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Development of a Handbook: The Classification of Vertebrates for Elementary Students

Weerawich Wongroj[1]

Ruthairat Siriwattanarat[2*]

[1]Srinakharinwirot University Prasarnmit Demonstration School (Elementary)

[2]Faculty of Science and Technology, Suan Sunandha Rajabhat University

[*]Corresponding author. E-mail: ruthairat.si@ssru.ac.th

Abstract

This research aimed to develop a handbook on the classification of vertebrates for elementary school students. This study employed a one-group pretest-posttest design. Thirty fourth-grade students were asked to learn through a conventional method for eight periods of 60 minutes each. This research was a quasi-experimental design and was conducted using one group pretest-posttest design based on cluster random sampling. The data were statistically analyzed by t-test for dependent samples.

The result of this research found that: 1) A handbook on the classification of vertebrates had expert validation in terms of accuracy, language, content suitability, clear illustrations, classification skills, effectiveness, and the feasibility of a handbook on the classification of vertebrates is "very valid", so that the conclusion of the validation is feasible to use; 2) the achievement of learning students in the last study by the classification of vertebrates for elementary school students was higher than before the experiment at a .01 level of significance; and 3) the satisfaction of students after learning from a handbook on the classification of vertebrates for elementary school students was higher than before the experiment at a .01 level of significance.

KEYWORDS: handbook, classification, vertebrates

Introduction

Animal classification systematics is considered an integral part of the topic of Vertebrates in class (Schaal *et al.*, 2012). One of the main goals of animal classification systematics is to construct a general reference system or classification (Subekti *et al.*, 2019). Classification is the process of organizing objects into groups based on observed properties so that the pattern becomes clear (Krause *et al.*, 2007). Classification skill is the ability to classify based on observable properties, give names, and classify a series of objects according to their appearance, size, or other characteristics (Krause *et al.*, 2007). Biological systematics is based on being able to correctly identify an animal to a species (Jeno *et al.*, 2017). An identification key is very important in animal classification studies. Identification keys are multidimensional scientific tools that describe characteristics, name, classify, and define relationships between species. Identification keys involve taxon measurements or inequality similarities in taxon (Stephen, 2007).

In accordance with Piaget's (1962) developmental theory, which stated that children between the ages of 7 and 11 who are in elementary school have the ability to group or classify objects, the development of classification skills aimed at the student's ability to analyze animal species at the youth level and therefore enable learners to develop both scientific process skills and critical thinking skills. The information being offered is relevant to today's psychology. Students in the second grade are interested and like playing games. For instance, (Zirawaga *et al*, 2017) found that gaming in education increases students' motivation and engagement, to enhance visual skills, to improve students' interaction and collaboration abilities with their peers, and to enable them to apply gaming values in a real-world situation.

In addition to having fun, kids will learn, a handbook on the classification of vertebrates can effectively stimulate childrens' interests and promote learning. Learning is difficult, and it fosters children's inventiveness, according to Malone's Theory of Motivation (1981). The ambiance is intriguing, stimulates the interest of students to have the option of choosing a program of study based on their aptitude. It reacts to minute modifications.

The following research had the goal to show the effects of learning after using a handbook on the classification of vertebrates approach to measure the learning achievement of students and students' satisfaction towards learning from a handbook on the classification of vertebrates. Previous research in the field of animal classification teaching was conducted in Poland. Chylen'ska and Rybska (2018) found that teaching with the context of using a handbook is far more successful than teaching and learning without context. The results show that pedagogical implications should be founded on, and linked to students' thoughts and interests about it. This allows us to understand the idea of teaching more thoroughly and holistically about animal classification. The findings of this study may provide fundamental knowledge that will be helpful for students to acquire and accomplish the desired learning goals. The vertebrate classification of local creatures includes help in the development of scientific method expertise, and can be used as a guide for teachers to use in controlling teaching and learning.

Objectives

1. To study the feasibility of using a handbook on the classification of vertebrates.

2. To study the efficiency of learning after using a handbook on the classification of vertebrates approach on the set criterion 80/80 standard.

3. To assess students' learning achievement before and after using a handbook on the classification of vertebrates.

4. To explore students' satisfaction with learning from a handbook on the classification of vertebrates.

Materials and Methods

This study was conducted with research and development. The experiment was divided into 4 stages as follows:

Step 1: The researcher studied the fundamental information for the development of a handbook on the classification of vertebrates by studying documents related to the classification of vertebrates, dichotomous keys, morphology, and the development of learners, then synthesized the information as a handbook on the classification of vertebrates for elementary school students. The researcher developed a handbook on the classification of vertebrates for elementary school students by drafting a handbook and evaluating its suitability and feasibility as a handbook on the classification of vertebrates. The target group for examination and suitability evaluation of a handbook on the classification of vertebrates consisted of 5 specialists in handbook development, a science teacher, a biologist, and an educational measurement and evaluation specialist who is certified as an educator. Improvement of student achievement in learning is measured using a questionnaire with a Likert scale given after using a handbook on the classification of vertebrates as shown in Table 1.

Table 1. Category of Validation.

Score Scale (100%)	Validity Criteria	Description
81-100	Very Valid	Appropriate
61-80	Valid	Appropriate
41-60	Fairly Valid	Not Appropriate
21-40	Less Valid	Not Appropriate
0-20	Strongly not Valid	Not Appropriate

Step 2: The researcher measured the efficiency of learning after using a handbook on the classification of vertebrates, the E1/E2 formula developed by Brahmawong (1978) was employed. The participants were required to learn science through the developed handbook on the classification of vertebrates for 3 weeks. During the semester, they were assigned to complete the five-unit exercises, and the score of each exercise was collected throughout the semester. The total core of all participants was used to measure the efficiency of the process (E1), and at the end of the chapter, students were given a posttest to measure the efficiency of the product (E2).

Step 3: The researcher studied the Pretest-Posttest Group Design. In the design, there was one group that was cluster random

sampling, which was 30 elementary 4/5 students who were studying at *Prasarnmit Demonstration School* (*Elementary*), Bangkok province in the first-semester academic year of 2022. Cluster random sampling was adopted to select one section of the 4th grade to be the sample group. Since the study adopted a one-group pretest-posttest design, only one section was chosen as the sample group. In order not to have any bias, the researcher did the lucky dip between sections of the 4th grade. Through the lucky dip, a section

Sample Group Pretest - Posttest used in a handbook on the classification of vertebrates with 30 students was chosen as the sample group for the study. The sample group was found to be equally divided in terms of academic abilities.

Step 4: The researcher studied the satisfaction assessment of a handbook on the classification of vertebrates from students using an instrument in the form of a questionnaire containing an assessment of the satisfaction of a handbook on the classification of vertebrates,

Table 2. Criteria for data interpretation.

Criteria	Level of satisfaction	Weight value
4.21-5.00	Most	5
3.41-4.20	Much	4
2.61-3.40	Moderate	3
1.81-2.60	Little	2
1.00-1.80	Least	1

Table 3. Collecting data technique.

No	Techniques	Instrument	Data Type	Data Source
1	Validation	Validation Sheet	Validation score of a handbook on the classification of vertebrates	Validator
2	Summative test	Multiple choice test	Student answer scores to determine the effectiveness of a handbook on the classification of vertebrates	Students
3	Summative test	Multiple choice test	Student answer scores to determine the increase in achievement in learning students	Students
4	Questionnaire	Question-naire Sheet	A questionnaire sheet used to analyze student responses in satisfaction after learning from a handbook on the classification of vertebrates	Students

a set of questionnaires framed using a five-point Likert scale was used. The questionnaire consisted of 20 statements relating to the student's satisfaction towards the use of a handbook on the classification of vertebrates. This survey used a 5 - level rating scale evaluation with 5 levels of weight values as Table 2 (Srisa-ard, 2002).

Data Analysis

A handbook on the classification of vertebrates was determined to be suitable and feasible for students by expert validation. Analysis of the effectiveness of a handbook on the classification of vertebrates was conducted with the processing and performance resulting effectiveness of E1/E2 criteria. The achievement in learning students was analyzed with means, standard deviation, percentage, and t-test for dependent samples. The satisfaction assessment

of a handbook on the classification of vertebrates was from students using a questionnaire.

Results and Discussion

The results of the study correspond to the four following.

The validation process produces notes that are considered for revision. The results of the validation process are a draft handbook that is ready for further field testing. The results of the validation of specialists in handbook development included a science teacher, a biologist, and an educational measurement and evaluation specialist for elementary students. The feasibility of a handbook on the classification of vertebrates is "Very Valid", so the conclusion of the validation is feasible to use. The summary of the Expert Validation results can be seen in Table 4.

Table 4. Summary of Expert Validation.

Validation	Average	Percentage (%)	Category	Criteria
Terms of accuracy	3.68	92.18	Very Valid	Appropriate
Language	3.56	88.89	Very Valid	Appropriate
Content suitability	3.90	97.50	Very Valid	Appropriate
Clear illustration	3.81	95.37	Very Valid	Appropriate
Classification skills	3.73	93.27	Very Valid	Appropriate
Effectiveness	3.42	85.54	Very Valid	Appropriate

Classification of living things contains a lot of memorization about the characteristics of living things and scientific terms, and because of that, students find it difficult to

understand (Subekti *et al.*, 2019). A handbook on the classification of vertebrates is an innovation in learning that has the characteristics of Classification skills. (Schaal *et al.*, 2012; Jeno

et al., 2017; Lestari *et al*., 2019; Norman *et al*., 2016; Rosamsi *et al*., 2019; Subekti *et al*., 2019; Yayan, 2022).

The effectiveness of a handbook on the classification of vertebrates with a sample of 30 elementary students at the 4th grade level science class with the processing and performance resulted in an effectiveness at 80/80 criteria. Table 4 reports the effectiveness of a handbook on the classification of vertebrates.

Table 5. Score Total, Mean, Standard Deviation, and Percentage for the Effectiveness of a handbook on the classification of vertebrates for students.

Efficiency Type	Total Score	Mean	Std. Deviation	Percentage (%)
Efficiency Performance Processes (E1)	30	25.36	4.21	84.52
Efficiency Performance Results (E2)	30	25.10	5.04	83.67
The Lessoning Effectiveness (E1/E2) = 84.52/83.67				

N = 30

Table 5 shows the results for the effectiveness of a handbook on the classification of vertebrates. The effectiveness of a handbook during the learning process (E1) reveals 84.52 and the performance effectiveness (E2) indicates that of 83.67, so handbook effectiveness (E1/E2) evidence of 84.52/83.67, over the threshold setting of 80/80.

To examine the effectiveness of the instructional package, the E1/E2 formula has been widely employed. The criteria for E1/E2 are usually set at 90/90 or 85/85 for the cognitive domain and 80/80 or 75/75 for the affective domain and psychomotor skills (Brahmawong, 1973), as cited in Educational Research and Innovation Development Institute (2017). Therefore, the content of this developed model was considered to be a process for developing classification skill ability as well as changing learners' behaviors and attitudes, which takes time; so, the acceptable criterion of E1/E2 should be set at 80/80. This is consistent with Chanphao (2006); Rattanawan (2017); Imanda *et al*. (2020), who developed instructional tools to improve science teaching and their students' behaviors and attitudes.

Comparisons between the learning outcomes of students' Pretest and Posttest assessments using a handbook on the classification of vertebrates using the 30-item test results were evaluated. The statistical significance of the difference between the learning results of students' pretest and posttest assessments is shown in Table 6.

Table 6. Test of significance in a handbook on the classification of vertebrates in the experimental group using t-test for one group samples.

Variables	N	Mean	Std. Deviation	Mean Diff.	t-value	Sig. (p)
Pretest	30	10.82	2.34	13.00	16.34***	.000
Posttest	30	16.64	2.51			

N = 30, *** $p < 0.01$

The achievement of learning students would need assessments at two points in time, with the average mean scores of the pretest of 10.82 and the posttest revealed as 16.64. In most cases, the standard deviation for the pretest was 2.34 and for the posttest was 2.51, and the mean difference between pre-tests and post-tests of 13.00 were compared. It also provides support for a handbook on the classification of verte-brates that teachers needed to take differences into consideration when planning and designing science with the dependent t-test, significantly ($\rho < 0.01$).

These results suggest that the increase in the mean attainment of the posttest of the experimental group might be attributed to the intervention that the respondents were subjected to. This is in line with the findings from a study by Ngakhala *et al*. (2017); Imanda *et al*. (2020) who reiterate that Biology teach-ers should adopt the learner-centered approach in teaching so that learners may show greater participation in practical activities and learn by self-discovery. Biology teachers should increase the frequency with which they teach practical lessons in their classrooms and laboratory. Fur-thermore, they should ensure that all biology practical activities are discussed to enable learn-ers to comprehend and understand the difficult concepts that they were unable to conceptualize. Although teaching using a handbook on the classification of vertebrates will help students to become more interested and have fun learning, some students still do not understand how to use a handbook. As a result, the average score after studying was slightly higher than 50%. The researcher found that learning management for all students in the class to develop knowledge, skills, and attitudes required organizing a variety of learning processes to respond to individual differences.

The results of exploring students' sat-isfaction towards learning from a handbook on the classification of vertebrates are shown in Tables 7 and 8.

Data presented in Tables 7–8 showed that the experimental group registered a signifi-cantly higher satisfaction at a 0.01 level after learning through a handbook on the classifica-tion of vertebrates.

Table 7. Test of significance in the overall satisfaction regarding learning through a handbook on the classification of vertebrates in the experimental group using t-test for one group samples.

	N	Satisfaction		t	p-value
		Mean	Std. Deviation		
Experimental group	30	3.61	0.49	6.073***	0.000

*** $p < 0.01$

Table 8. Analysis of basic statistical data in the experimental group's satisfaction with learning through a handbook on the classification of vertebrates.

Satisfaction	Experimental group	
	Mean	Std. Deviation
1) The handbook is able to explain and give examples clearly.	3.54	0.58
2) I prefer to use the handbook because I have opportunities to practice my animal classification skills.	3.57	0.41
3) I enjoy learning through the handbook; it is not boring.	3.58	0.41
4) The learning process in this handbook enables me to understand the classification of vertebrates.	3.63	0.53
5) The learning process in this handbook is very interesting and attractive to me for ongoing learning.	3.61	0.46
6) I enjoy the steps of teaching in this handbook, which encourage me to construct, analyze, and solve problems.	3.60	0.59
7) I feel that I can better develop classification skills by using the handbook.	3.64	0.56
8) The learning gained in using the handbook is useful to me.	3.41	0.58
9) I feel that I can classify better in vertebrates on various groups.	3.83	0.44
10) I am very satisfied regarding learning through the handbook.	3.67	0.42
Total	**3.61**	**0.49**

At the time of learning by using a handbook on the classification of vertebrates, the students looked enthusiastic and interested in the existence of the handbook. This shows that the handbook provides a picture of the teaching and learning process for students. In line with the research results of Purnamasari (2012), observing the pictures of living things in the media and students being required to group these pictures using the key to determine classification,

inspired enthusiasm, and increased students' motivation to learn. According to Lisa (2018), using the key to determine classification as a learning medium in biology, students not only estimated the facts and concepts they knew, but were also invited to prove for themselves every feature of the dichotomy that has been made in the key to determine the objects they observed.

Conclusion

The results confirmed that students' happiness with their learning and their learning achievement were both impacted by a handbook on the classification of vertebrates. It has been determined that the experimental fourth-grade student group can benefit from utilizing a handbook on the classification of vertebrates. It has been determined, after examining the growth of the experimental group based on the findings of this study, that this greatly improved their ability to classify. Students were satisfied with using a manual on vertebrate categorization since they found it enjoyable. They consequently indicated satisfaction with learning using this guidebook at a very high level in all aspects, particularly with specially developed classification abilities, which are crucial in today's environment.

Acknowledgments

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