life. It is not a mysterious concept but can be explained and trained to enhance creativity. Creative thinking in various academic disciplines such as art, science, mathematics, or engineering involves cognitive processes. The creative thinking process of individuals or groups is similar, with consistent thinking processes and outcomes, aligning with Suwit Moolkam and Aranthai Moolkam (2002: 113), who stated that the synectics learning process uses comparisons to enhance creativity, encourages free thinking in

various ways, and fosters bold expression of different opinions. Tisana Khaemmanee (2004: 252) studied the synectics teaching approach, which involves thinking as others to stimulate new ideas.

The synectics teaching approach, as conceived by Gordon, involves recognizing that individuals often stick to their usual problem-solving methods without considering others' ideas, leading to narrow and uncreative thinking. New creative ideas can emerge when individuals have the opportunity to solve problems in new ways or by imagining themselves as others. Involving people with diverse experiences in problem-solving results in more diverse and effective methods. Therefore, Gordon proposed that learners should have opportunities to solve problems with new ideas, imagining themselves as others or even objects. This stimulates new thinking. Gordon suggested three types of analogical thinking to stimulate new ideas: direct analogy, personal analogy, and compressed conflict. This method is particularly useful for learning creative writing, reading, and creating artistic works.

In developing a learning management strategy by combining metacognitive strategies and the synectics model to enhance reading comprehension and creative writing in Thai for primary school students, the researcher studied reading and creative writing for primary school students to identify elements supporting an effective strategy. Supporting elements include principles and ideas from Areeya Panmanee (2002: 173-193), involving:

1. Creating conducive learning environments both inside and outside the classroom to enhance reading comprehension and creative writing in Thai.

2. Using reading promotion books as teaching aids to develop these abilities.

From studying these principles and theories, the researcher aims to enhance reading comprehension and creative writing abilities in Thai for primary school students by developing a learning management strategy combining metacognitive strategies and the synectics model. The strategy consists of two parts: a primary strategy for the learning process and a supportive strategy for effective learning. This research aims to clearly enhance these abilities in primary students, providing a guideline for teachers and interested individuals to adapt the process appropriately for each context and improve Thai language teaching, benefiting further educational development.

From studying principles, theories, current conditions, and problems, the researcher is interested in enhancing reading comprehension and creative writing abilities in Thai for primary school students. To achieve this, the researcher aims to develop a learning management strategy by combining metacognitive strategies and the synectics model. The strategy is divided into two parts: a primary strategy focusing on the learning process and a supportive strategy to ensure the learning process is effective. The researcher hopes that the findings of this study will clearly enhance reading comprehension and creative writing abilities in Thai for primary school students. The results will provide a guideline for teachers and interested individuals to understand and adapt the process appropriately for each context. Furthermore, it will serve as a model for improving Thai language teaching and benefit those interested in applying new teaching techniques in Thai language education for further development and application across various fields in the future.

2. Research Objectives

Research Objectives

1. To develop a learning management strategy by integrating metacognitive strategies and the synectics model to enhance reading comprehension and creative writing abilities in Thai for primary school students.

2. To study the effectiveness of the integrated learning management strategy in enhancing reading comprehension and creative writing abilities in Thai for primary school students. Specifically:

2.1 To study and compare the reading comprehension abilities of Grade 6 students who learn through the integration of metacognitive strategies and the synectics model before and after the experiment.

2.2 To study and compare the creative writing abilities in Thai of Grade 6 students who learn through the integration of metacognitive strategies and the synectics model before and after the experiment.
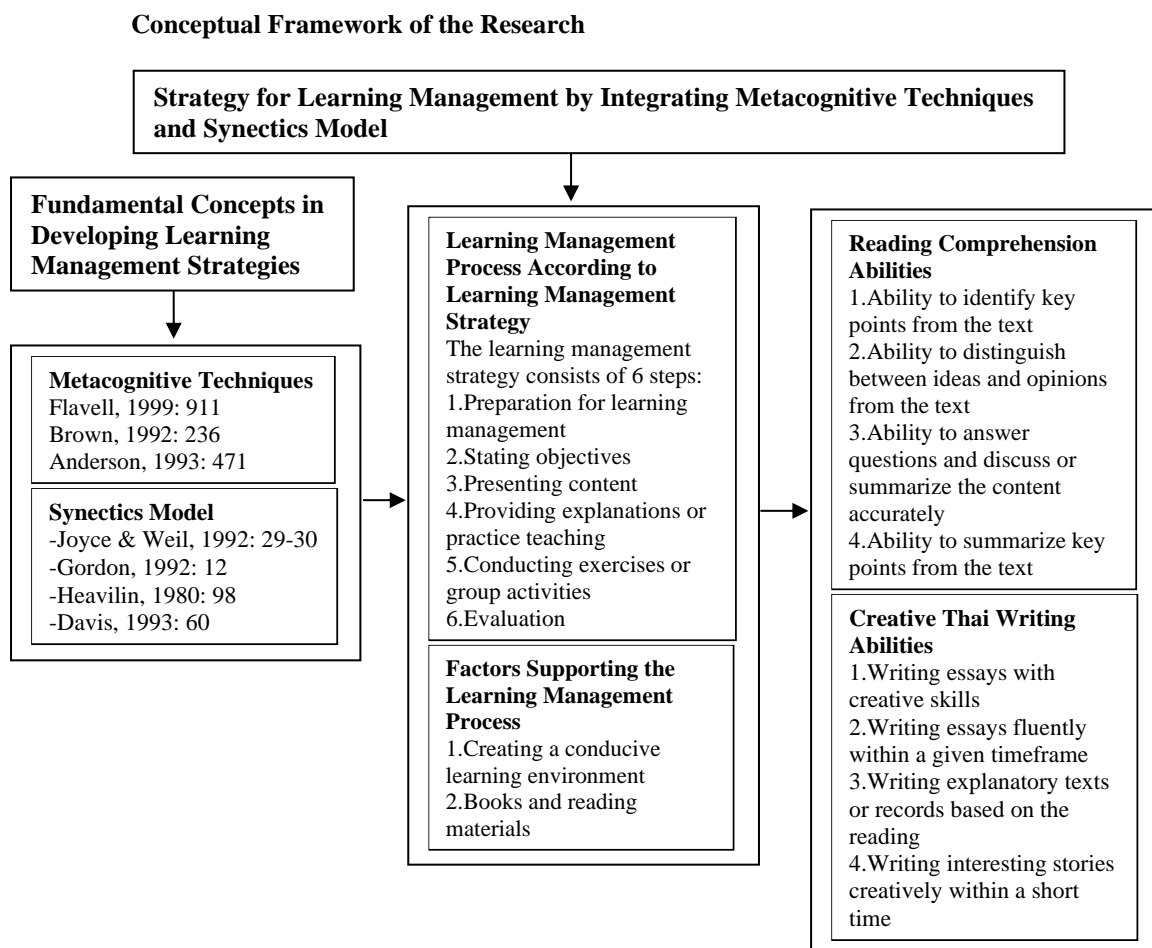
Conceptual Framework of the Research

Strategy for Learning Management by Integrating Metacognitive Techniques and Synectics Model

Fundamental Concepts in Developing Learning Management Strategies

Metacognitive Techniques
Flavell, 1999: 911
Brown, 1992: 236
Anderson, 1993: 471

Synectics Model
-Joyce & Weil, 1992: 29-30
-Gordon, 1992: 12
-Heavilin, 1980: 98
-Davis, 1993: 60

Learning Management Process According to Learning Management Strategy
The learning management strategy consists of 6 steps:
1.Preparation for learning management
2.Stating objectives
3.Presenting content
4.Providing explanations or practice teaching
5.Conducting exercises or group activities
6.Evaluation

Factors Supporting the Learning Management Process
1.Creating a conducive learning environment
2.Books and reading materials

Reading Comprehension Abilities
1.Ability to identify key points from the text
2.Ability to distinguish between ideas and opinions from the text
3.Ability to answer questions and discuss or summarize the content accurately
4.Ability to summarize key points from the text

Creative Thai Writing Abilities
1.Writing essays with creative skills
2.Writing essays fluently within a given timeframe
3.Writing explanatory texts or records based on the reading
4.Writing interesting stories creatively within a short time

Figure 1 Framework for Developing Learning Management Strategies by Integrating Metacognitive and Synectic Approaches to Enhance Reading Comprehension and Creative Writing Abilities in Thai Language for Elementary School Students

3. Research Procedures

The research procedures consist of three phases, detailed as follows:

Phase 1: Studying and analyzing basic information and the current problems in managing learning for reading comprehension and creative Thai writing for primary school students.

-Step 1: Study information on learning management strategies to guide the development of the learning management strategy to be used in the research by examining concepts, theories, and documents related to developing learning management strategies.

-Step 2: Study information on concepts, theories, and related research documents by examining teaching methods using metacognitive strategies and the synectics model, theories on managing learning for reading comprehension and creative Thai writing, and research documents on learning management for reading comprehension to gain knowledge and understanding in managing learning for reading comprehension and creative Thai writing for Grade 6 students.

-Step 3: Study information on the current state of learning management for reading comprehension and creative Thai writing for Grade 6 students and the problems related to reading comprehension and creative Thai writing for Grade 6 students by examining the state of learning management for reading comprehension and creative Thai writing, the problems related to reading comprehension and creative Thai writing, the components of learning management for reading comprehension and creative Thai writing, and the basic information supporting learning management for

reading comprehension and creative Thai writing. This includes identifying factors that enhance reading comprehension and creative Thai writing abilities for Grade 6 students to guide the development of learning management strategies for reading and writing. The study involves interviewing teachers who teach Grade 6 students and experts with knowledge and skills in the Thai language.

Phase 2: Developing the Learning Management Strategy for Reading Comprehension and Creative Thai Writing to Enhance these Abilities in Primary School Students

-Step 1: Analyze the current state of learning management based on the problems identified in Phase 1. This involves using the data obtained from related concepts, theories, documents on developing learning management strategies, and interviews with the target group.

-Step 2: Design the strategy. This process involves designing and selecting appropriate strategies synthesized from various options to achieve the objective of enhancing reading comprehension and creative Thai writing abilities in primary school students. This is divided into two components: the learning component and the supportive component of the learning process.

-Step 3: Review the strategy. The strategy design is reviewed by five experts.

-Step 4: Implement and refine the strategy. The reviewed strategy is implemented to test its feasibility and effectiveness, followed by evaluation and refinement based on the results, before proceeding to Phase 3.

Phase 3: Studying the Results of Using the Integrated Learning Management Strategy for Reading Comprehension and Creative Thai Writing to Enhance these Abilities in Primary School Students

This phase involves studying the results of using the integrated learning management strategy combining metacognitive strategies and the synectics model to enhance reading comprehension and creative Thai writing abilities in primary school students. The strategy consists of:

Supportive Factors:

These include creating conducive internal and external environments, providing reading promotion books, and involving primary school Thai language teachers.

Main Strategy:

The main strategy involves a learning process trial with Grade 6 students at Sawang Daen Din Kindergarten School, the sample group, while analyzing supportive factors in the classroom.

Research Population:

- Grade 6 students from the Office of Primary Education Area, Sakon Nakhon, Zones 1-3, during the first semester of the 2022 academic year.

Sample Group:

- 34 Grade 6/2 students.

Research Instruments:

1. Learning management plans based on the integrated metacognitive and synectics strategies.
2. Tests measuring reading comprehension abilities.
3. Tests measuring creative Thai writing abilities.

Data Analysis:

1. Content analysis and interview data from teachers and experts.

1.1 Analyze scores of reading comprehension and creative Thai writing abilities using mean, standard deviation, and percentage. Compare reading comprehension and creative Thai writing abilities before and after learning using the Dependent Sample t-test.

1.2 Qualitative Data Analysis The researcher used data analysis from interviews, audio recordings from interviews on learning Thai language from teachers and experts. The data was systematically organized and conclusions were written based on the collected data.

4. Research Summary

Research on the Development of Learning Management Strategies by Integrating Metacognition Strategies and Synectics Model to Enhance Reading Comprehension and Creative Thai Writing Abilities for Elementary School Students. The research summary is as follows:

Phase 1: Study and analyze basic information and problems in learning management for reading comprehension and creative Thai writing of elementary school students.

At this stage, the study analyzed basic information about learning management strategies, studied concepts, theories related to learning management for reading comprehension and creative Thai writing, and studied the learning management conditions of students who lack reading comprehension and creative Thai writing abilities. The issues obtained from the basic data analysis were then considered

to identify factors influencing reading comprehension and creative Thai writing abilities to inform the development of learning management strategies for reading comprehension and creative Thai writing. The study looked at learning management strategies, concepts, theories, and relevant research works focusing on teaching methods using metacognition strategies and the synectics model, theories related to learning management for reading comprehension and creative Thai writing, and research works related to learning management, reading comprehension of main ideas, in order to gain knowledge and understanding in managing learning for reading comprehension and creative Thai writing for 6th grade elementary students. The study also looked at information on the learning management conditions for reading comprehension and creative Thai writing of 6th grade elementary students, and problems related to reading comprehension and creative Thai writing, studying the conditions of learning management for reading comprehension and creative Thai writing, problems related to reading comprehension and creative Thai writing, components of learning management for reading comprehension and creative Thai writing, and basic information supporting learning management for reading comprehension and creative Thai writing, as well as enhancing reading comprehension and creative Thai writing abilities. This was done by interviewing teachers teaching 6th grade elementary students and experts knowledgeable in the Thai language.

Phase 2: Development of Learning Management Strategies for Reading Comprehension and Creative Thai Writing to Enhance Reading Comprehension and Creative Thai Writing Abilities for Elementary School Students.

The process of developing learning management strategies was divided into studying basic information and problems in learning management for reading comprehension and creative Thai writing to enhance reading comprehension and creative Thai writing abilities for elementary school students. The researcher used the data analysis results from Phase 1 to develop the strategies. The development of reading comprehension and creative Thai writing strategies to enhance reading comprehension and creative Thai writing abilities for elementary school students involved 3 steps: Step 1 - Environmental Analysis, Step 2 - Strategy Formulation, and Step 3 - Strategy Verification.

The development of learning management strategies by integrating metacognition strategies and the synectics model to enhance reading comprehension and creative Thai writing abilities for elementary school students can be summarized as follows:

Results of developing learning management strategies by integrating metacognition strategies and the synectics model to enhance reading comprehension and creative Thai writing abilities for elementary school students revealed strategies consisting of strategy principles, objectives, conceptual theories, content, processes, supporting factors, and measurement and evaluation. The strategies involve environmental conditions and reading promotion books, leading to a 6-step learning process: 1) Stimulating to the lesson 2) Reading 3) Reading control 4) Visualization 5) Rearranging knowledge 6) Summarizing content. Supporting factors for the learning process are environmental arrangement and reading promotion books.

The results of the strategic learning management assessment based on metacognitive methods and kinesthetic models have an overall average value at the highest level (mean = 4.51). Upon examining the details, it was found that: Principles of Strategy: are at a high level (mean = 4.51) Objectives: are at a high level (mean = 4.48) Theoretical Concepts: are at a high level (mean = 4.50) Content Substance: is at a high level (mean = 4.50) Learning Management Process: is at a high level (mean = 4.50) Supporting Factors - Environmental Conditions: are at the highest level (mean = 4.58) Measurement and Evaluation: are at a high level (mean = 4.50) The quality assessment of 10 books promoting reading to support the strategic learning management based on metacognitive methods and kinesthetic models found that the overall level is at the highest, with an average value of 4.61. Upon examining each book, it was found that each has an average quality value ranging from 4.58 to 4.63. The quality assessment of 20 learning management plans based on metacognitive methods and kinesthetic models found that the quality of the learning management plans is at a high to the highest level

Phase 3 - Study of the Effects of Using Learning Management Strategies in Reading Comprehension and Creative Thai Language Writing to Enhance the Ability in Reading Comprehension and Creative Thai Language Writing for Primary School Students: The researcher implemented the main strategy, which is the learning management strategy by integrating metacognitive techniques and synectics model to enhance the ability in reading comprehension and creative Thai language writing for primary school students. The supporting factors included organizing the internal and external

environment for reading promotion and the involvement of primary school Thai language teachers. The main strategy was tested over a period with 6th-grade primary school students, and the researcher arranged the supporting factors concurrently in the classroom. The results of the experimental implementation of the developed learning management strategy are proposed as follows:

Development of Reading Comprehension Ability: The average score for reading comprehension ability before the experiment was 12.47, which is 41.57%. After the experiment, the average score was 26.82, which is 89.41%. The reading comprehension ability of 6th-grade primary school students scored higher than 80%, and the post-experiment reading comprehension ability was significantly higher than the pre-experiment at the .01 statistical level.

Results of Creative Thai Language Writing Ability: The students who learned through the integration of metacognitive techniques and the synectics model had an average creative Thai language writing ability score of 12.12, which is 40.39% before the experiment. After the experiment, the average score was 26.03, which is 86.70%. The reading comprehension ability of 6th-grade primary school students scored higher than 80% after the experiment, which was significantly higher than before the experiment at the .01 statistical level.

5. Recommendation

1. Recommendations for Applying Research Findings:

1.1 Students with creative reading and writing abilities in Thai beyond the 80% threshold and improved creative reading and writing abilities after the experiment demonstrate the effectiveness of the metacognitive and synectic strategies blended learning approach. Teachers responsible for Thai language activities should incorporate this strategy to enhance learning effectiveness.

1.2 Educators or relevant individuals intending to use the blended learning approach to enhance creative reading and writing abilities in Thai should study the details of applying the metacognitive and synectic strategies from the manual before implementing them for better results.

1.3 The classroom and external learning environment should be aligned with students' learning processes. 1.4 Teachers should prepare reading promotion materials and assign reading and writing tasks to students for practical application.

2. Recommendations for Future Research:

2.1 Investigate the development of metacognitive and synectic strategies to enhance creative reading and writing abilities in Thai at the elementary level, covering analytical reading, summarization, essay writing, and advanced composition.

2.2 Study the impact of creative reading and writing in Thai using illustrated stories for narrative writing and summarization to foster diverse creative thinking. Identify factors supporting the blended learning strategy for enhancing creative reading and writing abilities in elementary students.

2.3 Explore the use of analytical skills from reading materials to enhance creative reading and writing abilities in Thai, promoting effective learning processes.

6. References

[1] Arayawinyoo, P. (2001). Construction of tools for screening children with learning problems. Master's Thesis, Bangkok: Srinakharinwirot University.
[2] Department of Academic Affairs. (2004). Organizing learning content for the Thai language learning strand. Bangkok: Kurusapa Ladprao.
[3] Department of Academic Affairs. (2000). Synthesis of research on Thai language teaching and learning at the elementary level. Bangkok: The Religion.
[4] Gordon, W. J. J. The metaphorical way of learning and knowing synaptic education press. Cambridge : Learning, 1992.
[5] Joyce, B., & Weil, M. Model of teaching. 2nd ed. New Delhi: Prentice – Hall, 1992.
[6] Kammanee, T., et al. (2001). Cognitive science. Bangkok: The Master Group Management.
[7] Kammanee, T., et al. (2004). Teaching science: Knowledge for effective learning process management. Bangkok: Chulalongkorn University.
[8] Moonkham, S., & Moonkham, O. (2002). 21 methods of managing learning to develop thinking processes. Bangkok: Parbpim.
[9] Nakhonsap, T. (2001). Teaching materials for the Thai language usage course, units 9-15. Nonthaburi: Sukhothai Thammathirat Open University.

[10] Naksaku, K. (2007). Patterns of amplification in Thai and Khmer languages. Thai Language and Literature, 14 (December 2007), 1-27.

[11] Panmanee, A. (2002). Practice to think creatively. Bangkok: Yaimai Educate Publishing House.

Flavell, J. H . Cognitive development. New Jersey: Prentice-Hall, 1985.

[12] Puangkasem, K. (2004). Teaching creative writing at the elementary level. Bangkok: Sunee Printing.

[13] Supamethi, T. (1999). Thai language usage (Thai 101). Bangkok: Thanakan Printing.

[14] Tancharoen, T. (2002). Development of a teaching model based on metacognition to increase musical ability in improvisation. Master's Thesis, Bangkok: Chulalongkorn University.

DEVELOPMENT OF ACADEMIC ACHIEVEMENT IN SCIENCE SUBJECT ON LIGHT FOR GRADE 5 STUDENTS IN SCHOOLS UNDER BUA YAI 2 QUALITY DEVELOPMENT NETWORK CENTER, NAKHON RATCHASIMA PRIMARY EDUCATIONAL SERVICE AREA OFFICE 6 USING 5-STEP INQUIRY-BASED LEARNING APPROACH

Rawisara Konjangreed, Ongad Sirimettaporn, Phioenphatsara Sirimettaporn

Development of Academic Achievement in Science Subject on Light for Grade 5 Students in Schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 Using 5-Step Inquiry-Based Learning Approach

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ABSTRACT

The objectives of this research were 1) to develop academic achievement using 5-step inquiry-based learning approach in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6, with efficiency according to the 80/80 criteria; 2) to compare the post-learning academic achievement in science subject on light of grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6, who learned through the 5-step inquiry-based learning approach with the 80 percent criteria; and 3) to study student satisfaction with the 5-step inquiry-based learning approach in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6. The sample group used in the study was grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 in the academic year 2019. The sample size was determined by Krejcie and Morgan's table (Krejcie & Morgan, 1970, cited in Boonchom Srisa-ard, 2010: 43) and purposive sampling, resulting in a sample of 97 students. The research instruments included 1) 10 lesson plans using the 5-step inquiry-based learning approach in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6; 2) an academic achievement test on science subject on light, which was a 4-choice, 30-item multiple-choice test; and 3) a 20-item questionnaire on student satisfaction with the 5-step inquiry-based learning approach in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6. Data analysis employed mean ($\bar{x}$), standard deviation (S.D.), and t-test (one group sample).

The research findings were as follows: 1) The 5-step inquiry-based learning management in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 had an efficiency of 83.77/83.02, which met the specified criteria; 2) The post-learning academic achievement in science subject on light of grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6, who learned through the 5-step inquiry-based learning approach, was higher than the 80 percent criteria with statistical significance at the .05 level; and 3) The grade 8 students were satisfied with learning through the 5-step inquiry-based learning approach in science subject on light, both overall and in each item, at a high level ($\bar{x}$= 3.99, S.D. = 0.54). Economic and financial policy and special topics.

Keywords: Science subject on light; Using 5-step inquiry-based learning approach

1. Background

The progress of science and technology in the present has a great role in human lives. It can be seen from various tools, appliances or products that are created to facilitate human daily life in all aspects such as communication, medical service, education, etc. All are the results of scientific knowledge integrated with creativity and other disciplines. Science enables people to develop knowledge, thinking, and the ability to solve work systematically. It can make decisions by using diverse information and evidence that can be verified. Science is a culture of the modern world, which is a knowledge-based society. Scientific knowledge also helps increase the ability to develop the economy and compete with other countries. Therefore, everyone needs to be developed to know science in order to have knowledge and understanding of nature and human-made technology, and to apply knowledge rationally, creatively, and ethically (Ministry of Education, 2008). The goal of teaching and learning in the science learning area according to the Basic Education Core Curriculum B.E. 2551 (2008) is to focus on learners to discover knowledge by themselves as much as possible, to learn science that focuses on linking knowledge with processes, to have important skills in researching and constructing knowledge, to do activities by practicing in a variety of ways and appropriately, to focus on learners to participate in learning at every step. The teachers have a duty to encourage learners to participate more in teaching and learning activities, stimulate learners to want to learn and see, encourage learners to do various activities that lead to self-learning through the inquiry process.

The inquiry process is a form of teaching and learning that focuses on learners. Learners use their knowledge and ability to learn by themselves. When learners have learned and have been stimulated to face challenges or problems, they think together, actually practice, enabling them to explain, predict, anticipate various things reasonably, trying to find conclusions until they have a conceptual idea of the study, having desirable characteristics. The teachers act as supporters, guides, helpers, as well as solving problems that may arise during teaching and learning. Therefore, it is an appropriate teaching and learning approach that can lead learners to the set goals. Inquiry teaching is a method that helps learners to analyze, not to memorize content without careful consideration. It aims to stimulate learners to be curious and to focus on learner participation, making it fun, giving learners the opportunity to compare their own work with others, discovering knowledge, learning with clear objectives, and helping learners to think rationally, have the ability to think, analyze the causes of problems that arise, as well as being able to research for knowledge by themselves, consistent with the Institute for the Promotion of Teaching Science and Technology (2011), which stated that organizing inquiry-based teaching and learning activities is a learning activity management process that focuses on learners. It is a teaching and learning approach that aims for learners to seek knowledge by themselves through scientific methods and processes in order for learners to practice thinking, practicing and solving problems by themselves until they have scientific process skills. The Institute for the Promotion of Teaching Science and Technology has defined 5 important steps (5E) in the inquiry process, which are 1) Engagement, 2) Exploration, 3) Explanation, 4) Elaboration, and 5) Evaluation, which is a continuous process. Therefore, it helps learners to develop learning skills in both main content and principles, theories, as well as actual practice.

From science teaching and learning in the classroom by conducting teaching and learning through lecture and experiment, it was found that students had an average score of less than 70 percent, which was lower than the criteria set by the school (average score of 68.73), and from the test results, the content that received the lowest score was about light.

From the above reasons, the researcher was interested in studying the development of academic achievement in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6, using the 5-step inquiry-based learning approach, in which learners will actually practice, be able to explain, predict, anticipate various things reasonably, trying to find conclusions until they have a better conceptual idea of light.

2. Research Objectives

1) To develop academic achievement using the 5-step inquiry-based learning approach in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6, with efficiency according to the 80/80 criteria.

2) To compare the post-learning academic achievement in science subject on light of grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary

Educational Service Area Office 6, who learned through the 5-step inquiry-based learning approach with the 80 percent criteria.

3) To study student satisfaction with the 5-step inquiry-based learning approach in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6.

Scope of the Research

1) Content Scope

This research is the development of academic achievement in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6, using the 5-step inquiry-based learning approach. The content scope of the science learning area for grade 5 under Strand 5: Energy, the topic of light, which has the following content: 1) Reflection of light, 2) Refraction of light, 3) Optical equipment, 4) Eyes and vision, 5) Effects of light on living things, 6) Seeing colors and applying knowledge.

2) Population and Sample Scope

The population in this study was grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6, in the second semester of the academic year 2019, consisting of 13 schools with a total of 129 students.

The sample in this study was grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 in the academic year 2019. The sample size was determined by Krejcie and Morgan's table (Krejcie & Morgan, 1970, cited in Boonchom Srisa-ard, 2010: 43) and purposive sampling in the second semester of the academic year 2019, with a total of 97 students.

3) Time Scope

The researcher conducted the research by herself by conducting an experimental teaching in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 in the second semester of the academic year 2019, using the 5-step inquiry-based learning approach for a total of 20 periods over 7 weeks. The total duration of the research was 2 months.

Variables Used in the Research

1. Independent Variables: 5-step inquiry-based learning management, consisting of
    1.1) Engagement
    1.2) Exploration
    1.3) Explanation
    1.4) Elaboration
    1.5) Evaluation

2. Dependent Variables:

2.1) Efficiency of the 5-step inquiry-based learning management in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6.

2.2) Academic achievement in science subject on light of grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6.

2.3) Student satisfaction with the 5-step inquiry-based learning management in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6.

Conceptual Framework of the Research

In the study on the development of academic achievement in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6, using the 5-step inquiry-based learning approach (5E), the researcher applied the concepts and theories related to the 5-step inquiry-based learning management (5E) of the Institute for the Promotion of Teaching Science and Technology (2005) as a conceptual framework in this study as follows:
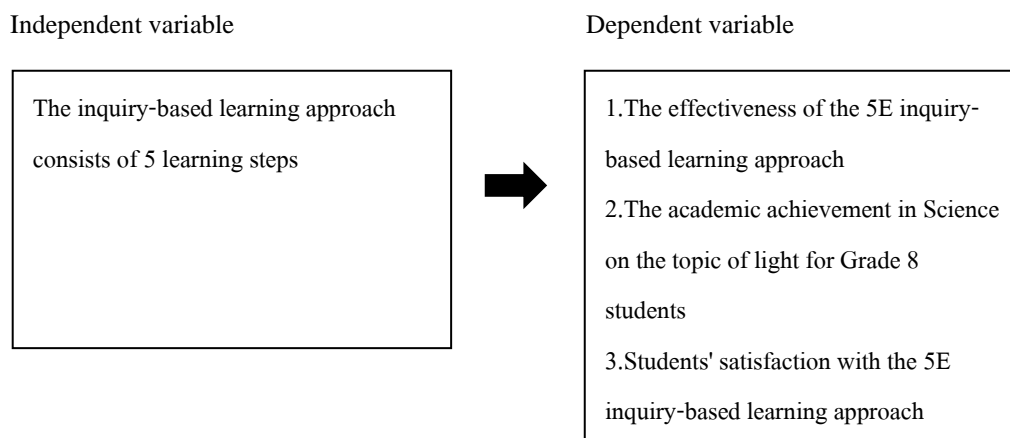
Independent variable   Dependent variable

| The inquiry-based learning approach consists of 5 learning steps | → | 1.The effectiveness of the 5E inquiry-based learning approach

2.The academic achievement in Science on the topic of light for Grade 8 students

3.Students' satisfaction with the 5E inquiry-based learning approach |

Figure 1 The conceptual framework in research

Research Hypotheses

1) The 5-step inquiry-based learning management in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 has an efficiency according to the 80/80 criteria.

2) The post-learning academic achievement in science subject on light of grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6, who learned through the 5-step inquiry-based learning approach, is higher than the 80 percent criteria (24 points or more).

Benefits of the Research

1) The research results can increase the academic achievement of grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 in science subject on light, indicating that the development of academic achievement using the 5-step inquiry-based learning approach can be used to effectively develop academic achievement.

2) The research results reveal that students are satisfied with the 5-step inquiry-based learning management.

3) It is a guideline for the development of teaching and learning in science subject using the 5-step inquiry-based learning approach.

Research Instruments

In this research, the researcher used the following instruments for data collection:

1. 10 lesson plans using the 5-step inquiry-based learning approach on light for grade 5 students, totaling 20 hours, including:

      1) Lesson plan 1 on reflection of light
      2) Lesson plan 2 on reflection of light on concave and convex mirrors
      3) Lesson plan 3 on refraction of light
      4) Lesson plan 4 on refraction of light through convex and concave lenses
      5) Lesson plan 5 on total internal reflection of light
      6) Lesson plan 6 on optical equipment
      7) Lesson plan 7 on eyes and vision
      8) Lesson plan 8 on effects of light on living things
      9) Lesson plan 9 on color mixing
      10) Lesson plan 10 on seeing colors and applying knowledge

2. An academic achievement test on science subject on light for grade 8 students, consisting of 30 items.

3. Learning activities and formative tests.

4. A questionnaire on student satisfaction with the learning management.

Construction and Efficiency Validation of the Instruments

1. Lesson Plans

The lesson plans on science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6,

totaling 10 plans, were created by the researcher to be used in teaching and learning using the 5-step inquiry-based learning approach, which had 6 steps of construction as follows:

Step 1: Study the curriculum and content of science on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 to determine the scope of the content and as a guideline for setting the objectives of the activities and content.

Step 2: Study the details about the principles and methods of teaching using the 5-step inquiry-based learning approach from documents and related research to be a guideline for creating lesson plans.

Step 3: Analyze the content on light, then determine the learning objectives, lesson plans, exercises for each lesson plan, and formative tests. The content was divided into 10 topics as shown in Table 5.

Table 5 Content of the Teaching Plan

Lesson Plan	Topic	Number of Class Periods
1	Pre-test on the topic of light reflection	2
2	Reflection of light on plane mirrors and curved mirrors	3
3	Refraction of light	2
4	Reflection of light through concave and convex lenses	3
5	Total internal reflection of light	1
6	Optical instruments	2
7	Eye lenses and vision	1
8	Effects of light on living organisms	2
9	Mixing of colors	2
10	Color vision and application of knowledge for practical experiments	2
Total		20

After that, write the general objectives and behavioral objectives, and then write the lesson plans for each period in order.

Step 4: Content Validation: The lesson content was submitted to 3 experts in teaching science to check the accuracy as follows:
1) Consistency with the teaching objectives
2) Accuracy of content and activities

Step 5: Lesson Plan Design and Writing: The researcher studied and created 10 lesson plans. Then the lesson plans were presented to teaching experts to check the consistency of concepts according to the theory used in learning activity management, using a questionnaire to obtain opinions from experts by measuring the Index of Congruence (IOC), which had 3 levels of opinions and scores as follows:

Expert Opinion Levels
Agree means a score of +1
Unsure means a score of 0
Disagree means a score of -1

The results of the data analysis from the experts' opinions on the creation of lesson plans for science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 had an index of congruence between 0.67 - 1.00.

Step 6: The lesson plans were revised according to the suggestions of the experts to be accurate and complete, and then submitted to the research advisor for review and further implementation.

2. Academic Achievement Test

The academic achievement test on science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 had the following construction steps:

1) Study the content and behavioral objectives of science subject on light.

2) Study how to create an academic achievement test on science subject on light from textbooks on measurement and evaluation of science teaching and learning.

3) Create an academic achievement test on science subject on light for grade 5 students, consisting of 40 items, which were 4-choice multiple-choice items, and then submit them to 3 experts in teaching science to check the appropriateness of the content, language, and content validity to consider the consistency with the learning outcomes. The Index of Congruence (IOC) was considered from 0.50 and above, resulting in 34 test items with an index of congruence between 0.67-1.00.

4) Conduct a try-out of the academic achievement test on science subject on light for grade 5 level with a group of 15 students in grade 6 of the academic year 2019 who were not the sample group and had already learned about light in order to find the quality of the academic achievement test.

5) Score the test taken by the students, giving 1 point for each correct answer and 0 points for each wrong answer, unanswered item, or multiple answers, using a computer program.

6) Analyze the test results by item to find the difficulty (p) and discrimination (r) using calculation techniques with a computer program.

7) Select only the test items with difficulty (p) between 0.20 - 0.80 and discrimination (r) from 0.20 and above, resulting in 30 quality test items with difficulty between 0.30 - 0.76 and discrimination between 0.38 - 0.93.

8) Analyze the reliability of the 30 selected test items for the whole test and each item using the KR-20 (Kuder Richardson - 20) formula of Kuder-Richardson (Luan Saiyot and Angkana Saiyot, 1995: 197-199), resulting in a reliability of the whole test equal to 0.8769.

9) Use the complete academic achievement test with the sample group.

3. Learning Activities and Formative Tests

3.1 The learning activities of each lesson plan were in the form of subjective items, totaling 9 plans with a total of 56 items, consisting of:

1) 4 items for Lesson Plan 1 on reflection of light

2) 6 items for Lesson Plan 2 on reflection of light on concave and convex mirrors

3) 8 items for Lesson Plan 3 on refraction of light

4) 8 items for Lesson Plan 4 on refraction of light through convex and concave lenses

5) 11 items for Lesson Plan 6 on optical equipment

6) 5 items for Lesson Plan 7 on eyes and vision

7) 6 items for Lesson Plan 8 on effects of light on living things

8) 4 items for Lesson Plan 9 on color mixing

9) 4 items for Lesson Plan 10 on seeing colors and applying knowledge

3.2 Formative tests (pre-test - post-test) on light were 4-choice, 20-item multiple-choice tests.

The researcher conducted the construction according to the following steps:

1) Study how to create learning activities and tests from textbooks on techniques for creating and analyzing tests.

2) Study the curriculum, content, and expected learning outcomes derived from the analysis of learning objectives of science subject on light for grade 5 level.

3) Create learning activities for learners and formative tests covering all content, then present them to the research advisor for review and revision. After that, submit them to 3 experts in teaching science on light for grade 5 level to check the consistency of content and indicators, and the appropriateness of the language of each item.

4) Calculate the Index of Congruence (IOC) between objectives of the tests received from the experts' review, selecting the items with an IOC from 0.50 and above, resulting in 56 learning activity items and 20 formative test items, totaling 76 items with an index of congruence (IOC) between 0.67 - 1.00.

3.4 Satisfaction Questionnaire

The questionnaire on student satisfaction with the 5-step inquiry-based learning approach was adapted by the researcher from the satisfaction assessment form for grade 5 students' learning management in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6. The researcher conducted the construction according to the following steps:

1) Study how to create a satisfaction questionnaire from documents and textbooks related to methods and principles of creating satisfaction questionnaires, then set guidelines for designing satisfaction questionnaires according to Likert's method.

2) Create a 20-item questionnaire on student satisfaction with the 5-step inquiry-based learning activity management in science subject on light for grade 8 level. The satisfaction questionnaire was a 5-level rating scale according to Likert's method: strongly agree, agree, neutral, disagree, strongly disagree.

5 means having satisfaction at the highest level.
4 means having satisfaction at a high level.
3 means having satisfaction at a moderate level.
2 means having satisfaction at a low level.
1 means having satisfaction at the lowest level.

And use Likert scale interpretation criteria by comparing with the 5-level average criteria as follows:

Average 4.51 - 5.00 means having satisfaction at the highest level.
Average 3.51 - 4.50 means having satisfaction at a high level.
Average 2.01 - 3.50 means having satisfaction at a moderate level.
Average 1.51 - 2.00 means having satisfaction at a low level.
Average 1.00 - 1.50 means having satisfaction at the lowest level.

3) Submit the revised satisfaction questionnaire to 3 experts to check the accuracy and content validity, as well as the appropriateness of the language used, and then revise and improve it.

4) Calculate the Index of Congruence (IOC) of the 20-item student satisfaction questionnaire on the 5-step inquiry-based learning activity management in science subject on light for grade 5 level that was checked by the experts, selecting the items with an IOC from 0.50 and above, resulting in an index of congruence (IOC) between 0.67 - 1.00.

5) Conduct a try-out of the revised satisfaction questionnaire to find the quality of the instrument.

6) Analyze the results to find the reliability by finding Cronbach's alpha coefficient (Luan Saiyot and Angkana Saiyot, 1995: 170-172), which had a reliability of 0.955.

7) Use the student satisfaction questionnaire on the 5-step inquiry-based learning activity management in science subject on light for grade 5 level with the sample group.

Data Collection

1) Prepare an official letter to request permission to conduct research and collect data.

2) Submit the letter requesting cooperation in the research and data collection to the directors of schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6.

3) Request cooperation from schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 to conduct an experiment with grade 5 students, who were the sample group of this experiment. The researcher conducted the experiment using the 5-step inquiry-based learning approach (5E) according to 10 lesson plans in science subject on light.

4) Explain to the sample group students about learning using the 5-step inquiry-based learning approach (5E) so that the students have the same understanding and obtain true results.

5) Conduct the experiment by managing learning according to the lesson plans, having a pre-learning achievement test (pre-test), doing learning activities in class, formative tests, end-of-unit exercises, and a post-learning achievement test (post-test) after the completion of the experimental process.

6) Bring the students' scores from doing learning activities in class and formative tests, end-of-unit exercises (Exercise), and the post-learning achievement test (post-test) to find the efficiency of the 5-step inquiry-based learning management by comparing according to the E1/E2 formula.

Research Design

This research was an experimental research using a one-group-pretest-posttest design as shown in Table 6 (Puangrat Taweerat, 1997: 60).

Table 6: One-Group Pretest-Posttest Design Experiment Plan

Group	Pretest	Experiment	Posttest
E	T1	x	T2

Symbols Used in Research Proposal

E represents the experimental group.

X represents teaching using the inquiry learning method.

T1 represents the pre-test.

T2 represents the post-test.

Data Analysis

1. Find the efficiency of the 5-step inquiry-based learning management by finding the relationship between the scores obtained from doing learning activities in class and formative tests, end-of-unit exercises, and the scores obtained from the post-learning achievement test, calculated as a percentage. Then bring the results to compare and find the efficiency according to the 80/80 criteria.

2. Compare the post-learning academic achievement in science subject on light for grade 5 level using the 5-step inquiry-based learning approach with the 80 percent criteria of the total score (24 points) by t-test.

3. Study student satisfaction with the 5-step inquiry-based learning management in science subject on light for grade 5 level by analyzing using mean, standard deviation statistics, and evaluating the level of satisfaction using Likert scale interpretation criteria.

Statistics Used in Data Analysis

The researcher used the following statistics in data analysis:

1. Descriptive Statistics:

1) Frequency

2) Percentage

3) Mean ($\bar{x}$)

4) Standard Deviation (S.D.)

2. Inferential Statistics for Hypothesis Testing:

1) Find the efficiency of the 5-step inquiry-based learning management using the E1/E2 formula.

2) Use dependent t-test statistics to compare student academic achievement after the 5-step inquiry-based learning activity management with the 80 percent criteria (24 points).

3. Research Results

1. The 5-step inquiry-based learning management in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 had an efficiency of 83.77/83.02, which met the specified criteria (80/80).

2. The post-learning academic achievement in science subject on light of grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6, who learned through the 5-step inquiry-based learning approach, was higher than the 80 percent criteria with statistical significance at the .05 level.

3. Grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 were satisfied with the 5-step inquiry-based learning management in science subject on light, both overall and in each item, at a high level (= 3.99, S.D. = 0.54).

4. Discussion

The findings of the research on the development of academic achievement in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6, using the 5-step inquiry-based learning approach, are discussed as follows:

1. The 5-step inquiry-based learning management in science subject on light for grade 8 level had an efficiency of 83.77/83.02, which met the specified criteria. That is, the 5-step inquiry-based learning management in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 resulted in the students having academic achievement during learning, overall 83.77 percent, and post-learning academic achievement, overall 83.02 percent. This is because the researcher had a systematic process of creating lesson plans by studying and analyzing the curriculum, content according to the Basic Education Core Curriculum B.E. 2551 (2008), school curriculum, course structure, studying guidelines for writing plans and teaching and learning management using the 5-step inquiry-based learning approach consisting of 1) Engagement, 2) Exploration, 3) Explanation, 4) Elaboration, and 5) Evaluation, and then creating lesson plans, presenting them to the advisor and experts to check the quality before trying them out with the sample group. And when used to teach and learn with the sample group, from focusing on having students do activities and seek answers by themselves, it resulted in the students being interested and enthusiastic to learn according to the 5-step inquiry-based learning management process developed by the researcher. In addition, the 5-step inquiry-based learning is a process in which students must inquire, explore, and study by various methods until they understand and perceive that knowledge meaningfully, able to construct it as their own knowledge and store it in the brain for a long time (The Institute for the Promotion of Teaching Science and Technology, 2011: 18). Therefore, the scores during learning from doing exercises, group and individual activities, which are part of the process efficiency, and the post-learning scores, which are the outcomes, were higher than the specified criteria (80/80). This is consistent with the research of Wanphet Wansut (2007: 81) who studied the results of organizing learning activities in the science learning area on ecosystems for grade 9 students using the inquiry process. The study results found that the development of learning activity plans using the inquiry process had an efficiency of 85.74/80.17, and the research of Wiwatthana Sukhma (2015: Abstract) who studied the development of a learning activity package on light and vision in the science learning area using the inquiry process for grade 8 students. The research results showed that the learning activity package on light and vision in the science learning area using the inquiry process for grade 8 students had an efficiency of 78.30/77.33, passing the specified criteria of 75/75.

2. The students who received the 5-step inquiry-based learning management in science subject on light for grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6 had post-learning academic achievement higher than the 80 percent criteria with statistical significance at the .05 level. This is because the 5-step inquiry-based learning management is a learner-centered teaching and learning approach, finding answers by oneself in order to acquire lasting knowledge. The knowledge that has been inquired through a process that focuses on the scientific process and the teacher acts as a promoter, supporter for students to think, ask and try to find answers, collect data and make hypotheses, experiment and predict results from actual practice, thus enabling students to have post-learning academic achievement, overall higher than 80 percent. This is consistent with the research of Kittiphong Mokmungmueang (2003: Abstract) who studied the academic achievement and practical skills in science subject on light of upper secondary school students who received inquiry teaching supplemented with experimental design activities. The research results showed that the students who received inquiry teaching supplemented with experimental design activities had practical skills in science subject on light at the assessment level of 88.06 percent. It is also consistent with the research of Saowalak Lueangdee (2009: Abstract) who studied the results of organizing inquiry-based learning activities affecting conception and satisfaction in science learning on light and image formation of grade 8 students. The research results revealed that after the students received inquiry teaching, the students had more correct conceptions, with an average score of 82.81. It is consistent with the research of Rotchana Jaihao (2012: Abstract) who studied the effects of 5E inquiry-based learning management using science teaching strategies on learning achievement in the properties of geometric optics of grade 11 students at Suratthani 2 School, Surat Thani Province. The research results showed that the learning achievement of students who learned through 5E inquiry-based learning management using science teaching strategies on the properties of geometric optics was significantly higher after learning than before learning at the .01 level. It is also consistent with the research of

Jirapantip Thonuwong (2012: Abstract) who studied the development of learning activities on light for grade 8 students using the 5E inquiry process. The study results found that the students' post-learning achievement was significantly higher than before learning at the .05 level. Therefore, using learning activities on light can increase students' learning achievement because it is an activity that focuses on students actually practicing, which results in students learning by themselves effectively.

3. The students were satisfied with the learning management using the 5-step inquiry-based learning approach in science subject on light, overall and in each item, at a high level. When considering each item, it was found that the item with the highest student satisfaction was that students can apply knowledge from this subject in their daily life, followed by the teacher being able to apply what is taught to the social and environmental conditions, and the teacher encouraging students to search for knowledge from various learning sources, respectively. This is because the subject content is about things around the students in their daily life, enabling them to see the benefits of learning, including having activities that allow students to actually practice and find answers by themselves from various learning sources, making the learning activities interesting. The students were satisfied with the learning activities using the inquiry process. The students were interested in the activities and wanted to do the activities with their friends, in which the students could learn and construct knowledge by themselves, as well as develop research skills that can be applied in real life. This is consistent with the concept of Krathwohl et al. (1964: 95) who stated that actually doing things that students are interested in results in satisfaction, which is the result that occurs after doing various activities. And from the researcher's inquiry, it was found that the students were interested in the activities because they were science experiments that could be applied in daily life, creating analytical thinking to find conclusions to be their own knowledge that could be used to solve problems. This is consistent with the research of Saowalak Lueangdee (2009: Abstract) who studied the results of organizing inquiry-based learning activities affecting conception and satisfaction in science learning on light and image formation of grade 5 students in schools under Bua Yai 2 Quality Development Network Center, Nakhon Ratchasima Primary Educational Service Area Office 6, a total of 97 students. The students were satisfied with the learning activity management using inquiry teaching at a high level (= 4.19, S.D. = 5.09). It is also consistent with the research of Rotchana Jaihao (2012: Abstract) who studied the effects of 5E inquiry-based learning management using science teaching strategies on learning achievement in the properties of geometric optics of grade 11 students at Suratthani 2 School, Surat Thani Province. The research results showed that the students were satisfied with the 5E inquiry-based learning management using science teaching strategies at a high level. And it is consistent with the research of Wiwatthana Sukhma (2015: Abstract) who studied the development of a learning activity package on light and vision in the science learning area using the inquiry process for grade 8 students. The research results revealed that the students' satisfaction with learning through the learning activity package on light and vision in the science learning area using the inquiry process for grade 5 students was overall at a high level.

5. Suggestions

1. Suggestions for Applying the Research Results

1.1 Apply the research results in learning management for maximum teaching and learning efficiency.

1.2 Apply the research results as a guideline for developing science learning achievement of students at various grade levels to be higher.

2. Suggestions for Further Research

2.1 There should be a study on the development of teaching and learning management using the 5-step inquiry-based learning approach in other science contents that are considered appropriate in order to benefit teaching and learning more.

2.2 There should be a study on the development of teaching and learning management using the 5-step inquiry-based learning approach with other learning areas and grade levels.

2.3 There should be a study on the development of teaching and learning management using the 5-step inquiry learning management to experiment with students to study science learning achievement, science process skills, and scientific attitudes.

6. References

[1] Andrew M. Ray and Paul M. Beardsley. (2008). "Overcoming Student Misconceptions about Photosynthesis : A Model-and Inquiry-Based Approach Using Aquatic Plants", Science Activities. 45(1) : 13-22.

[2] Boonchom Srisa-ard. (2010). Basic Research. 5th edition. Bangkok: Suweeriyasan Publishing House.The Bureau of Academic Affairs and Educational Standards. (2008). Indicators and core learning content of the science learning area according to the Basic Education Core Curriculum B.E. 2551 (2008). Bangkok: The Agricultural Co-operative Federation of Thailand Limited Publishing.

[3] Collette, Alfred T., and Eugene L. Chiappetta. (1986). Science Instruction in the Middle and Secondary Schools. Columbus, Ohio : Charles E. Merrill Publishing Company.

[4] Jirapantip Thonuwong. (2012). The development of learning activities on light for grade 8 students using the 5E inquiry process. Master's Thesis. Science Education Program. Ubon Ratchathani University.

[5] Khumsak Phichayanurat. (2008). The development of science teaching and learning activities for grade 8 students who received inquiry cycle teaching. n.p.: Khon Kaen University.

[6] Kittiphong Mokmungmueang. (2003). Academic achievement and practical skills in science subject on light of upper secondary school students who received inquiry teaching supplemented with experimental design activities. Master's Thesis. Science Education Program. Chiang Mai University.

[7] Krathwohl, D.R., al. (1964). Taxonomy of educational objectives: the classification of educational goals handbook II : affective domain. London: Longman.

[8] Luan Saiyot and Angkana Saiyot. (1995). Principles of Educational Research. Bangkok: Thaweekijjapim.

[9] Ministry of Education. (2008). The Basic Education Core Curriculum B.E. 2551 (2008). Bangkok: The Agricultural Co-operative Federation of Thailand Limited Publishing.

[10] Morse, Bruce. (1955). Models of Teaching. Englewood Cliffs, New Jersey: Prentice-Hall.116.

[11] Muchinsky, P.M. (1993). Psychology Applied to Work. California: Brooke & Cole Publishing Company.

[12] Muhlenbruc, Thomas Michael. (2001). "Though the eyes of school personnel administration," What matters in selecting elementary school principals, Dissertation Abstracts International. 62 (02) : 414-A.

[13] Muzaffar, Khan and Muhammad Zafar Iqbal. (2011). "Effect of Inquiry Lab Teaching Method on The Development of Scientific Skills Through the Teaching of Biology in Pakistan". Language in India Strength for Today and Bright Hope for Tomorrow. 11(1), 169-178. Retrieved from www.languageinindia.com/.../inquirymethodpakistan.pdf.

[14] Orathai Chandai. (2010). Factors influencing English learning achievement of grade 6 students under Sakon Nakhon Primary Educational Service Area. Master's Thesis. Curriculum and Instruction Program. Mahasarakham University.

[15] Pairot Kachenthorn. (2013). Measurement of learning achievement. (Online) Available from: http://www.wattoongpel.com/

[16] Pariyathip Boonkhong. (2003). A study of some factors related to mathematics learning achievement of grade 7 students. Master's Thesis. Educational Research and Statistics Program. Srinakharinwirot University.

[17] Pichit Ritjaroon. (2011). Social Science Research Methodology. 5th edition. Bangkok: Chulalongkorn University Press.

[18] Pimpan Dechakup. (2005). Learner-Centered Teaching and Learning. Bangkok: The Master Group Management.

[19] Pisut Areerard. (2008). Development of Educational Software. Maha Sarakham: Apichart Printing.

[20] Pranee Kongjinda. (2006). A comparison of mathematics learning achievement and mental arithmetic skills of students who received CIPPA model teaching using exercises that emphasize mental arithmetic skills with students who received teaching using teacher's manuals. Master's Thesis. Curriculum and Instruction Program. Phranakhon Si Ayutthaya Rajabhat University.

[21] Preeda Trithawat. (2014). A study of physics learning achievement on fluid by using 5Es inquiry teaching model of grade 12 students at Nong Ruea Wittaya School. Master's Thesis. Curriculum and Instruction Program. Khon Kaen University.

[22] Puangrat Taweerat. (1997). Behavioral and Social Science Research Methods. 7th edition. Bangkok: Chulalongkorn University.

[23] Riggs, Pamela J. (1997). Literacy Development Through Inquiry Learning. Dissertation Abstracts International. 57(9): 3802-A.

[24] Rowley and Eric Noel. (2006). "The Effects of Conceptual Change -- Inquiry Cycle investigation On student understanding of independence of mass in rolling motion on incline plane". Dissertation Abstracts International. The University of lower.

[25] Rueangyot Sirisao. (2010). The development of reading and writing words with unconventional spellings using exercises for Thai language learning area for grade 4 students at Ban Nong Bua Kut Oo School. Master's Thesis. Curriculum and Instruction Program. Rajabhat Maha Sarakham University.

[26] Saowalak Lueangdee. (2009). The results of organizing inquiry-based learning activities affecting conception and satisfaction in science learning on light and image formation of grade 8 students. Master's Thesis. Curriculum and Instruction Program. Khon Kaen University.

[27] Sawan Phuengbunhan. (2008). The development of spelling writing exercises for Thai language learning area for grade 3 students. Master's Thesis. Curriculum and Instruction Program. Rajabhat Maha Sarakham University.

[28] Sibel Balaci, Cakiroglu and Ceren Tekkaya. (2006). "Engagement, Exploration, Explanation, Extension, and Evaluation (5E) Learning Cycle and Conceptual Change Text as Learning Tools". Biochemistry and Molecular Biology Education. 34(3): 199-203.

[29] Sirichai Namburee. (2007). Research report on a comparison of learning achievement and satisfaction of learners using electronic book activities and electronic programmed lessons in an e-learning environment through Moodle program. Yala Rajabhat University, Yala.

[30] Siriporn Honghem. (2012). The development of scientific problem-solving thinking ability and inquisitive characteristics of grade 10 students through inquiry-based learning management. Master's Thesis. Curriculum and Supervision Program. Silpakorn University.

[31] Siraya Trisuwanand. (2012). The development of critical thinking ability on light, sound, electricity of grade 12 students through inquiry-based learning management. Master's Thesis. Science Education Program. Kasetsart University.

[32] Sombat Tairoekham. (2010). Statistical Methods for Research. Master's Thesis. Measurement and Educational Research Program. Mahasarakham University.

[33] Somnuek Pattiyathanee. (2010). Educational Measurement. 7th edition. Kalasin: Prasan Printing.

[34] Somporn Chuaphan. (2004). A comparison of mathematics learning achievement of grade 9 students using self-constructivist teaching method with normal teaching method. Master's Thesis. Curriculum and Instruction Program. Phranakhon Si Ayutthaya Rajabhat Institute.

[35] Sund, R.B. & Trowbridge, L.W. (1973). Teaching Science by Inquiry in Secondary School. Columbus, Ohio : Charles E. Merrill Publishing Co.

[36] Suporn Janpratuek. (2008). The construction of a learning package for the science learning area on water and air on Earth for grade 3 students using the 5Es inquiry cycle teaching. Master's Thesis. Curriculum and Instruction Program. Khon Kaen University.

[37] Suthapinand Nonsrichai. (2007). Analytical thinking and biology learning achievement of grade 11 students who received 5Es inquiry teaching. Master's Thesis. Curriculum and Instruction Program. Khon Kaen University.

[38] Thapthim Chuenjit. (2013). The development of wave mechanics learning outcomes in the science learning area for grade 11 students using the 5-step inquiry cycle with STAD technique. The sample group was grade 11 students. Master's Thesis. Curriculum and Instruction Program. Rajabhat Maha Sarakham University.

[39] The Institute for the Promotion of Teaching Science and Technology. (2005). Published documents on inquiry-based teaching and learning models. Bangkok: The Institute.

[40] Waenphet Wansut. (2007). The results of organizing learning activities in the science learning area on ecosystems for grade 9 students using the inquiry process. Independent Study, Master's Degree. Curriculum and Instruction Program. Mahasarakham University.

[41] Weena Prachakuland Prasart Nuangchalerm. (2010). Teaching and Learning Models. 2nd edition. Maha Sarakham: Mahasarakham University Press.

[42] Wiwatthana Sukhma. (2015). The development of a learning activity package on light and vision in the science learning area using the inquiry process for grade 8 students. Master's Thesis. Curriculum and Instruction Program. Buriram Rajabhat University.

DEVELOPING LEARNING ABOUT EXPONENTS USING THE STAD TECHNIQUE. MATHEMATICS LEARNING GROUP OF SECONDARY SCHOOL STUDENTS YEAR 1

Satawat Sangsoongnoen

Developing learning about exponents using the STAD technique. Mathematics learning group of secondary school students Year 1

Satawat Sangsoongnoen

ABSTRACT

The purpose of this study is To create and develop a learning management plan on exponents using the STAD technique for the mathematics subject group of Mathayom 1 students to be effective according to the criteria of 75 / 75. To study the effectiveness index of the learning management plan on exponents. power using S.T.A.D techniques according to specified criteria To compare learning achievement on exponents using the STAD technique between before and after studying. with a learning management plan using the STAD technique and to study Student satisfaction Mathayom 1, Nong Wua So Pittayakhom School Continuing the development of learning about exponents with a learning management plan using the STAD technique, mathematics learning subject group.

The results of the study found that

1. Efficiency of the learning plan on exponents using the STAD technique, mathematics learning subject group. Mathayom 1 has an efficiency of 78.01/77.16, which is higher than the specified criteria.

2. Effectiveness index of the learning management plan The purpose of this study is To create and develop a learning plan on exponents using the S.T.A.D technique, Mathematics learning subject group. Mathayom 1 level has a value of 0.5235, that is, the progress increased by 52.35 percent.

3. Learning achievement on the subject of exponents using the S.T.A.D technique, Mathematics learning subject group Mathayom 1 level after studying is higher than before studying. Statistically significant at the .01 level.

4. Student satisfaction with the development of learning about exponents using the STAD technique, mathematics learning subject group. Overall Mathayom 1 students had a high level of satisfaction.

Keywords: Develop learning; exponents using the stad technique; mathematics learning group

1. Introduction

Learning management according to the National Education Act B.E. 2542 adheres to the principle that all learners are capable of learning and self-development and considers learners as the most important. Mathematics learning management must promote learners' development by emphasizing the importance of knowledge, process skills, morality, ethics, and desirable values (Ministry of Education, 2008: 188). The Basic Education Curriculum B.E. 2544 has focused on education management by setting learning standards for learner development according to learners' developmental levels into 4 key stages: Key Stage 1 for Grades 1-3, Key Stage 2 for Grades 4-6, Key Stage 3 for Grades 7-9, and Key Stage 4 for Grades 10-12. It also specifies the core learning content necessary for all learners, consisting of mathematical content and mathematical process skills, with a total of 6 learning strands: Strand 1 - Numbers and Operations, Strand 2 - Measurement, Strand 3 - Geometry, Strand 4 - Algebra, Strand 5 - Data Analysis and Probability, and Strand 6 - Mathematical Skills/Processes (Ministry of Education, 2008: 56-57).

Mathematics teaching and learning involves many elements such as learners' intelligence levels, content and curriculum, teachers' teaching methods, and importantly, the organization of learning activities. At the secondary level, many students have problems learning mathematics because mathematics teachers' learning activity management methods are strict with only one correct answer, not emphasizing thinking processes and mathematical abilities in problem-solving, logical thinking, and expressing thoughts systematically (Ministry of Education, 1999: no page number).

From the report on the quality assessment results of students in Grades 9 and 12 in the Secondary Educational Service Area Office 31 in the 2022 academic year, it was found that at Key Stage 3, the student quality assessment results were not as successful as they should be. And from the report on the average learning results by grade level of students at Chakkarat Wittaya School, Secondary Educational Service Area Office 31, in the 2021 academic year, from the average learning results by grade level for Grade 7 in all 8 learning strands, it appeared that in the overall average learning results at the school level, the lowest 2 were the Science subject group with an overall average learning result of 62.80 and the Mathematics subject group at 67.40, which found that the overall average learning results at the school level in the mathematics subject had not yet achieved the set goals and were not as successful as they should be. This was caused by both the teachers and the students themselves. Teachers were still transmitting subject content rather than allowing learners to learn from actual practice. Teachers organized teaching and learning without emphasizing process skills that would enable learners to develop their thinking, analysis, expression, and participation in learning. That is, teachers' teaching and learning management had very little learner participation because learners were merely listeners and did exercises as instructed by the teacher. The teacher may use questions, but only a small group of 4-5 students who understood the content taught by the teacher might answer the teacher's questions, while the remaining students lacked the opportunity to express opinions and accumulated a lack of understanding of that content until it became a lack of knowledge and understanding, making learning mathematics boring. Learners did not pay attention to learning, did not develop learning skills, and ultimately resulted in low learning achievement. In the teaching and learning management of the Mathematics subject group in Strand 1 - Numbers and Operations, the learning unit on exponents at the Grade 7 level, it appeared that students did not understand the content and skills in doing exercises. Suwan Kanchanamayoon (2000: Preface) discussed the problem of teaching and learning mathematics on exponents that learners often have problems with not understanding concepts and principles as well as lacking computational thinking skills, causing students to forget when learning more content. One reason may be due to the students themselves because each student differs in many aspects such as intelligence, aptitude, physical, emotional, and social aspects. Another reason is due to the teacher's teaching processes and techniques, which often do not consider individual differences, resulting in not achieving the teaching objectives.

From the aforementioned problems, it was found that the reason that causes learners to have relatively low learning results partly arises from teachers not yet managing learner-centered learning. Therefore, teachers should adjust their teaching and learning methods by reducing the role of the teacher to become a learning coordinator, providing guidance, opening opportunities for group or individual learning activities, allowing learners the opportunity to speak, express opinions, and practice by themselves, and have interactions as a group or team in order to exchange learning with each other and have assistance among learners with different abilities. One teaching method that can be used in teaching and learning that allows learners to participate is cooperative learning (The Cooperative Learning Model). It is a method where the teacher encourages learners to work together and help each other in the classroom. This teaching style helps create a good atmosphere in the classroom and promotes cognitive and psychomotor learning objectives. There are 3 types of cooperative learning models that have been researched and widely used: (1) Jigsaw, (2) TGT, and (3) STAD (Chanathip Pornkul, 2001: 134-136).

Student Teams Achievement Divisions or STAD is a cooperative learning teaching method that is popularly used in teaching mathematics. The teaching starts with the teacher providing knowledge, then the teacher divides the learners into groups of 4 with different abilities and works on assigned tasks together, explaining how to study exercises to each other. But during the testing, it is done individually. At the end, there is a calculation of the group's average score (Ministry of Education, 1998: 60). This learning method results in learners having knowledge and understanding of the subject content, skills in working together, acceptance of each other, and self-confidence, which will result in learners being eager to learn (Somdej Boonprajak, 1997: 55).

From the above concepts, the researcher has applied the STAD cooperative learning method to organize learning activities because they realize that the learning process does not only arise from the one-sided transmission of knowledge from the teacher, but learning is a collaboration of activities between the teacher and learners through various methods. This is consistent with the research results of Orain Kotmontri (2004: 88), which found that STAD cooperative learning resulted in students having higher learning achievement. Students who studied using the STAD cooperative group had learning retention. And Prapatsorn Wangdee (2005: 92-94) found that STAD cooperative learning resulted in students having higher learning achievement. Students were satisfied with STAD cooperative group learning at a high level. The researcher, as the person responsible for teaching the mathematics subject

group for Grade 7, is interested in applying the STAD cooperative learning method to develop learning management in the mathematics subject group on the topic of exponents for Grade 7 in order to use it to develop students to have higher learning achievement, develop desirable characteristics according to the objectives of the Basic Education Curriculum B.E. 2551, and to develop Thai children to grow up to be complete human beings both physically and mentally, intellectually, knowledgeably, and morally, have ethics and culture in living life, able to live happily with others according to the objectives of the National Education Act B.E. 2542, and as a guideline for further developing the teaching and learning of the mathematics subject group to be more effective.

2. Research Objectives

1. To create and develop a learning management plan on exponents using the STAD learning technique for the mathematics subject group, Grade 7, to be effective according to the 75/75 criteria.

2. To study the effectiveness index of developing a learning management plan on exponents using the STAD learning technique for the mathematics subject group, Grade 7, according to the specified criteria.

3. To compare learning achievement on exponents between before and after learning using the STAD learning technique for the mathematics subject group, Grade 7.

4. To study the satisfaction of Grade 7 students towards learning development on exponents using the STAD learning technique for the mathematics subject group.

Research Hypotheses

From the study of relevant concepts, theories, and research results, the following hypotheses can be set for the study:

1. The learning management plan on exponents using the STAD learning technique for the mathematics subject group, Grade 7, has an efficiency of 75/75.

2. The effectiveness index of the learning management plan on exponents using the STAD learning technique for the mathematics subject group, Grade 7, has a value of 0.50 or higher.

3. The learning achievement on exponents between before and after learning using the STAD learning technique for the mathematics subject group, Grade 7, is higher after learning than before learning.

Research Scope

The scope of the study is divided into content scope, population scope, and time scope as follows:

1. Content Scope

The content used in this independent study is the content of the mathematics subject group in Strand 1 - Numbers and Operations on the topic of exponents, which the researcher has used to create 13 learning management plans, consisting of the meaning of exponents, operations of exponents, and applications.

2. Population Scope

The population used in this study is Grade 7 students at Chakkarat Wittaya School, Secondary Educational Service Area Office 31, in the first semester of the 2022 academic year, totaling 6 classes: Grade 7/1 with 34 students, Grade 7/2 with 32 students, Grade 7/3 with 31 students, Grade 7/4 with 36 students, Grade 7/5 with 35 students, and Grade 7/6 with 32 students, for a total of 200 students.

3. Time Scope

The researcher began analyzing the data components, conducted in the first semester of the 2022 academic year, between March 1, 2022 and June 30, 2022.

Research Conceptual Framework

The researcher has studied documents, textbooks, educational curriculums, and research related to the STAD learning technique and then synthesized them into a conceptual framework for the study as follows:

Independent Variable **Dependent Variables**

| Lesson Plan on Exponents Using STAD Technique for Mathematics Subject in Grade 7 at Chakrach Wittaya School, Secondary Educational Service Area Office 31 | → | **Results of the Lesson Plan on Exponents Using STAD Technique for Mathematics Subject in Grade 7"**

1. Academic Achievement in Exponents

2. Student Satisfaction with Learning Development

in Exponents Using STAD Technique |

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3. Research Methodology

This research is a preliminary experimental research with a one-group pretest-posttest design.

Population: The population used in this study is Grade 7 students at Chakkarat Wittaya School, Secondary Educational Service Area Office 31, in the first semester of the 2022 academic year, totaling 6 classes: Grade 7/1 with 34 students, Grade 7/2 with 32 students, Grade 7/3 with 31 students, Grade 7/4 with 36 students, Grade 7/5 with 35 students, and Grade 7/6 with 32 students, for a total of 200 students.

Sample: The sample is Grade 7/1 students at Chakkarat Wittaya School, Secondary Educational Service Area Office 31, in the first semester of the 2022 academic year, obtained by simple random sampling using the lottery method, totaling 34 students.

The tools used for data collection in this study consist of ..... sets as follows:

In this study, the researcher used the tools in the following order:

1. Learning management plans on exponents using the learning technique (STAD), totaling 12 plans, consisting of:

- Learning management plan on writing numbers in exponential form
- Learning management plan on finding the value of exponents
- Learning management plan on multiplying exponents with positive integer exponents
- Learning management plan on dividing exponents with positive integer bases and exponents when the exponent of the dividend is greater than the exponent of the divisor
- Learning management plan on dividing exponents with equal bases and positive integer exponents when the exponents of the dividend and divisor are equal
- Learning management plan on dividing exponents with equal bases and the exponent of the dividend is less than the exponent of the divisor
- Learning management plan on multiplying and dividing exponents when the exponents are integers
- Learning management plan on finding the value of exponents with exponents as bases
- Learning management plan on finding the value of exponents with bases in the form of multiplication or division of many numbers
- Learning management plan on writing exponents in simple form and positive integer exponents
- Learning management plan on using exponents to represent very large numbers in scientific notation
- Learning management plan on using exponents to represent very small numbers in scientific notation

2. Learning management plans on exponents for the mathematics subject group, Grade 7, Chakkarat Wittaya School, Secondary Educational Service Area Office 31, totaling 12 plans, for a total of 12 hours.

3. An achievement test on exponents for the mathematics subject group, Grade 7, Chakkarat Wittaya School, which is a 4-choice objective test, totaling 30 items.

4. A satisfaction questionnaire for Grade 7 students at Chakkarat Wittaya School, Secondary Educational Service Area Office 31, towards learning development on exponents using learning management plans for the mathematics subject group, which is a rating scale according to Likert's method with 5 levels as follows:

5 means having satisfaction at the highest level
4 means having satisfaction at a high level
3 means having satisfaction at a moderate level
2 means having satisfaction at a low level
1 means having satisfaction at the lowest level

Steps for determining the quality of the tools:

1) Creating and developing learning management on exponents for the mathematics subject group, Grade 7.

2) Creating and determining the quality of the achievement test.

3) Creating and determining the quality of the satisfaction questionnaire.

Data collection steps:

1) Request a letter from the Graduate School, Nakhon Ratchasima College, to request assistance in collecting research data from the director of Chakkarat Wittaya School, Secondary Educational Service Area Office 31.

2) Before the experiment, the researcher clarifies the principles and reasons for the sample students to acknowledge.

3) Experiment with the learning management plans with the sample group, which are 30 Grade 7 students at Chakkarat Wittaya School, Secondary Educational Service Area Office 31, in the first semester of the 2022 academic year, between March 1 and March 31, 2022.

4) Experiment with the learning management plans with the sample group, which are 30 Grade 7 students at Chakkarat Wittaya School, Secondary Educational Service Area Office 31, in the first semester of the 2022 academic year, between March 1 and March 31, 2022.

5) After the end of the experiment, the researcher conducts a post-test using the same achievement test as the pre-test and surveys the satisfaction of Grade 7 students at Chakkarat Wittaya School, Secondary Educational Service Area Office 31, towards learning management using the learning management plans for the mathematics subject group.

Statistical Analysis

The following statistical methods were employed to analyze the data:

1. Effectiveness Analysis of the Learning Plan: The effectiveness of the learning plan for the topic "Exponents" was evaluated based on the 70/70 criterion using the formula E1/E2.

2. Effectiveness Index (EI): The effectiveness index (EI) for the "Exponents" learning plan was calculated using the Goodman and Schneider method, comparing pre-test and post-test scores to full marks.

3. Comparison of Academic Achievement: A t-test (paired-samples t-test) was used to compare the pre-test and post-test academic achievement of Grade 10 students at Chakkrarat Witthaya School in Secondary Education Area 31 regarding their understanding of "Exponents" using the learning plan.

4. Analysis of Student Satisfaction: The mean () and standard deviation (S.D.) were calculated to assess the satisfaction level of Grade 10 students towards the development of their learning in the topic "Exponents" using the learning plan for the Mathematics subject area. The mean scores were then compared to the following criteria (Bunjom Srisaad, 2010: 103, 106):

4.51 – 5.00: Indicates the highest level of satisfaction
3.51 – 4.50: Indicates a high level of satisfaction
2.51 – 3.50: Indicates a moderate level of satisfaction
1.51 – 2.50: Indicates a low level of satisfaction
1.00 – 1.50: Indicates the lowest level of satisfaction

Research Findings (Summary of Key Findings)

Section 1: Analysis of the Effectiveness of the Learning Plan

Table 11 presents the results of the analysis of the effectiveness of the learning plan for the topic "Exponents" using the STAD technique for Grade 10 students in the Mathematics subject area.

Please note: The provided text seems to be an excerpt from a research paper. Without the complete context, it is difficult to provide a more comprehensive and accurate translation. If you can provide the full research paper, I can offer a more detailed and informative translation.

Table 11: Effectiveness of the Learning Plan for "Exponents" using the STAD Technique for Grade 10 Mathematics Students

Learning Plan	Pre-test Score	Post-test Score
Plan 1	78.24	76.47
Plan 2	78.53	77.35
Plan ที่ 3	78.82	76.47
Plan 4	79.71	75.88
Plan 5	79.41	75.88
Plan 6	77.65	77.35
Plan 7	79.12	77.35
Plan 8	78.82	76.76
Plan 9	80.59	77.94
Plan 10	78.82	78.82
Plan 11	78.53	77.06
Plan 12	79.71	77.06
Overall	78.01	77.16

Interpretation:

Table 11 indicates that the effectiveness of the learning plan for the topic "Exponents" using the STAD technique for Grade 10 Mathematics students is 78.01/77.16. This suggests that the implementation of the STAD technique led to an overall academic achievement of 78.01% and an overall post-test score of 77.16% for students in their understanding of "Exponents."

Additional Notes:

The provided text seems to be an excerpt from a research paper. Without the complete context, it is difficult to provide a more comprehensive and accurate interpretation. If you can provide the full research paper, I can offer a more detailed and informative analysis.

The table format can be improved by adding column headers and aligning the numbers properly.

Table 12: Effectiveness Index of the Learning Plan for "Exponents" using the STAD Technique for Grade 10 Mathematics Students

Number of Students	Full Score	Pre-test Total Score	Post-test Total Score	E.I.
34	30	531	787	0.5235

Interpretation:

Table 12 shows that the Effectiveness Index (EI) of the learning plan for the topic "Exponents" using the STAD technique for Grade 10 Mathematics students is 0.5235. This indicates that students' academic progress increased by 52.35% when they learned the topic using the STAD technique.

4. Discussion of Results

Based on the research findings, the following discussion can be made:

1. Effectiveness of the Learning Management Plan on Exponents Using STAD Technique for Grade 10 Math Students

The effectiveness of the learning management plan (LMP) on exponents using the Student Team Achievement Divisions (STAD) technique for Grade 10 math students was 78.01/77.16. This indicates that the LMP using STAD resulted in students having an overall achievement of 78.01% during the learning process and 77.16% after the learning process. The index of effectiveness of the LMP was 0.5235, indicating that students showed a 52.35% increase in their progress when learning exponents using STAD.

1.1. Consistency with Research Hypotheses

The findings of this study are consistent with the research hypotheses 1 and 2. This is because the researcher followed the guidelines for writing LMPs based on the Basic Education Curriculum 2008. The LMP was developed systematically, starting with an analysis of the learners' needs and conditions, followed by an analysis of the curriculum, standards, indicators, and learning content.

The assessment methods were also clearly defined. The LMP was piloted with students and reviewed by experts before being implemented with the target group.

1.2. Supporting Research

The findings of this study are supported by previous research on the effectiveness of LMPs using STAD. For example, Nonglak Labthawi (2005) [URL ที่ไม่ถูกต้องถูกนำออกแล้ว] found that the LMP based on the STAD model for teaching multiplication and division of fractions for Grade 5 students had an effectiveness of 8140/87.37, which was higher than the set criterion.

1.3. Implications

The findings of this study have implications for the development and implementation of LMPs for teaching exponents to Grade 10 math students. The STAD technique can be an effective way to improve student learning outcomes.

Additional Notes:

The researcher should consider using more precise language when describing the findings. For example, instead of saying "the effectiveness of the LMP was 78.01/77.16," it would be more accurate to say "the mean pre-test and post-test scores for students in the STAD group were 78.01 and 77.16, respectively."

The researcher should also discuss the limitations of the study, such as the small sample size and the lack of a control group.

The researcher should make recommendations for future research, such as replicating the study with a larger sample size and a control group.

2. Effectiveness Index of the Learning Management Plan on Exponents Using STAD Technique for Grade 10 Math Students

The effectiveness index of the learning management plan (LMP) on exponents using the Student Team Achievement Divisions (STAD) technique for Grade 10 math students was 0.5235. This indicates that students showed a 52.35% increase in their progress when learning exponents using STAD. This finding is consistent with research hypothesis 2.

The effectiveness of the LMP can be attributed to the fact that it provides students with opportunities to learn exponents in an active and collaborative manner. The STAD technique encourages students to work together to achieve common goals, which helps them to develop their understanding of the material and improve their problem-solving skills.

3. Achievement in Exponents Using STAD Technique for Grade 10 Math Students

The achievement of Grade 10 math students in exponents using the STAD technique was significantly higher after learning than before learning. This finding is consistent with research hypothesis 3.

The improvement in student achievement can be attributed to the effectiveness of the LMP and the STAD technique. The LMP provides students with a clear and structured learning experience, while the STAD technique encourages them to actively participate in the learning process.

4. Satisfaction of Students with the Development of Learning on Exponents Using STAD Technique for Grade 10 Math Students

The overall satisfaction of Grade 10 math students with the development of learning on exponents using the STAD technique was high. This finding is consistent with research hypothesis 4.

The high level of student satisfaction can be attributed to the fact that the LMP and the STAD technique made learning exponents enjoyable and engaging. Students appreciated the opportunity to work together and learn from each other.

5. Recommendation

Based on the findings of this study, the following recommendations are made:

1. Recommendations for Implementation

•Teachers should study the teaching model and principles before implementing it.

•Teachers should understand their students in order to make their teaching effective.

•If some groups finish their work slowly, teachers should provide guidance and advice to those groups and instruct the groups that finished their work first to check their results again.

•In collaborative learning activities, teachers should encourage and motivate students to be confident in their learning and to dare to express their opinions to the group.

•When reporting students' progress scores, teachers should inform students of their scores before the next teaching session to encourage all members to work together to achieve the group's goals.

•Students should be allowed to change groups within the classroom so that they can practice working with other students.

•Teachers should provide a variety of teaching materials to attract students' attention.

2. Recommendations for Further Research

•The study should be replicated with a larger sample size and a control group.

•The study should investigate the long-term effects of the LMP and the STAD technique on student learning.

•The study should investigate the effectiveness of the LMP and the STAD technique for teaching other subjects.

2. Suggestions for future research

2.1 There should be a study on organizing cooperative learning activities in other content or grade levels.

2.2 There should be a study on comparing learning achievement and learning retention between teaching with effective STAD learning plans and teaching with other methods in the same content and grade level in order to use the results to improve and develop more effective teaching and learning.

6. References

[1] Arunsukrujee, K. (2015). Member Satisfaction with the Operations of Chai Prakan Agricultural Cooperative Limited, Chai Prakan District, Chiang Mai Province. Master's Thesis in Agricultural Science, Chiang Mai University.

[2] Boonchom, S. (2017). Basic Research. Bangkok: Suweeriyasarn.

[3] Chaemphutra, N. (2021). The Development of Mathematics Learning Management with Computational Thinking Skills Exercises on Polynomials for Grade 9 at Nikhom Phimai Suksa School, Phimai District, Nakhon Ratchasima Province. Independent Study, M.Ed. Mahasarakham: Mahasarakham University.

[4] Ekasaengsri, W. K. (2019). Principles of Teaching and Life Skills Development. Printed at Darnsutha Printing Co., Ltd. Bangkok, pp. 112-113.

[5] Khosuk, N. (2020). The Development of Mathematics Teaching Sets on Integer Addition and Subtraction for Grade 2. Master's Thesis in Education, Ubon Ratchathani Rajabhat Institute.

[6] Mongkolmuang, J. (2020). The Development of Learning Management Plans Using Mathematics Skills Practice Exercises on Factors of Counting Numbers for Grade 6. Independent Study, M.Ed. Mahasarakham: Mahasarakham University.

[7] Promjabock, O. (2018). Effects of Using Science Project Activity Exercises in Teaching Science Projects and Quality of Life for Lower Secondary Students. Thesis, M.Ed. Khon Kaen: Khon Kaen University.

[8] The Royal Society. (2015). Royal Society Dictionary B.E. 2542. 5th printing. Bangkok: Aksorn Charoen Thas.

[9] Suntornrojana, W. (2021). Teaching Materials for Learning and Teaching Development Courses. Mahasarakham: Department of Curriculum and Instruction, Faculty of Education, Mahasarakham University.

[10] Thaphet, T. (2018). The Development of Skills Practice Sets for Reviewing Mathematical Word Problems on Integer Addition and Subtraction for Grade 3 Students. Master's Thesis in Education, Mahasarakham University.

[11] Wongsila, N. (2018). The Development of Difficult Word Spelling Skills Practice Exercises in Thai Language for Grade 3 Students. Independent Study Report, M.Ed. Mahasarakham: Mahasarakham University.

[12] Woranatnarumol, C. (2019). The Development of Basic Scientific Process Skills Practice Models for Grade 7 Students. Independent Study, M.Ed. Mahasarakham: Mahasarakham University.

IMPROVING THAI SPELLING LEARNED USING GAMES AND SONGS AND SATISFACTION OF 3RD GRADE STUDENTS AT BAN KHOK SAMRONG SCHOOL NAKHON RATCHASIMA EDUCATIONAL SERVICE AREA OFFICE 6

Namfon ThinThonglang

Improving Thai spelling learned using games and songs.
and satisfaction of 3rd grade students at Ban Khok Samrong School
Nakhon Ratchasima Educational Service Area Office 6

Namfon ThinThonglang

ABSTRACT

The objectives of this research are to 1) develop learning achievement in Thai spelling. that is learned using games and songs of students in Grade 3 between before and after school. 2) Study students' satisfaction with the development of Thai spelling skills. using games and music of students in Grade 3 at Ban Khok Samrong School Nakhon Ratchasima Educational Service Area Office 6

The results of the study found that

1. Achievement in writing and spelling Thai words of students in Grade 3 after being taught by using games and songs to teach higher than before being taught using games and music Significant at the .05 level.

2. Grade 3 students are satisfied with learning activities regarding the development of Thai spelling skills. using games and music. Overall, satisfaction was at the highest level. and were satisfied with each item at a high and highest level

Keywords: learning management; sound and hearing; inquiry-based teaching (5Es)

1. Introduction

The conservation and promotion of the Thai language to remain as a legacy for future generations is an important national mission. The National Education Act B.E. 2542, Section 4(3), stipulates that educational institutions shall provide language instruction with an emphasis on the correct use of Thai language and organize learning processes based on real experiences, practical training, thinking skills, practical skills, love for reading, and continuous learning (Office of the National Education Commission, 2002: 14). Therefore, in the era of information technology or globalization, Thai society is facing crises in many aspects, especially in the economy. Education is expected to be an important factor that will help society escape from various crises. The ideas and changes in education have been continuously occurring, such as education reform, educational quality assurance, curriculum changes, and learning reform, all of which aim to make education create individuals who are learning persons, able to seek knowledge by themselves, and engage in lifelong learning. To develop people to have quality, it is necessary to organize learning processes, and those processes must rely on language because language is an important tool for communication. Listening, speaking, reading, and writing skills are important foundations for learning other subjects, and the Thai language is a tool used for communication among Thai people throughout the nation, creating mutual understanding and a sense of unity. The Thai language subject is also a very necessary foundation because, in addition to learning Thai for daily communication, Thai is also a tool for learning other subjects. The organization of Thai language teaching (Pensri Kanka, 2018: Introduction) starts with changing negative attitudes towards learning Thai as the first priority because if children have negative thoughts about learning Thai, it will also negatively affect learning in other subjects since all subjects involve the Thai language. To create an attitude for children to love learning Thai, the emphasis is on creating an atmosphere for learning theories and practicing Thai language skills to be fun, lively, and colorful both inside and outside the classroom to create learners' motivation (Sukhaphong Tassanakulkit, 2019: 36).

However, for most children, learning Thai language principles and practicing reading and writing skills are boring, sleepy, and even more so if the teacher's teaching is not engaging. Thai language is often neglected and its role is reduced because it is a language used since birth. People who do not like to learn Thai may have many reasons, such as finding Thai difficult, the teacher's teaching is not fun, it is not as important as other subjects because as a Thai person, one must be able to use Thai anyway, so even without learning, one can still understand, speak, and communicate, and there is no clear path for how it can be used as a profession (Department of Academic Affairs, 1998: 1). In summary, the causes of spelling errors are due to a lack of proficiency in language principles, which results from various factors such as teachers not paying enough attention, some language rules being too complicated and

confusing for students to comprehend, and the environment contributing to spelling errors (Khemthong Jitjak, 2016: 15). Similarly, students do not like to write, are not interested in writing, cannot write essays, summaries, and letters, misspell words, use words with incorrect meanings, and use incorrect phrases (Orathai Suntharakijja, 2018: 1). This is consistent with the research of Pilanthana Suphadon (2019: Abstract), who studied the analysis of errors in writing basic Thai words according to the 1978 elementary school curriculum (revised in 1990) of first-grade students at the Demonstration School of Khon Kaen University and found that students made a total of 144 word errors, which could be classified into 14 types and 4 categories as follows: spelling errors accounted for 64.78%, consonant errors accounted for 19.12%, tone mark errors accounted for 8.49%, and vowel errors accounted for 7.6% of all errors. It can be seen that the percentage of spelling errors is very high, so the problem is how to solve these issues and how to organize teaching and learning in a way that learners have fun along with learning, which is a challenge for teachers' abilities. Engaging lessons and teachers who teach children with interesting styles, such as taking them to see real things, allowing children to express themselves and share opinions, and providing practical experiments, offer many ways to help children learn without being limited to the classroom (Education Reform Journal, 2000: 66).

In addition, playing and thinking leisurely can also stimulate students' interest because teaching Thai to elementary school children when they first start studying in the school system is a very important task (Pensri Kanka, 2018: Introduction). Regardless of which teaching method the instructor chooses to use in each stage of teaching and learning for learners to achieve the learning objectives, the instructor must consider the purpose of organizing a systematic teaching and learning process that maximizes learning for children (Pratheep Methakhunnavut, 2020: 2). Similarly, children's abilities vary, and teachers should accept these differences and find ways to develop them to the fullest extent, on par with others, just as each person's abilities in various aspects are outstanding in different ways (Education Reform Journal, 2015: 67). Likewise, the current Thai language teaching emphasizes teaching as a learning tool so that learners can seek knowledge by themselves and can apply that knowledge to develop themselves (Department of Academic Affairs, Ministry of Education, 2001: Introduction).

The results of the external quality assessment of basic education institutions over the 6th year period by agencies including the Office of the Inspector General of the Ministry of Education, the Office of the Education Council (OEC), and the Office for National Education Standards and Quality Assessment (ONESQA), using a 3-level evaluation criteria of 75-100% as good, 50-74% as fair, and below 50% as needing improvement, which are evaluation criteria referenced from the National Education Act of 1999, found that the standard for learners having the ability to think analytically, synthesize, have critical thinking, and have creativity was at a good level of only 11.1%. The aspect of having skills in seeking knowledge by oneself, loving to learn, and continuously developing oneself was at a good level of 26.5%. The aspect of having the necessary knowledge and skills according to the curriculum was at a good level of 12.6%. Meanwhile, learning achievement was at a very low good level in all learning subject groups (Nantiya Tansricharoen, 2021: 14-15) as follows: Mathematics learning subject group had learning results at a good level of 2.5%, Science learning subject group had learning results at a good level of 3.3%, Social Studies, Religion and Culture learning subject group had learning results at a good level of 3.5%, Thai Language learning subject group had learning results at a good level of 3.8%, Arts learning subject group had learning results at a good level of 6.2%, Health and Physical Education learning subject group had learning results at a good level of 14.5%, Occupations and Technology learning subject group had learning results at a good level of 18.5%, and Foreign Languages learning subject group had learning results at a good level of 47.6%.

From the report on the results of the national educational quality assessment of grade 3 students in the 2022 academic year at Ban Khok Samrong School, with the test taken simultaneously nationwide, the national assessment results showed that grade 3 students in the Nakhon Ratchasima Educational Service Area Office 6 had learning achievement in the Thai language subject in the 2009 academic year with an average total score of 47.50% (Khon Kaen Educational Service Area Office 4, 2007: 72), which is consistent with the development assessment results of the National Economic and Social Development Board, which concluded that the language achievement of the nation is an important foundation for learning at all levels.

Therefore, if teachers can organize learning activities on any topic combined with play or arrange learning to be like playing, it will greatly contribute to successful learning in that topic. The researcher has realized and seen the importance of organizing learning activities that enable learning and knowing along with the enjoyment of children. Together with the spelling achievement of grade 3 students at Ban Khok Samrong School in the 2022 academic year, which was at 47.50% and at a level

that requires urgent improvement, teaching and learning that incorporates games and songs into the instruction is one method that the researcher is interested in using to solve the aforementioned problem. This is consistent with teaching using games, which is one way to promote learners' learning and help develop various skills, as well as promote work processes and coexistence in society, and can be used to teach in all subject groups and in research that uses games in Thai language teaching (Sukon Sintapanon et al., 2017: 2). It was also found that using games and songs in Thai language teaching increases students' learning achievement (Waraporn Liamthaisong, 2020: Abstract; Pattama Ratdusadi, 2018: Abstract; Wanjai Bunyok, 2020: Abstract; Thaniya Amonpalang, 2019: Abstract; Titti Khalikham, 2020: Abstract).

From the above statements, the importance of spelling problems can be confirmed. The researcher is confident that developing Thai spelling skills using games and songs for grade 3 students to supplement the teaching as proposed from the beginning will be able to further improve learners' spelling skills and will also be beneficial for other Thai language teachers to adapt for use in the future. The researcher will develop spelling on the topic of final consonants in the "Kor Kai," "Kor Kwai," "Kor Kong," and "Kor Kuat" classes, consonant clusters, silent letters, and leading and non-leading letters in the "Ngor Ngu," "Ngor Mu," "Ngor Yao," and "Ngor Aeo" classes because these four classes do not cause spelling problems for learners.

2. Research Objectives

Research Objectives

1. To develop learning achievement in Thai spelling that is learned using games and songs of grade 3 students between before and after learning.

2. To study students' satisfaction with the development of Thai spelling skills using games and songs of grade 3 students at Ban Khok Samrong School, Nakhon Ratchasima Educational Service Area Office 6.

Research Hypotheses

1. Grade 3 students have higher learning achievement in Thai spelling learned using games and songs after learning than before learning.

2. Grade 3 students have satisfaction with activities to develop Thai spelling skills using games and songs at a good level or higher.

Research Scope (including research conceptual framework)

1. Content Scope

1.1 Activities to develop Thai spelling skills using games and songs for grade 3 students that are created are writing content as specified in the Basic Education Curriculum B.E. 2544. The content used to create activities and tests was selected from the basic learning textbook set "Language for Life, Phasa Phatee" for grade 3 by the Department of Academic Affairs. The content used to create is consistent with the Thai language learning curriculum in the first level, which requires learners to write words correctly, spell correctly, have writing etiquette, and have a love for writing.

1.2 The test measures learning achievement in Thai spelling before and after learning, consisting of 30 items in a 4-choice format.

2. Population Scope: The population is grade 3 students in the first semester of the 2022 academic year at Huai Yang Wittayasap School. The researcher used purposive sampling and there are 8 students.

3. Scope of Variables Used in the Study

3.1 Independent variable is the organization of activities to develop spelling skills using games and songs.

3.2 Dependent variable is the development results as follows:

3.2.1 Thai spelling achievement using games and songs

3.2.2 Student satisfaction with spelling using games and songs

4. Scope of Time Used in the Experiment: The first semester of the 2022 academic year, between May 17, 2022 and September 30, 2022, using 3 weeks, 5 days per week, 1 hour per day. The researcher conducted the experiment herself.

Conceptual Framework of the Research

From the study of relevant concepts, theories, and research, the researcher has determined the conceptual framework for the study as follows:

Independent Variable   **Dependent Variables**

Organizing Activities to Develop Thai Spelling Skills Using Games and Songs → **Student Development**
1. Achievement in Thai spelling using games and songs
2. Student satisfaction with spelling using games and songs
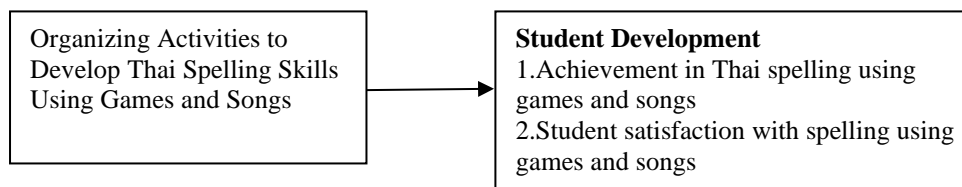
3. Research Methodology

This research is a one-group pretest-posttest design experimental study with purposive sampling and a randomized control group pretest-posttest design.

Population: The sample used in this study is grade 3 students. The researcher selected the sample used in the study by purposive sampling, which are grade 3 students studying in the first semester of the 2022 academic year at Ban Khok Samrong School, Nakhon Ratchasima Educational Service Area Office 6, totaling 8 students.

The tools used for data collection in this study consist of ...... sets as follows:

In the study by creating activities to develop Thai spelling skills using games and songs for grade 3 students at Ban Khok Samrong School, Nakhon Ratchasima Educational Service Area Office 6, the researcher created the following tools for data collection:

1. Learning management plans for developing Thai spelling skills using games and songs, consisting of 4 learning units, 12 plans, used for teaching 3 weeks, 5 days per week, 1 hour per day, including:

1.1 Learning management unit 1: Practice spelling words with final consonants in the "Kor Kai," "Kor Kwai," "Kor Kong," and "Kor Kuat" classes using Bingo games, spelling, and the Do Re Mi spelling song, used for teaching 3 times.

1.2 Learning management unit 2: Practice spelling consonant cluster words using the "Together We Are" game and the "Remember Consonant Clusters Well" song, used for teaching 3 times.

1.3 Learning management unit 3: Practice spelling silent letter words using the "Because We're a Pair" game and the "Silent Letters Are Important" song, used for teaching 3 times.

1.4 Learning management unit 4: Practice spelling leading letter words using the "Lucky Ball" game and the "Oh Leading Letters" song, used for teaching.

2. A test to measure learning achievement in Thai spelling for grade 3 students, which is an objective test with 4 choices, 1 set, used for pre-test and post-test, consisting of 30 items.

3. A questionnaire on students' satisfaction with using Thai spelling skills exercises using games and songs, which is a rating scale according to Likert's method with 5 levels.

Steps for determining the quality of the tools:

1. Methods for creating learning management plans and manuals for using learning management plans to develop Thai spelling skills.

2. Creating a test to measure Thai spelling achievement.

3. Creating a questionnaire on satisfaction with Thai spelling.

Data collection steps:

In the study on developing Thai spelling skills using games and songs for grade 3 students, conducted in the first semester of the 2011 academic year, the researcher determined the following methods for data collection:

1. Orientation to create understanding with students about the teaching and learning methods, learner roles, learning objectives, and learning assessment methods in this experiment.

1.1 Testing students' basic knowledge using the Thai spelling achievement test, pre-test set, using 1 hour, then recording the scores to compare with the post-test scores.

1.2 Using the created learning management plans to develop Thai spelling skills using games and songs to organize learning with students in the first semester of the 2022 academic year.

Data analysis using statistical software packages. The statistics used in data analysis are as follows: In the study on developing spelling skills using games and songs in the Thai language subject group of grade 3 students at Ban Khok Samrong School, Nakhon Ratchasima Educational Service Area Office 6, conducted in the first semester of the 2022 academic year, the researcher determined the following methods for data analysis:

1. Determining the quality of the learning achievement test.

1.1 Finding the difficulty level and discrimination power using Brennan's method (Boonchom Srisa-ard, 2017: 90).

1.2 Finding the reliability of the entire test using Lovett's method (Boonchom Srisa-ard, 2017: 96).

1.3 Finding the validity of the learning achievement test using the index of item-objective congruence formula (Arunee Onsawad, 2019: 102).

2. Quality of the satisfaction questionnaire.

Analyzing students' satisfaction with the learning management of the Thai spelling learning management plans by interpreting and setting the following criteria (Boonchom Srisa-ard, 2017: 103):

Mean of 4.51 - 5.00 means having the highest quality and satisfaction.
Mean of 3.51 - 4.50 means having high quality and satisfaction.
Mean of 2.51 - 3.50 means having moderate quality and satisfaction.
Mean of 1.51 - 2.50 means having slight quality and satisfaction.
Mean of 1.00 - 1.50 means having the least quality and satisfaction.

Research Results (summarizing key points from the research results)

Part 1: Comparing learning achievement in Thai spelling learned using games and songs between before and after learning. Details are shown in Table 2.

The researcher took the results of testing students' Thai spelling ability between before and after being taught using games and songs. The analysis results are shown in Table 4.1.

Table 4.1: Results of comparing learning achievement in Thai spelling learned using games and songs between before and after learning

Using games and songs	N	$\overline{X}$	S. D	ΣD	$\sum D^2$	t	df	Sig.
before learning	8	13.63	1.06					
after learning	8	25.13	1.73	92	1068	-27.21*	7	.00

* Statistically significant at the 0.05 level (df = 7)

From Table 4.1, it shows that the Thai spelling ability of grade 3 students after being taught using games and songs is higher than before being taught using games and songs with statistical significance at the .05 level.

Part 2: Analyzing students' satisfaction with learning through learning activity management related to the development of Thai spelling skills using games and songs.

The results of analyzing students' satisfaction with learning through learning activity management related to the development of Thai spelling skills using games and songs are shown in Table 4.2.

Table 4.2: Assessment of students' satisfaction with learning through learning activity management related to the development of Thai spelling skills using games and songs

Questionnaire on Organizing Learning Activities for Developing Thai Spelling Skills Using Games and Songs	S.D.	Level of Satisfaction	Level of satisfaction
1. I enjoy learning Thai in groups with friends.	4.62	0.51	The most
2. I understand the content better through playing games and singing with friends.	4.75	0.46	The most
3. I have fun playing games and singing in Thai class.	4.87	0.35	The most
4. I learn better by playing games and singing with a group than alone.	4.75	0.46	The most
5. I enjoy playing games and singing with friends.	4.75	0.46	The most
6. My friends and I like to help each other.	4.62	0.51	The most
7. I have the opportunity to express my opinions and practice through games and songs with friends.	4.75	0.46	The most
8. I listen to my group members' opinions.	4.62	0.51	The most
9. If I don't understand the Thai content, I often consult with my group members.	4.62	0.51	The most
10. I want to practice spelling using games and songs like this again.	4.75	0.46	The most
11. I am satisfied that my score helps the group succeed.	4.75	0.46	The most
12. If my friends can't do the exercises, I usually help them.	4.50	0.53	more
13. Playing games and singing with friends helps me understand spelling better.	4.87	0.35	The most
14. Learning Thai in a group by playing games and singing helps me do better on exams.	4.75	0.46	The most
15. I find Thai content not difficult if I learn through playing games and singing with friends.	4.62	0.51	The most
Average	4.70	0.48	The most

From Table 4.2, it was found that students were satisfied with the learning activity management related to the development of Thai spelling skills using games and songs for grade 3 students. Overall, satisfaction was at the highest level ($\bar{x}$ = 4.70). When considering each item, it was found that satisfaction was at a high level in 1 item: If my friends cannot do the exercises, I often provide help and suggestions ($\bar{x}$ = 4.50). Besides that, satisfaction was at the highest level, with the items having the highest level of satisfaction being: I have fun playing games and singing songs in Thai class and playing games and singing songs with friends helps me understand spelling more ($\bar{x}$ = 4.87), followed by I understand the content more from playing games and singing songs with friends, I can learn better by playing games and singing songs with the group than learning alone, I like playing games and singing songs with friends, I have the opportunity to express opinions and practice from playing games and singing songs with friends, I want to practice spelling using games and singing songs like this again, I am satisfied that my scores contribute to the success of the group, learning Thai in a group through playing games and singing songs makes me do better on tests ($\bar{x}$ = 4.75), and I like learning Thai in a group with friends, my friends and I like helping each other, I listen to the opinions of friends in the group, if I don't understand the Thai content, I often consult friends in the group, I think Thai content is not difficult if I learn from playing games and singing songs with friends ($\bar{x}$ = 4.62) respectively.

4. Discussion

From the results of the study on the development of Thai spelling learning using games and songs and the satisfaction of grade 3 students at Ban Khok Samrong School, Nakhon Ratchasima Educational Service Area Office 6, it was found that:

The organization of activities to develop Thai spelling skills using games and songs for grade 3 students at Ban Khok Samrong School, Nakhon Ratchasima Educational Service Area Office 6, after receiving the organization of activities to develop Thai spelling skills using games and songs with an efficiency of 83.65/82.91, had higher spelling skills than before training with statistical significance at the .05 level. The results of this study are in accordance with hypotheses 1 and 2. This may be because

students learning using spelling skills exercises that were well developed, went through systematic preparation steps and appropriate methods, studied from the curriculum, content, and construction techniques from relevant documents, and also applied concepts and methods that have been successful before by Titti Khalikham, then proceeded to create and passed the examination and correction of defects according to the suggestions of experts, and received quality and suitability checks from content experts, which is consistent with Thaniya Amonpalang (2019), Jintana Phrommet (2019), Udai Phonkaew (2017), Prawan Aumatmuntri (2016), Pratheep Dee (2020), Rungruang Samorn (2021), Amonlak Namyotha (2019), Bangon Kosolparinyanan (2015 Abstract), who studied and developed exercises with an efficiency of 70/70 and found that it clearly resulted in higher student achievement. It resulted in students being satisfied with using the spelling skills exercises with the highest level of satisfaction, which is higher than hypothesis 3 that was set. This is because the activity format is interesting, a new thing, students practiced, evaluated, and improved by themselves, students had fun, there are pictures, games, songs, language that is easy to read and understand, students can understand and spell better. It can be observed from students wanting to practice spelling using exercises like this again and wanting the researcher to create additional exercises for them.

5. Suggestions

1. Suggestions for implementation

1.1 Before using the skills exercises, teachers may add more problematic spellings or make changes as appropriate.

1.2 Teachers may use activities to develop Thai spelling skills using games and songs with other grade levels by improving the content to be appropriate and consistent with the curriculum and learner level, and should apply learning management techniques using games and songs to use in learning management of various subjects.

1.3 The 5-step learning management process should be used to develop spelling skills in Thai language learning in other grade levels or applied to other learning subject groups.

1.4 Students' work should be checked and scores reported immediately upon completion of the teaching and learning process so that students know their shortcomings and can improve their work next time.

1.5 Teachers should supervise and give importance to students who are underachieving to enable them to better develop themselves.

2. Suggestions for future research

2.1 This study used spelling of final consonant words that were problematic in students' spelling found in the classroom. If conducting further studies, words in other final consonant classes or words that often have spelling problems should be sought from other frequently found sources.

2.2 There should be a comparison of Thai spelling achievement using games and songs with learning management using other innovations.

2.3 There should be a comparison of Thai spelling achievement using games and songs at other grade levels to study children's spelling ability.

6. References

[1] Amonpalang, T. (2019). The development of a Thai language principles learning plan on Triyang using skills practice games and songs for Prathom Suksa 4 students. Master of Education thesis, Curriculum and Instruction Program, Mahasarakham University.

[2] Bunyok, W. (2020). The development of a lesson plan for difficult words in Thai language subject using games and songs for Prathom Suksa 4. Master of Education thesis, Curriculum and Instruction Program, Mahasarakham University.

[3] Dee, P. (2020). Using song activities to promote vocabulary knowledge and creative writing ability for certificate students at Chiang Mai Commercial School. Master of Education thesis, English Teaching Program, Chiang Mai University.

[4] Department of Academic Affairs, Ministry of Education. (2002). Basic Education Curriculum B.E. 2544. 3rd printing. Bangkok: Kurusapa Ladprao Press.

[5] Jitjak, K. (2016). A comparison of spelling achievement of difficult words among Mathayom Suksa 3 students at Namon Phitthayakhom School, Kalasin Province, with different Thai language ability levels, learning through using games, using skills practice exercises, and normal learning methods. Master of Education thesis, Silpakorn University.

[6] Kanka, P. (2018). Teaching Thai writing for elementary school teachers (4th printing). Bangkok: Chulalongkorn University.

[7] Khalikham, T. (2020). The development of Thai language learning subject group spelling skills using games and songs for Prathom Suksa 3 students. Master of Education thesis, Curriculum and Instruction Program, Phuket Rajabhat University.

[8] Khon Kaen Educational Service Area Office 4. (2022). Report on the results of the national educational quality assessment. Khon Kaen: Khon Kaen Educational Service Area Office 4.

[9] Liamthaisong, W. (2020). Reading and writing skills in spelling difficult Thai words for Prathom Suksa 2 students between teaching using games and using skills practice exercises. Master of Education thesis, Mahasarakham University.

[10] Ratdusadi, P. (2018). Using games to develop Thai spelling of Mathayom Suksa 1 students at Chonprathan Songkroh School, Nonthaburi Province. Master of Education thesis, Mahasarakham University.

[11] Suphadon, P. (2017). An analysis of errors in writing basic Thai words according to the 1978 elementary school curriculum (revised in 1990) of Prathom Suksa 1 students at the Demonstration School of Khon Kaen College. Master of Education thesis, Curriculum and Instruction Program, Khon Kaen University.

[12] Suntharakijja, O. (2018). Finding the efficiency of a Thai language teaching set to develop creative thinking in writing of Prathom Suksa 2 students. Master of Education thesis, Elementary Education Program, Srinakharinwirot University.

[13] Tansricharoen, N. (2021, September). Education Reform Journal, 98, 15.

EMPOWERING QUALITY EDUCATION: TRAINING ENGLISH LANGUAGE TEACHERS FOR MULTICULTURAL SOCIETIES

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EMPOWERING QUALITY EDUCATION: TRAINING ENGLISH LANGUAGE TEACHERS FOR MULTICULTURAL SOCIETIES

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ABSTRACT

Industrialization and globalization have made the world community multicultural. In most of the countries, educational institutions have become multicultural, too. Many schools and higher educational institutions have a multicultural body of students coming from various ethnic and cultural backgrounds. This increases the importance of Teacher Education Programmes. However, most of these programmes pay little or no attention to the training of culturally respectful teachers. The report claims that teachers who are appropriately and consciously trained to teach in a culturally sensitive manner effectively prepare their classes to help students acquire values and respect each other. This task necessitates careful planning. The purpose of this research is to offer fresh light on how teachers model and exemplify the behaviour and values that they expect from their students to exhibit. The paper concludes with a call to rethink the course content in teacher education programmes with a view of re-focusing on the practical aspect of training culturally respectful English language teachers. This study would also have implications on the quality of teacher education. In addition, it will promote peace, tolerance and harmony among the citizens of the global village.

Keywords: Respectful, global world, teachers, teacher education, multicultural society.

1. Introduction

"Sacred duty of teachers and each of us is to prepare worthy generation from well bred,
educated and morally stable young people."

National Leader of Turkmen People, Hero Arkadag Gurbanguly Berdimuhamedov

Being a teacher in your own country should be quite easier comparing to well-developed, multicultural countries and societies. In present, the author is a teacher. The author likes teaching and believes that "enlightened, emancipated and empowered teachers lead communities and nations in their march towards better and higher quality of life" [1. P. vii; 2. P. 119]. People can see the proof of this in their lives, too. There are very good teachers, who really guide their students towards a better life. This paper is dedicated to all those teachers, who have been enlightening their students' personal and academic lives.

In the tradition of Turkmenistan, like in most of other Asian traditions, teaching is a sacred job and teachers are highly respected people in the society. As the author is an alumna of School of Education, they had several courses in this field. Each of them was interesting, attractive and exciting. Their lecturers were bringing some issues where they were having discussions. However, in real life teaching environment it was quite different. They have experienced colleagues, but they do not have resourceful teachers who can guide them in this path. They have problem-making students, but they do not have colleagues who can support them in solving problems. Moreover, there are so many other "haves and do not haves". Shortly, in education, like in other fields, there is difference between theory and practice. This difference pushed the author towards the truth that "A teacher can never truly teach unless he is still learning himself" [3, P.64]. That is where a life-long learning should take place. It is a good teacher's responsibility to teach and enlighten the students with the latest developments in education. Our students should be able to live and study in this globalized world – global village. They should learn who they are, respect their national heritage, culture and respect others', as the word goes "Give respect, take respect". If a teacher wants all these from the students, then what the teacher should do. As in many situations, teachers are role models for their students. The teacher, with all personal behaviours and activities, should be an excellent sample and a perfect role model for the students. Keeping in mind all these responsibilities and qualities of a teacher, the author has taken this title "Training English Language Teachers in Multicultural Societies" as a chapter of on-going research under the Teacher Education and Development Project. As in well-developed countries where representatives of different cultures live in harmony, the author thought, it would be appropriate to exchange the idea of Training culturally respectful English language teachers in multicultural societies.

2. Literature Reviews

Who is a culturally respectful teacher? How does a teacher make a lesson culturally respectful? The mission of the culturally respectful teacher-training programme is to educate a persona educada. "A persona educada is a person who is welcoming-especially to the stranger-compassionate, respectful, and accords human dignity to all who enter their home. That is to say, it is someone who embodies hospitality. It is someone who is unfailingly polite and attentive to the needs of others. A persona educada is someone who creates a sacred place and is attentive to the embodied presences of the other" [13, P.67]. A culturally respectful teacher should be a persona educada. They have a significant role to play in supporting children and families of cultural and language diverse backgrounds. When the teacher is welcoming and approachable, it helps to build a sense of belonging and trust for students and their families. Cultivating a culture of respect, caring and inclusion of difference amongst the whole school community is very important for supporting positive mental health and reducing school-based risk factors for children from different cultural and linguistic backgrounds. Culturally respectful education has an awareness of one's own cultural identity and views about difference, and the ability to learn and build on the varying cultural and community norms of students and their families. This understanding creates better teaching practices in culturally respectful teacher's classroom. Culturally respectful teaching can be defined as a student-centred approach to teaching in which teachers recognize the importance of every student's unique cultural strengths and consider them in order to promote achievement and a sense of cultural place. Considering each student's culture while teaching and making them feel identified in what they are learning has the potential to increase their academic performance as well as their self-confidence in their culture and ethnicity [14]. According to Zaretta Hammond, culturally respectful education is a multi-faceted approach in which different departments come together to create an interaction that allows students to accelerate their personal learning. Only culturally respectful teaching is focused on the cognitive development of underserved students [15]. Rajput and

Walia evaluate schools not according to their performances and achievements in some tests, but they do that according to their establishment of cultural uniqueness [2]. Deal and Peterson [16] highlight the importance of culture in education and they highlight the effects of culturally respectful education. They are as follows:

-Respecting each other, even in informal conversations in the faculty lunchrooms,

-Culturally respectful education has a significant impact on rational and structural forms and functions,

-Fosters school effectiveness and productivity,

-Improves collegiality, communication and problem solving,

-Promotes innovation and improvement,

-Builds commitment and kindles motivation,

-Amplifies the energy, vitality and trust of school staff members, students and community,

-Focuses attention on what is important and valuable [16, PP. 14-15].

3. Methodology

As part of the study, syllabuses of several pre-service teacher education programmes were checked. Unfortunately, as per the ethics of research and official permission to observe their syllabuses were not obtained, the names of those institutions cannot be revealed. Most of those programmes do not include a course on cultural diversity and cultural respect. However, while making this study the author came across with some in-service teacher training programmes, which arose as a need because of multicultural educational settings around the globe. The objective behind establishing a teacher-training programme should be to prepare competent teachers with higher abilities to bring qualitative and quantitative change in the school education system. They should have a solemn commitment to address themselves vigorously to the needs arising from a dynamic and rapidly changing society. They should align themselves to the requirements of the new age teaching, conducting research, disseminating new knowledge and developing application of existing knowledge. They should prepare life-long learners who are able to apply their knowledge, in a cross cultural and diverse society. The findings also proved that in many education settings if the content of education is not reflecting their cultural values then they "believe that education beyond basic literacy and numeracy has little value for their immediate and future social and economic capabilities" [17, P.171].

4. Results

A primary goal of culturally respectful education is to help all students become respectful of the multitudes of cultures and people that they will interact with once they exit the educational setting [4]. This goal is achieved only through the channel of culturally respectful teacher who is teaching based on the principles of respecting and welcoming students who have diverse cultural and linguistic background. The teacher might have not had a course on culturally respectful teaching, but he or she may use these guidelines to develop a lesson and teach respecting other cultures. Kea, Campbell-Whatley, and Richards provide characteristics of culturally respectful teachers with the next words:

Sociocultural consciousness

An affirming attitude toward students from culturally diverse backgrounds

Commitment and skills to act as agents of change

Constructivist views of learning

Learning about students'

Culturally responsive teaching strategies [18, PP. 5-6].

Culturally respectful teaching is a student-focused education process. It identifies not only the differences between students but also the unique strengths of each child to encourage their academic achievement and sense of belonging in the classroom. As a teacher, we should create a culturally respectful environment in our classroom and we can do that only if we are respecting other cultures. We teach the whole child when we include student culture in daily instruction because culture is such an important element of a person's identity. We enable the youngster to maximize on their individuality and distinctiveness. We also encourage a love of variety. [19]. Kathy Deady recommends few steps in order to become a culturally respectful teacher. According to her, culturally respectful teachers should:

1. Assess own behaviour

2. Get to know students

3. Make classroom a judgment-free zone

4. Adapt teaching

5. Include all cultures in teaching [5].

Creating a culturally respectful classroom is all about creating an environment in which students of all cultures feel comfortable and ready to learn. As a teacher, one should work on strategies, study and learn experience around the globe. It is important to honestly assess current teaching practices and modify them to consider all students' backgrounds and readiness levels. Research on culturally respectful teaching has shown that students are more engaged in learning and learn more effectively when the knowledge and skills taught are presented within the context of their own experiences and cultural frames of reference [20]. Geneva Gay mentions that, students will perform better on multiple measures of achievement when teaching is filtered through students' own cultural experiences [21].

Teachers should research to make their classrooms a space in which students of all cultures feel supported to learn and succeed. As Kerri McLaughlin-Phillips [22] cited from Gloria Ladson-Billings, "culture is central to learning. It plays a role not only in communicating and receiving information, but also in shaping the thinking process of groups and individuals. A pedagogy that acknowledges, responds to, and celebrates fundamental cultures offers full, equitable access to education for students from all cultures" [22, p.1]. By accepting and applying culturally respectful teaching principles effectively, the classroom can become a more positive learning environment for all of the students. "When students experience a positive and culturally responsive learning environment, they are more likely to be relaxed, receptive to learning and more confident to take risks" [22, P.1]. Here, the training of culturally respectful teachers reveals its importance. It should be a type of education, which emphasizes the importance of incorporating students' cultural references into all parts of learning. [23] It all starts with teachers, who, as instructors, are the ones who bring about change in the classrooms..

5. Conclusion and Recommendation

"Come, come whoever you are
Wanderer, worshipper, lover of leaving come"
Mevlana Jelaladdin Rumi

With the process of globalization, training culturally respectful teachers has gained an enormous reputation in almost all multi-cultural educational contexts. There are various roles played by teachers in understanding students' needs. Some of them are learning about students' interests, planning and organizing classroom activities, assessing the students' performance, understanding the basic needs of students, encouraging them to improve, calling for students-parents meeting and discussing with them about the students' performance or discipline, motivating students to do better, encouraging them to participate in extracurricular activities, and so on. Teachers in this type environment need to be social and have friendly nature so that the students feel comfortable to seek any help without hesitation. Among all the school subjects, English language teachers may accommodate these characters easily. Educating, guiding and bringing up the youth is counted one of the most sacred duties of a man in front of the Nationhood or Motherland. In this case, as English is lingua franca, an international language and taught in almost all educational institutions, for an English teacher it is crucially important to respect students' culture in order to have a space in their hearts', in order to achieve great success. These teachers would respect other cultures, so their students. When there is respect between two people, they can talk, listen to each other and solve their problems together, if there are any. A Teacher who loves and respects students from various cultural backgrounds would be like a gardener who has various flowers in the garden, but who loves and cares all without any discrimination. As teachers are gurus and guides of societies Culturally Respectful Teachers would enlighten their students, teach and show them how to live in harmony with others. Training English language teachers would be a reasonable solution. As they would teach and practice respecting others' culture and contribute peace in multicultural societies. That is why training English language teachers in multicultural societies in order to become culturally respectful teachers is an urgent need.

The findings of this study are hoped to have implications for training culturally respectful English language teachers in education institutions, they would be helpful in not only respecting cultures of others but also promoting peace in multicultural societies.

Acknowledgement

6. References

[1] Curriculum Framework for Quality Teacher Education, National Council for Teacher Education, Tan Prints India Pvt. Ltd., New Delhi 1998.

[2] J.S. Rajput, and K. Walia, Teacher Education in India. Sterling Publishers Pvt. Ltd. New Delhi, 2002.

[3] R. Tagore., The English Writings of Rabindranath Tagore: A miscellany. Sahitya Akademi, New Delhi. 1994, p.64.

[4] M.   Lynch, Promoting Respect for Cultural Diversity in the Classroom. 2012. Retrieved from https://www.huffingtonpost.com/matthew-lynch-edd/promoting-respect-for-culb1187683.html

[5] K. Deady, 5 steps to becoming a culturally responsive teacher, 2017. Retrieved from website https://medium.com/accelerated/5-steps-to-becoming-a-culturally-responsive-teacher-2e22b9a714d0. Also available on the website https://www.teachaway.com/blog/5-steps-becoming-culturally-responsive-teacher.

[6] Y. Acar-Çiftçi, and H. Aydın, Türkiye'de Çokkültürlü Eğitimin Gerekliliği Üzerine Bir Çalışma. SDU Journal of Social Sciences 33(1) (2014) 197-218.

[7] M. Gurbanov, Designing Culturally Friendly ELT Syllabus and Materials. International Academic and Industrial Research Solutions. Hyderabad, India. 2013, pp.197-209

[8] K. Karataş, & B. Oral, Teachers' perceptions on culturally responsiveness in education. Journal of Ethnic and Cultural Studies 2(2) (2016) 47-57.

[9] B. Bağçeci, M. Başaran, & Ö. F. Vural, Sınıf Öğretmenlerinin Yapılandırmacı Programın Uygulanışı Üzerine Görüşlerinin Analizi: 2016 Yılında Gelinen Son Nokta. Akademik Sosyal Araştırmalar Dergisi (ASOS Journal) 4 (31) (2016) 241-253.

[10] K. Karataş, & B. Oral, Culturally Responsive Pedagogy. The Journal of Academic Social Science 4(34) (2016) 431-447

[11] N. Koltuk, Kültürel Değerlere Duyarlı Eğitime İlişkin Öğretmenlerin Öz-yeterlik Algılarının ve Görüşlerinin İncelenmesi, PhD Dissertation, Van, 2018.

[12] G. Gay, Preparing for culturally responsive teaching. Journal of Teacher Education 53(2) (2002) 106–116.

[13] Fernandez, E.S. Teaching for a Culturally Diverse and Racially Just World. Wipf and Stock Publishers. Eugene, Oregon, 2014, p.67

[14] J. L.M. Gunn. Understanding Culturally Responsive Teaching. EDxEDNYC Education Conference. New York City, 2018. Retrieved from website:https://education.cu-portland.edu/blog/ leaders-link/culturally-responsive-teaching-strategies/

 [15] Z. Hammond, Culturally Responsive Teaching and The Brain: Promoting Authentic Engagement and Rigor Among Culturally and Linguistically Diverse Students. SAGE Publications, 2014.

[16] T.E. Deal, and K.D. Peterson, Shaping School Culture. John Wiley & Sons Inc. San Francisco. 2016, pp. 14-15

[17] J. DeJaeghere, and S. J. Miske, Limits of and possibilities for equality: An analysis of discourse and practices of gendered relations, ethnic traditions, and poverty among non-majority ethnic girls in Vietnam, in D. Baker, and A.W. Wiseman (Eds.), Gender, Equality and Education from International and Comparative Perspectives. Emerald Group Publishing. Bingley, UK, 2009, pp. 145-184.

[18] C. Kea, G.D. Campbell-Whatley, and H.V. Richards, Becoming culturally responsive educators: rethinking teacher education pedagogy. National Center for Culturally Responsive Educational Systems. Arizona State University, Arizona, 2006.

[19] V. Gonzalez, V. Culturally Responsive Teaching in Today's Classrooms, 2018. Retrieved from https://ncte.org/blog/2018/01/culturally-responsive-teaching-todays-classrooms/

[20] M. Gurbanov, Culture Learning in EFL Classes. In 2nd International Young Scholars conference "Lexicon, Discourse and Speaker Studies," UGPU. Ulyanovsk, Russia, 2014, pp 327-341.

[21] G. Gay, Culturally Responsive Teaching: Theory, Research, and Practice. Teachers College Press, 2018.

[22] K. McLaughlin-Phillips, Understanding ESL Learners: Moving Toward Cultural Responsiveness—A Guide for Teachers. English as a Second Language Council of the Alberta Teachers' Association 3(6) (2010) 1-8

[23] G. Ladson-Billings, The dreamkeepers. San Francisco: Jossey-Bass Publishing Co. 1994.

MODEL OF TRANSFER MISSIONS IN WATER RESOURCE DEVELOPMENT TO LOCAL GOVERNMENT ORGANIZATIONS THAILAND

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Model of Transfer Missions in Water Resource Development to Local Government Organizations Thailand

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Abstract

This study explores the model of transferring water resource development missions to local government organizations (LGOs) in Thailand, a critical step toward sustainable development and efficient resource management. Amidst growing recognition of the need for localized water governance, this qualitative research draws upon in-depth interviews with 17 key informants deeply engaged in the decentralization process. The study reveals that while capacity building, stakeholder engagement, and policy alignment are pivotal to the successful decentralization of water resource management, significant challenges in implementation persist. These challenges include technical, financial, and administrative barriers, which not only impact the effectiveness of LGOs but are also shaped by the very process of decentralization itself. Through thematic analysis, the research identifies the bidirectional nature of these challenges, thereby contributing to a nuanced understanding of the decentralization phenomenon. The proposed model underscores the interconnectedness of enabling factors and acknowledges the complexities introduced by implementation challenges. As such, the findings suggest that addressing these challenges is crucial for achieving the anticipated outcomes of improved local water management and enhanced resilience and sustainability. This study's implications resonate beyond the Thai context, offering insights for policymakers and practitioners involved in the decentralization of water resources globally. It recommends that future policy initiatives strengthen LGO capacities, foster inclusive stakeholder participation, and align local actions with national policy frameworks. Further research is suggested in several areas, including longitudinal impact assessments and comparative studies, to support the evolution of decentralized water resource management practices. This research contributes to the literature on public administration and environmental management, particularly within decentralized governance in developing countries.

Keywords: water resource management, decentralization, local government, Thailand

Introduction

Water resource management is increasingly recognized as critical to sustainable development, economic growth, and environmental preservation. In Thailand, a nation characterized by viral biodiversity and varying climatic conditions, managing water resources efficiently is essential to balancing urban development with agricultural demands and ecological sustainability (Maiglad, 2014). The decentralization of water resource management to local government organizations (LGOs) has been identified as a potential solution to improve the adaptability and effectiveness of water governance, aligning with global trends towards local empowerment in resource management (Easter & Hearne, 1993). The move towards decentralization is informed by the principle that local entities are better positioned to understand and manage the nuances of local environments

(Carrasco et al., 2023). This approach is supported by international models and frameworks, which suggest that localized management can lead to more targeted and effective resource handling (Smoke, 2015). However, implementing such a decentralized approach in Thailand has faced multiple challenges. These include limited local capacity in technical, financial, and administrative domains, gaps in coordination between national and local bodies, and a lack of comprehensive frameworks to facilitate the transition (Nelson, 2001).

According to the Local Decentralization Plan, 2000 (Issue 1) and the Action Plan for Decentralization of Local Administration, 2002 (Issue 1), government entities must shift the responsibility of managing water for consumption to local government organizations. This encompasses the water resources objective of the Royal Irrigation Department. The organizations involved include the Department of Cooperative Promotion, the Office of Agricultural Land Restoration, the Department of Fisheries, the Department of Land Development, the Department of Provincial Administration, the Department of Water Resources, and the Department of Groundwater Resources. For example, the transfer of the responsibility for constructing, caring for, and maintaining water supplies to local government bodies. However, there is an issue with the transfer of battery power. Owing to the sluggish advancement resulting from the issue of insufficient staff, Issues related to the capacity of water sources and the transfer of previously responsible individuals pose significant impediments to success in operations.

Therefore, This research aims to bridge these gaps by proposing a model for effectively transferring water resource development missions to LGOs in Thailand. The model will consider factors such as policy alignment, stakeholder engagement, and capacity building, which are crucial for empowering LGOs to manage water resources effectively and sustainably. The study will employ a comprehensive review approach by gathering data to assess current practices and identify best practices from local and international contexts. By contributing to the body of knowledge on decentralized water resource management, this study aims to improve local governance in Thailand and offer insights applicable to other regions facing similar challenges. The outcomes of this research are intended to support policymakers and local administrators in crafting strategies that enhance the resilience and sustainability of water resource management at the local level.

Research objective

To study the model of Transfer Missions in Water Resource Development to Local Government Organizations in Thailand

Literature review

Decentralization of Water Resource Management: Global Perspectives and Local Contexts

Decentralization has been widely advocated as a strategy to enhance the management of natural resources by bringing decision-making closer to the local stakeholders directly affected by the outcomes (Jariego, 2024). In the context of global water governance, decentralization is seen as a means to increase the efficiency and responsiveness of water management systems (Deroubaix & Gobert, 2024). Studies have demonstrated that local management of water resources can lead to more effective conservation practices and sustainable usage patterns due to a greater understanding of local ecological and social dynamics (Carrasco et al., 2023).

In Thailand, the diversity of climatic conditions and ecological zones adds complexity to water resource management. Suksaroj et al. (2024) note that rapid urbanization and agricultural expansion exacerbate the country's water management challenges, increasing pressure on water resources. The decentralization approach has been supported by Thai policy frameworks, such as the Local Decentralization Plan, 2000 and the Action Plan for Decentralization of Local Administration, 2002, which aim to empower local government organizations (LGOs) by transferring responsibilities related to water management from national agencies to local entities.

Challenges in Implementing Decentralization

Despite the theoretical benefits of decentralization, its implementation in Thailand has encountered significant barriers. Nelson (2001) identifies several challenges, including limited local capacity in technical, financial, and administrative areas, which hinder the effective management of water resources at the local level. Additionally, issues such as inadequate staffing and the complexities of transferring authority from national bodies to LGOs complicate the process (Richards, 2024). These challenges reflect broader issues in decentralized governance, where local entities often struggle with insufficient resources and lack of expertise (Baker, 2005).

Capacity Building and Stakeholder Engagement

Effective decentralization requires not only the transfer of responsibilities but also the building of local capacities and the engagement of stakeholders in the management process (Ostrom, 2000). Capacity building in local entities is crucial to ensure they are equipped to handle the complexities of water resource management, including planning, implementation, and monitoring water usage (Pahl-Wostl, 2007). Moreover, stakeholder engagement is essential to ensure that the interests of all community members are represented and that local governance mechanisms are transparent and accountable (Warner, 2014).

Frameworks and Models for Successful Decentralization

Research has suggested that successful decentralization depends on establishing clear frameworks that outline the roles and responsibilities of all stakeholders and provide guidance on governance processes (Ostrom, 2000). In addition, empirical studies from other countries can offer valuable insights into best practices that can be adapted to the Thai context. For instance, models from countries like Brazil and India, which have implemented successful decentralized water management strategies, could provide valuable benchmarks (Silva & Mosse, 2003; Gupta et al., 2013).

The literature reveals that while decentralization offers potential benefits for water resource management, substantial challenges must be addressed to realize these benefits in practice. The proposed research aims to contribute to this field by developing a model that supports the effective transfer of water resource management to LGOs in Thailand, considering the unique challenges and leveraging global best practices.

Methodology

Research Design

This study adopts a qualitative research design to explore the complexities of transferring water resource development missions to local government organizations (LGOs) in Thailand. Qualitative research is particularly suited to this study as it allows for a deep understanding of the perspectives and experiences of the key stakeholders involved in the decentralization process. This approach enables the exploration of subjective experiences, opinions, and responses essential for developing an effective model for mission transfer (Creswell, 2014).

Participants

The research involved in-depth interviews with 17 key informants directly engaged with Thailand's decentralization of water resource management. These participants were selected based on their expertise, experience, and roles in water resource management, including government officials from various departments (such as the Department of Water Resources and the Department of Local Administration), representatives from LGOs, and experts from non-governmental organizations (NGOs) involved in water governance. The diversity of participants ensures a comprehensive understanding of the challenges and opportunities associated with the decentralization process.

Data Collection

Data were collected through in-depth, semi-structured face-to-face interviews and via videoconferencing due to geographical or logistical constraints. Each interview lasted between 40 and 60 minutes. The semi-structured format allowed for flexibility in the discussion, enabling participants to express their views thoroughly while ensuring that all relevant topics were covered. The interview guide included questions on participants' experiences with the decentralization process, perceived challenges, practical strategies for capacity building, and suggestions for improving the transfer of water resource management to LGOs.

Data Analysis

The data from the interviews were transcribed verbatim and analyzed using thematic analysis, a widely used method in qualitative research for identifying, analyzing, and reporting patterns (themes) within data (Braun & Clarke, 2006). The analysis involved rigorous coding of the transcripts in several phases to ensure comprehensive theme development. Initially, preliminary codes were generated and collated into potential themes. These themes were reviewed and refined in an iterative process, ensuring they accurately represented the interview data. The final themes were defined and named after discussing their relevance to the research objectives and existing decentralized water resource management literature.

Ethical Considerations

The study was conducted following ethical guidelines for qualitative research. Before conducting the interviews, all participants were informed about the purpose of the study, the nature of their involvement, and their rights to confidentiality and withdrawal from the study at any point. Informed consent was obtained from all

participants. The participants' confidentiality and their responses' anonymity have been maintained throughout the research process, with no identifiers being used to report data.

Results

The thematic analysis of the in-depth interviews with 17 key informants revealed several critical themes regarding transferring water resource management missions to local government organizations in Thailand. These themes include Challenges in Implementation, Capacity Building Needs, Stakeholder Engagement, and Policy Alignment.

1. Challenges in Implementation

A predominant theme from the interviews is the challenges LGOs face in implementing decentralized water management. Key informants highlighted technical challenges, such as inadequate infrastructure and technological support, that hinder the effective management of water resources. Financial constraints were also frequently mentioned, with LGOs often lacking the necessary budget to undertake significant water management projects independently.

2. Capacity Building Needs

Nearly all respondents emphasized the urgent need for capacity building within LGOs. This theme encompassed the need for training in technical skills, such as water quality testing and system maintenance, as well as managerial skills, including project management and financial planning. Informants suggested that enhancing these capacities would empower LGOs to manage water resources more effectively and respond more adeptly to local needs.

3. Stakeholder Engagement

Another key theme was engaging multiple stakeholders in the decentralization process. Participants noted that effective water resource management requires active collaboration between LGOs, national government agencies, community groups, and private sector entities. However, several informants reported that current levels of stakeholder engagement were insufficient, leading to misalignments in goals and misunderstandings about roles and responsibilities.

4. Policy Alignment

Respondents also discussed the need for better alignment between national policies and local management practices. While national frameworks support decentralization, informants noted that policies often do not translate into practical support or clear guidelines for LGOs. This gap hinders the ability of local governments to implement policies effectively and to integrate their activities into broader national objectives.

5.   Integration of Traditional Knowledge

A significant finding was the potential role of traditional knowledge and practices in enhancing water resource management at the local level. Several informants pointed out that incorporating traditional methods could complement modern techniques and provide more sustainable solutions tailored to local environmental conditions.
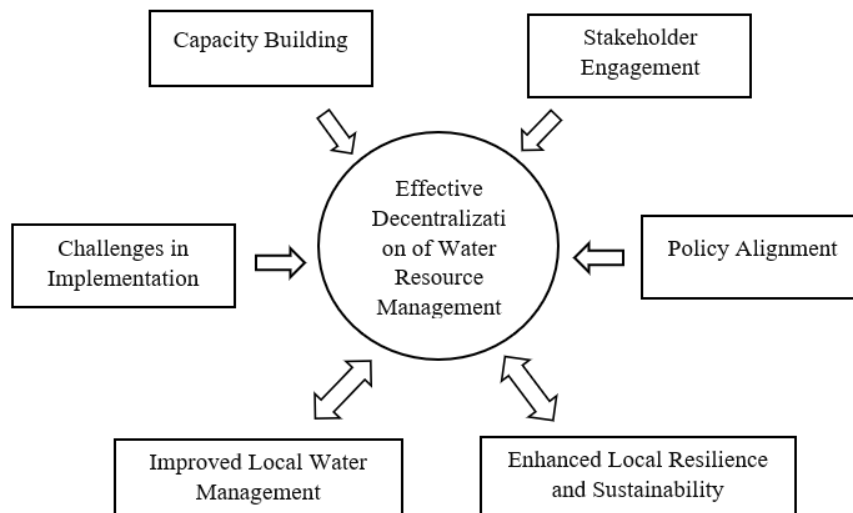

Figure 1 The model of Decentralization of Water Resource Management

Figure 1 illustrates the dynamic relationship between various factors contributing to the Effective Decentralization of Water Resource Management as follows:

Contributing Factors:

Capacity Building: This factor emphasizes the importance of enhancing the skills, competencies, and abilities of local government organizations (LGOs) to manage water resources effectively.

Stakeholder Engagement: This highlights the need for active participation and collaboration among all stakeholders, including LGOs, community members, government bodies, and possibly private entities, to ensure a participatory approach to water resource management.

Policy Alignment: This involves aligning local water management practices with national policies and ensuring that the local actions comply with national objectives and regulatory frameworks.

Challenges in Implementation: Positioned uniquely in the model, this box denotes the challenges and obstacles that might impede the decentralization process. It has a bidirectional relationship with the central concept, indicating that while challenges affect the process, the process itself can modify or introduce new challenges.

Outcomes:

Improved Local Water Management: One of the desired outcomes shows that effective decentralization leads to better management of water resources at the local level.

Enhanced Local Resilience and Sustainability: The other key outcome implies that decentralization not only improves management but also bolsters local systems' resilience and sustainability against environmental and economic stresses.

In the model, arrows indicate the direction of influence. The factors of Capacity Building, Stakeholder Engagement, and Policy Alignment point toward the central goal, suggesting they are foundational inputs or enablers for decentralization. The Challenges in Implementation are shown with arrows both toward and away from the central concept, suggesting a complex interplay where challenges can hinder effective decentralization. However, the process can generate new challenges or help mitigate existing ones. Finally, successful decentralization leads to the two outcomes, demonstrating the end goals of the process. The model serves as a conceptual framework that guides understanding of how decentralized water resource management can be achieved in practice and what factors are critical for its success.

Conclusion and discussion

The research sought to understand the model of transfer missions in water resource development to LGOs in Thailand. The results suggest a nuanced landscape where capacity building, stakeholder engagement, and policy alignment play critical roles in the success of decentralization initiatives (Sterling et al., 2017). Challenges in implementation, while acting as potential impediments, also offer opportunities for refining and evolving decentralization strategies.

The outcomes of improved local water management and enhanced local resilience and sustainability indicate the long-term benefits of a well-executed decentralization model. These findings corroborate those of Chen et al. (2020), who found that effective decentralization could lead to better resource management outcomes. The research contributes to the broader discourse on decentralized governance, suggesting that decentralization can significantly improve water resource management in Thailand with the right various enabling factors and the mitigation of challenges (Nikomborirak, 2016).

Moving forward, policymakers should consider the model's implications for designing interventions that enhance the capacity of LGOs, promote inclusive stakeholder engagement, and ensure policy coherence. Additionally, recognizing and addressing the implementation challenges will be vital in creating resilient and sustainable water resource management practices in Thailand and other regions with similar contexts.

Suggestions for Further Research

While this study has made significant contributions to understanding the decentralization of water resource management in Thailand, several areas warrant further investigation:

- **Longitudinal Studies**: Future research could undertake longitudinal studies to track the evolution of decentralized water resource management over time. This would provide insights into the sustainability of initiatives and the long-term impacts on local water management.
- **Comparative Analysis:** Comparing the decentralization models across different regions within Thailand or between Thailand and other countries with similar initiatives could highlight contextual factors that influence the effectiveness of decentralization.
- **Quantitative Analysis:** Developing quantitative analysis to evaluate the impact of capacity building and stakeholder engagement on decentralization's success could offer a more objective analysis of these factors.
- **Policy Impact Studies:** Detailed studies on the impact of specific policy alignments or misalignments on the decentralization process could help formulate more coherent policies supporting mission transfer to LGOs.
- **Barriers to Stakeholder Engagement:** Research dedicated to understanding and mitigating the barriers to effective stakeholder engagement could help design more inclusive and participatory governance models.
- **Impact of Decentralization on Local Communities:** Examining how decentralization affects local communities, including social equity, access to water, and economic outcomes, would contribute to a holistic understanding of decentralization's impact.

References

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research In Psychology, 3*(2), 77–101.

Carrasso, B., Rahemtulla, H. A., & Rohdewohld, R. (2023). *Decentralization, Local Governance, and Localizing the Sustainable Development Goals in Asia and the Pacific.* Routledge.

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitaive, and Mixed Methods Approch.* LA.: SAGE Publications.

Deroubaix , J.-F., & Gobert , J. (2024). Chapter 25: The resistance of centralised socio-technical systems: the 'dynamic status quo' between centralised wastewater sanitation and decentralised stormwater management in France. doi:https://doi.org/10.4337/9781800889156.00037

Easter, W. K., & Hearne, R. R. (1993). Decentralizing water resource management: economic incentives, accountability, and assurance. *RePEc*, 1–32.

Jariego, I. M. (2024). Using stakeholder network analysis to enhance the impact of participation in water governance. *Humanities and Social Sciences Communications, 11*(5), 1–15. doi:https://doi.org/10.1057/s41599-024-02958-x

Maiglad, P. (2014). *Solutions for Water Management in Thailand.* Retrieved April 12, 2024, from TDRI: https://tdri.or.th/water/thaipublica20140309/

Nelson, M. H. (2001). Thailand: Problems with Decentralization? In *Thailand's New Politics: KPI Yearbook 2001* (pp. 219–281). Nonthaburi: Bangkok: King Prajadhipok's Institute and White Lotus Press.

Nikomborirak, D. (2016). *Ckimate Change and Instutional Challenge for Developing Countries: The case of Water Resource Management inTHailand.* Bangkok: Thailand: TDRI.

Ostrom, E. (2000). Collective Action and the Evolution of Social Norms. *The Journal of Economic Perspectives, 14*(3), 137–158.

Pahl-Wostl, C. (2007). Transitions Towards Adaptive Management of Water Facing Climate and Global Change. *Water Resources Management, 21*(1), 49–62.

Richards, P. G. (2024). *The Reformed Local Government System.* Taylor & Francis.

Smoke, P. (2015). MANAGING PUBLIC SECTOR DECENTRALIZATION IN DEVELOPING COUNTRIES: MOVING BEYOND CONVENTIONAL RECIPES. *Public Administration and Development, 35*(2), 250–262.

Sterling, E. J., Betley, E., Sigouin, A., Gomez, A., Toomey, A., Cullman, G., . . . Porzecanski, A. L. (2017). Assessing the evidence for stakeholder engagement in biodiversity conservation. *Biological Conservation, 209*(4), 159–171.

Suksaroj, T. T., Jha, N. K., Chuanpongpanich, S., Siriraksophon, W., Kwanyuen, B., & Suksaroj, C. (2024). Strategy development for domestic water use reduction in special economic zone of Thailand through water user perception and factor analysis. *Environmental and Sustainability Indicators, 24*(1), 1–14.

FUNCTIONAL ANALYSIS OF COMPUTER SOFTWARE FOR ENHANCING CREATIVITY IN ART EDUCATION

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FUNCTIONAL ANALYSIS OF COMPUTER SOFTWARE FOR ENHANCING CREATIVITY IN ART EDUCATION

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ABSTRACT

The purpose of this master's program is to investigate the effectiveness of three computer software programs which are Scratch, Krita and Photoshop on enhancing creativity in art education at Fuzhou Software Vocational and Technical College. Quantitatively and qualitatively measured the impact of these tools on key creativity factors (logical thinking, color sensitivity, emotional expression) and the self-achievement satisfaction in the final through a carefully structured survey of 203 participants. The study found that Scratch significantly improved logical reasoning and problem-solving skills by introducing students to basic programming concepts through creative storytelling and game design. Krita, the advanced brush dynamics and color management tools, excelled at facilitating students' exploration of color theory and artistic expression enable them to develop a deeper emotional connection with their own work. Photoshop is renowned for superior image editing capabilities, helping students realize complex creative visions and push the limits of innovation and artistic expression. The findings have emphasized the important role these digital tools play in fostering creativity, advocating for their wider integration into the fine arts curriculum. This integrated approach not only enriches the educational experience by combining technology with traditional art forms but also prepares students to adapt to the evolving needs of the digital art industry, thus making a significant contribution to educational research and teaching strategies in the field of art education.

Keywords: Creativity, Scratch, Krita, Photoshop, Art Education

1. Introduction

The integration of digital technology in art education, particularly through computer software, has transformed traditional teaching methodologies and enhanced creativity in the educational process. This study evaluates the effectiveness of three specific software tools which are Scratch, Krita, and Photoshop on fostering creativity at Fuzhou Software Vocational and Technical College. By examining their impact on logical thinking, color sensitivity, emotional expression, and self-achievement satisfaction, this research aims to provide a detailed analysis of how these digital tools contribute to artistic development. Given the rapid advancement of technology in educational settings, this investigation is particularly relevant. It seeks to clarify the roles of Scratch, Krita, and Photoshop within art education, supporting their integration into curricula to better prepare students for the digital art industry. This study not only enhances academic understanding of these tools but also offers practical insights for educators aiming to cultivate a more innovative and creative learning environment.

2. Literature Reviews

The use of computer software in art education has become a pivotal area of study as educators seek to leverage technological advancements to enhance creativity and learning outcomes. This literature review examines several scholarly articles that explore the intersection of digital tools and creative processes in the educational sphere. Specifically, the analysis includes works by Kara (2020), Thorsteinsson & Gisli (2014), and Pycior (1984), which provide insights into the role of technology in fostering creativity within educational settings.

1. Kara (2020) - Prospective Visual Arts Teachers' Innovation Skills and Attitudes towards Computer Assisted Instruction: Kara's study investigates the relationship between the innovation skills of prospective visual arts teachers and their attitudes towards computer-assisted instruction (CAI). The research found significant correlation between a positive attitude towards CAI and higher innovation skills among these teachers. This suggests that embracing digital tools in teaching can directly influence the creative capabilities of educators, which in turn impacts their teaching effectiveness. Kara emphasizes

the importance of educational strategies that encourage the adoption of technology to foster a conducive learning environment for creativity.

My perspective to Kara's findings are instrumental in highlighting how digital literacy among teachers can enhance creative teaching methodologies. The study underscores the need for training programs that equip educators with the necessary digital skills to effectively incorporate technology into their teaching practices.

2. Thorsteinsson & Gisli (2014) - Impact of Computer Technology on Design and Craft Education: This article examines the influence of computer technology on design and craft education, focusing on the use of e-student portfolios. Thorsteinsson and Gisli discuss how these digital tools facilitate a more interactive and reflective learning process among students. They argue that technology-enhanced learning environments promote not only creativity but also critical thinking and problem-solving skills. However, they also note the necessity for teacher training to maximize the benefits of technology in education.

The insights provided by Thorsteinsson and Gisli are particularly relevant to this thesis as they reinforce the notion that technology, when effectively integrated, can substantially enrich the educational experience. Their emphasis on teacher training aligns with the findings from Kara (2020), further supporting the argument that successful integration of technology in art education requires competent and technologically adept educators.

3. Pycior (1984) - The Enhancement of Creativity in Art Education through Computer Technology: Pycior's work explores how computer-aided design (CAD) software can be used to enhance creativity in art education. The study suggests that CAD tools not only facilitate the learning of design principles but also enhance students' ability to think creatively and execute complex designs. Pycior points out that the adoption of technology in art education can lead to significant improvements in students' creative outputs and learning processes.

Pycior's study is critical in understanding the direct benefits of specific software tools like CAD in art education. This aligns with the current research, which investigates the impacts of Scratch, Krita, and Photoshop. Pycior's findings bolster the argument that practical exposure to digital tools can enhance creativity, providing a strong foundation for integrating these technologies in art curricula.

In the conclusion: The literature reviewed provides compelling evidence that the integration of computer software in art education offers significant benefits in enhancing creativity and learning efficacy. The studies by Kara, Thorsteinsson & Gisli, and Pycior collectively emphasize the need for a strategic approach to technology integration, highlighting the critical role of educator readiness and the direct impact of digital tools on creativity. These studies affirm the hypothesis that digital tools not only facilitate a richer educational experience but also enhance the creative capacities of students. However, the successful implementation of such technologies hinges on the ability of educators to effectively utilize these tools within the curriculum. This literature review underscores the importance of ongoing professional development for educators and the strategic selection of digital tools that align with educational goals in art education. This literature review has established a solid theoretical foundation for the proposed study, which seeks to further elucidate the specific impacts of Scratch, Krita, and Photoshop on creativity in art education. By building on the existing research, this thesis aims to provide actionable insights that could guide the future integration of digital technologies in art educational practices, ultimately enhancing the creative output and educational experiences of students.

3. Methodology

In this study, the effectiveness of three computer software program which are Scratch, Krita, and Photoshop on enhancing creativity within art education at Fuzhou Software Vocational and Technical College is explored through a detailed questionnaire survey method. The objective is to quantitatively assess how these digital tools impact key creativity factors among students, such as logical thinking, color sensitivity, emotional expression, and self-achievement satisfaction.

The research employs a quasi-experimental design tailored to measure changes in students' creativity before and after the intervention of using the specified software. A total of 203 students enrolled in the Computer Painting course were selected as participants for this study. These students were chosen because their curriculum involves extensive use of the software under investigation, thereby ensuring that the findings are directly applicable to the target demographic.

Data collection was conducted using a carefully designed questionnaire, developed to gather both pre and post-intervention data on students' creative capabilities. The questionnaire included a range of questions crafted to capture the extent of creative enhancement perceived by the students due to the

software usage. The areas focused on were specifically chosen based on the literature review and theoretical framework laid out in earlier sections of the thesis, which highlighted the importance of these creativity factors in art education. The structure of questionnaire allowed for a comprehensive collection of quantitative data. Students responded to items on a Likert scale, providing insights into their levels of agreement or disagreement with statements concerning their experiences and outcomes related to the software usage. This approach not only facilitated the measurement of changes in specific creativity factors but also provided a nuanced understanding of the students' subjective educational experiences with the digital tools.

The collected data were then analyzed using statistical methods. Descriptive statistics were employed to summarize the data, providing mean scores and standard deviations for each creativity factor before and after the software intervention. The analysis aimed to identify significant changes in the creativity levels of students, which were further tested for statistical significance using appropriate inferential statistics to confirm the reliability of the observed trends.

This methodology, with its focus on a quantitative survey approach, offered a robust framework for assessing the impact of technological tools on creativity in art education. By quantifying the effects of Scratch, Krita, and Photoshop, the study contributes valuable empirical evidence to the ongoing discourse on the integration of digital tools in educational settings. Furthermore, the findings from this research are expected to provide actionable insights for educators and curriculum designers seeking to enhance creativity through technology in art education environments.

4. Results

The data analysis results of this study highlight the significant impact that the use of Scratch, Krita, and Photoshop has on enhancing creativity in art education at Fuzhou Software Vocational and Technical College. Through a comprehensive evaluation using pre and post-intervention surveys filled out by 203 students, the analysis demonstrated notable improvements in several creativity factors.

Quantitative analysis revealed that students experienced significant enhancements in logical thinking, color sensitivity, and emotional expression after using the software. These findings were supported by statistical tests that showed substantial increases in mean scores from pre- to post-use of the digital tools. For instance, the mean scores for logical thinking and problem-solving skills improved markedly, suggesting that the software facilitated a deeper engagement with creative processes and critical thinking.

Color sensitivity also showed notable improvement, with students reporting a better understanding and application of color in their artwork. This enhancement is particularly significant for courses involving digital painting, where color manipulation and application are key skills. Emotional expression, another critical component of creativity, was enhanced as students felt more confident in translating their thoughts and emotions into digital artworks.

The qualitative data, collected through student interviews and classroom observations, corroborated these findings, providing rich insights into how students perceived their interactions with the software. Many students expressed a greater sense of achievement and satisfaction in their creative projects, attributing this to the advanced features and user-friendly interfaces of the software tools.

These results underscore the value of integrating Scratch, Krita, and Photoshop into the art education curriculum. The analysis not only confirms the positive effects of these digital tools on student creativity but also suggests that such technologies can be pivotal in modernizing educational practices and outcomes in the field of art.

5. Conclusion and Suggestions

Conclusion

The study's investigation into the use of three computer software programs which are Scratch, Krita, and Photoshop on enhancing creativity in art education at Fuzhou Software Vocational and Technical College has yielded significant insights. The data analysis, grounded in both quantitative and qualitative research method, highlights the positive impacts these tools have on fostering key elements of creativity among students.

Enhanced Creativity and Skills Development

Firstly, the application of Scratch, Krita, and Photoshop has demonstrably enhanced students' creative skills and cognitive abilities. Scratch, with its simple, block-based programming interface, significantly improved logical reasoning and problem-solving capabilities. This enhancement is crucial

as it lays a foundational skill set that students can apply in various disciplines, not limited to digital arts. Krita, known for its sophisticated brush engine and comprehensive color palette, enabled students to explore advanced color theories and artistic techniques, thus fostering a deeper emotional connection with their work. Photoshop, as a leading digital editing tool, expanded the boundaries of creativity and innovation, allowing students to execute complex visual concepts and enhance their visual communication skills.

Educational Implications

The study's findings suggest that integrating these software tools into art education curricula not only enriches the learning experience but also prepares students more effectively for the digital dimensions of contemporary art careers. The positive feedback and increased confidence among students underscore the value of these digital tools in educational settings, suggesting a need for educational policies to support and expand technology use in creative disciplines.

Barriers to Technology Integration

However, the research also identified challenges in the full integration of these technologies. The primary barrier observed was the lack of adequate training for educators in effectively using these tools. This gap can hinder the potential benefits of digital tools in education, as teachers may not be fully prepared to guide students through the technical aspects or creative potentials of the software. Additionally, the study noted the variability in students' access to technology, which can lead to disparities in learning outcomes and needs to be addressed to ensure equitable educational opportunities. For future research, it would be beneficial to conduct longitudinal studies to track the long-term effects of digital tool integration in art education. Such studies could provide deeper insights into how continuous exposure to these tools affects students' creative careers post-graduation. Additionally, exploring a broader range of digital tools and their specific uses within different artistic disciplines could further delineate the scope of digital technology in enhancing art education.

Conclusion

The integration of Scratch, Krita, and Photoshop into the art education curriculum at Fuzhou Software Vocational and Technical College has been found to significantly enhance various aspects of creativity among students. The evidence suggests that these tools not only improve technical skills and creative expression but also enhance students' confidence and satisfaction with their artistic endeavors. While challenges remain, particularly in terms of equitable access to technology and adequate teacher training, the overall impact of these digital tools is profoundly positive. This study contributes to the growing body of literature advocating for the integration of advanced digital tools in art education, highlighting their potential to transform traditional creative teaching methodologies and prepare students for the digital future.

Discussion

The results of this study have provided robust evidence supporting the integration of digital tools like Scratch, Krita, and Photoshop into the art education curriculum at Fuzhou Software Vocational and Technical College, significantly enhancing creativity among students. This discussion contextualizes these findings within broader educational practices and the evolving digital landscape in art education.

Enhancement of Creative Capacities

The study clearly demonstrated that each software tool uniquely contributes to enhancing students' creative capabilities. Scratch excels in developing logical thinking through interactive storytelling and game design, which are critical for conceptual development in art. Krita enhances sensory and emotional aspects of art through advanced tools that allow nuanced color manipulation and textural effects, enabling students to express more complex emotional narratives in their artworks. Photoshop's impact is most evident in its ability to refine students' technical skills and expand their creative visions through sophisticated image manipulation.

Implications for Teaching and Learning

These findings underscore the importance of technology in modernizing art education and preparing students for a digitized creative industry. The enhanced creativity and expanded skill set that students develop through these tools are indicative of the significant potential of integrating technology in educational curricula. However, the success of such integration heavily relies on overcoming existing challenges, such as ensuring equitable access to technology and providing adequate training for educators to effectively use these tools in their teaching practices.

Future Directions

Moving forward, art education institutions are encouraged to adopt a more structured approach to technology integration. This includes developing comprehensive training programs for

educators, investing in technology infrastructure, and continuously assessing the impact of these digital tools on student outcomes to ensure they meet educational goals effectively.

Suggestions

Based on the findings of this study, several recommendations are proposed to enhance the role of digital tools in art education effectively.

Educator Training and Development: It is crucial to provide comprehensive training for art educators in the use of digital tools like Scratch, Krita and Photoshop. Professional development programs should focus not only on technical skills but also on integrating these tools into the creative process to maximize their educational impact.

Infrastructure Investment: Institutions should invest in the necessary technological infrastructure to ensure all students have access to these digital tools. This includes upgrading hardware and software in schools and providing resources for students who may not have access at home.

Curriculum Integration: Digital tools should be seamlessly integrated into the art curriculum to enhance their usage across various art forms and disciplines. This integration should be reflective of current industry standards and practices, preparing students for professional art careers.

Further Research: Ongoing research is recommended to continuously assess the effectiveness of these tools in education. Future studies should explore broader applications and potential new digital tools that could further enhance creativity in art education.

6. References

[1] Kara, S. (2020). Prospective Visual Arts Teachers' Innovation Skills and Attitudes towards Computer Assisted Instruction. International Journal of Technology in Education and Science, 4(2), 98-107. https://doi.org/10.46328/ijtes.v4i2.60

[2] Lu, L.-F. L. (2005). Pre-Service Art Teacher Negative Attitudes and Perceptions of Computer-Generated Art Imagery: Recommendations for Pre-Service Art Education Programs. Visual Arts Research, 31(1), 89–102. http://www.jstor.org/stable/20715371

[3] Ning, X. L. (2020). Analysis of the disadvantages and future development direction of art education in colleges and universities. Beauty and the Times (Chinese), (08), 105-106. https://doi.org/10.16129/j.cnki.mysdz.2020.08.051

[4] Thorsteinsson, G., & Gisli. (2014). Impact of Computer Technology on Design and Craft Education. Journal of Educational Technology, 10(4), 40-50.

[5] Pycior, S. W. (1984). The Future of Teaching the Past: Computer-Assisted Instruction in History. Computers and the Humanities, 18(3/4), 205–214. http://www.jstor.org/stable/30204331

PRACTICAL STRATEGY TO ENHANCE CHINESE PRIMARY STUDENTS' CREATIVITY IN LEARNING ART

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PRACTICAL STRATEGY TO ENHANCE CHINESE PRIMARY STUDENTS' CREATIVITY IN LEARNING ART

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Abstract

The objectives are to find the practical strategy to enhance primary Chinese students' creativity in learning art and the opinions and satisfaction of primary art teachers on this practical strategy. Because of the current education system generally focuses on exam-oriented education, students learn passively, not being encouraged to use creativity, develop the personality and imagination. Researcher analyse data from the related literature, interview teachers and collect learning style data of grade 4-5 students which have their own independent thinking rapidly from Xinhua Primary School and Dongjie Primary School in Hohhot city of China.

The practical strategy from analysis are as follow: Encourage students to think freely, use modern technology such as digital art tools or online resources to expand students' creativity, stimulate students' imagination and creative thinking, encourage students to express their views on social issues through art works, organize regular visits to art galleries and exhibitions to stimulate students' desire for expression, Interact and collaborate with artists, learn art forms from different cultures, allow students to improvise in class assignments, and provide diverse artistic experiences such as music, drama, and dance. Through the implementation of this strategy, it can effectively promote the improvement of the creativity of primary school students in art learning, cultivate their style of independent thinking and innovative expression, so as to comprehensively improve their artistic quality and aesthetic style. Primary art teachers satisfy in the practical strategy.

Keywords: Practical strategy, Creativity, Learning in art, Primary Art education

Introduction

Nowadays, the art taught in primary school in China is only some basic art knowledge, and the weekly art class is less, due to the pressure of college, the art class is seriously neglected. Classroom teaching is the main form of school education, and now the primary school art teachers basically adopt the method of "infusing" and "training". Although the students can learn according to the teacher's intention and complete the homework well, this fixed teaching mode virtually limits the students' creativity and makes the creative thinking not improve. For creativity thinking, I think that it come from the art activities under some strategy that I call practical strategy that is like approaches or methods that are effective and applicable in various situations to achieve desired outcomes. The outcome in this case means creativity of the primary students when they learning art. All of these made researcher think what approaches it should be. Therefore, it is the origin of this research.

Literature Review

The 4 issues of literature that relate to this research are 1) Creativity in learning art at primary level 2) Learning Style 3) Instructional design in learning art at Primary level 4) Learning Strategy.

Creativity in learning art at primary level: Creativity as Franken (1994) said that creativity as the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others. It is a psychological quality necessary for the successful completion of certain creative activities [5] and important to art activities in generating new ideas, discover and create new things. Consistent with the concept of Csikszentmihalyi (1997) told the way that creativity can happen in the case of persons who express unusual thoughts, who are interesting and stimulating - in short, people who appear to unusually bright. Or People who experience the world in novel and original ways.[4] These are individuals whose perceptions are fresh, whose judgements are insightful, who may make important discoveries that only they know about like the meaning of creativity that Vygotsky (1967) said it is an active process that required skill as well as specific understanding of the contexts in which creativity is being applied which I agree that is the style in doing new things, following by creative thinking which is an internal thought process. Creative thinking divided in 4 categories, as follow [12]:

Originality means the style to generate ideas, works or solutions that are different, innovative and unique.

Fluency means the flow and coherence of creative thinking and action allows ideas to flow naturally without mental barriers.

Flexibility means think about problems in a variety of ways, explore solutions, and adapt and change your approach as situations or needs change.

Elaboration means attention to detail and depth, as well as refinement and refinement of ideas or ideas.

These four elements of creative thinking can help art teachers do something for students follow these to be creativity, students will be expertise, style to think creativity and work together to achieve creativity by motivation. Factors affected creativity in person or students should be these 3 factors (Furnham & Safiullina, 2010)[3], the first factor is Knowledge, rich knowledge is the source of creativity, only on the basis of rich knowledge experience, our brain can Blossoms of wisdom, bear the fruit of creation. The second factor is Intelligence, creativity is not only a part of intelligence, and is the highest level of intelligence. Soviet scholars and most Western scholars generally held this view. The third factor is *Personality*: psychologists have found that generally, creating personality had a huge impact on creative thinking and creative, it is generally believed creativity than intelligence in a larger extent, depends on the personality factors. However, Aambile (2012) [1] show that the style to think of new things for students requires important elements to push or encourage them consist of expertise (in technical, procedural and intellectual knowledge), creative thinking skill (how flexibly and imaginatively people approach problem) and motivation (intrinsic motivation is more effective than extrinsic motivation). These three elements must work together to achieve creativity and have impact of learning art in primary level on creativity.

Learning style: The ways and methods that individuals tend to learn, including their preferences for information reception, processing, and memory. Common learning style include visual style, auditory style and kinesthetic style. Visual style: In art learning, visual learners may be more inclined to learn by observing and appreciating artworks, colours, and shapes. They may prefer to understand and express

their ideas through drawing, drawing, or looking at images. Auditory style: Auditory learners may be more inclined to understand and express art through music, sound effects or oral explanations. They may prefer to learn and understand artistic concepts through music creation, listening to discussions, or explanatory art lectures. Kinesthetic style: In art learning, kinesthetic learners may prefer to learn and understand through kinesthetic artistic activities, such as sculpture, pottery, or crafts. They tend to express and understand the concept of art by making, manipulating and experiencing it themselves

Instructional design in learning art at Primary level: Passive learning and active learning are the two Instructional design in learning art. Students only receive and digest the information provided by teachers, but do not actively participate in the learning process, lack of initiative and creativity. This may be manifested as that students just passively listen to the lecture and imitate the teacher's demonstration, and lack independent thinking, creative expression and independent exploration. Passive learning may limit students' development and creativity. Teachers can set up a series of stimulating questions, discussion topics or art projects to encourage students to put forward their own ideas, opinions and creativity, and promote students' active participation and expression. While active learning refers to the situation that students actively participate in and control the learning process. This way of learning focuses on students' initiative, participation and creativity, allowing students to explore, think, express and solve problems independently under the guidance of teachers. Teachers create an environment that encourages students to learn and express themselves, provide a variety of art materials and resources, and give space to be creative.

Learning Strategy: The operations and actions that students use in order to optimize the processes of obtaining and storing information and course concepts and framework is a useful tool for conceptualizing a learning and development strategy. Teachers guide students through observation, thinking, discussion and other ways to stimulate interest, provide students with rich practical opportunities, let them hands-on painting, sculpture, handicraft and other artistic creation. This helps develop their skills and creativity. One of the learning strategy such as Hattie & Donoghue (2016) proposed
the model describes three inputs (skill, will and thrill) and three outcomes within the success criteria (surface, deep and transfer) and an acquiring and consolidation phase within each of the surface and deep phases. It is important to look at specific strategies within each phase of the model [8].

By the researches that related and support the idea in finding practical strategy that I would like to propose such as "Scientific Creativity and Artistic Creativity: Initiation Effects and Domain Impacts" research by Yi & Hu (2013) which the objective is to explore effective modes of creative stimulation through 3 initiation experiments, 1cross-lagged design study and 2 professional background groups' analysis of scientific and artistic creative works [14]. Provide a scientific basis for the teaching and promotion of scientific and artistic creativity. Mi (2020) studied "The cultivation of students' imagination and creativity in junior high school art teaching", teachers can adopt different teaching methods and integrate materials from daily life into teaching, enhance students' imagination and creativity in the continuous teaching practice process, and achieve students' comprehensive development requirements[15]. Same as Luo & Re (2020) studies "The Importance of Cultivating Students 'Creativity in Primary Art Education under Core Literacy"[10], with the aim of exploring how students' creativity under core literacy searchers have found that the creativity in primary art education is indispensable in art teaching one link, but it should pay more attention to the development of primary school art education in combination with "core literacy". Thalia R. Goldstein (2016) studied "Creating Your Own World: Art

and Learning" to explore how we can foster this exploration and creativity in children [7]. Researchers have found that art can provide learning opportunities and a sense of security for play and exploration, personal development and self-confidence, leading children to gain confidence in cross-domain creativity.

All of the researches show the importance of creativity in art education in primary schools, especially that art students may show a higher level of creative thinking and design skills than science and engineering students, which is also one of the purposes of my research. In order to explore practical strategies to improve the creativity of art learning in primary school students, I will conduct research on students in art classes. In the second study, it is mentioned that teachers can adopt different teaching methods, integrate materials from daily life into teaching, and enhance students' imagination and creativity in continuous teaching practice. I think this point is very good for me to learn, and it is a multi-faceted and continuous process to explore and develop teenagers' creativity in the field of art. Develop young people's style to think for themselves and encourage them to freely express their thoughts, emotions and opinions. I think it is also necessary to provide them with a platform to display and share their works and enhance their self-confidence.

Research Method

This paper focuses on the creativity and cultivation strategies in art learning of primary school students. Firstly, the definition, elements and influencing factors of creativity are summarized, with special attention to the development of creativity of primary school students aged 7-12 years, from the two primary schools are representative schools in Hohhot city of China, name Xinhua Primary School and Dongjie Primary School. Students in grade 4 and 5 develop their thinking style rapidly and they begin to have their own independent thinking. Secondly, it discusses the influence of learning art on creativity and how to stimulate the creativity of primary school students, and emphasizes the importance of learning style on the development of creativity. In the aspect of teaching design, two modes of passive learning and active learning are proposed, and the current situation of Chinese primary school students learning art is discussed. The definition and framework of learning strategies are further discussed, as well as strategies applicable to arts learning in primary schools. Finally, the paper reviews relevant researches at home and abroad to provide practical strategies for improving the creativity of Chinese primary school students' art learning.

The research methods include questionnaires, teacher and student interviews and a research tool by Leonard (2005) [9]. The Online Learning Styles Inventory of Primary School Students collects all data through interviews with teachers and students and data on students' learning styles. All data collected is analysed under the supervision of the main project consultants and experts to design practical strategies. To show all the teachers practical strategy, asked the teacher for her advice and satisfaction, data analysis of teachers' opinions and satisfaction, summarize and make overall project reports. The data analysis adopted qualitative and quantitative analysis methods to provide empirical support for the conclusion of the paper, and the impact of the research results on the art education practice of primary school students was deeply discussed, demonstrating the scientific and practical significance of the research.

Data analysis results

The data collected by the researchers was divided into three parts: the first part was teacher-student interviews; The second part is the learning style data obtained from the sample (students); The third part is the analysis of teachers' satisfaction with practical strategies. The following conclusions can

be drawn from this interview: Encourage students to think freely, use digital art tools or network resources and other modern technologies to expand students' creativity, stimulate students' imagination and creative thinking, encourage students to express their views on social issues through art works, organize regular visits to art galleries and exhibitions, stimulate students' desire for expression, interact and cooperate with artists, and learn art forms of different cultures. All of the above practical strategies such as having students improvise in class assignments will help students improve their creativity in art learning.

In the analysis of students' learning styles, it is concluded that there are differences in students' learning styles, but they generally prefer visual and kinesthetic styles. There is no significant difference in learning style between different schools and different grades. Therefore, teachers should fully consider the differences of students' learning styles in the teaching process, and adopt a variety of teaching methods and means to meet students' different learning needs.

Conclusion

The researchers summarized the results according to the study objectives as follows:

To find the practical strategy to enhance primary Chinese students' creativity in learning art，I propose it from teacher-student interviews and many data analysis of the learning style scale, and find the following practical strategies to explore and improve the creativity of primary school students in art learning:

A: How to learn

  1. Learn outside classroom (in school)

  2. Learn art history of different cultures

  3. Learn art forms of different cultures

  4. Provide a wealth of art materials and resources to stimulate students' imagination

  5. Guide students to learn different art style.

  6. Organize art exhibitions to stimulate students' desire for expression

  7. Teachers provide inspiration for creation to students

  8. Provide diversified artistic experiences, such as music, drama, dance, etc.

  9. Guide children to think differently

  10. Use modern technology, such as digital art tools or online resources, to expand students' creativity

  11. Regular visits to art galleries and exhibitions

B: How to encourage

  1. Encourage students to create freely on their thinking.

  2. Encourage students to integrate knowledge from different fields into their creations.

  3. Encourage students to express their views in social issues through artworks.

  4. Encourage children to come up with a variety of possible artistic solutions

C: How to manage

  1. Interact and collaborate with artists

  2. Give students improvisation for class work

  3. Activities should be problem-solving task

  4. Activities should be group projects

  5. Activities should be simulations and in class activities

  6. Activities should be field trips

When studying primary school art teachers' satisfaction with practical strategies, it can be seen from relevant data that most of them agree with each of the practical strategies for improving the creativity of primary school students' art learning and think it is practical. Some strategies illustrate the advantage of Elaboration in terms of originality, fluency, flexibility, and elaboration.

Discussion

According to the research results, it can be seen that practical strategies to improve students' art learning creativity cover many aspects. Primary school art teachers generally agree on practical strategies to improve students' art learning creativity, indicating that they highly recognize the effectiveness of these strategies to promote students' art learning and creative development. This widespread recognition reflects the positive effects of these strategies observed by teachers in practice. Teachers encourage students to give free play to their own ideas, which is to cultivate students' style of independent thinking and expression. In this environment, students are free to explore and express their ideas without restrictions or preconceived notions. At the same time, rich art materials and resources are provided to stimulate students' imagination and creativity. By being exposed to a wide variety of works of art, learning about art history, and understanding different art style, students can expand their artistic horizons and get inspiration and creative materials from them, encourage students to integrate knowledge from different fields into their creations, which helps to cultivate students' interdisciplinary thinking style. By participating in exhibitions and cooperating with artists, students can have a more intuitive understanding of the process of artistic creation and expression, as well as receive guidance and advice from professionals, so as to continuously improve their artistic level. In terms of technology, the introduction of modern technologies such as digital art tools or online resources can further expand students' creativity and forms of expression. These technological tools cannot only help students make art more convenient, but also stimulate their interest and enthusiasm for digital art and open up new possibilities for artistic creation. Finally, the practical strategy in terms of places and products is to provide students with a richer and more diverse art experience through visiting art galleries and exhibitions, extracurricular learning and interaction and cooperation with artists, so as to stimulate their creativity and desire for expression and promote their art learning and development.

The analysis of teachers' satisfaction with practical strategies shows that most of them agree and believe that this is a practical strategy to improve students' creativity in art learning. Among them, the strategies of encouraging students to think freely, providing diversified artistic experiences such as music, drama and dance, using modern technologies such as digital art tools or online resources to expand students' creativity, conducting extracurricular learning in school, interacting with artists, learning art forms of different cultures, and organizing problem-solving tasks and activities are highly recognized. And these practical strategies are helpful to improve students' creativity in art learning. Teachers' recognition of these practical strategies also reflects their emphasis on art education and their expectations for the development of students' art learning. Art is not only a kind of skill, but also a comprehensive subject, which can cultivate students' creativity, aesthetic feeling and comprehensive thinking style. Therefore, teachers realize that adopting these strategies is of great significance to the comprehensive development of students, and are willing to actively apply them in teaching practice.

Suggestions

Provide regular teacher training and professional development opportunities are provided to help teachers understand and master the effective implementation methods of various creative practice strategies for arts learning. The training content can include theoretical knowledge, practical skills and case studies to help teachers better cope with the challenges of daily teaching. School administrators should provide adequate art teaching resources and support, including art materials, equipment and technical support, as well as encourage and support teachers to innovate their practices in classroom teaching.

References

[1]   Amabile, T. (2012). **Component of Creativity**. (Online):
      https://kumardeepak.wordpress.com/2012/07/18/components-of-creativity/

[2]   Boyles, M. (2022). **Business insights: The Importance Creativity in Business.**
      (Online): https://online.hbs.edu/blog/post/importance-of-creativity-in-business

[3]   Batey, M., Furnham, A., & Safiullina, X. (2010). **Intelligence, general knowledge and personality as predictors of creativity**. *Learning and Individual Differences, 20*(5), 532–535.

[4]   Csikszentmihalyi, M. (1997). **Creativity - Flow and the Psychology of Discovery and Invention.** HarperCollins Publishers.

[5]   Franken, R.E. (1994). **Human motivation**. 3rd Ed. Pacific Grove, CA: Brooks/Cole Publishing Co.

[6]   Gupta, A. (2023). **The Future of Creativity.** (Online): https://www.linkedin.com/
      (pulse/future-creativity-how-cultivate-your-imagination-innovate-gupta

[7]   Goldstein, T. (2016). Creating Your Own World: Art and Learning. (Online):
      https://www.brookings.edu/articles/creating-their-own-worlds-arts-and-learning

[8]   Hattie, J & Donoghue, G.M. (2016). **Learning strategies: a synthesis and conceptual model.** (Online): https://www.nature.com/articles/npjscilearn201613

[9]   Leonard, E. (2005). College Success Simplified.

[10] Qin,L. & Maiti.R.(2020). **The Importance of Cultivating Students 'Creativity in Primary Art Education Under Core Literacy.** Education Research. Xinjiang Normal University.

[11] Taber, K.(2020) .**The Role of Imagination and Creativity in Science Education and the Importance of Encouraging Students to Stimulate Imagination and Creativity in Science Education.** (Online):https://doc.taixueshu.com/foreign/rgConf2020183440626.html

[12] Vygotsky, L. S. (1930/1967). Chapter 4: Innovation and creativity. In Smolucha, F. (Ed.), Publisher. (Original work published 1930)

[13] Xiaoxi (2023). Children's big world teaching research.
      (Online):https://wenku.baid.com/view/c0f2ab0368d97f1922791688384868762cbaebb45.html

[14] Xinfa, Y. &Weiping.H.(2013). **Scientific Creativity and Artistic Creativity: Initiation Effects and Domain Impacts.**
      (Online): https://www.researchgate.net/publication/275878273

[15] Zhigang, M.(2020). **The cultivation of students' imagination and creativity in junior high school art teaching.** Curriculum education research. Baishahe sub-district office Zhang ge zhuang Middle School, Qingdao City, Shandong Province

THE DEVELOPMENT OF CHINESE ANIMATION INNOVATION AND APPLICATION: THE CHARACTER OF CHINESE CARTOON

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THE DEVELOPMENT OF CHINESE ANIMATION INNOVATION AND APPLICATION: THE CHARACTER OF CHINESE CARTOON

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ABSTRACT

The purpose of this research is to analyze development, innovation, character and application of Chinese animation in order to understand the animation industry of China for further development. The first step of this research is to analyze potential of development and currently problem, and the second step is to study cultural characteristics of Chinese animation and its position in the market in order to set up means of development. The process of this research consists of 2 methods as 1) by questionnaire survey and 2) by interviewing. The obtained information was analyzed in wide and deep aspects and reveals that Chinese animation industry has been remarkably developed in diversity direction and internationally accordance with developing of technology. The outcome of this research is a guidance for developing and promoting cartoon industrial of China. The research results are as follows; 1.The cultural characteristics of Chinese animation are the integration of traditional cultural elements and modern innovation, showing deep historical heritage and unique artistic style.2.TThe market positioning of Chinese animation is to seek the promotion of international influence in the integration of innovation and traditional culture.3. To formulate guidelines for the development of Chinese animation, formulate guidelines that encourage innovation, promote diversity and focus on international cooperation, and promote the development of China's animation industry to a more positive, diversified and influential direction on the world stage.

Keywords: Chinese Animation, Innovation and Application, Character of Chinese cartoon.

1.Introduction

Research on "The development of Chinese Animation Innovation and Application:The Character of Chinese Cartoon"start by the idea of how can improve the character of Chinese cartoon.

This chapter starts with background information, problem statement, research questions, research objectives, research scope, research methods, timetable, research definition, expected research benefits, and conceptual framework. The background information describes the current situation of Chinese animation and why we need to develop Chinese animation, and a clear understanding of these can provide help for subsequent research. The problem statement proposes how we can strike a balance between the preservation and innovation of traditional Chinese culture to meet the needs of different audiences. According to the statement of the problem, two research questions are raised. First, how to balance the creation and innovation of Chinese culture to meet the needs of different audiences? Second, when designing Chinese cartoon characters, how to create attractive and influential cartoon characters? According to the research questions, two research objectives are confirmed: first, to study the needs of different audiences for Chinese cartoon characters; second, to design Chinese cartoon characters. The research scope is Fuzhou Software Vocational and Technical College. Variables are divided into independent variables and dependent variables. Population and samples are selected from the research scope, and population samples of different ages are selected to provide more accurate support for the research data. Research methods: Literature review and analysis, investigation, content analysis, comparative study. The schedule is arranged according to the research content to be done at different stages. Research definitions write about the innovation and creation of animation, the integration and creativity of traditional cultures, audience changes and marketing strategies, the application of technology and cross-media expansion, legal, commercial and copyright issues, international cooperation and influence. Expected research benefits include understanding industry trends, promoting innovation and creativity, cultural inheritance and innovative integration, meeting the needs of diverse audiences, expanding business value and market impact, enhancing domestic cultural confidence, increasing international influence, and providing references for policy formulation.

2.Literature Review

The literature review of "The Development of Chinese Animation Innovation and Application: The Character of Chinese Animation" should be as follows:

In this chapter, the characters in Chinese animation, the cultural integration and inheritance of Chinese animation innovation, the innovation and development of animation technology, the application in movies, TV games and other fields, the impact of animation on education and society, the cultivation of innovative talents and industrial development, and the prospect of technological innovation and related research are discussed.

From the animation "Pig Eating Watermelon",Scriptwriter Bao Lei,   (1958)

From the animation Little Tadpoles Looking for their Mother,based on the fairy tale of the same name created by Fang Huizhen and Sheng Lude (1960)

From the animation Clever Duck, Zheguang Yu,(1960)

From the animation Uproar in Heaven, Laiming Wan,(1965)

Relevant research：

Liu Zhen & Yin Na, (2024). Inheritance and Fusion: A Brief Discussion on the symbolic construction of Meaning in contemporary Chinese Animated Films. Journal of Culture (01),71-74.

Yang Teng-xiao.(2024). Chinese Animation: New Expression of Traditional Culture. Cultural Industry (01),111-113.

Chen Ying.(2020). Inheritance and Innovation of National Culture in Chinese Animation. Journal of Luliang Institute of Education (01),161-162.

Zhang Yi Dan. (2020). "Chinese school" inheritance and innovation of animation research (a master's degree thesis, Beijing institute of printing).

https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CMFD&dbname=CMFD2020&file name=1020762572.nh

3.Research Method

This chapter contain the research method applied for gather data in order to answer the research question for this study.The chapter covers design of the study,development experimental treatment,data collection procedures,data analysis procedures, method of verification.

The study aims to explore the balance between creativity and innovation in Chinese cartoons and investigate the needs of different audiences for Chinese animation. Through the integration of traditional and modern elements, as well as diversified forms of creation, the combination of cultural inheritance and innovation can be achieved to meet the needs of diverse audiences and promote the development of China's animation industry. Data types include social survey data, marketing data, animation data, and cultural data. Social survey data collected opinions and suggestions on the innovation and development of Chinese animation, marketing data analyzed the publicity strategy and box office of animation works, animation production data revealed the production process and resource investment, and cultural data covered the application of traditional Chinese cultural elements in animation and the transmission of cultural values. The research scope covers teachers of different ages and freshmen majoring in animation design in Fuzhou Software Vocational and Technical College. Research focuses on the impact of technical innovation, visual style, content themes on animation, and audience responses to artistic style, plot design, and emotional expression. This paper adopts questionnaire survey as research tool and inserts questionnaire form. The study uses social survey, marketing and animation data to draw conclusions through quantitative and comparative analysis. Balance traditional culture and innovation, cultivate creative talents, promote traditional culture education, diversify creative forms, use social media interaction, organize cultural events, optimize marketing strategies, and promote cross-cultural communication.

4.Data analysis result

In scientific research, researchers often use questionnaires and interviews as research tools to collect data. Questionnaires can help researchers understand the views, attitudes, behaviors and other information of the respondents, providing important data support for the research, while interviews are a method of collecting original data and information, and researchers can obtain their views, experiences, attitudes, beliefs and so on by communicating with the interviewees. This data and information can help researchers answer research questions, test hypotheses, or discover new ideas and trends.

For descriptive analysis, the resulting data showed that the gender distribution of the sample showed slightly more women than men, but was generally more balanced. This shows that both men and women have shown a strong interest in exploring the level of design and innovation in Chinese animation. The questionnaire survey data shows that the number of people aged 18-24 is the largest, accounting for more than half, reflecting the high attention of contemporary young people to Chinese animation. Other age groups, though smaller, also showed interest in and engagement with Chinese animation, indicating the broad appeal of the topic. By occupation, students have a strong interest in Chinese animation, accounting for 60% of the survey sample, and teachers participate in 40%, reflecting a shared concern among teachers and students to explore this field of animation. Regarding the balance between creativity and innovation of Chinese cartoon characters, the data showed that students and teachers who participated in the survey generally agreed that the two should be combined. There are also different

views presented. Firstly, good cartoon characters are the product of creativity and innovation. Secondly, innovation is not to subvert tradition, but to seek new development on the basis of inheritance. Finally, the balance between innovation and creativity will be different for different audiences. The survey on how to achieve the long-term development of Chinese animation shows that the long-term development of Chinese animation needs to focus on creativity, the integration of traditional culture, the application of emerging technologies and the expansion of cross-border cooperation. These aspects together constitute the basis and driving force for the sustainable development of China's animation industry. A survey on whether there is a lack of innovation in Chinese animation shows that innovation in Chinese animation has both progress and shortcomings. Respondents generally believe that Chinese animation needs to continue to strengthen its competitiveness with international animation, while focusing on the transformation and application of market demand and innovation results to promote the sustainable development of China's animation industry. Through exchanges with animation industry professionals, the following points can be drawn about the development trends and changes in China's animation industry: In recent years, China's animation industry has made remarkable progress, thanks to factors such as policy support, technological innovation and international cooperation. The quality of animation works continues to improve, a large number of high-quality original works emerge, especially the rise of online animation and online platforms to inject new vitality into the industry.

The status and influence of Chinese animation on the international stage has gradually increased, mainly due to the implementation of policy support and industrial development planning. The combination of technological innovation and traditional culture is an important feature of China's animation industry. The rise of online platforms has promoted the development of online animation, making animation content more diverse and introducing more advanced production techniques and special effects. The implementation of the administrative licensing system of network drama by the State Administration of Radio, Film and Television has promoted the development of the network animation industry, and the market operation value system has also shown a spiral upward trend.

Talking and communicating with Teacher Fan

Talking and communicating with Miss Li

Talking and communicating with Teacher Zhang

5.Conclusion, Discuss results and Suggestions

The conclusions, discussions and recommendations of the researchers concerning the development of research on Chinese animation innovation and application: The character of Chinese animation, the information obtained is as follows:

Audiences have different needs for Chinese cartoon characters, including cute images, characters related to traditional Chinese culture, and characters with unique personalities and charm. This demand is influenced by factors such as audience age, occupation and preference. When designing Chinese cartoon characters, factors such as audience preferences, cultural characteristics and market demand should be comprehensively considered to create attractive and influential characters. These characters should be able to appeal to the target audience, reflect the innovation and application of Chinese animation, and improve the quality and influence of the works. Audience preferences vary by age and occupation. Teenagers may prefer animations with depth and emotional expression, while younger

respondents may pay more attention to the quality and innovation of the work. Middle-aged and older respondents may be more inclined to traditional and nostalgic animation styles. Cartoon character design should be combined with traditional Chinese cultural elements, such as historical stories, folk customs, festival customs, etc., in order to increase the cultural connotation and national characteristics of the work, and attract more audience's attention and recognition.

6.References

[1]   Fu Guangchao.(2023). On the individual expression of animators in collective Creation -- A case study of character animation creation in Uproar in Heaven. Contemporary Animation (03),48-57.

[2]   Zhang Yongning & Han Le.(2023). Application Analysis of Virtual Reality technology in 3D animation design. Grand View (12),130-132.

[3]   Liu Zhen & Yin Na, (2024). Inheritance and Fusion: A Brief Discussion on the symbolic construction of Meaning in contemporary Chinese Animated Films. Journal of Culture (01),71-74.

[4]   Yang Teng-xiao.(2024). Chinese Animation: New Expression of Traditional Culture. Cultural Industry (01),111-113.

[5]   Chen Ying.(2020). Inheritance and Innovation of National Culture in Chinese Animation. Journal of Luliang Institute of Education (01),161-162.

[6]   Zhang Yi Dan. (2020). "Chinese school" inheritance and innovation of animation research (a master's degree thesis, Beijing institute of printing). https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CMFD&dbname=CMFD2020&file name=1020762572.nh

[7]   Li Hua.(2023). The representation of the Glorious Tang Dynasty in China's film and television works in recent years -- The Twelve Hours in Chang 'an, the Di Renjie Series, Chang 'an Thirty Thousand Li, etc., as examples. Film Review (19),61-65. DOI:10.16583/j.cnki.52-1014/j.2023.19.002.

[8]   Zhang J. (2015). The development context of domestic animated films under policy support since 1990s. Contemporary Film (11),185-188.

[9]   Gong Li.(2023). The Dilemma and Path Analysis of Chinese Film Communication under the Background of "Culture Going Global" -- A Case study of Ne Zha and Monkey King Is Back. Journal of Hengyang Normal University (05),122-127. DOI:10.13914/j.cnki.cn43-1453/z.2023.05.017.

[10] Tao Ye & Shao Zixuan.(2024). At the right time -- a survey on the development of Chinese TV animation and network animation in 2023. Contemporary Animation (01),15-23.

THE INTEGRATION ARTISTIC CREATION: MODERN CONCEPTS AND TRADITIONAL CHINESE METICULOUS PAINTING

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THE INTEGRATION ARTISTIC CREATION: MODERN CONCEPTS AND TRADITIONAL CHINESE METICULOUS PAINTING

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ABSTRACT

The purpose of this study is to study the specific ways and methods of integrating modern concepts with Chinese meticulous painting and how to maintain a balance between the two. This study analyzes the historical background, development innovation, characteristics and applications of the integration of modern concepts and Chinese meticulous painting to understand the further development of the integration of modern concepts and Chinese meticulous painting. This study used quantitative and qualitative methods to investigate the opinions of 200 painting students from art colleges and 5 professional art teachers in the researcher's school on the integration of modern concepts and Chinese meticulous painting.

Judging from the current situation, modern people support the integration of modern concepts and Chinese meticulous painting. In addition, the research results also show that: 1) Fusion can inject new vitality and sense of the times into traditional meticulous painting, making it more in line with the aesthetic needs and cultural trends of modern society. 2) Meticulous painting reflects the living conditions, emotional experiences and thoughts of modern people by introducing themes, concepts and expression techniques from modern society. In order to achieve this balance, artists can innovate in the choice of subject matter and incorporate modern elements and concepts.

The conclusion is that balancing tradition and innovation becomes a major challenge for artists and researchers. While respecting the techniques and aesthetics of traditional meticulous painting, meticulous painting introduces modern themes, concepts and techniques, which can more vividly reflect the living conditions, emotional experiences and thoughts of modern people. This process not only promotes the inheritance and development of traditional art, but also inspires more young people to become interested in and participate in traditional meticulous painting, showing the wonderful possibility of traditional art and modern innovation going hand in hand.

Keywords: Chinese meticulous painting; Integration; modern concepts; Innovation

1. Introduction

In current artistic exploration, the integration of modern concepts and traditional Chinese meticulous painting style has become a significant trend. meticulous a traditional painting style that pays attention to detail and exquisite technique, has historically been known for its intricate details and vivid colors depicting narrative scenes. This style usually focuses on themes such as flowers and birds, figures and landscapes, and is traditionally biased towards showing aristocratic and elegant life. This study aims to explore how meticulous painting can achieve integration and innovation with modern social structure, cultural development and ideological concepts in the context of modern social concepts and cultural changes.

By analyzing how this artistic style absorbs and reflects the changes in modern society, this article explores how meticulous painting inherits tradition while expressing modern themes and concepts through innovative techniques. The research will also cover how cultural diversity in modern society affects the expression form and theme selection of meticulous painting, and how these changes promote the further development and deepening of meticulous painting art.

This kind of artistic practice is not only the inheritance of tradition, but also the pursuit of innovation. It reflects how artists introduce innovative elements to reflect the diversity and complexity of contemporary society on the basis of respecting tradition. Through this study, we can gain a deeper understanding of the active role and significance of cultural heritage in modern society, and how art serves as a bridge between the past and present, East and West.

2. Literature Reviews

The literature review chapter of this study comprehensively explores the evolution of traditional Chinese meticulous painting and its integration with modern concepts. From the peak of the Tang Dynasty to the technical innovation of the Song Dynasty, to the impact of social and cultural changes on the subject matter in the 20th century, the literature records the development and changes of meticulous painting in different historical stages. In addition, this chapter also focuses on the diverse theme selection and changes in aesthetic concepts of meticulous painting in modern society, as well as the application of modern technology in traditional art forms.

Although existing research has provided an in-depth understanding of meticulous painting techniques, aesthetics, and its cultural value, there are several significant research gaps. First, the existing literature has not fully explored the views of contemporary art college students on the integration of Chinese meticulous painting and modern concepts. This group of people may have unique insights into the modern significance and future direction of meticulous painting, and their perspective is crucial to understanding and predicting the development trend of meticulous painting.

Second, there is insufficient analysis of specific case studies of how specific artists blended traditional and modern elements into meticulous paintings' practical and theoretical contributions. Research and discussions with these artists will help reveal the innovative paths of modern meticulous painting in terms of artistic expression and technical techniques.

This study aims to fill these gaps by collecting data using both quantitative and qualitative methods to provide a more comprehensive perspective on how Chinese meticulous painting adapts to and reflects changes in modern society. This includes surveying contemporary art students' perceptions, analyzing how they combine meticulous painting with modern art concepts in their creative practices, and in-depth case studies of specific artists' works to explore how they maintain the essence of their techniques while introducing innovative elements. enrich this traditional art form。

（Liu, L. (2019). Exploration of Chinese meticulous painting teaching in art design majors. Education and Teaching Forum, (03), 156-157. doi:CNKI:SUN:JYJU.0.2019-03-065.

Zhao, Y. (2016). On the influence of Western "realism painting" on the expressive language of contemporary meticulous painting (Master's thesis, Jilin Arts College).

（Wang, X. (2017). A study on the aesthetic characteristics of meticulous flower and bird painting in the contemporary humanistic context (Master's thesis, Yanbian University).

（Qiu, Y. (2020). The influence of Western painting color theory on the development of Chinese modern meticulous painting. Comedy World (Second Half of the Month), (01), 58-60.

（Zhao, L. (2020). The fusion of traditional meticulous painting and modern concepts. Chinese Art Education Research, (2), 86-88.

Liu, X. L. (2020). The coloring of Chinese meticulous paintings. Art Appreciation, (05), 64-65.

Ge Ziwei & Wang Cheng. (2021).The Fusion of Chinese and Western painting —— The Spirit of The Times of "Innovation School" Chinese Painting. Frontiers in Art Research(8.0).

3. Methodology

This chapter contains the research methods used to collect data to answer the research questions of this study. This chapter covers the design of the study, development of experimental treatments, data collection procedures, and data analysis procedures. Authentication method.

In the process of studying the influence of the integration of modern concepts and traditional Chinese fine brushwork, the researcher used text analysis, questionnaires and interviews. First, the researcher determined the theme and goal of the research, focusing on analyzing the integration process of modern concepts and traditional meticulous painting and its impact on artistic creation, audience experience and cultural inheritance. Then the scope of the research and the type of data required were determined. The scope of the research was students of different grades majoring in painting in the School of Art, Entrepreneurship College of Inner Mongolia University. (The reason for choosing students from different grades in the painting major of the School of Art is that students in the School of Art master basic art knowledge and techniques and are professional in investigation. The reason for choosing the painting major is that traditional Chinese meticulous painting is a subject of the painting major), the sample is Inner Mongolia There are a total of 400 people in 8 classes of different grades in the painting major of the School of Art of the University Entrepreneurship College. 25 people (25*8=200 people) and five teachers are selected from each class. The data types include art work data, historical document data and social survey data. The research tools were text analysis, student questionnaires and interviews, and statistical methods and qualitative analysis were used to interpret the data and answer the research questions. Finally, the researchers drew conclusions about cultural integration, artistic innovation and inheritance development, and put forward suggestions on respecting tradition, cultural education, etc. Through the comprehensive application of these methods and techniques, researchers have deeply

explored various aspects of the integration of modern concepts and traditional Chinese meticulous painting, providing useful insights and suggestions for the development of the art world and cultural fields.

4. Results

Questionnaire Summary

The analysis of the questionnaire provided a thorough understanding of university art majors' attitudes, perceptions, and practices concerning the fusion of modern concepts with traditional Chinese meticulous painting. It highlighted the slightly higher interest among first-year students compared to sophomores, with females exhibiting a stronger inclination toward integration. Traditional Chinese painting majors showed the greatest interest, followed by oil painting and art education majors. The internet, art exhibitions, and academic seminars were preferred channels for learning about art. Most students had either attempted or contemplated incorporating modern concepts into meticulous painting, recognizing the potential impacts of globalization, diversification, technology, and environmental awareness. They acknowledged the cultural, aesthetic, and self-cultivation values of meticulous painting and emphasized the importance of preserving traditional techniques while incorporating modern aesthetics. Challenges included market acceptance and conceptual conflicts, with suggestions for better promotion through integration with modern art forms, online platforms, education enhancement, and exhibition activities. Statistical analyses confirmed the reliability and validity of the data, underscoring the significance of this research in advancing the understanding and practice of integrating modern concepts with traditional meticulous painting in contemporary art discourse.

Interview summary.

Interviews with five art teachers provide valuable insights into the fusion of modern concepts and traditional Chinese meticulous painting. Across all interviews, interviewees agreed on the positive impact of combining modern concepts with traditional meticulous painting, with interviewees noting that it has breathed new life and relevance into the traditional art form, attracting a wider audience, especially young generation.

All interviewees recognized the irreversible trend of integrating traditional meticulous painting with modern social concepts and emphasized the need to adapt to changing social norms and aesthetic preferences. They are optimistic about the future of this convergence, foreseeing innovative and contemporary work that resonates with modern audiences.

In terms of integration methods, interviewees focused on themes, expression techniques, and artistic styles. They suggest incorporating modern themes into traditional creations.

The interviews highlighted the importance of combining modern concepts with traditional meticulous painting to ensure its continued relevance and appeal in modern society.
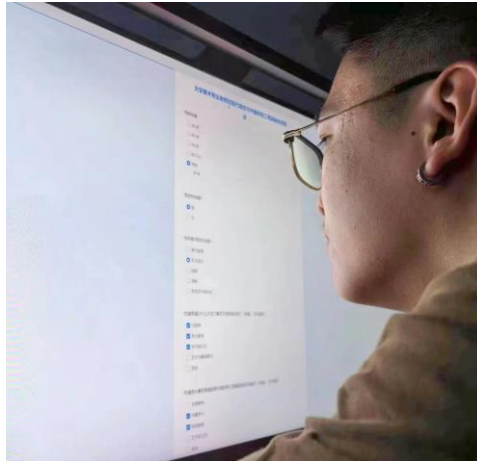
Figure 1 February 23 Student Li filled out the questionnaire.

Figure 2 Exclusive interview with Liu Rong at the Entrepreneurship School of Inner Mongolia
University on September 18, 2023

5. Conclusion and Recommendation

Conclusion1 ：The researcher can see that the integration of modern concepts and traditional Chinese meticulous painting shows a variety of forms and methods, which is specifically reflected in several main aspects. First of all, through interviews, researchers can find that the innovation of theme and content is an obvious way of integration [8], by introducing elements such as life scenes, social reality and individual emotions in modern society, making traditional meticulous paintings more relevant Modern people's lives and thoughts have also injected new vitality into traditional art forms. In the creation of contemporary meticulous paintings in the new century, some "new meticulous" phenomena have appeared. These works pursue expression in the form of ink and wash media and pursue the expression of the aesthetic effect of the picture. They try to break the shackles of traditional meticulous and show the unique charm of modern art [11]. Secondly, the update of expression techniques and technology is also another way of integration, including the use of digital technology for creation, borrowing expression forms from Western painting art, and combining with contemporary art forms [9] These all-open new opportunities for traditional meticulous painting. In order to create a new field of

expression and creative space, contemporary meticulous painting has accepted the innovative ideas of Western realistic modeling and "modern ink painting" on the basis of tradition, forming a new style of meticulous. This style not only retains the charm of traditional meticulous painting, but also incorporates elements of modern art, giving meticulous painting a new vitality. In addition, the selection of materials and the innovation of artistic styles are also important aspects of integration. By using modern materials or exploring new artistic styles [10], traditional meticulous painting not only maintains its unique aesthetic value, but also demonstrates Characteristics of modern art.

Conclusion 2 ：the integration of traditional Chinese meticulous painting and modern concepts is a process of inheritance and innovation in parallel, with far-reaching and multifaceted influences. It can be seen from the questionnaire survey and interviews that the interviewees generally believe that this integration can inject new vitality and sense of the times into traditional meticulous painting, making it more in line with modern society while retaining the traditional essence. aesthetic needs and cultural trends. The key to integration lies in how to balance tradition and innovation. On the one hand, we should maintain respect and inheritance for the techniques and aesthetics of traditional meticulous painting, and retain its unique cultural value and artistic characteristics; on the other hand, by introducing themes, concepts and expression techniques of modern society, we should make meticulous paintings reflect modern people living conditions, emotional experiences and ideas, thereby enhancing its sense of the times and universal appeal. In order to achieve this balance, artists can innovate subject selection, integrate modern elements and concepts, and even combine digital technology and new media to explore new forms of expression while retaining traditional techniques. In this way, it can not only ensure the traditional charm of meticulous painting, but also make it an important carrier to convey modern culture and ideas, promote the inheritance and development of traditional art, and stimulate the interest and participation of more young people.

Recommendation：

1. Respect tradition

1.1 Maintain the inheritance of techniques and spirit: When integrating modern elements, artists should retain the basic techniques and spirit of meticulous painting. This includes the mastery of line, the use of color, and the traditional rules of composition. This respect is not only reflected in techniques, but also in conveying traditional cultural values and philosophical concepts.

1.2 Balance innovation and inheritance: When artists innovate, they need to find a balance so that their works can not only show the characteristics of modern aesthetics, but also retain the charm and artistic conception of traditional meticulous paintings. This requires artists to have a deep understanding and respect for traditional meticulous painting.

2．Culture and education

2.1 The role of art education: Art education should emphasize the study of traditional art and the exploration of modern creation, helping students understand the connections and differences between tradition and modernity. Educators can allow students to experience and understand this integration process through case studies, workshops, and practical projects.

2.2 Popularization and appreciation by the public: Through exhibitions, lectures, media and online platforms, convey to the public the meaning and value of artistic works that combine traditional meticulous painting with modern concepts. This can help the public better understand the culture and creative process behind these works and enhance their sense of cultural identity and aesthetic appreciation.

Acknowledgement

6. References

[1]   Wang, Z. Q. (2021). An analysis of the use of lines in meticulous painting. Fine Art Literature, (09), 67-68.

[2]   （Liu, L. (2019). Exploration of Chinese meticulous painting teaching in art design majors. Education and Teaching Forum, (03), 156-157. doi:CNKI:SUN:JYJU.0.2019-03-065.

[3]   Zhao, Y. (2016). On the influence of Western "realism painting" on the expressive language of contemporary meticulous painting (Master's thesis, Jilin Arts College).

[4]   （Wang, X. (2017). A study on the aesthetic characteristics of meticulous flower and bird painting in the contemporary humanistic context (Master's thesis, Yanbian University).

[5]   （Qiu, Y. (2020). The influence of Western painting color theory on the development of Chinese modern meticulous painting. Comedy World (Second Half of the Month), (01), 58-60.

[6]   （He, Y., & Shen, J. (2019). The role of art education in enhancing cultural identity. Journal of Art & Design Education, 38(2), 226-239.）。

[7]   （Li, C. (2021). The evolution of traditional Chinese painting in the context of contemporary art. Journal of Contemporary Art Studies, 29(1), 54-68.）。

[8]   （Liu, Y. (2019). "The Integration of Modern Concepts and Traditional Chinese Ink-wash Painting: A Demonstration of the Innovation of Theme and Content." Journal of Art & Design, 32(5), 67-72.

[9]   （Chen, D. (2008). Integration of Chinese and Western styles: New explorations in contemporary Chinese meticulous painting. China Art, (1), 36-40.

[10] （Wu, G. (2018). The fusion of traditional meticulous painting and modern art styles. Art Research, (2), 45-47

[11] （Lu, T. (2019). Concept first: On the semantic expression innovation of new meticulous. Beauty and the Times (Middle), 2019(09), 28-29

[12] （Zhao, L. (2020). The fusion of traditional meticulous painting and modern concepts. Chinese Art Education Research, (2), 86-88.

[13] Liu, X. L. (2020). The coloring of Chinese meticulous paintings. Art Appreciation, (05), 64-65.

[14] Ge Ziwei & Wang Cheng. (2021).The Fusion of Chinese and Western painting —— The Spirit of The Times of "Innovation School" Chinese Painting. Frontiers in Art Research(8.0).

[15] Sun, H. (2021). Creation and Interpretation: Study on the Symbolism of Traditional Chinese Painting. In Proceedings of the 5th International Conference on Art Studies: Research, Experience, and Education (pp. 241-247). Amsterdam University Press.

[16] Qing Zou. (2020).The Embodiment of Chinese ink Culture in the Creation of Traditional Chinese Painting. Frontiers in Art Research (5).

[17] Xiaomiao Tian. (2019). Research on the Influence of Chinese Traditional Philosophy on the Artistic Conception of Contemporary Chinese Painting. (eds.) Proceedings of 2019 7th International Education, Economics, Social Science,Arts,Sports and Management Engineering Conference(IEESASM 2019)(pp.236-239).Clausius Scientific Press,Canada.

ENHANCING PARTICIPATION IN HIGH SCHOOL ARTS EDUCATION IN GUIYANG,CHINA

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ABSTRACT

The purpose of this paper is to explore how to enhance the participation of art education in high school. With the continuous development of society and the implementation of the reform of college entrance examination, the importance of art education in senior high school has become increasingly prominent. However, at present, there is a problem that students' participation in art courses is not high. This paper suggests several ways to enhance engagement: increasing classroom interaction formats, such as group discussions and collaborative projects; offering a rich variety of art courses to meet students' interests and needs; introducing new technologies and media, such as virtual reality and digital art, to attract students' attention; and providing opportunities for students to participate in art activities, such as school exhibitions and cultural festivals. By taking these measures, we can effectively improve the participation of high school art education, stimulate students' creativity and artistic potential, and cultivate their interest and love for art.

Keywords: High school, Art Education, Enhancing

1. Introduction

Since the 21st century, the maturity of technology and the rapid development of the economy have made it extremely easy for young people to feel lost and anxious about their future. This problem is essentially a reflection on life. Art education, as an important way to help young people establish their thinking ability, cognitive structure, and values, can cultivate their aesthetic ability, creativity, expression ability, and critical thinking ability, Thus improving the comprehensive quality and innovative ability of students, laying a foundation for their future learning and work.

As an extension of compulsory education, the high school stage bears more important and in-depth responsibilities. Therefore, based on improving the participation of art education in high schools in China, this article proposes a study on "strengthening the participation of art education in high schools in Guiyang, China", providing reference for the cultivation of innovative talents and the comprehensive improvement of national humanistic literacy.

2. Literature Reviews

High School art education is divided into several subjects that play different roles in practice. This literature review examines several academic articles exploring the field of high school art education. Specifically, the analyses included Chen Xinhuang (2017), Zhou Yiqiang, (2012), and Shi Jie (2020), which provided their own diverse insights.

1.Chen Xinhuang(2017).Exploration of Tao Xingzhi's Art Education Practice [D]. Shanghai Theatre Academy : The uniqueness of art education makes art education unique, which can not be replaced by other education. From art, students can get knowledge, beliefs and values about ourselves and the world. The experience and significance of these knowledge and viewpoints can not be provided and replaced by any other discipline, so art education is an indispensable and important part of school quality education. It plays an important role in the implementation of quality education, and art education has the function of cultivating students' good ideological quality. The things reflected by excellent works of art are usually artistically processed by the author to make the prototype of life more vivid and typical, so as to make the essence of things more real.

My view of the scholar's findings is that through art, students can gain knowledge, beliefs, and values about ourselves and the world. The experience and significance of such knowledge and ideas can not be provided and replaced by any other discipline, which shows the uniqueness of art education.

2. Zhou Yiqiang(2012). The Importance of Strengthening the Cultivation of Humanistic Spirit in High School Art Education [J]. Time Education (Education and Teaching), (10): 65：Art education also contributes to the emotional regulation and mental health of high school students. Adolescence is a period of great emotional ups and downs, and students often face pressure and challenges. Art education provides an outlet for students to vent their emotions and regulate their emotions through creation. Art forms such as painting, music and dance can help students express their inner feelings and find ways to vent their stress. Studies have shown that participation in art activities can improve students' emotional state, reduce the degree of anxiety and depression, and improve their mental health.

Zhou Yiqiang's insights are particularly relevant because he reinforces the idea that art education also contributes to emotional regulation and mental health among middle school students.

3. Shi Jie.(2020).Current Situation and Countermeasures of Art Education in Middle Schools [J]. Wenli Navigation (Mid-Autumn), (10): 72-73: The evaluation system to promote the all-round development of students has not been effectively implemented, and students' academic performance is still the main basis for evaluating the development of students and the quality of school running. As a non-college entrance examination subject, the new art curriculum in high school is in a very secondary position in the minds of schools, teachers, students and parents. Because the general college entrance examination system has not changed much, the enrollment rate will remain the theme for a long time. The academic performance of the students is still the main basis for evaluating student development and the quality of running a school. This problem is one of the main reasons that restrict the expansion of high school art curriculum

In the conclusion: In recent years, the research on improving the participation of art education in senior high school is an important issue in the field of education. With the social recognition of the value of art education, more and more scholars and educators begin to pay attention to how to effectively improve the interest and participation of high school students in art education. The importance of promoting the participation of high school art education is self-evident. Art education can not only cultivate students' aesthetic ability and creativity, but also help to improve students' comprehensive quality and competitiveness. However, the participation of high school students in art education is generally low, which limits the development and effect of art education to a certain extent. To sum up, enhancing participation in arts education at senior secondary level is a systems engineering that requires concerted efforts from various parties. Future research can further explore how to effectively combine these strategies and methods to form a complete and operational lifting scheme. At the same time, with the deepening of educational reform and the increasing demand for art education, I believe that the participation of art education in senior high school will be further enhanced.

3. Methodology

Using comprehensive research methods such as literature study, questionnaire survey, CASE study and data analysis, this paper analyzes the attitudes of teachers and students in a middle school in Guiyang with regard to the low level of participation in the art curriculum, through the existing literature summary and specific analysis of the specific problems of the differences in the treatment of the main causes of problems and solutions

The purpose of studying the issue of student engagement in high school art courses is to gain insight into student performance and engagement in the art classroom in order to provide teachers and schools with effective instructional guidance and suggestions for improvement. First of all, art courses are of great significance to the development and growth of students. Art education can cultivate students' creativity, imagination, expressive ability and aesthetic consciousness, and has a positive impact on students' cognitive, emotional and social abilities. Therefore, understanding students' participation in the art classroom can help teachers better meet students' learning needs, stimulate students' learning motivation, and improve teaching effectiveness. Secondly, the participation of students in high school art courses is closely related to academic performance and academic development. Studying student engagement can help teachers understand students' learning attitudes, learning styles and learning difficulties in the classroom, and provide a basis for personalized education. At the same time, the evaluation and assessment methods of art courses are usually special, different from the traditional written examination and written homework, and the study of students' participation can also provide a reference for evaluating and monitoring students' learning progress. Finally, the study of students' participation in high school art courses can also provide feedback for classroom teaching improvement and curriculum design. Understanding the participation of students can help teachers find problems and shortcomings in teaching, so as to adjust teaching strategies and methods. At the same time, it can also

provide guidance for curriculum design, design more interesting and attractive art learning activities, and improve students' participation and learning effect. Therefore, the specific study of students' participation in high school art curriculum is helpful to promote students' art learning and all-round development, and improve the quality of teaching and education.

Through literature collection and analysis, some problems and improvement methods to improve the participation of high school students in art classes are obtained. Through questionnaires, case studies and data analysis, specific feedback from teachers and students in high schools is collected, and real participation in art courses is obtained. The research questions identified the following three areas: What are the reasons for the decline in student participation in art courses? What is the impact of declining participation on students' creative development and general abilities? What are the teaching methods and curriculum designs that help to revive high school students' interest in art education? Through the analysis and research of specific problems, we can get the final solution through the school, teachers and students.

4. Data analysis results

The main data comes from the real feedback of art course teachers and students in Guiyang No.2 Middle School, Guizhou Province, China. Through questionnaires and some interviews, including before class, during class, after class and the real feelings of art course, teachers and students can get the evaluation of art course. The secondary data mainly come from published papers, including the development of art curriculum in high school, the problems in music, art and calligraphy curriculum and the proposed solutions.

Population：The target population of this study is high school students from a middle school in Guiyang City, China. The population for this study was divided into the following three groups:

1) There are 157 teachers in total, including 57 in Grade One, 50 in Grade Two and 50 in Grade Three.

2) Guiyang No.2 Middle School students in Grade One, Grade Two and Grade Three = 1959, including 677 students in Grade One, 659 students in Grade Two and 623 students in Grade Three.

Sample：Students from two classes of each of the three age groups in Guiyang No.2 Middle School, China.

1) There are 57 teachers in total, including 20 in Grade One, 18 in Grade Two and 19 in Grade Three.

2) A total of 857 students, including 456 students in Grade One, 301 students in Grade Two and 100 students in Grade Three, were selected by systematic random sampling from the schools of Grade One, Grade Two and Grade Three.

Count the class attendance of each student: Record the attendance of each class, track the attendance rate of students, and compare the performance differences between students with regular attendance and those with irregular attendance.

The relationship between test scores and participation: analyze the relationship between students' test scores and their participation in the classroom. We can analyze the correlation between test scores and participation to find out whether there is a positive correlation between participation and test scores.

Subdivision analysis of students' participation: students' participation can be further divided into active participation and passive participation. Active participation includes the behavior of actively participating in classroom activities such as answering questions, asking questions and completing projects, while passive participation refers to the behavior of passively accepting teaching such as listening to lectures and taking notes. By comparing the impact of these two ways of participation on students' learning performance, we can understand which way of participation is more conducive to students' learning progress.

The relationship between students' participation and satisfaction: To understand the relationship between students' satisfaction with the course and their participation, we can obtain students' evaluation of the course through a questionnaire survey, and make a comparative analysis with their participation, so as to determine the correlation between students' satisfaction and participation.

In data analysis, statistical analysis software (such as Excel, SPSS, etc.) Can be used to make data statistics, draw corresponding charts, and make correlation analysis and regression analysis, so as to better understand the participation data of high school art courses.

5. Conclusion and Suggestions

Conclusion

When collecting data, especially questionnaires and case studies, we should pay attention to the following contents.

Active participation: Actively participate in discussions in class and put forward their own opinions and views. Share your understanding and feelings about the works of art with your classmates, and promote interaction and communication.

Respect other people's opinions: respect other people's views and opinions, and be open to different opinions. Art is pluralistic, and everyone's understanding and preferences for works of art may be different, so it is important to maintain a respectful and inclusive attitude.

In-depth discussion: The topics discussed in class can be further considered and discussed. It can be studied in depth from the artist's creative background, the form of expression of his works, and the artistic style, so as to enrich his knowledge and understanding.

Ask questions: In the process of discussion, if you have doubts or need to explore a topic more deeply, you can actively ask questions. By consulting teachers and classmates, we can better understand and master art knowledge.

Cooperation and communication: cooperate and communicate with students, learn from each other and learn from each other. It is possible to organize group discussions, study and display works of art together, and think and solve problems together.

Multi-perspective thinking: In discussion and analysis, try to think from different perspectives, such as history, culture, social background, etc. By broadening the way of thinking, we can understand the connotation and expression of works of art more abundantly.

Combining the above measures, schools can effectively improve the participation of high school art education, stimulate students' enthusiasm for learning and self-expression ability, cultivate their comprehensive ability and teamwork spirit, and make art education an important support for students' growth and development.

Discussion

Improving creativity and imagination: Art courses can cultivate students' creativity and imagination, and help them develop their unique way of thinking in the process of artistic creation by creating and expressing their ideas.

Enhance aesthetic ability: Art courses can help students develop aesthetic ability, improve the ability to perceive and understand works of art, apply this ability to life, and better appreciate and understand beauty.

Enhance the ability of emotional expression and emotional management: Art courses can provide students with a way to express their emotions and emotions, release their inner pressure through painting, music, dance and other forms, and cultivate the ability of emotional expression and emotional management.

Cultivating teamwork and communication skills: Art courses usually involve cooperation and collaboration, and students need to cooperate with others to complete art projects, which cultivates students' teamwork and communication skills, and cultivates students' collective concept and team consciousness.

Enhance self-confidence and self-identity: Art courses encourage students to express their views and ideas, show their talents and personality through works of art, enhance self-confidence and self-identity, and help students establish a positive self-image.

Generally speaking, participating in art courses is of great significance to the development of senior high school students, not only to cultivate their artistic skills, but also to improve their comprehensive quality and personal development.

Suggestions

On the basis of analyzing the main problems existing in the teaching of art course in senior high school, this paper puts forward some concrete optimization paths: solving the problem of declining participation degree of art education of senior high school students in China, this can be achieved through three aspects: first, school infrastructure construction and school policy support; second, teachers' sharing of diverse curriculum content and good role models; Third, the cross-discipline improvement of students' self-regulated learning consciousness.

Firstly,Schools can build classrooms and studios dedicated to art education, including painting rooms, sculpture rooms, photography studios, etc., to ensure that students have a good creative environment.Invest in facilities and equipment such as music rooms, stage theaters, and dance studios to

support students' learning and performance in music and performing arts.Provide good equipment and tools required for art education, such as painting materials, musical instruments, stage lighting, etc., to ensure that students have good conditions for creation and performance.

Secondly,Interdisciplinary integration: Design interdisciplinary art courses, combine literature, history, science and other disciplines to expand students' artistic vision and knowledge.Practical experience: Organize field trips, art workshops and other practical activities to allow students to experience the process of art creation and improve their practical ability and creative skills.Introduce cutting-edge trends: pay attention to the cutting-edge trends and development trends in the field of art, update the course content, introduce new art forms and media, and stimulate students' innovative thinking and desire to explore art.

Thirdly, Interdisciplinary project learning: Design interdisciplinary projects to allow students to combine the content of other disciplines in art courses, such as drawing artworks with historical backgrounds, exploring the application of scientific principles in art, etc., to stimulate students' understanding of the relevance between different disciplines. Encourage self-directed learning: Encourage students to independently explore the relevant knowledge of other disciplines outside of class, such as visiting museums, reading relevant books, watching art documentaries, etc., to deepen the connection and logical thinking between different disciplines.

Cross-discussion and sharing: Organize interdisciplinary discussion and sharing activities for students to share their learning experiences and experiences in other subject areas, so as to expand their thinking, expand their disciplinary cognition, and promote interdisciplinary self-art learning awareness.

6. References

[1] Chen Xinhuang. (2017).Exploration of Tao Xingzhi's Art Education Practice [D]. Shanghai Theatre Academy.

[2] Zhou Yiqiang.(2012). The Importance of Strengthening the Cultivation of Humanistic Spirit in High School Art Education [J]. Time Education (Education and Teaching), (10): 65.Thorsteinsson, G., & Gisli. (2014). Impact of Computer Technology on Design and Craft Education. Journal of Educational Technology, 10(4), 40-50.

[3] Shi Jie.(2020).Current Situation and Countermeasures of Art Education in Middle Schools [J]. Wenli Navigation (Mid-Autumn), (10): 72-73.

[4] Kang Zhiqun. (2016).Discussion on Innovative Art Education Facing Society [J]. Art Appreciation, (01): 293.

[5] Lu Xudong. (2018).Research on Aesthetic Construction of High School Curriculum with Fine Arts Characteristics [D]. East China Normal University.