Educational statistics textbooks to develop collaborative skills and critical thinking

D Astuti¹, A Prabowo¹, N A Hidayati¹, U Khasanah¹
¹Program Studi Pendidikan Matematika, Fakultas Keguruan dan Ilmu Pendidikan, Universitas Ahmad Dahlan, Jalan Ringroad Selatan Banguntapan Bantul DIY, 55166

E-mail: dwi.astuti@pmat.uad.ac.id

Abstract. Educational statistics textbook based cooperative learning is expected to facilitate teachers in delivering educational statistics lessons. This study aims to identify the characterization of the textbook based on the students characteristics. The research method used was research and development of the 4D (define, design, develop, and disseminate) model. This research was on define step. The first step of this study was analyzing the students and materials characterization. The next step was defining the characterization of the textbook based on students and materials characterization. The textbook was developing based on the characteristics. Data collected by the interviewing the students and observing the learning process. The characteristics of the textbook are (1) interactive, (2) show the contextual problem on education (3) facilitate to developing collaborative skill and critical thinking, and (4) task from the easy to hard task.

1. Background

The observations in the educational statistics class shows that there are not yet available in accordance with the KKNI curriculum. Students have difficulty choosing the main reference in accordance with the lecture material. If the main handbook is not provided, students will only study from lecturer’s powerpoint material. The material presented in powerpoint is still limited to the concept. The sample problems given are very limited. In addition, the material in ppt cannot facilitate students to be able to do many activities. The problems presented can develop 21st century student skills.

There are four abilities that students must have in the 21st century, namely: 1) Communicate clearly; 2) Collaborating with others; 3) Think critically and be able to solve problems; 4) Creativity and Innovation [1-5].

From some of the 21st-century abilities mentioned above, one of the important abilities to be possessed and developed by students is the ability to collaborate. The ability to collaborate is very important to be developed so that students can cooperate in group differences as a provision to face the era of globalization in the 21st century [6]. In order for students to have the ability to collaborate, the teacher must be able to practice it by using the right strategies in learning activities, for example by conducting group discussion activities during the implementation of learning. Students can be said to have the ability to collaborate, so they must meet the 3 components of collaborative capabilities, namely: a) Demonstrating the ability to work effectively and appreciate the diversity of the team; b)
Showing flexibility and willingness to accept the opinions of others in achieving common goals. c) Carrying out joint responsibilities in collaborative work and respecting the contribution of each team member [1].

In addition to collaboration capabilities, it is also important to develop critical thinking skills. Critical thinking is a process, the goal is to make reasonable decisions about what to believe and what to do [7,8]. Critical thinking consists of various mental processes, strategies, and resources that a person uses to solve problems, make decisions and learn new concepts. Critical thinking involves the process of evaluating the knowledge that students have. The process of critical thinking involves thinking reflective and productive and evaluating evidence [9,10]. People who are able to think critically will reflect the results of their thinking to find a synthesis of a problem.

There are several important elements in critical thinking that must be learned by students in order to have critical thinking skills as follows: identifying issues; identifying relationships between elements; deducing implications; inferring motives; independent combining elements to create new patterns of thought (creativity); and making original interpretation (creativity) [11].

Collaborative skills and critical thinking skills need to be developed. Cooperative learning type Group Investigation and Think Talk Write can improve students' critical thinking skills [12]. Cooperative learning of the Inter-Teams Games Tournament type could enhance student collaborative skills [13]. Based on the results of these studies indicate that cooperative learning models can improve critical thinking skills and collaborative skills of students. In this study, it has not shown how the role of teaching materials in improving these two aspects. Therefore in this study educational didactic teaching materials will be developed that can be used to develop students' critical thinking skills and collaboration skills. Learning using guided discovery-based teaching materials can improve students' critical thinking skills [14]. The use of media or learning resources will help the learning process activities, especially in improving student achievement or learning outcomes [15]. Teaching materials that are one of the learning resources can help educators in implementing learning [16]. The purpose of preparing teaching materials is 1) assisting students in obtaining alternative teaching materials in addition to textbooks which are sometimes difficult to understand, 2) facilitating educators in carrying out learning, 3) providing teaching materials that are in accordance with curriculum demands and characteristics college student [17]. Therefore, it is necessary to develop an educational statistics book that is in line with the KKN curriculum to develop collaboration skills and critical thinking skills.

2. Objectives
The objective of this study is describing the characteristics of educational statistics textbook that can improve critical thinking and collaborative skills of students.

3. Methods
The research conducted is the 4D type development research including define, design, develop and disseminate. The steps taken are defined and design stages so that the output produced is the design of educational statistics teaching materials to develop thinking skills and collaboration skills. The subjects in this study were 98 students of the English Education Study Program who took courses in educational statistics. Data collection techniques used were the lecture evaluation questionnaire and interviews. The indicator of lecture evaluation sheet is teaching materials, learning methods, and motivation.

4. Results and Discussion
The results of the questionnaire about the need for teaching materials indicate that 87% of students stated that teaching materials were needed. The results of the questionnaire were followed up with interviews. The results of the interview show that all this time there are statistics books available. However, students say that the material presented in most of the books is not following the competencies set by the study program and must be achieved by the participants. In addition, existing books have not provided examples of problems in the field of education. Education students will be
faced with the problem of education in the area, so it is important that educational statistics teaching materials should present examples in the field of education. Educational statistics need to be developed that are tailored to the characteristics of students and material.

Analysis of Students

Students who take educational statistics are students outside the mathematics education study program. At the beginning of each lecture, it is always asked why students choose X study program (besides Mathematics Education)? One of the main reasons for students is because students do not want to meet with mathematics courses. When students find out there are educational statistics courses or education statistics, what they think about is the subject matter which counts. Characteristics of students like this require the preparation of teaching materials that do not give the impression that mathematics is complicated. In preparing this teaching material, examples of easy to solve questions will be displayed so that the perception that mathematics is easy will change the initial mindset about mathematics.

Based on the results of observations during the learning process, all students will pay attention to the explanation from the lecturer in the early minutes of learning. After learning has been going on for more than 15 minutes, there will be a shift in the student's focus. Different when learning is done is learning that requires students to participate or require students to move actively. Based on these characteristics, teaching materials are developed interactively and facilitate collaboration between students in the learning process.

In addition to the above, the observation also shows that most students will ask for a more practical or not. Students choose an instant way to solve problems presented by the lecturer. This can limit student creativity. Students become less creative in solving problems. Based on this, the teaching material was developed to facilitate the development of student creativity through the presentation of problems or the presentation of questions as exercises.

Material Analysis

Based on the results of the analysis of competencies in the IQF, generally, the material in the educational statistics course is divided into 2, namely descriptive statistics and inferencing statistics. The material developed in this teaching material is descriptive statistics. The material presented in this teaching material develops collaborative abilities and students' creative thinking abilities.

In addition to the material, the tasks given in this teaching material are tasks related to problems in the field of education. There need to be assignments on each part of the material so that students can measure their abilities. Teaching materials developed generally include three main components: (1) involve students in the activities nonroutine problem solving; (2) facilitating students to develop the ability to analyze and evaluate (critical thinking) and the ability to create (creative thinking); and (3) encourage students to construct their own knowledge [18].

The framework of the book developed includes the following material: (a) statistical understanding; (b) data presentation; (c) the size of the symptom of the data center; (d) size of data location; (e) size of data distribution.

Teaching materials are developed based on the above characteristics. Each character is shown in the sections in the book as follows:

a) The problem presented is a contextual problem.

Students in the study program of English Language Education and Islamic Education will often be faced with data about education. Therefore, the teaching material developed presents problems related to the field of education. This is so that students can apply their knowledge to the final assignment (particular purpose) and apply knowledge in the area when they become educators (general purpose).

b) Interactive teaching materials.

This teaching material facilitates interaction with students or in other words this book can communicate with students. Books developed using the greetings of readers. Greetings used in
books, for example, Try to look at, let's learn, try to discuss with your friends, etc. Examples of teaching material sections that show interaction with students are presented in Figure 1 below.

![Figure 1. The Book Section that Shows that Interactive Book](image)

c) Teaching materials are developed based on the principles of cooperative learning. This book facilitates collaboration between students. There are several parts of the book that gives students the opportunity to work in groups [12] [13]. Think Pairs Share learning model can activate all students during the learning process and provide opportunities to work together between students who have various abilities [19] [20]. This model is effective for class discussions because the procedures used can give students more time to think, respond, and help each other. Collaboration will provide several advantages for students, including: 1) can learn independently and not rely too much on the teacher, 2) can develop the ability to express ideas or ideas, 3) help children to respond to others, 4) empower students to be more responsible in learning, 5) improve academic achievement as well as social ability [21]. Some examples of assignments in teaching materials are illustrated as shown in Figure 2 below.

![Figure 2. Examples of Rubrics that Facilitate Students to Work in Groups](image)

d) Examples of questions presented are examples of simple questions so that the impression that students have is that mathematics is simple. This book is not only for students of the Mathematics Education Study Program but also for students outside the Mathematics Education Study Program. The results of interviews conducted with students outside the Mathematics Education Study Program showed that one of the reasons they chose the Study Program other than Mathematics was not to meet mathematics. Most of them judge that mathematics is full of complicated calculations. The reality is that when they met with a statistics subject, they initially said that this was a subject that was not easy because of the calculations. Therefore, the problem exercises presented in this developed book are questions whose calculations are not complicated.
5. Suggestion

Based on the results of the analysis, educational statistics teaching materials for education students will be developed. Characteristics of teaching materials to be improved are 1) teaching materials that present contextual problems, 2) interactive teaching materials, 3) teaching materials developed based on the principles of cooperative learning, and 4) teaching materials that present examples of simple questions. The lecture could use this book on the education study program. If the lecture use in other study program, the lecture should modify the example and the problem shown.

6. References

[1] Trilling B & Fadel C 2009 21st Century Skills: Learning for Life in Our Times (USA: Jossey Bass Wiley)
[2] Binkley M 2012 Defining twenty-first century skills Assesment and Teaching of 21st Century Skills (Dordrecht: Springer)
[3] Scott C L 2015 The Futures of Learning 2: What Kind of Learning for The 21st Century? Education Research and Foresight Working Papers p 1-14
[4] Häkkinen P, Järvelä S, Mäkitalo siegl K, Ahonen A, Näykki P & Valtonen T 2016 Theory and practice Preparing teacher-students for twenty-first-century learning practices (PREP 21): a framework for enhancing collaborative problem-solving and strategic learning skills Teachers and Teaching Theory and Practice p 602
[5] Permendikbud 2016 Standar Isi pendidikan Dasar dan Menengah yang memuat tentang Tingkat Kompetensi dan Kompetensi Inti Sersuai dengan Jenjang dan Jenis Pendidikan tertentu
[6] Muiz A, Wilujeng I, Jumadi & Senam 2016 Implementasi Model Susan Loucks-Horsley Terhadap Communication and Collaboration Mahamahasiswa SMP Unnes Science Education Journal
[7] Sternberg R J 1986 A triangular theory of love Psychological review 93 p 119
[8] Ennis R H 1996 Critical Thinking (USA: University of Illinois)
[9] Santrock 2011 Educational psychology (New York: McGraw-Hill)
[10] Nitko A J & Brookhart S M 2007 Educational asessment of students (5th ed) (New Jersey: Pearson Educational)
[11] Orlich D C, Harder R J, Callahan R C, Trevisan M S & Brown A H 2012 Teaching strategies: A guide to effective instruction (Boston: Cengage Learning)
[12] Listiana L 2013 Pemberdayaan Keterampilan Berpikir Dalam Pembelajaran Biologi Melalui Model Kooperatif Tipe GI (Group Investigation) dan TTW (Think, Talk, Write) Proceeding Biology Education Conference 10
[13] Rohman A 2013 Model pembelajaran inter-teams game tournament untuk pengembangan kemampuan kolaborasi mahasiswa calon guru Jurnal Penelitian Ilmu Pendidikan 6
[14] Dewanti S S 2015 Upaya Mengembangkan Kemampuan Berpikir Kritis Melalui Pembelajaran Menggunakan Bahan Ajar Geometri Analitik Berbasis Guided Discovery Jurnal AdMathEdu 5
[15] Munadi Y 2010 Media Pembelajaran (Jakarta: Gaung Persada Press)
[16] Muhaimin, Sutiah and Sugeng 2008 Pengembangan Model Kurikulum Tingkat Satuan Pendidikan pada Sekolah dan Madrasah (Jakarta: PT Raja Grafindo Persada)
[17] Arlitasari O, Pujiyanto Budiharti R 2013 Pengembangan Bahan Ajar IPA Terpadu dengan Tema Biomassa Sumber Energi Alternative Terbarukan Jurnal Pendidikan Fisika 11
[18] Apino E & Retnawati H 2017 Developing instructional design to improve mathematical higher order thinking skills of students Journal of Physics: Conference Series 812 012100
[19] Arends R I 2008 Learning To Teach: Belajar untuk Mengajar Buku Dua (Yogyakarta: Pustaka Belajar)
[20] Arends R I and Kilcher A 2010 *Teaching for Student Learning: Becoming an Accomplished Teacher* (New York: Published in the Taylor & Francis e- Library)

[21] Sanjaya W 2009 *Strategi Pembelajaran Berorientasi Standar Proses Pendidikan* (Jakarta: Prenada Media Group)