

Constructive Learning to Increase the Integration of Students' Knowledge and Skills in the Numerical Methods Subject

Susila Bahri^{1,*} Budi Rudianto²

¹ *Department of Mathematics, Andalas University, Padang, West Sumatera 25163, Indonesia*

² *Department of Mathematics, Andalas University, Padang, West Sumatera 25163, Indonesia*

**Corresponding author. Email: susilabahri@sci.unand.ac.id*

ABSTRACT

Constructive learning is applied to Numerical Method lectures. The lecture is held online using Zoom Meeting. The day before lectures begin, the lecturer provides lecture materials, some examples of cases and solutions. In order to encourage activity and improve student skills, some real cases were also presented. Students are directed to get their solutions from real case examples. Unresolved cases were discussed during the lecture. To improve their skills, students are also trained in using Matlab software to find solutions to several cases. The assessment indicators obtained 75%, 87%, 92%, 83% of students respectively get the letter B- and above for quizzes, assignments, resumes, and practicum.

Keywords: *Constructivism learning, Numerical Method, Online using Zoom Meeting*

1. INTRODUCTION

The Numerical Method is one of the compulsory subjects in the undergraduate program at the Mathematics Department, Andalas University. This subject is taught in the 4th semester. The course contains various methods that can be used to solve various problems numerically. This course is intended for students to combine abilities, theoretical knowledge, and computer skills in solving problems. Therefore, students are required to attend lectures in the classroom and practicum in the computer laboratory.

Efforts to sharpen students' thinking abilities (cognitive domain) are formed through various algorithmic preparation exercises based on applied problems. This exercise can unconsciously generate student interest and participation (affective domain) because students know the usefulness of mathematical concepts that have been learned during lectures. Efforts to find solutions to problems were continued with physical activity (psychomotor domain) through Matlab computer software.

In the last three years, Numerical Method lectures have always been preceded by a lecturer's presentation

in the classroom. To generate interest, activeness, and ability of students, lecturers provide questions to work on. Lecturers monitor and guide students directly. If there are obstacles, the lecturer then explains the problem solution at the end of the lecture. Therefore, students of mathematics study programs must be prepared in both ways to have both abilities before completing their studies. another schedule, the laboratory assistant explains the practicum material. The assistant also guides the practicum directly.

In fact, in the two types of lecturing activities, students seemed less independent and still relied on Teaching Centered Learning (TCL). Besides, students are also guided by two different mentors, and the coordination does not work well. As a result, the integration of theoretical abilities and problem-solving skills through computers is also not achievable.

Furthermore, in order for jobs to be easily obtained currently, university graduates must have academic knowledge and have expertise in the field of computers. Therefore, students of mathematics study programs must be prepared in both ways to have both abilities before completing their studies.

In mathematics, the Constructive Method is a learning method based on constructive theory and encourages students to actively build their new knowledge from experience and knowledge [1]. This effective method of learning mathematics requires students to understand what they know and need to learn. This motivation will help students learn more [2,3]. The learning method also emphasizes that students and teaching teams find and build knowledge together [4]. Therefore, this method is very suitable to be applied in Numerical Method lectures.

1.1. Constructive Learning in Mathematics

From the results of research conducted by IMSTEP-JICA, it is known that most teachers in Indonesia still use conventional methods in the teaching and learning process. Also, the material being tested is emphasized more on groups with moderate ability [5].

In traditional mathematics learning, students passively absorb what other people have created. Students also tend to imitate the method by memorizing so that the teacher's goals are achieved [6]. In contrast to constructive learning, students are motivated and directed to learn the main idea through self-discovery. In the learning process, their activities and creativity will help them improve their thinking processes (cognitive) and take responsibility for their own learning outcomes. Furthermore, the learning process is also experimental based on concrete experiences in the laboratory, adapting and discussing with classmates and generating ideas to develop new concepts. Therefore, the emphasis on education and teaching is focused on learners and not on educators [7].

According to [2], students can form their mathematical understanding by connecting existing ideas to a concept to solve a particular problem. Then, in making it easier for students to learn, the teaching team follows the guidelines or curriculum in the learning process.

2. METHODS

The Constructive Learning Method is applied to the learning process of the Numerical Method subject through the following stages:

- (i) Learning starts the day before. Lecture materials and several examples of cases and their solutions are submitted to students the day before lectures. Besides, applicable cases (related to real-world problems) are given to students as assignments that must be completed and submitted at the beginning of the lecture. Through the assignment given, students are encouraged first to learn and understand solving real cases that have been given. The material given is in the form of a theory of the

method is discussed and the Matlab program of that method. For the practicum, the practicum module is given 3 days before the practicum is held

- (ii) At the beginning of the lecture, students are assigned to make a material resume from the learning results and understand the material received the day before. Students can have direct discussions with the course lecturer or ask questions about resumes and material that is not understood. The discussion and question and answer were carried out directly during lectures with Zoom Meeting or through the Numerical Method Whatsapp group. Furthermore, for the practicum, which was also held with the Zoom Meeting, a pretest was held on the material given in the first ten minutes. Furthermore, under the lecturer's supervision who teaches the course, the laboratory assistant explains the material from the practicum module, especially those that are not understood. Students at the end of the practicum make a final report on the practicum.
- (iii). If the topic discussed is rather difficult, the learning strategy is slightly modified by appointing a group member who can answer or explain the solution to the problem. If no one can answer it, the lecturer immediately intervenes to discuss the problem and solve it.
- (iv) Students are given questions that must be solved by hand and using the Matlab program
- (v) At the end of the lecture, the teaching lecturer repeats the conclusions of the lecture material that time so that a common understanding and depth of the material for each student can be achieved

3. RESULTS AND DISCUSSION

To evaluate the success of implementing the constructive method, several assessment parameters are used, namely:

- (i) Learning Outcomes

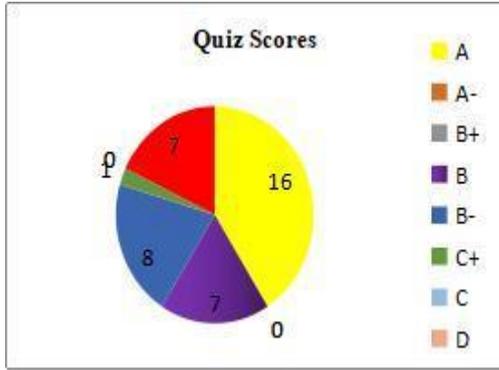
During the lecture process, learning outcomes are monitored through 10% of the quiz score, 10% of the assignment score, 10% of the resume value, and 20% of the practicum score obtained by each student. These scores are then combined with 25% of the Mid- Semester Exam score and 25% of the score for the Final Semester Exam. The final results obtained by students illustrate the integrity of students' theoretical abilities and practical skills

- (ii) Distribution of Each Assessment Item (Quiz, Resume, Assignment, and Practicum)

The following are the results achieved by students on each assessment item:

1. Quiz

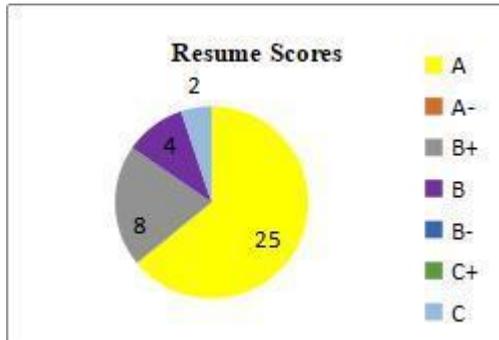
In this lecture, there are six main subjects. To see the development of student abilities in the learning process, quizzes were held three times. In each quiz, two main materials were tested. The student quiz scores are shown in the following pie chart:



From the diagram, it is known that almost half of the total students (42 people) got an A score, and more than 75% of the students scored above average or above C. From the results of this quiz, it can be concluded that the application of this Constructive Method can boost students' grades and abilities.

2. Resume

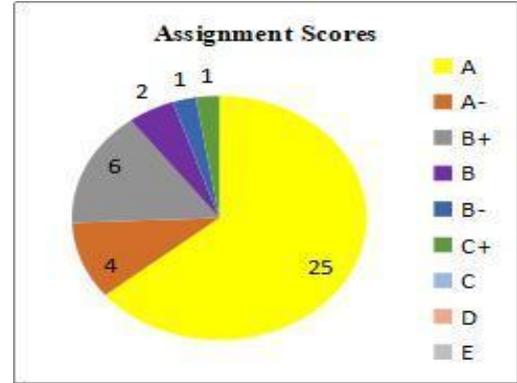
The following diagram reveals the students' ability to deduce the knowledge they have constructed themselves.



Resume assessment is based on the student's ability to re-express the theory he has learned and constructed in his own language. This value also states students' ability to conclude various problems that are solved during the practicum. From the results displayed in the diagram, students have a satisfactory score (92% got B- resume scores). This means that students have theoretical and practical knowledge

3. Assignment

From the six assignments given, the achievement of each student's ability in this course is stated in the diagram below:



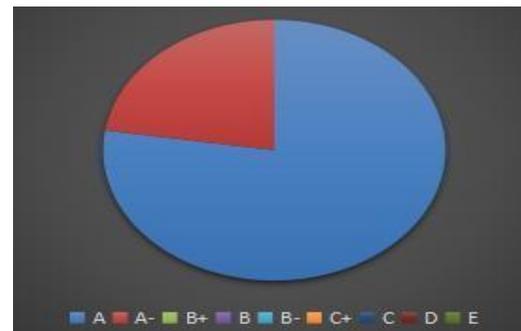
The student work scores looked really good. In fact, about 80% of the 42 students scored satisfactorily. Thus it can be concluded that students have been able to do two types of tasks well. Both types of tasks are solving theoretical problems and problems that have to be solved by computer programs.

4. Practicum

Due to the limited space and the number of computers available in the computer laboratory, students are divided into three classes, namely A, B, and C. The acquisition of practicum scores for each student that show the students' expertise in solving problems using Matlab computer software is stated as follows:

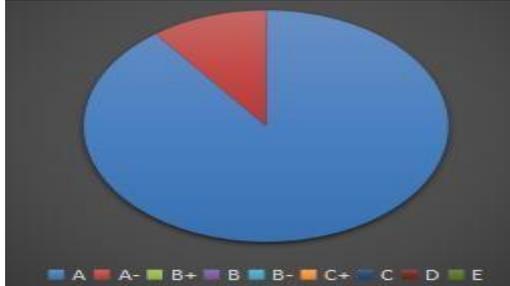
(i) Class A

11 out of 14 students in this class got the letter A grade while 3 others got the letter A-. This means that 78.6 % of students in this class can solve various problems perfectly with their own computer skills. The following diagram illustrates this result.



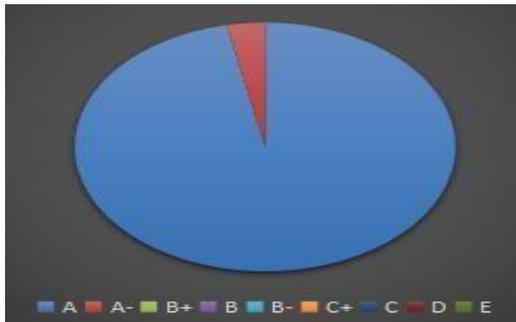
(ii) Class B

14 students took lab class B. 12 students obtained the letter A while the other 2 students got the letter A-. This very satisfactory result is depicted in the following diagram,



(iii) Class C

14 students also attended the practicum in class C. 13 students attained the highest letter grade A while 1 student gained the letter A-. The practical letter grades of students in this class are expressed in the diagram below,



4. CONCLUSION

From several indicators (quizzes, resumes, assignments, and practicum), the application of Constructivist Learning Methods in Numerical Methods course is proven to increase students' knowledge and skills in solving many problems. Besides, students can understand how to construct their knowledge and directly feel the benefits of this method.

ACKNOWLEDGMENTS

This research was funded through the Education Development and Quality Assurance Research Grant (PPMP) by Andalas University.

REFERENCES

[1] L. D. E. Diaz, The Teaching and Learning Process of Mathematics in The Primary Education Stage: a Constructivist Proposal Within The Framework of Key Competencies, International Electronic Journal of Mathematics Education. 12(3)(2017)709-713.DOI: <http://creativecommons.org/licenses/by/4.0/>

[2] Bhowmik, M. Constructivism Approach in Mathematics Teaching and Assessment of Mathematical Understanding. Basic Research Journal of Education Research and Review ISSN 2315-6872 Vol 4(1) pp 08- 12 January 2015. DOI <http://www.basicresearchjournals.org>

[3] Jazim, R. B. Anwar, D. Rahmawati, The Use of Mathematical Module Based on Constructivism Approach as Media to Implant the Concept of Algebra Operation, International Electronic Journal of Mathematics Education. 12(3) (2017) 579-583. DOI: <http://creativecommons.org/licenses/by/4.0/>

[4] D. Adair, M. Jaeger, Constructive Learning Applied to The Teaching of Numerical Methods For Engineers, Proceedings of 3th Annual Project Based Learning (PBL) Symposium, ACK, Mishref, Kuwait, March 2018. DOI:<https://www.researchgate.net/publication/323627859>

[5] Sato, Manabu, Tantangan Yang Harus Dihadapi Guru, Dalam Bacaan Rujukan Untuk Lesson Study:Systems (Strengthening In Service Training of Mathematics and Science Education at Junior Secondary Level), Dirjen PMPTK-Depdiknas dan JICA

[6] D. H. Clements, M. T. Battista, Constructivist Learning and Teaching, Journal of National Council of Teachers of Mathematics, Inc. www.nctm.org

[7] A. Suhendi, Purwarno, Constructivist Learning Theory Theory: The Contribution to Foreign Language Learning and Teaching, The 1st Annual International Conference on Language and Literature, KnE Social Science, 87-95, DOI 10.18502/kss.v314.1921