The effectiveness of STAD on the learning of fishes in vertebrate zoology among biology education pre-service teachers in Sriwijaya university

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Abstract. This study aimed to compare the effects between Student Teams-Achievement Divisions (STAD) of Cooperative Learning method with traditional method on academic achievement in the learning of Fishes (Vertebrate Zoology) among pre-service teachers. A quantitative approach was employed using a quasi-experimental design with a sample of 64 Biology Education pre-service teachers from two intact groups (30 in the experimental group and 34 in the control group) at Sriwijaya University, Palembang, Indonesia. Implementation of the study involving three topics of Fishes was carried out over a three-week intervention. The topics consisted of Agnatha & Placoderm, Chondrichthyes and Osteichthyes. STAD effects were measured by using zoology achievement test instruments The data were analyzed using ANCOVA for academic achievements in three corresponding tests. The results indicated that STAD was more effective than the traditional method in two topics of Fishes: F(1,61) = 6.479, p = 0.013 < 0.05 for Agnatha & Placoderm and F(1,61) = 24.098, p = 0.000 < 0.05 for Osteichthyes, favouring the experimental group. However, there was no significant difference between the groups [F(1, 61) = 3.150, p = 0.81 > 0.05] in the learning of Chondrichthyes. The findings of this study are discussed in the context of science education and implications for future research are proffered.

1. Introduction
Student Teams-Achievement Divisions (STAD) is one of the simplest and most flexible Cooperative Learning methods. This method is best suited to teach science and scientific science concepts [1]. From several studies it can be surmised that STAD is a method that can fulfill the aspirations and goals of education in learning by means of fun-filled teaching and learning for teachers and students [2-8]. Many reviews on the effectiveness of the STAD method across low, middle and high education levels have been made. The use of STAD has been advocated as one of the approaches for learning in the context of the 21st century given that it meets the elements of communication and collaboration [9]. Based on the classroom application of STAD, it was found that its team formation in learning is a more effective method than traditional learning [4]. Additionally, it was found that STAD not only has an impact on the achievement and responsibility for low-level pre-service teachers [2,10], it is also equally effective for high-level pre-service teachers [8].
STAD has been widely applied in Indonesian classrooms across disciplines, especially in Biology with diverse effects. Based on the review of the literature, it is seen that STAD learning method is more effective in terms of academic achievement compared to the traditional methods [3], [5,7]. While research on STAD has been conducted in many countries with positive effects and success stories, it is still in an embryonic stage as far as Indonesia is concerned, let alone in the Vertebrate Zoology course at higher or tertiary education level.

In the course on Vertebrate Zoology, Agnatha & Placoderm, Chondrichthyes and Osteichthyes are parts of the topic for Fishes. Agnatha & Palcodermi is a group of jawless fish & scaly plate while Chondrichthyes or cartilaginous fish is a group of fish that lacks true bones and has skeleton cartilage instead. Osteichthyes are a group of fish that has true bones [11]. As a branch of Biology, Zoology is a difficult course because according to [12] Biology content, which is generally memorized and abstracted, is filled with many foreign words such as Latin, and detailed knowledge which are easily and quickly forgotten upon learning and testing. Therefore, given the positive effects of STAD on student learning, it is an interesting line of inquiry to investigate if the application of the STAD is equally effective and yields a positive result in the learning of Vertebrate Zoology among the pre-service teachers of the Biology Education Program at the Faculty of Teacher Training and Education (FKIP) at Sriwijaya University (Unsri).

Improving the Zoological Learning System will create an atmosphere of interactive learning and discourse between lecturers and students, as well as among students themselves. Considering the need to improve the learning outcomes of Vertebrate Zoology in the Biological Education Study Program, it is necessary to investigate the effectiveness of STAD. Specifically, the purpose of this study was to investigate and determine if STAD method could enhance the academic achievement in the learning of Fishes, particularly the Agnatha & Placoderm, Chondrichthyes and Osteichthyes. Accordingly, the research question to be investigated is given below. What are the effects of using STAD cooperative learning method as compared to the traditional method on the academic achievement among the pre-service teachers in the learning of Agnatha & Placodermi, Chondrichthyes and Osteichthyes? This research question is worth researching. The benefits deriving from this study may be used to improve the atmosphere of teaching and learning in order to enhance the academic performance of pre-service teachers.

2. Methods
2.1. Type Research
This study employed the quasi-experimental pretest-posttest control group designs. Using a sample of 64 pre-service biology education teachers of Sriwijaya University of two naturally occurring intact groups (i.e., namely 30 students in the experimental group and 34 students in the control group), the experimental group was taught using the STAD cooperative learning method, while the control group followed through the teacher-centred traditional method. Essentially, STAD was carried out by following the phases developed by [1], namely (1) teacher states goals/objectives of the lesson, (2) teacher teaches/presents, (3) students work in small cooperative groups where questions and worksheets are provided, (4) individual quiz, (5) each student determines his/her improvement point and the group score, and (6) team recognition. These steps or phases followed when STAD was implemented in this research at Sriwijaya University.
2.2. Techniques of Data Collection
The instrument used in this study was that of a multiple-choice-question test consisting 60 items for each of the three topics. The instrument was validated by experts who scrutinized the content, item construction and the language used. Furthermore, validity and reliability procedures followed the suggested guidelines [13]. Subsequently, the pilot test was carried out using a sample of 30 pre-service teachers who had taken previous Vertebrate Zoology courses. Item Analysis in terms of difficulty index, validity and reliability was carried out using the Anatest V4 software. Finally, three sets of multiple-choice test, each corresponded to the topics in Fishes, namely Agnatha & Placoderm (20 questions), Chondrichthyes (20 questions) and Osteichthyes contents (20 questions).

2.3. Procedure
The academic achievement data were derived from the students’ responses on each of the three sets of test questions. The pre-test was administered to determine students’ readiness before learning while the posttest was administered after the learning process. During the STAD learning process, pre-service teachers were grouped heterogeneously in terms of gender and ability. In team learning, students were seen actively in giving and/or listening to explanation, discussing the problems posed on the worksheet, and checking their answers. Finally, individual quizzes were given individually where pre-service teachers had to respond individually and independently. The quiz was meant to assess the learning of each individual, and individual raw scores were then converted into improvement points based on their initial base scores. These improvement points within each group were added up and averaged as a team score as indicated by [1]. Improvement points were derived from the difference between posttest scores and their corresponding base scores. In this case, the scores obtained in the Invertebrate Zoology course in the previous semester constituted the base scores. Rating was done by giving a score of 1 for the correct answer and 0 for the wrong answer. Then the total score is converted to a maximum score of 100.

2.4. Data Analysis
Data were analyzed using the SPSS Version 21 software. Before the data were used for analysis, they were inspected for normal distribution using the skewness and kurtosis with the range of -2 to +2 as adopted by [14]. Academic analysis with detailed Analysis of Covariance (ANCOVA) where students are taught for initial conditions. Pretest data were used as covariates in the ANCOVA to compensate for any initial group differences which exist at the outset of the experimental study. Thus, the ANCOVA was used to analyse the posttest means after adjusting for pretest differences.

3. Result and Discussion
The data were first analysed to determine their normality before hypothesis testing was carried out. The results of the normality test show that the values of skewness and kurtosis are in the normal range, as such, that data could be declared as normally distributed [14] since they are within the range of -2 to 2. Based on the analysis, the skewness value is in the range of -1.117 to 1.117 and also the kurtosis value is in the range 0.924 to 1.176 for three topics of Fishes. Table 1 summarises the pretest and post test means for the experimental and control groups in each of the three topics of Fishes, namely Agnatha & Placoderm, Chondrichthyes, and Osteichthyes.
Table 1. The results of pretest and post test score analysis

| Topics             | Groups     | Pretest  | Posttest |          |          |
|--------------------|------------|----------|----------|----------|----------|
|                    |            | Mean     | Standard Deviation | Mean     | Standard Deviation |
| (1) Agnatha & Placodermi | Experiment | 46.33    | 12.45    | 85.00    | 12.24    |
|                    | Control    | 39.41    | 10.99    | 74.71    | 12.61    |
| (2) Chondrichthyes | Experiment | 59.68    | 14.61    | 80.41    | 13.55    |
|                    | Control    | 45.00    | 17.75    | 72.13    | 15.34    |
| (3) Osteichthyes   | Experiment | 44.13    | 13.48    | 70.26    | 13.97    |
|                    | Control    | 34.94    | 8.29     | 53.33    | 11.48    |

ANCOVA was used to determine if there are differences between the experimental and control groups across the three topics. However, the assumption for homogeneity of regression was checked to see if ANCOVA was justified. The results of the analysis indicated that the pretest did not have significant interaction with the posttest across the three topics: Agnatha & Placoderm, Chondrichthyes, Osteichthyes. Therefore, the assumption for "homogeneity of regression slopes" was fulfilled and this justifies the use of ANCOVA to compare the posttests. The results of ANCOVA are shown in Table 2.

Table 2. The results of ANCOVA for the three topics of Fishes

| Topics             | Adjusted Mean | F   | P    |
|--------------------|---------------|-----|------|
|                    | Experiment    | Control |     |
| (1) Agnatha & Placodermi | 83.72         | 75.33 | 6.48 | 0.013* |
| (2) Chondrichthyes  | 80.71         | 73.15 | 3.15 | 0.081 |
| (3) Osteichthyes    | 70.34         | 53.24 | 24.10 | 0.000** |

*statistically significant at p < 0.05,  **statistically significant at p < 0.001

ANCOVA was used to determine if statistical differences do exist between the experimental and control groups. The ANCOVA results for the three topics are shown in Table 2. Based on Table 2, the results indicated that, after controlling for the initial pretest differences, there were statistical significant difference between the experimental group and the control group in the learning of two topics, namely Agnatha & Placoderm (F = 6.48, p 0.013 < 0.05) and Osteichthyes (F = 24.10, p 0.000 < 0.001). Therefore, the adjusted means obtained by the experimental group in Agnata & Placodermi (83.72), and Osteichthyes (70.34) are higher and statistically significant as compared to the adjusted means obtained by the control group (means of 75.33 and 53.24 correspondingly). However, there was no statistical significant difference (F = 3.15, p 0.081 > 0.05) between the adjusted mean obtained by the experimental group and the adjusted mean obtained by the control group in the learning of Chondrichthyes topic (see Table 2).

In summary, based on the results of hypothesis testing shown in Table 2 with p < 0.05 for Agnatha & Placoderm, and Osteichthyes, the corresponding hypotheses were rejected. The use of STAD cooperative learning method has a significant impact on the academic achievement in the learning of Agnatha & Placodermi and Osteichthyes. Conversely, with p > 0.05 for Chondrichthyes, the corresponding hypothesis was accepted which implies that the use of STAD cooperative learning method has no significant effect on the academic achievement in the learning of Chondrichthyes.

There are several factors that might explain the positive effect of learning using the STAD method. The learning with STAD method is in fact a combination of several learning strategies such as lectures, assignments and discussions. In the initial stage, the lecturer delivers a class presentation, before the
student team learning stage where the students were put in their respective teams to discuss and solve the questions posed in the given worksheet. The integration of several methods of learning in STAD is in line with the study by [1] who advocates that STAD is one of the simplest methods and it is also the most flexible of other cooperative learning methods. Thus, the integration of methods in STAD seems to have accommodated more student learning styles. Furthermore, learning is a process in which a person's environment intentionally enables him/her to participate in certain behaviors in special conditions, or perhaps to produce responses to certain situations. In connection with the learning objectives, the STAD method makes the pre-service teacher training more superior in understanding difficult and difficult concepts. According to [12], and [15], biological content in general is not only abstract, broad and detailed, it also contains many Latin words which are easily forgotten upon learning and testing. Although the contents of Vertebrate Zoology in three topics were presented as characteristics, the learning difficulties have been solved by applying the STAD method in the learning. Overall, STAD has created a good learning environment among the pre-service teachers.

The effectiveness of the STAD method on academic achievement in the learning of Vertebrate Zoology is at least supported by three main factors. The first factor which supports the successful impact of STAD is the implementation of the constructivist theory, particularly the social constructivist theory which promotes the vicarious learning. The second factor is the learning environment inherently exists within the use of STAD whereby supportive learning is at play. Finally, the use of STAD instills the use of cooperative skills among the pre-service teachers. These three factors act in synergy in achieving the educational goals by learning together. Although previous research has indicated that the content of Vertebrate Zoology is one of the difficult canopies to be adequately mastered by the pre-service teachers [12], [16], [15], this problem can be overcome because they (the pre-service teachers) were provided with the constructivist learning environment which is supportive and collaborative in nature.

In this particular study, the findings support the very fact that STAD cooperative learning method is indeed successful in increasing the academic achievement of the pre-service teachers undergoing the Biology Education Study Program at FKIP Unsri. The exhibited success in academic achievement by the pre-service teachers is the evidential proof of the positive effect of STAD cooperative learning method. Each pre-service teacher has succeeded in overcoming the difficult learning situation through the providence of a supportive and collaborative environment [1]. Additionally, pre-service teachers will find it easier to understand the difficult concepts when they can talk to each other about problems [1] – a supportive and collaborative environment provided for in the Team Learning Phase of STAD whereby they work in groups. Such a supportive and collaborative environment is thought to have made pre-service teachers more active, releasing them (the pre-service teachers) from the conventional or traditional ways of learning and improving their motivation for learning to be better than before.

The learning atmosphere inherent in the use of STAD for the learning of Zoology was the togetherness created within the heterogeneous grouping. According to [19] learning using the STAD method is not only academically effective, but also it develops other values in accordance with the goals of education, namely the values of mutual cooperation, social awareness, mutual trust, willingness to accept and give, collaboration, and responsibility. The collaboration comes into play because within the use of STAD, there are elements of positive interdependence, individual accountability, and group processing [18]. Besides, pre-service teachers were involved more actively in learning during STAD.

While STAD did improve in the learning of Agnatha & Placodermi, and Osteichthyes, it however did not have an impact in the learning of Topic 2 (Chondrichthyes). In this particular topic, STAD method did not have a significant difference in achievement. Essentially, Topic 2 examines the distinctive characteristics, taxonomy and animal life of the Chondrichthyes class. This group consists of cartilaginous body fish consisting of sharks, rays, roller skates, and chimaera [11]. As for the problems posed in the worksheet, almost all the examples were from a textbook and that the examples were not contextualized (i.e., these examples came from outside the local area where pre-service teachers live). As such, the non-contextualized content could be the factor which contributed to the non-significant result in the learning of Chondrichthyes.
4. Conclusion

Based on the data obtained from the analysis in this study, it can be concluded that the use of STAD cooperative learning method is effective as compared to the traditional learning method in enhancing the academic achievement among pre-service teachers. While the use of STAD cooperative learning method is effective, its effect, however, is limited to the learning of two out of the three topics within the Fishes, namely Agnatha & Placodermi and Osteichthyes. As for the learning of the topic on Chondrichthyes, it was not statistically significant although the experimental group achieved a higher mean score than the control group. Such non-significance could be attributed to the less contextualised content and examples used, or perhaps, it could also be due to sampling errors.

5. Recommendations
The findings from this research have broad meaning and implications for the Curriculum and Instruction of Vertebrate Zoology at tertiary level. Given that STAD has a significant impact on the learning of certain topics in Vertebrate Zoology at university level, Biology lecturers should capitalise on the use STAD in the teaching and learning and also as an added teaching skill to their pedagogical repertoire. Besides, further studies on the effect of STAD should also be carried out on other topics in Vertebrate Zoology across levels and also in other branches of biology. In the design of Zoological curriculum, we strongly recommend the inclusion of STAD cooperative learning method.

References
[1] Slavin, R.E, (2002). Cooperative Learning: Theory, Research, and Practice. Massachusetts: Davidson Simon & Schuster, Inc.
[2] Can, H.B, & Boz, Y. (2014). Structuring Cooperative Learning for Motivation and Conceptual Change in the Concepts of Mixtures. International Journal of Science and Mathematic Education, 14(14), 635-657.
[3] Haloho, L. (2014). Perbaikan Pembelajaran Biologi melalui Pembelajaran Kooperatif tipe STAD pada kelas X-3 SMAN 12 Medan. Journal Saintech, (6)2, 18-25.
[4] Khan, G. N., & Inamullah, H. M. (2011). Effect of Student’s Team Achievement Division (STAD) on Academic Achievement of Students. Asian Social Science. 7(12), 211-215.
[5] Muldayanti, N.D. (2013). Pembelajaran Biologi Model STAD dan TGT ditinjau dari Keingintahuan dan Minat Belajar Siswa. Jurnal Pendidikan IPA Indonesia JPII, (2)1, 12-17.
[6] Nikou, F.R., Bonyandi, A. & Ebrahimi, Kh.. (2014). The Effect of Student Team-Achievement Division (STAD) on Language Achievement of Iranian EFL Students across Gender. European Online Journal of Natural and Social Science, (3)4, 936-949.
[7] Nuaja, I.K. (2011). Pengaruh Model Pembelajaran Kooperatif Tipe STAD terhadap Prestasi Belajar Biologi ditinjau dari Motivasi Belajar dan Kerjasama Siswa SMA (Studi Eksperimen di SMAN 1 Tampaksiring). Jurnal Pascasarjana Undhiksa, (1)1, 1-5.
[8] Tran, V., D. (2013). Effects of Student Teams Achievement Division (STAD) on Academic Achievement and Attitude of Grade 9th Secondary school Students toward Mathematics. International Journal of Sciences, 2(April), 1-15.
[9] Sudarisman, S. (2015). Memahami hakikat dan karakteristik pembelajaran Biologi dalam upaya menjawab tantangan abad ke-21 serta optimalisasi implementasi Kurikulum 2013. Jurnal Florea, (2)1, 29-35.
[10] Tarim, K. & Aknediz, F. (2008) The effects of cooperative learning on Turkish elementary students’ Mathematics achievement and attitude towards mathematics using TAI and STAD. *Methods. Educ Stud Math*, (6)7, 77–91

[11] Hickman, C.P., Roberts, L.S & Larson, A. (2003). *Animal Diversity*. New York: The McGraw–Hill Companies.

[12] Cimer, A. (2012). What makes biology learning difficult and effective: Students’ views. *Educational Research and Reviews*, 7(3), 61-71.

[13] Heale, R. & Twycross, A. (2016). Validity and reliability in quantitative studies. *Evid Based Nurs*, (18)3, 1-2.

[14] Hair, J.F., Black, W.C., Babin, B.J., & Anderson, R.E. (2010). *Multivariate Data Analysis*. New Jersey: Pearson Education.

[15] Koba, A. & Tweed, A. (2009). *Hard to Teach Biology Concepts: A Framework to Depen Studen Understanding*. USA: National Science Teachers Association.

[16] Diki, D. (2013). Creativity for Learning Biology in Higher Education. *LUX: A Journal of Transdisciplinary Writing and Research from Claremont Graduate University* (3) 1-10. Available at: http://scholarship.claremont.edu/lux/vol3/iss1/3

[17] Slavin, R.E. (2006). *Educational Psychology; Theory and Practice*. Boston: Pearson Education.

[18] Johnson, D.W., Johnson R.T., & Holubec, E. J. (2010). *Collaborative Learning, Strategi Pendekatan untuk Sukses Bersama*. Bandung: Nusa Media.

[19] Solihatin, E. & Raharjo. (2009). *Cooperative Learning; Analisis Model Pembelajaran IPS*. Jakarta: Bumi Aksara