

Teaching mathematics at a distance: learning from practices at Universitas Terbuka

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Abstract. Teaching mathematics in distance education has uncovered many problems and possibilities. The objective of this paper was to expose the obstacles and potentials of distance education based on practices of Universitas Terbuka in offering mathematics courses. The method used was a case study in teaching PMAT4210 – Statistics for education offered by the study program of mathematics education, Universitas Terbuka, and enrolled by thousands of students. The discussion in this paper included the effects of self-learning material which was provided by Universitas Terbuka, face-to face tutorial, and online tutorial to students' learning results. The solely source of data was the database of the student record system of Universitas Terbuka. The data then was analyzed by using ANOVA to analysis the effect of those learning supports services to the students' final examination results. The lessons from the study included how to develop learning materials that could be learned in self-directed learning mode and how to provide effectively a student learning support service.

1. Introduction

Distance higher education is characterized by the separation between learners and lecturer by space or time. This separation makes learning in distance education basically an attempt to artificially present lecturers in front of students to realize the learning process. This effort as a reintegration of the teaching acts in order to create conditions for the emergence of magical moments in which learning from teaching occurs [1,2].

How does UT implement the distance teaching process to artificially present lecturers to teach in front of their students so that learning events occur? Open University (UT) which was established in 1984 by the government of the Republic of Indonesia carries out the following steps: (1) developing printed teaching materials that can be studied independently by students, (2) preparing learning assistance services in the form of face-to-face tutorials and online tutorials to help students understanding teaching materials, (3) preparing an exam that serves to measure student competency achievements, based on the competency objectives stated in the education curriculum.

Printed learning materials that can be studied independently by students are arranged in the form of modules. Each module has competency objectives that students can achieve after learning it. The discussion in the module is designed to resemble a lecturer's exposure when giving face-to-face lectures [3,4]. The tutorial (face-to-face or online) serves to explain things that are difficult for students to understand when studying modules [5,6]. Activities in the tutorial are similar to question and answer sessions on face-to-face lectures.

The discussion of teaching on distance education in this paper is limited to the teaching of mathematics held in the mathematics education study program, the Department of Mathematics and Science Education. Faculty of Teacher Training and Educational Sciences, UT. The course that is used as a case in the discussion of this paper is Educational Statistics. This course is used as a case because it has the most participants in the 2017/2018.1 semester. As with other courses held at UT, the course on Educational Statistics is carried out through the learning process as follows.



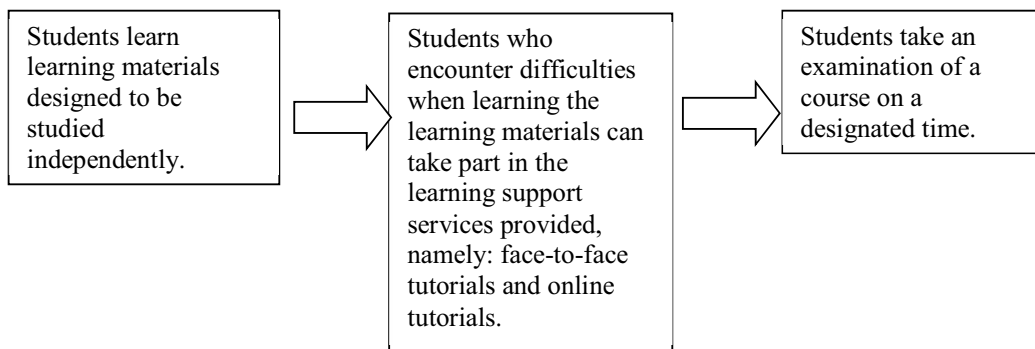


Figure 1. Teaching Process of Educational Statistics Course

Teaching mathematics at a distance is not a new thing in the world of education, as by the year 2000 alone there were 3431 courses that were held by distance education with satisfied results [7-9]. What about the effectiveness of mathematics teaching at UT which is a long distance higher education institution in Indonesia? This question will be tried to be answered in this study by taking the case of the course on Statistics for Education at UT. The discussion focused on learning assistance provided by UT to help students achieve certain competency goals.

2. Methods

The Statistics for Education course is used as a case in this study because it is the subject with the most participants in the semester of 2017/2018.2 offered by the mathematics education study program, Faculty of Teacher Training and Educational Sciences, Universitas Terbuka. The number of participants in this course reached 17516 students. Based on the data available at the UT database, all students participating in this course are grouped into four groups as follows:

- Group A –the students who joined both face-to-face and online tutorial
- Group B – the students who joined only online tutorial
- Group C –the students who joined only face-to-face tutorial
- Group D – the students who join neither face-to-face tutorials nor online tutorial

The four groups of students then compared the results of their final examinations with one-way ANOVA to find out whether the four groups had differences in the exam scores. In addition, a posthoc test with Tukey test was used to find out which groups which had differences in the scores.

3. Result and Discussion

Table 1 shows the number of students in each group from total of 17516 students participating in the final examination in the second semester of 2018.

Table 1. Number of Students in Each Group

Group*)	Frequency	Percent	Valid Percent	Cumulative Percent
A - Both F-2-F & OT	62	.4	.4	.4
B - Only OT	2557	14.6	14.6	15.0
C - Only F-2-F	384	2.2	2.2	17.1
D - Neither F-2-F nor OT	14513	82.9	82.9	100.0
Total	17516	100.0	100.0	

*) F-2-F = face to face tutorial
OT = online tutorial

Table 1 shows that the D group, which is a group of students who did not attend any learning assistance, or did not follow neither face to face tutorials nor online tutorials dominated the data (82.9%). The D group of students is a group of students who only rely on independent learning from the printed material modules. Students in this group do not follow the tutorial with two possible reasons, namely they do not need learning assistance because they already understand the learning material or they do need learning assistance but they do not have access to the learning supports services provided by UT.

The group with the second largest number of students (14.6%) is a group of students who only take an online tutorial, i.e. the B group. This group can be seen as a group of students who need learning assistance and they choose only online tutorials as a learning support service. Flexibility in terms of time and place to access learning support service is a logical reason for the students to choose the online tutorial [10]. Online tutorials allow them to access this learning assistance from various places and places they want. Based on research by Sugilar [11], students access online tutorials from home, office, and mobile in their free time.

Other groups, those who access both (online tutorial and face-to-face tutorial) and who only access the face-to-face tutorial are the smallest groups, 0.4% and 2.2% respectively. Unlike online tutorial which is provided free of charge to UT students, face-to-face tutorial is a learning support services which is subject to additional fees outside tuition fee. It might be that it is the reason why students who take part in the face-to-face tutorial have only a few participants. In addition to cost factors, perhaps the face-to-face tutorial is not much in demand due to rigid place and time, making it difficult for students who have worked to adjust the face-to-face tutorial schedule with their work and social activities.

Table 2. Average of Examination Scores

Group*)	Mean	N	Std. Deviation
A - Both F-2-F & OT	39.89	62	12.01
B - Only OT	37.61	2557	12.07
C - Only F-2-F	34.54	384	11.27
D - Neither F-2-F or OT	38.59	14513	12.67
Total	38.36	17516	12.57

*) F-2-F = face to face tutorial

OT = online tutorial

Table 2 shows the average score of the semester's final exams from each group. The difference in scores between groups is statistically significant as shown in Table 3. Furthermore, Table 4 shows that groups that differ significantly in the final semester exam scores are group B with C, B with D, and C with D. Thus, It can be concluded that the grouping of students based on participation in the type of learning support services (face-to-face and online tutorial) distinguishes the scores obtained by students in the final examinations.

Table 3. ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7969.454	3	2656.485	16.852	.000
Within Groups	2760487.602	17512	157.634		
Total	2768457.056	17515			

It can be seen in Table 2 that group A, which is a group of students who follow both face-to-face tutorial and online tutorial, have the highest average score for the examination with the score of 39.89. Although the number of participants for this group was not large enough, the average score of the highest examination in this group described that participation in extensive learning assistance provided

better learning outcomes. In addition, this fact also shows that the learning assistance provided by UT is quite effective.

The group of students who did not join any learning assistance, neither face-to-face tutorial nor online tutorial, turned out to be the group with the second largest average score in the final examination, with a score of 38.59 which was exceeding the average score of the final examination from the group that consist of students who joined online tutorial only and face-to-face tutorial only, with scores of 37.61 and 34.54 respectively. As stated earlier that the learning assistance provided by UT is intended for students who have difficulty understanding the learning materials that was studied independently. Participation in the tutorial is students' decision based on their confidence whether they are able to learn learning materials independently or need external assistance. In this case, groups that do not attend one of the tutorials provided by UT can be interpreted as a group of students who are able to learn teaching materials through independent learning.

Group B and C are groups of students who take part in one of the two learning support services provided by UT (face-to-face tutorial or online tutorial) with an average score of the examination below the group of students who did not participate in any learning assistance (group D). However, statistically, see Table 4, the difference in the examination scores for group B was not significantly different from group D. Whereas, group B (only taking an Online Tutorial) had a final examination score that was significantly better than group C (the group of students that was only joining the face-to-face tutorial). Possible explanations for this case are:

- The group C consists of students who have difficulty understanding a learning material when they learn it without assistance. Therefore, they joined with a learning support service in the form of face-to-face tutorials provided by UT. However, the learning support service was apparently not effective for group C in helping them understand the material so that the scores obtained were still lower. [12]
- The effectiveness a learning support service depends on students' preference and entry behavior. Face-to-face tutorial followed by group C may be effective in increasing the mastery of material for students who are slightly below the standard mastery of the material in the module of teaching materials, but students in group C have a substantial material mastery gap in mastering the material required in the final examination so that the face-to-face tutorial is not enough to increase the mastery of the material.
- The online tutorial relates to high-tech learning support service [13-15]. The group B consists of students who preferred with high-tech learning support service. The students in group B might have higher entry behavior compared to students in group C.

The discussion above shows that the students of Universitas Terbuka are heterogeneous in initial abilities because UT does not carry out entrance tests to recruit prospective students. All high school graduates can enter UT without testing. In this case UT applies the concept of openness in education to provide the widest possible opportunity for citizens to pursue higher education [9,15]. The heterogeneity of this initial ability is not owned by conventional universities because they usually hold entrance tests to attract prospective students who have adequate initial abilities.

Another factor, in addition to the heterogeneity of the initial ability of UT students, which influences the process of teaching mathematics is the tightness of hierarchy in the mathematics material itself. Mathematics has a strict hierarchy structure of substances. As a result, learning a mathematical material requires prerequisites for other materials that need to be mastered before. The interaction between hierarchy in the structure of mathematical material and the initial ability of students entering UT raises several difficulties in the process of teaching mathematics.

Table 4. Comparison of The Scores of Final Examination among Groups

	(I) Label	(J) Label	Mean Difference		Sig.	95% Confidence
			(I-J)	Std. Error		Interval Lower Bound
Tukey HSD	A	B	2.28241	1.61373	.490	-1.8637
		C	5.35280*	1.71843	.010	.9377
		D	1.30039	1.59792	.848	-2.8051
	B	A	-2.28241	1.61373	.490	-6.4285
		C	3.07039*	.68713	.000	1.3049
		D	-.98202*	.26928	.002	-1.6739
	C	A	-5.35280*	1.71843	.010	-9.7679
		B	-3.07039*	.68713	.000	-4.8358
		D	-4.05241*	.64913	.000	-5.7202
	D	A	-1.30039	1.59792	.848	-5.4059
		B	.98202*	.26928	.002	.2902
		C	4.05241*	.64913	.000	2.3846

Some opportunities to overcome the difficulties of teaching mathematics in distance education include:

- Material substance needs to be compiled into modules that are based on hierarchical structures of mathematical contents. Prerequisite modules must be studied by students who have not mastered it before they learn a mathematical topic. Students who have mastered the prerequisite material can pass the prerequisite modules. Thus the learning process of students can be different from each other [16]. In this case the process of teaching mathematics in distance education needs to be centered on learners (student's centered learning).
- Learning support services provided for students should be different from one student to another. The initial ability of students varies so that the required learning assistance varies according to the learning difficulties they experience [16]. The provision of diverse learning assistance will be more difficult to carry out at classical face-to-face meetings (such as in face-to-face tutorials). In the online tutorial the situation is a bit better. The time for online tutorials is mostly left to students. Thus, online tutorial participant students are more free to convey their learning difficulties directly to the tutor and will be discussed in a discussion forum [17] [18]. This explains why student learning outcomes that follow the online tutorial are better than students who follow a face-to-face tutorial.
- Distance education requires students to carry out independent learning more than students face to face. Independent learning is learning that is more controlled by students themselves than by parties outside the student. Learning control includes setting learning goals, learning time, place of learning, what is learned, how to learn, and how to know that learning goals have been achieved [4]. Independent learning skills are skills that can be learned. In this case every new UT student gets Independent Learning Skills training. This training is important to be followed by students who will enter the distance learning environment. In a distance learning environment, the control of the learning process is mostly in the students themselves. If in conventional education there are parties who make lecture schedules, then in self-education distance is the one that regulates the schedule when studying module teaching materials instead of face-to-face lectures.

4. Conclusion

The process of teaching mathematics in distance education as implemented by UT is characterized by separation in place and time between learners and teachers. This separation resulted in the teaching of mathematics process requiring the following teaching actions:

- Mathematical learning materials should be arranged in modules that can be studied independently by students. In distance teaching, lectures occur when students study the module in a more

flexible place and time. The modules are also to overcome various initial abilities of students. Students can pass modules that have been mastered by previous learning experiences.

- Learning assistance is needed to help overcome student difficulties in understanding teaching materials. Learning assistance needs to be carried out based on individual difficulties faced by students. Learning support services that is classical and lecture-based has proven to be less effective than individually learning support services.
- Independent learning skills need to be mastered by students who study in a distance learning environment. These skills can be trained for students.

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