Tutors' opinions on students' difficulties of learning mathematics in the distance higher education: A Delphi survey

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Abstract. Learning in the distance in higher education was challenging since the students were supposed to study in a self-regulated learning mode. The difficulties were double in learning mathematics, especially for the students of the non-mathematics study program. The primary purpose of the research was to identify the students' problems in learning mathematics at a higher education institution that implementing a distance education system. The method was a Delphi survey to 23 tutors for mathematics courses in the study program of a bachelor's degree in elementary school teachers for identifying the student difficulties in learning mathematics. The research concluded that the problems of learning mathematics for the students in the distance higher education consisted in five components: 1) the nature of mathematics, 2) learning material, 3) the nature distance learning, 4) learning support services, and 5) motivation. The proposed recommendation was that to facilitate students' learning mathematics, an institution of distance higher education should overcome the students' difficulties in learning mathematics by preparing the learning materials and the student learning support services to accommodate the students.

1. Introduction
There were many definitions of distance education in the literature to explain various forms of teaching and to learn in the distance. Based on a summary conducted by Keegan in 1980, Holmberg formulated five elements that distinguish distance education from conventional education, namely: 1) an almost permanent separation between teacher and learner in the whole learning process (to differentiate from face-to-face teaching), 2) there is the influence of educational institutions in planning, preparing learning materials, and student learning support services (to differentiate to self-studies), 3) the use of media - print, audio, video or computer - to unite teachers and learners and deliver learning material, 4) availability of two-way communication that allows students to benefit or be able to initiate dialogue with instructors or peers (to differentiate from the only use of technologies in education); and 5) the learning process prioritizes individual learning, although it is also possible for a study group [1].

Separation in the above definition could mean a break in terms of time or place. Separation in time and place could occur when learners and instructors were in different areas, so the learning and teaching process was done through asynchronous communication, such as through printed teaching materials, correspondence, or via e-mail. The use of telecommunications for communications, such as a webinar, allowed communication to be synchronous; in this case, the separation occurred in place only, not separated in time. The influence of educational organizations on the definition of distance education
showed that distance education could be formal, informal, or non-formal education [2]. Furthermore, the use of learning media intended to overcome the separation between instructors and learners, so the use of technology allowed to unite teachers, learners, and course material, and let dialogue between learners and instructors or among learners [3].

I was learning used media - print, audio, video, computers, or gadgets - to overcome separations between instructors and learners and to provide instructor dialogue with students and among learners, which were inherent in the characteristics of distance education. The implementation of distance education was based on scientific knowledge about how effective learning is through media. Russell (1999) compiled a book called The No Significance Differences Phenomenon, which was the result of 355 studies carried out starting from 1928 [2]. In the book, it was explained that the results of the study revealed that there were no differences in learning outcomes between learners in distance education who studied through face to face. With this argument, distance education could convince itself that the learning outcomes obtained by its students were no different from the learning outcomes obtained by students of face to face learning.

Mathematics courses are subjects that are difficult to be studied by students as indicated by the level of mathematics learning outcomes, which tended to be low, especially in undergraduate students of Elementary School Teacher Education (S1-PGSD) in Universitas Terbuka (UT), which had an average of around 45 and 56 for a maximum of 100 [4]. Therefore, the students of distance education had difficulty in learning mathematical material, especially for the students of a nonmathematical study program. However, there had not been much research on learning mathematics in the distance education environment, and - of that few – scarce research had been conducted to identify difficulties in learning mathematics in distance education.

Some research on learning mathematics in distance education were presented here. Smith & Ferguson, in 2005, confirmed that the difficulty of students learning mathematical material through e-learning indicated by the high attrition compared to students who study nonmathematical material in e-learning [5]. The learning modes also differentiated the inefficiency of time in learning mathematics, as reported by Safavil et al., that concluded that the learning outcomes of high school students who studied mathematics in distance education were less efficient than their peers who study face to face [6]. In line with the research, Jones and Long compared the mathematics teaching of two groups of students studying online versus on-site and showed no different learning outcomes [7]. The use of teaching strategies in distance education gave no effect on learning outcomes. It is in line with DePriter, which concluded no differences in learning outcomes between the application of objectivist-based teaching strategies and constructivist-based teaching strategies for adult students learning mathematics at a distance [8].

From the description of the results of research on distance education for mathematics learning, it could be concluded that little research had been reported on distance education in mathematics learning. So, this article specifically to answer the question: what difficulties do students face in learning mathematics in distance education? The purpose of this paper was to describe the problems of distance higher education students in learning mathematics based on mathematics tutors' opinions.

2. Methods

The research approach was qualitative research aimed to reveal judgmental opinions from the person who is the most recognizing the students' difficulties of learning mathematics in a distance education environment. The method used was a Delphi survey [9][10][11] to mathematics tutors of the face-to-face tutorial. The instrument for the Delphi survey was developed in two phases. In the first phase, the instrument was constructed within focus group discussions among the tutors to identify statements that reflected the difficulties of learning mathematics. In the second phase, the instrument was evaluated by the tutors through the Delphi survey itself, which consisted of several rounds, and in each Delphi's round, the tutors could add, change, or erase any item in the instrument.

The assumption used in this study was that the tutors in the face-to-face tutorial were the most directly dealing with students to be used as a source of information to find out students' difficulties in learning
mathematics. Sources of information came from 23 tutors from UPBJJ-UT Bandung (4 tutors), Jambi (5 tutors), Jember (9 tutors), and Surabaya (5 tutors). Based on the level of education, tutors involved in this study were S-2 (74%) and S-3 (26%). Based on sex, the distribution of the percentage of tutors involved in this study was male (61%) and female (39%). The average age of the tutors is 49 years. Concerning work, 65% of the tutors are lecturers in universities, and the rest are teachers or supervisors in the provincial education department.

3. Result and discussion
The identification of students' difficulties in learning mathematics in a distance learning environment was explored from the intuitive opinions of 23 tutors who gave face-to-face tutorials on mathematics courses in the S-1 Elementary School Teacher Education Program. The 23 experts shared their views on the Delphi technique, which was carried out in two rounds via e-mail communication. A face-to-face meeting with the experts was previously held to equalize perceptions regarding procedures in the Delphi technique and Focus Group Discussion (FGD) to formulate the types of difficulties UT students have in studying mathematics courses. In this FGD, 29 types of student difficulties were developed in the form of statements. Table 1 showed some examples of the ideas of learning difficulties.

Table 1. Statements of students' difficulties.

| #Statements | Statements of learning difficulties |
|-------------|-----------------------------------|
| 1           | Students did not have a sufficient prerequisite mathematical knowledge to learn college-level mathematics |
| …           | The mathematics module (printed text material) was difficult to comprehend |
| 20          | It's difficult to self-directed learning; the students used to learn in face-to-face learning |
| …           | No learning material explained the benefit of mathematics to motivate students |

3.1. The first round of the Delphi technique
In the first round of the Delphi technique, 29 statements showing the types of difficulties students had in learning mathematics courses were circulated to the tutors to get an agreement. In this first round, the tutors were also able to add, subtract, or change the student's difficulty statement. In the first round, it obtained 16 reports agreed by the experts. The remaining 13 items will be included in the second round after accommodating input from the experts. Table 2 showed the results of the first round of the Delphi survey.

Written comments from experts on unanimously agreed statement items should proceed to the second round. Comments from experts consisted of them relating to the choice of agreement on each item in the statement regarding students' difficulty in learning mathematics. These comments are of two types, namely optional comments provided in the questionnaire form and written words. Some disputing comments from the experts were as follows:

1. For statement items stating that student difficulties related to the characteristics of the mathematical material itself, the disagreement between experts revealed in their written comments. Experts who disagree with the contents of the statement stated that it was not a source of student difficulties because it had been completed by the tutor's task to overcome these difficulties. A total of six experts stated that they never found students encountered challenges because of the mathematics itself. Also, they wrote that the students' problems were depending on how the tutor explained it. However, even more, experts agreed with the statement that the students had problems because the mathematics was challenging to understand without understanding the previous mathematical concepts that support them.
2. For statement items stating that student difficulties related to student motivation to learn (items 6 and 8), some experts who disagree commented that it was the tutor's job to motivate students and associate mathematical material with everyday life to motivate them. The 18 experts who agreed with gave comments that students’ motivation to learn was indeed a problem for some students, regardless of subject matter and learning mode.

3. For statement items stating that student difficulties related to distance education carried out by UT, expert groups who disagree commented that it should not, because the curriculum requirements and minimum standards of achievement of learning materials expected to graduate were the same, and depended on how effective a face to face meeting. While the group of experts who agreed commented that they understood the difficulties because even people who studied mathematics face-to-face was indeed challenging to learn and even more through distance learning.

Table 2. Round 1 of the Delphi technique.

| #Item | Median | IQR | Decision   | #Item | Median | IQR | Decision   |
|-------|--------|-----|------------|-------|--------|-----|------------|
| 1     | 4.00   | 1   | To round 2 | 16    | 4.00   | 0   | Accepted   |
| 2     | 4.00   | 0   | Accepted   | 17    | 4.00   | 0.5 | Accepted   |
| 3     | 4.00   | 1   | To round 2 | 18    | 4.00   | 0   | Accepted   |
| 4     | 4.00   | 0   | Accepted   | 19    | 4.00   | 1   | To round 2 |
| 5     | 4.00   | 1   | To round 2 | 20    | 4.00   | 0   | Accepted   |
| 6     | 4.00   | 1   | To round 2 | 21    | 4.00   | 0   | Accepted   |
| 7     | 4.00   | 1   | To round 2 | 22    | 4.00   | 0   | Accepted   |
| 8     | 4.00   | 1   | To round 2 | 23    | 3.00   | 0   | Accepted   |
| 9     | 3.00   | 1   | To round 2 | 24    | 3.00   | 1   | To round 2 |
| 10    | 4.00   | 0   | Accepted   | 25    | 4.00   | 0   | Accepted   |
| 11    | 4.00   | 0   | Accepted   | 26    | 3.00   | 1   | To round 2 |
| 12    | 4.00   | 0.5 | Accepted   | 27    | 3.00   | 1   | To round 2 |
| 13    | 4.00   | 0.5 | Accepted   | 28    | 3.00   | 1   | To round 2 |
| 14    | 4.00   | 0   | Accepted   | 29    | 3.00   | 1   | To round 2 |
| 15    | 4.00   | 0   | Accepted   |        |        |     |            |

3.2. The second round of the Delphi technique
A total of 13 items of the difficulties statements in the first round required experts' evaluation in the second round. The second round instrument was similar to the first, but the statement items included were only 13 items. Also, each item in the second round had the results of the evaluation and comments obtained in the first round without including the experts' identity that provided the words. The experts could evaluate more deeply in the second round by looking at the evaluation results in the first round. Table 3 showed the results of the median and IQR calculations and decisions in the second round.

Table 3. Round 2 of the Delphi technique.

| #Item | Median | IQR  | Decision  | #Item | Median | IQR  | Decision  |
|-------|--------|------|-----------|-------|--------|------|-----------|
| 1     | 4      | 0    | Accepted  | 19    | 4      | 0    | Accepted  |
| 3     | 4      | 0    | Accepted  | 24    | 4      | 0    | Accepted  |
| 5     | 4      | 0.75 | Checked   | 26    | 3      | 0.75 | Checked   |
| 6     | 4      | 0.75 | Checked   | 27    | 3      | 1    | Checked   |
| 7     | 4      | 0    | Accepted  | 28    | 3.5    | 1.5  | Checked   |
| 8     | 4      | 0.75 | Checked   | 29    | 2      | 1    | Checked   |
| 9     | 3      | 1    | Checked   |        |        |     |           |

Examining the items 5, 6, 8, 9, 26, 27, 28, and 29 used Spearman's Rank correlation formula to calculate the correlation of the experts' responses in the first round and the experts' responses in the second round.
A high correlation value indicated that the expert response tends to be consistent, there are no significant changes, so there was no reason to make the next round for these items [12]. The results of Spearman’s Rank correlation calculations for items 5, 6, 8, 9, 26, 27, 28, and 29 respectively are 0.994, 0.990, 0.993, 0.998, 0.984, 0.985, 0.983 and 0.985. The critical value of the Spearman’s rank correlation coefficient for n = 23, at α = 0.05, was 0.70. The calculation of the correlation coefficient was higher than 0.70, and it concluded that the expert response did not change and tended to be saturated so that no next round (the third round) was needed. Thus, based on the experts through the Delphi technique, it concluded that the difficulties of learning mathematics of the distance education students identified in 21 statements agreed by 23 experts.

The research team then discussed each statement's contents and meaning to classify the ideas based on collective meaning [13][14][15]. The result, the research team obtained five dimensions from 21 statements of students’ difficulties in learning mathematics in the distance education environment, namely those related to 1) learning motivation, 2) characteristics of mathematical material, 3) learning materials, 4) characteristics of distance education and 5) learning support services.

4. Conclusion
Mathematical content material is hierarchical [16][17] students learn a topic that requires mastery of the topics that support it. Students who do not master the prerequisite material will have difficulty learning a mathematical material. In the distance higher education environment, the problems in learning mathematics caused by these mathematical characteristics contribute to other learning difficulties, such as difficulties in comprehending learning materials, self-directed learning, assessing learning support services, and student motivation. Therefore, learning mathematics in distance education requires unique treatments different from other subjects. Recommendations for distance education institutions, for mathematics courses for students not in the mathematics study program, it is necessary to provide supporting material before discussing the primary material of the course. Supporting material can be delivered via online tutorials, face to face tutorials, or MOOCs.

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