

The Implementation of Discovery Learning and Adapted SKKNI to Optimize Learning Outcome

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Abstract. Education is one of important factors in improving human resources. Education growth in Indonesia, especially at the tertiary level, has shifted to the formation of competent graduates. Nationally, there is a formulation of work competencies according to legislation referred as SKKNI (Indonesian National Work Competency Standards). Adapting SKKNI in the learning process is expected to help students understanding the work circumstance. Discovery-learning methods, that is student-centred, is employed in order to motivate students to be more active in learning activities. By having minimal lecturers’ guidance, students build problem solution using their initial knowledge. This research takes Introduction to Financial Statistics because this subject supports several concentrations in the Department of Statistics, such as Business-Social, Actuarial, and Data Science. The competencies formulated in the *Capaian Pembelajaran Mata Kuliah* (CPMK, Subject Learning Outcomes) in this course require students to understand the concept of financial statistics. Mastery the concepts along with the development of technology require the help of a software, namely software R. In the process of building function in R, students use their prior knowledge of programming to solve some problems in finance. Applying this collaborative method, the *Ujian Kompetensi* (UK, competency test) shows the increment of the number of the students who are regarded as competence. Students who have final scores less than or equal to grade C is 12.7%. This result is lower than the previous year, which is 21.8%. In addition, the results of midterm examination and final examination show that the average CPMK achievement in Introduction to Financial Statistics is 68.08%.

1. Introduction

Introduction to Financial Statistics is one of the elective courses in Universitas Islam Indonesia at the Department of Statistics. Although it is an elective course, this course supports several concentrations, such as Business-Social, Actuary, and Data Science concentrations. Competencies formulated in the *Capaian Pembelajaran Mata Kuliah* (CPMK, Subject Learning Outcomes) in the Academic Year 2016/2017 requires students to master financial statistics. Mastery of the concepts along with technological development requires the assistance of software, one of them is R software. In this Academic Year, the learning method used is teacher-centred learning where the lecturer provides R software applications for problem solving in one direction.

On the other hand, the learning method that is used to realize the goals in even semester, the Academic Year 2017/2018, is the discovery-learning model. Discovery learning model is a learning

method where students investigate and construct the knowledge they have to solve new problems. Students use their previous learning experiences and use of their prior knowledge to find new facts, interrelation and to find new truth to be learnt. By utilizing basic programming knowledge obtained in Programming Algorithms course, students construct new programs in solving financial statistics problems. The roles of lecturers in the discovery learning model are to provide instructions (methods) to trace a knowledge that must be learnt by students, to examine, and to provide a review for the results of self-learning performed by students.

Based on the application of the Indonesian National Work Competency Standard (SKKNI) Categories of Information and Communication Principal Programming Activities, Fields of Software Development Programming, the learning process of Introduction to Financial Statistics courses is implemented to one of the competency units in the SKKNI. Meanwhile, the competency unit adapted to CPMK of Introduction to Financial Statistics is Implementing Structured Programming with unit code J.620100.017.02.

The implementation of SKKNI for Introduction to Financial Statistics course is in the form of programmer competency test. The recommendation of the program competency test in accordance with the SKKNI is that students are declared 'Competent' or 'Not Competent'. Students who are declared 'Competent' have a great opportunity to solve problems given by lecturers in the form of midterm examination or final examination since they are able to understand and implement the R program/function that they compile.

This paper will first describe the background of the research before discussing the method used in this research. The third section explains the empirical result. Meanwhile, the conclusion is provided in the fourth section.

2. Literature review

Discovery learning model is quite popular to be applied in learning activities in order to improve cognitive, affective, and/or psychomotor abilities of students. The class action research implements discovery learning models to improve science skills, social attitudes, and positive responses [2]. Using the t test on the results of the pre-test and post-test, students' cognitive abilities, namely the ability of science increase. Students' social attitudes measured by five attitudes, such as honesty, responsibility, discipline, tolerance, and cooperation increase from meeting 1 to meeting 5. In addition, students show a positive response to the application of learning models as presented in the survey results.

The application of discovery learning, besides being used to improve the three basic abilities of students, is also used to improve the ability to think creatively [3]. The ability to think creatively is measured using indicators of fluency, elaboration, flexibility, and originality. Using multiple linear regression, the research concludes that there is a linear relationship between curious characters and communication skills towards creative abilities. Furthermore, it is also stated, there is an increase in the ability to think creatively with the application of discovery learning.

Discovery learning that is applied to learning English, it is used to improve listening skills and social attitudes **Error! Reference source not found.** Using the Wilcoxon test, there is a significant increase from pre-test to post-test for listening ability. Social attitudes during learning are observed. The result is an increase in positive social attitudes.

SKKNI Automotive is applied to compile learning documents at the State Polytechnic in mechanical engineering for the study of automotive and electrical electricity [4]. Practical work is prepared based on one competency standard with eight learning achievement indicators. The result is a positive response of students to learning, students' interest in learning is high, students are motivated by high learning, while the level of student understanding is quite good.

A study develops web applications to accommodate question banks that are in accordance with SKKNI Programmers [5]. Web-based assessment applications are prepared using the Scrumban method. There are 508 items that refer to the SKKNI Programmer.

3. Methodology

By considering the advantages of discovery learning methods and the benefits of SKKNI, this research combines these two methods. Discovery learning focuses on learning that encourage students to solve new problems by utilizing their prior knowledge. In the learning process, discovery learning is carried out when students are actively composing functions in R to solve problems in financial statistics. In detail, the contribution of the two methods of learning activities is as follows.

Table 1. Discovery Learning Method

Discovery Learning	SKKNI sub-field Programmer	Activities		Competence (CPMK)
		Lecturer	Student	
Using past knowledge to construct new problem solving	-	<ul style="list-style-type: none"> • Provide feedback about the basic concepts of interests and their types 	<ul style="list-style-type: none"> • Compile the maps of the basic concepts of interests and their types 	KU(a) i: Students are able to explain the basic concepts of interests and their types
	-	<ul style="list-style-type: none"> • Provide feedback about the basic concepts of securities 	<ul style="list-style-type: none"> • Compile the maps of the basic concepts of securities 	KU(a) iv: Students are able to explain the basic concepts of securities
	Implementing Structured Programming: <ul style="list-style-type: none"> • Using data types and program controls • Making a simple program • Creating programs using procedures and/or functions • Creating programs using arrays • Creating a program to access files • Compiling the program 	<ul style="list-style-type: none"> • Demonstrate the examples and/or work instructions on how to arrange functions 	<ul style="list-style-type: none"> • Formulate a program/function of financial statistics: interest theory, annuity, amortization, securities valuation 	PP(b): Students are able to model and/or formulate securities prices KU(a) ii: Students are able to distinguish the basic concepts of simple interest, nominal interest, and compounds interest KU(a) iii: Students are able to formulate annuity-immediate and annuity-due

KU(a) v:
Students are
able to
estimate the
volatility of
securities.

The role of the lecturers in this learning process is to provide relevant problems in accordance with the contextualized learning. Besides directing each student to be able to solve the problem given, the lecturers also have a role as an assessor that will assess students' competencies in material being tested.

The learning media in this lecture has been adjusted to the learning model being used, both offline and online. When performing offline or face-to-face learning, the lecturer and students use laptops/notebooks. On the other hands, the lecturer chooses several media such as *Google classroom*, *Google form*, *lecturer WordPress blog*, *R-pubs*, and *GitHub* when performing online learning model.

The lecturers use online media, namely *WordPress blogs* and *R-pubs*, to upload material since they provide more convenience and easier organizing than other online media do. Meanwhile, *Google classroom* is used to upload tasks or information that require two-way communication with students. Furthermore, Competency Test (UK) is carried out via *Google form* in order to minimize paper usage and to ease lecturer storing the results. Then, students uses *GitHub* to upload the results of the compiled functions. The use of various online media above intends to make the learning outcomes as students' online portfolio.

4. Empirical Result

Discovery learning and the adaptation of SKKNI Sub-Fields Implementing Structured Programming are divided into various activities. Discovery learning activities are carried out when students are active in rediscovering and formulating functions to solve financial statistics problems. In its implementation, four Competency Test (UK), which is adapted from SKKNI, are held during Introduction to Financial Statistics learning. Two UKs are held before the midterm examination, while the other two are held after midterm examination. Each UK adapts the competency elements and KUKs needs to support CPMK's achievement.

Table 2. Relationship between UK and achievement of CPMK

Competency Test (UK)	CPMK	Test Material
UK 1	KUa2, KUa3	Theory of interest and annuity
UK 2	KUa3	Amortization
UK 3	KUa5, PPb1	Volatility Estimates, Expected Stock Prices
UK 4	PPb1	Bond Valuation

The final recommendation result from the UK is students' competency declaration; students are declared 'Competent' or 'Not Competent' in order to arrange functions according to the test material. The recommendation diagram is as follows:

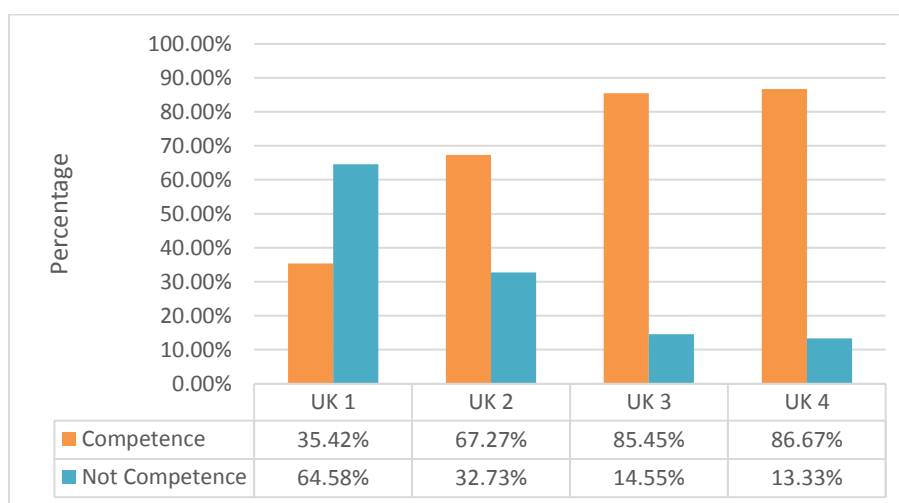


Figure 1. Diagram of Recommendation for Competency Test

Based on the **Figure 1.**, the percentage of competent students from UK 1 to UK 4 is increasing. Conversely, the percentage of students who are declared as 'Not Competent' has declined. The percentage is calculated from the total students who follow every UK. The diagram shows the achievement of the students' learning process in creating a function to help solving problems in financial statistics.

Based on the findings in UK 1, UK 2, UK 3, and UK 4, there are several things that are noted: students have not fully mastered the basics of R programming such as mathematical operations, basic array/vector/matrix, looping structure, and basic statistical functions. In addition, students are not used to tidying up function files by affixing the input/output variables.

To measure the achievement of CPMK, questions used in the middle examination and final examination. The CPMK achievement is presented in Table 3 below.

Table 3. Achievement of CPMK

CPMK	Middle Examination			Final Examination		
	KUa1	KUa2	KUa3	PPb1	KUa4	KUa5
Reached	4	20	54	48	52	44
Not reached	51	35	1	6	2	10
Total	55	55	55	54	54	54

Based on the **Table 3.**, there is no CPMK that is fully achieved by all students. PPb1, KUa3 and KUa4 are CPMK with a large number of achievements. While KUa1 is a CPMK with a large number of no achieved.

The reality of the percentage of achievement compared to the target percentage of achievement is presented in the following table.

Table 4. Actual Achievement Percentage CPMK

Alat Ukur	CPMK	Percentage of Target Score	Percentage of Minimal Target Score	Percentage of Actual Score	Mean of percentage
Mid test	KUa1	20%	10%	7,27%	47.27%
	KUa2	40%	20%	36,36%	
	KUa3	40%	20%	98,18%	
Final test	PPb1	30%	15%	88,89%	88.89%
	KUa4	40%	20%	96,30%	
	KUa5	30%	15%	81,48%	

Based on the **Table 4.**, CPMK that does not reach the target is KUa1; its competence is students being able to explain the basic concepts of interest and its types. The final result is the calculation of midterm examination and final examination scores. The percentage of student grades is as follows,

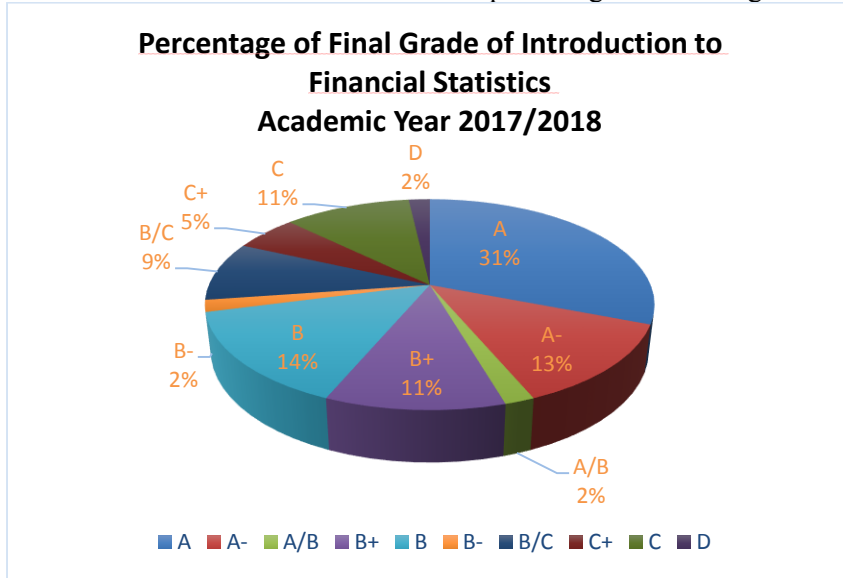


Figure 2. Diagram of Percentage of Final Grade of Introduction to Financial Statistics

Based on the pie chart in **Figure 2.**, almost one third of students, which is 31%, get an A. Meanwhile, students who get grades less than or equal to C is 13%. The comparison of the percentage of the final grade of students in the Introduction to Financial Statistics Academic Year 2016/2017 and the Academic Year 2017/2018 is presented in the following graph.

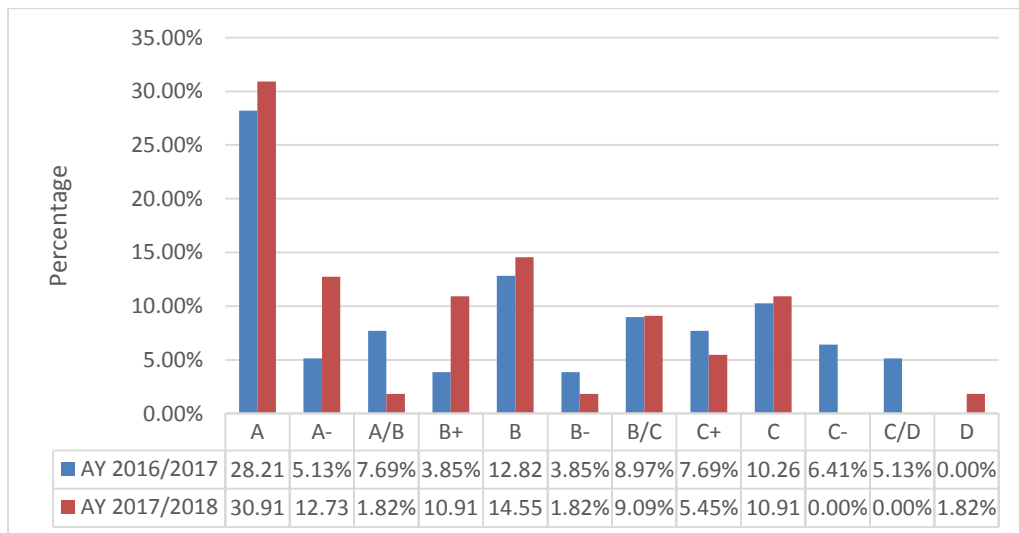


Figure 3. Comparison of Percentage of Final Grade of Introduction to Financial Statistics

The Academic Year 2016/2017 does not use discovery learning methods and the adaptation of SKKNI in the learning process. Based on the **Figure 3.**, the percentage of students who get A in the Academic Year 2017/2018 is higher than students in Academic Year 2016/2017. On the other hand, the percentage of students who score less than or equal to C in the Academic Year 2017/2018 is less than the Academic Year 2017/2018. However, 1.82 % students obtain D in the Academic Year 2017/2018 since they could not take part in the final examination.

Based on the field analysis, the difficulty in arranging the functions is due to Programming Algorithms, that is the prerequisite for arranging the functions, use different software. Although it has the same algorithm, it uses different program language.

The final scores and recommendations of the UK are analysed by using the rough set method. This analysis is used to determine the relationship between the results of UK recommendations and the final scores. Before being analysed, the final grades of students are divided into 3 categories, namely:

1. 1st Category : $grade \geq 75$
2. 2nd Category : $67.5 \leq grade < 75$
3. 3rd Category : $grade < 67.5$

The purpose of the score division is to simplify the analysis. The final grades for the 1st category are A, A-, and A / B. The 2nd category includes B +, B, and B-. Meanwhile, the 3rd category includes B / C, C +, C, C-, C / D, and D. The final scores are used as a decision variable; while the recommendations of UK 1, UK 2, UK 3 and UK 4 are used as a condition variable.

Based on the value of the certainty factor, the following conclusions are obtained:

1. Competent recommendations in UK 2, UK 3 and UK 4 will make students get 1st category grade in 70.6% of cases.
2. Competent recommendations on UK 1 and UK 4 will make students get 1st category grade in 60% of cases.
3. Not competent recommendation in UK 1 and UK 2, competent in UK 4 always cause students to get 2nd category grade.
4. Not competent recommendations in UK 3 always cause students to get 3rd category grade.

If the conclusion is drawn from the coverage factor value, the obtained conclusions are: As many as 85.7% of students who got 1st category grade are declared 'Competent' in UK 1, UK 3 and UK 4.

1. As many as 28.6% of students who got 2nd category are declared 'Not Competent' in UK 1 and UK 2, but competent in UK 4.
2. As many as 33.3% of students who got 3rd category are declared 'Not Competent' in the UK 3.

Based on the result of descriptive analysis, the combining method that are adapted SKKNI and discovery learning success to improve the percentage of students whose get highest score (A) and lessen the percentage of students whose get low score (less than or equal to C). The increasing number of students recommended as competent in the series of UK show that students learn from their prior knowledge to solve new problem and/or fix their previous mistakes. Thus the discovery learning works on their learning process. The comparing result of mid test and final test of CPMK achievement represent the fruitfulness of adapted SKKNI in improving score.

Rough set analysis is used to observe the correlation between UK and final score. Based on the result, competent recommendations in UK 1, 2, 3, and 4 makes student reach the highest score. The students whose are categorized in the second or third grade is ever recommended as not competent in one or more UK.

5. Conclusion

Discovery learning method from the learning scheme (RPS) which has been compiled subsequently is proposed to be applied to the curriculum of the next academic year since the percentage of students who get final grades less than or equal to C is only 12.7%. This result is lower than the previous year that still apply the teacher-centred learning method; the result of the pervious academic year is 21.8%. Besides, the competency test (UK) results the increase of students declared 'Competent' from UK 1 to UK 4; a total 87% of students are declared 'Competent' in the UK 4. Whereas, as seen from CPMK achievement, the average CPMK achievement Introduction to Statistics Finance is 68.08%.

The combination of adapted SKKNI and discovery learning is effective to improve student achievement. The adapted SKKNI helps the student to orderly follow the sequence of procedure (of making function). While the discovery learning encourage student to active using their knowledge.

There are a lot of field that is regulated in SKKNI. Teacher/educator can adapt it to their learning needs in order to support achievement. In the vocational education, the adapted SKKNI is very useful to introduce the students with the standard of work according to their profession.

Discovery learning plays the biggest part in the learning process. The student centred learning can be accomplished. Teacher/educator roles as facilitator to the students need.

Acknowledgement

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