Mathematics Teaching Innovations and The Evaluation during the Pandemic: What Else Can We Do to Help Our Students Learning?

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Abstract This paper describes the innovations in mathematics teaching for the D3 Dep. of Electrical Engineering Politeknik Negeri Semarang (Polines), Indonesia during the corona pandemic and the evaluation. The case study method is chosen to observe the qualitative and quantitative data based on three considerations, i.e. the technologies, goals and assessments. The results show three things: teaching innovations based on the processes and products and the evaluation. Processes here mean the variety on the technology use in teaching. During the pandemic, not only Whatsapp (WA) application is used to support the teaching but also two learning management systems (LMS), i.e. Elnino (Moodle-based) and Google Classroom (Google-based). These technologies are used simultaneously to record the attendances as well as to deliver teaching and assignment materials. Meanwhile, Whatsapp (WA) application is then used specifically for discussions, Google Classroom for submitting assignment and Elnino for managing the grades. Beside the LMS, another technology, i.e. Youtube channel, is used to share teaching materials in the video format. Meanwhile products here mean innovations on the goals and assessments modifications. Goals are simplified into three (out of four) purposes only. While assessments only consist of the two (out of three) individual assignments and two (out of four) group works. As the evaluation given by students’ feedback, more teaching innovations are needed to balance the synchronous and asynchronous teaching approaches. Which means more technologies can be used to conduct online meeting (e.g. Zoom meeting, Google Meet) and interactive online quizzes (e.g. Kahoot, Mentimeter).

1. Introduction
The corona pandemic has pushed educators entire the world to create innovation in their teaching1-4. Innovations here means, educators need to modify their teaching including technologies use, goals, assessments etc. to help students learning1, 2, 3. Inspired by these literatures, research on the teaching innovations was carried out. The focus of the research is mathematics teaching innovations for D3 Dep. of Electrical Engineering Politeknik Negeri Semarang (Polines). As an addition, the research presents the evaluation of the innovations from the students’ perspective as well.
Politeknik Negeri Semarang (Polines) uses e-learning Moodle-based namely Elnino. Since Elnino is an LMS, lecturers are able to conduct their online teaching here. This includes delivering teaching materials, create discussion forum with their students, collecting students’ assignment and managing the grades. However, to avoid the technical issues, lecturers may also use other LMS or online applications to support their teaching.

This paper presents the results of a case study on how mathematics teaching innovations are created. It was further analyzed what are technologies use and how lecturers modify their teaching goals and assessments. To balance the data, online survey using Elnino was conducted to gather information from students to evaluate the innovations.

2. Research Methods
This research is a case study on the mathematics teaching innovations and the evaluations in Dep. of Electrical Engineering Politeknik Negeri Semarang (Polines). There are two groups of respondents in this study, i.e. lecturers and students. Three mathematics lecturers were selected based on three considerations, i.e. technology used, teaching goals and assessments in their teaching. Furthermore, one hundred students were participated in the online survey on the second last meeting to give the evaluation.

This research describes the quantitative and qualitative data analysis. The first stage of this research is reviewing the literature. Second, collecting quantitative data from the lecturers using Google Form. Third, gathering qualitative data on the teaching innovations by observing their online classrooms. Fourth, analyzing and coding the data. Fifth, conducting online survey using Elnino to get students’ feedback. There are one hundred students (65 male and 35 female) participating in this survey. Sixth stage, analyzing both qualitative and quantitative data from the feedback. Last stage, draw the conclusion.

3. Results
This section review the results of each stage of research on the mathematics teaching innovations and the evaluations.

3.1. Description of Respondents’ Demographics and Quantitative Data Using Google Form in Mathematics Teaching Innovations
This section begin with the demographic data of the lecturer respondents of this study, which are presented in Table 1 below.

| No. | Name | Gender | Teaching Experience (x) | Study Program |
|-----|------|--------|--------------------------|---------------|
| 1   | ET   | F      | x>20 years               | LT            |
| 2   | IT   | F      | 10<x<20 years            | EK            |
| 3   | MN   | F      | 10<x<20 years            | TK            |

All the three (100%) respondents are female. There is only one (0.33%) respondent with teaching experiences more than twenty years, while the rest two (0.67%) between ten to twenty years. Each respondent teaches in different study program, i.e. Power Engineering, Electronics Engineering and Telecommunication Engineering.

Next, presented quantitative analysis of data from the results of the questionnaire using Google Form with the following seven questions: (i) whether there is WA use in teaching, (ii) whether there is Elnino use in teaching, (iii) whether there is more than one LMS use in teaching, (iv) whether there is online channel use in teaching, (v) whether there is online applications in teaching, (vi) whether there is modifications in teaching goals and (vii) whether there is modifications in assessments. These questions or quantitative instruments of this study were created by reaserchers themselves to be able
to adjust to the research topic and conditions in the Electrical Engineering Polines. Data are presented in Table 2 below.

**Table 2. Questionnaire Results using Google Form**

| No. | Name | Questions |
|-----|------|-----------|
|     |      | Q1        | Q2      | Q3      | Q4      | Q5      | Q6      | Q7      |
| 1   | IT   | Y N Y Y   | N Y Y Y | Y N Y N | Y N     | Y Y Y N | Y N Y N | Y Y N N |
| 2   | IT   | Y Y Y Y   | Y Y Y Y | Y Y Y Y | Y Y Y Y | Y Y Y Y | Y Y Y Y | Y Y Y Y |
| 3   | MN   | Y Y Y Y   | Y Y Y Y | Y Y Y Y | Y Y Y Y | Y Y Y Y | Y Y Y Y | Y Y Y Y |

All of the three lecturers (100%) use WA and Elnino. Only one (0.33%) respondent uses more than one LMS while the rest two (0.67%) use only one LMS. Similarly, the results remain the same for the last four questions. Only one (0.33%) respondent uses online channel and applications in teaching and modify teaching goals and assessments while the rest two (0.67%) do not use. In other words, there only one respondent who always answer Yes for the given questions while the others two always answer No.

Furthermore, from Table 2 above, it can be concluded that two groups in these respondents. Group one is lecturer with teaching innovations and Group two is lecturers with less teaching innovation. Lecturer IT in Group one uses various technologies in teaching (i.e. WA, two LMS, online channel and application) and modify her teaching goals and assessments.

The research continued on exploring the qualitative data on the teaching innovation based on technology use. The results were then described in the section 3.2 below.

3.2. **Description on The Teaching Innovations Based on Technology Use**

As a beginning, given the recapitulation data on the group one (lecturer with innovation). The data were shown on the Table 3 below.

**Table 3. List of Recapitulation Data on The Teaching Innovation**

| No. | Name | Questions |
|-----|------|-----------|
|     |      | Q1        | Q2      | Q3      | Q4      | Q5      | Q6      | Q7      |
| 2   | IT   | Y Y Y Y   | Y Y Y Y | Y Y Y Y | Y Y Y Y | Y Y Y Y | Y Y Y Y | Y Y Y Y |

By looking at demographic data, the respondent namely IT is a female Mathematics lecturer in the Electronics Engineering study program with 10-20 years of teaching experiences.

Furthermore, to collect the qualitative data by observing the kinds of technology use in her online mathematics classroom. The results are presented in Figure 1 below.
Respondent IT uses WA, Elnino, Google Classroom, online channel and application in her mathematics teaching. It can be seen in Figure 1 that IT uses WA especially for discussion, Google Classroom for students’ submission assignments, Elnino for grading management, Youtube channel for sharing teaching materials in video format and Mathtools application to calculate Fourier series.

The research continued on exploring the qualitative data on the teaching innovation based on modification teaching goals. The results were then describe in the section 3.3 below.

3.3. Description on The Teaching Innovations Based on Modification Teaching Goals

Given data on the teaching goals before and during the pandemic, shown in Table 4 below.

| No | Before Pandemic | During Pandemic |
|----|----------------|----------------|
| 1  | First-order Differential Equations: Homogenous and Linear | First-order Differential Equations: Homogenous and Linear |
| 2  | Second-order Differential Equations: \( f(x) = 0 \) and \( f(x) = \) polynomial, exponential, sine and cosine, sum or product | - |
| 3  | Laplace Transform: solution of differential equation and simultaneous differential equation | Laplace Transform: solution of differential equations only |
| 4  | Fourier series: odd, even, neither odd nor even, any range and non periodik | Fourier series: odd, even, neither odd nor even only |

From Table 4, it can be seen that before the pandemic, there were four teaching goals. During the pandemic, the goals were then modified, but of course without reducing the quality and students’ learning objectives.

The research continued on exploring the qualitative data on the teaching innovation based on modification assessments. The results were then describe in the section 3.4 below.

3.4. Description on The Teaching Innovations Based on Modification Assessments

Given data on the assessments before and during the pandemic, shown in Table 5 below.
### Table 5. List of Mathematics Teaching Assessments

| No | Before Pandemic | During Pandemic |
|----|-----------------|-----------------|
| 1  | Midtest 1       | GW1             |
| 2  | Midtest 2       | GW2             |
| 3  | Endtest         | GW3             |
| 4  |                 | GW4             |

From Table 5, it can be seen that before the pandemic, there were three individual and four group work assessments. During the pandemic, the assessments were then modified due to the time constraint and health factor. By this modification, IT hopes that her students have less pressure and able to maintain stable immunity while studying mathematics.

### 3.5. Description on The Evaluation from Students’ Feedback

This section begin with the demographic data of the student respondents of this study, which are presented in Table 6 below.

#### Table 6. Students Demographics

| Gender | Age          | Study Program | Type of the mobile phone |
|--------|--------------|---------------|--------------------------|
| M 65%  | F 35%        | 16 – 19 years old | Android (100%)            |
|        |              | EK            | -                        |

From the results in section 3.1 – 3.4, it can be seen that only one lecturer who has teaching innovation, i.e. responden IT from Electronics Engineering study program. Therefore, in order to gather information about the evaluation the survey was conducted for IT students in the same study program only at the second last meeting. From Table 6, it can be seen students’ demographics. There were 100 students (65% are male and 35% are female). Students age range from 16 years old to 19 years old. All respondents’ type of mobile phone is Android (100%).

Next, presented quantitative and qualitative analysis of data from the survey using Feedback menu in Elnino with the following eight questions: (i) whether student is facilitate enough using WA for discussion with the lecturer, (ii) whether student is facilitate enough using Google Classroom for submitting assignments, (iii) whether student is facilitate enough using Elnino for gathering information about grades, (iv) whether student is facilitate enough using Youtube channel to receive teaching materials in video format, (v) whether student is facilitate enough using Mathtools to calculate Fourier series, (vi) whether student’s feel his/her learning objectives are well-crafted in the new syllabus, (vii) whether the assessments are enough to reach the objectives and (viii) whether there is/are improvements needed for the teaching, if Yes, write down the answers. These instruments of this study were created by researchers themselves to adjust with the research topic and conditions in the Electronics Engineering study program Polines. Data are presented in Table 7 below.

#### Table 7. Students’ Feedback on the Innovations

| Questions | Y | N | Y | N | Y | N | Y | N | Y | N | Y | N | Recommendations |
|-----------|---|---|---|---|---|---|---|---|---|---|---|---|-----------------|
| Q1        | 100% | 100% | 93% | 7% | 100% | 83% | 17% | 100% | 100% | - | - | - | Elnino sometimes down |
| Q2        | 100% | 100% | 93% | 7% | 100% | 83% | 17% | 100% | 100% | - | - | - | Mathtools sometimes is not clear, there are some free Android apps can be used |
| Q3        | 100% | 100% | 93% | 7% | 100% | 83% | 17% | 100% | 100% | - | - | - | Video conference using Zoom or Google Meet can be conducted once a month |
| Q4        | 100% | 100% | 93% | 7% | 100% | 83% | 17% | 100% | 100% | - | - | - | Online interactive quizzes can be conducted using Kahoot or Mentimeter to increase engagement |
Students voices are very important to improve teaching. That’s why this research conducted online survey using Elnino at the second last meeting to receive students’ feedback. From Table 7 it can be seen that all students (100%) were facilitated enough using WA for discussion. This can be explained because WA is real time, user friendly and has a lot of features for discussion. Similarly, the result remains the same for questions 2, 4, 6 and 7. Furthermore, there were only 93% students were able to gather information using Elnino and 7% were unable. Students wrote that sometimes Elnino had technical issues. For Q5 only 83% students were able to gain the information from Mathtools application while 17% were unable. Some students prefer to use another free Android application for calculating Fourier series than Mathtools. Moreover, there were two recommendations from students regarding the teaching, i.e. lecturer should conduct video conference using Zoom or Google Meet once a month and online interactive quizzes using Kahoot or Mentimeter every two meeting to enhance students’ engagement and motivation in learning mathematics.

Next, a deeper discussion about the results obtained in section 3.1. to 3.5 is presented in the discussion section below.

4. Discussion
This research is a case study on the mathematics teaching innovations and the evaluations in Dep. of Electrical Engineering Politeknik Negeri Semarang (Polines). Respondents of this study were three lecturers (all are female), with teaching experience of between ten to twenty years (two lecturers) and more than 20 years (one lecturer). Each respondent teaches in different study program, i.e. Power Engineering, Electronics Engineering and Telecommunication Engineering. Second group respondents of this study were one hundred students (65 male and 35 female) with the age range between 16 – 19 years old and they have Android mobile phone. This fairly varied demography is expected to eliminate bias so the data is valid.

In general, this study shows there are two mathematics teaching innovations created by respondent IT, i.e. innovations on the teaching products and on the teaching processes\(^1,2,3\). From Table 2, it can be seen IT uses more technologies to support her teaching compared to others. The kinds of technology used by IT can be found in Figure 1. This shows how she creates teaching innovation using products point of view as stated in \(^1,2\). From Table 2 questions 6 and 7 quantitatively IT modified her teaching goals and assessments to fit with pandemic situation. By this means, she creates teaching innovations using process point of view as mentioned in \(^1,2\).

On the other side, from Figure 1, this research pictorially shows the kinds of technology used by IT. Respondent IT uses WA since it has a lot of features to facilitate real time discussion \(^5, 6\). Google Classroom is used as the medium for submission since it has a cloud storage with minimum delay \(^7, 8\). Elnino is used for grading management since it has a good learning analytic \(^9, 10, 11\). Youtube channel is used as a medium for sharing video since it is one of the most popular social media with video content format \(^12, 13\). Mathtools application is used since it has complete feature as the Fourier series calculator \(^14, 15\). Above all, this variation of technologies is used to have her students feel engage, able to participate, comprise and empower \(^1, 2, 15\).

Looking at Table 4 and 5 this research qualitatively shows the modification created by IT in order to fit with the pandemic situation. The goals and assessments were seemed to be reduced but the quality and students’ learning objective can be maintained optimal. Students’ health is the foremost consideration on modifying the assessments.

Furthermore, this study shows that teaching experiences and study program do not determine the mathematics teaching innovations.

The evaluation about the innovations can be seen in Table 7. One hundred students participated and gave their voices using menu Feedback in Elnino created by IT on the second last meeting. She eagers to listen her students’ evaluations to improve her teaching. Qualitatively, students mentioned about some technical issues related to Elnino, opinions to use other applications to calculate Fourier series and recommendations in conducting online meeting using Zoom or Google Meet and interactive online quizzes using Kahoot or Mentimeter. This align to \(^1, 2, 15\).
Next, research about analysis and design factors of the Elnino mathematics classroom could be conducted to create more innovations.

5. Conclusion
From the results presented in sections 3 and 4 it is found that there are mathematics teaching innovations in the Electronic Engineering study program Polines. Three considerations were taken into account, i.e. technology use, teaching goals and assessments. This paper presents two kinds of innovations, i.e. innovation in the teaching products and processes. As the innovation in teaching product, there are at least five technologies used by respondent IT to support her teaching. On the other hand, as the innovation in teaching processes, the teaching goals and assessment were modified to adjust with the pandemic situation. Furthermore, this study shows teaching experiences and study program do not determine the innovations. To balance the data, students’ voices were collected using online survey to get the evaluation. There are at least two recommendations from students to improve teaching, i.e. in the future, lecturer should conduct online meeting using Zoom or Google Meet once a month and conduct online interactive quizzes using Kahoot or Mentimeter to enhance students’ engagement and motivation in learning mathematics.

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