Technology Integration to teaching mathematics in Higher Education during Coronavirus Pandemic using SAMR Model

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Abstract. Technology integration is one of the abilities teachers need to support teaching and learning activities and direct students to deep learning. Choosing a learning media based on technology is more difficult in statistics lesson. This study aimed to analysis the ability of teachers in integrating technology during the coronavirus pandemic using the SAMR model. This research used a qualitative method, this research data was in the form of information on what technology was used and how the teacher integrated technology during the coronavirus pandemic. Data was collected by means of observation and interviewing 2 Guangxi Normal University students who took this course. The results showed that the ability of teachers to integrate technology in statistics lesson during coronavirus pandemic was at every SAMR level. This study proves that the coronavirus pandemic has a positive impact on teachers' ability to integrate technology.

1. Introduction
The need for the use of technology is increasing in the 21st century [1–3]. The use of technology is proven to have a huge impact on teaching and learning activities such as several studies have shown that technology integration can improve students' abilities in a various lesson [4–6]. The use of technology can also improve students' abilities in mathematics and science lessons [7,8]. But, the use of technology must be designed by the teacher. Teachers sometimes have many reasons for not using technology to teach in class [9,10]. The reasons for teachers not to use technology to teach are not having time to prepare lesson plans, not being proficient in utilizing technology, using technology to waste time, and being too comfortable with the habit of using the blackboard for teaching.

The SAMR (Substitution, Augmentation, Modification, and Redefinition) model was first created by Puentedura in 2006 as an initiative to use technology in learning [11]. The SAMR model talks about the design of teachers to integrate technology in teaching [12]. The SAMR model divides the use of technology in teaching and learning activities into 4, namely; direct use of technology without change (substitution), use of technology with functional changes (augmentation), significant use of technology with re-design (modification), and use of technology creation in new tasks that previously did not exist (redefinition) [13]. A more complete picture of the SAMR model can be seen in Figure 1. The 4 levels of the SAMR model depend on teacher knowledge when integrating technology.
In the previous research, Aprinaldi et al [14] analyzed the integration of technology using the SAMR model in vocational education and found that technology was very important for children's vocational education. In the language lesson, Sri Wahyuni et al. [15] conducted qualitative research by interviewing 2 teachers in Indonesia to find out about the use of technology when they were teaching. After the data was processed using the SAMR model, Sri Wahyuni found that schools in Indonesia had used technology at 4 levels, Substitution, Augmentation, Modification, and Redefinition. At the higher education level, Jude T et al. [16] analyzed the causes of the lack of technology integration in higher education by taking a sample of Makerere University. Jude's research found that several factors influenced teachers in technology integration. These factors were 1) lack of technological facilities that supported the use of technology in teaching and learning activities 2) lack of knowledge and experience of teachers in using technology 3) lack of government support regarding the use of technology in the field of education.

Coronavirus pandemic made teaching and learning activities unable to run normally [17,18]. Students could not go to school and must study at home. This situation made the use of technology for teaching and learning needs to increase. Learning, which was usually offline in the classroom, turned into using a meeting platform, website, or video learning to support student learning activities. This study aimed to analyze the use of technology used in universities to teach during the coronavirus pandemic based on SAMR model. Based on the result of this study, universities know if lecturers integrate technology with learning during coronavirus pandemic at the level of transformation (modification and redefinition). The result of this study also can be supporting data and suggestions for researchers in other countries to conduct further studies on the technology integration with learning during the coronavirus pandemic.

2. Method
This research adopts qualitative research with a case study to explore technology integration at the higher education level during the coronavirus pandemic. Data collection was carried out in March 2020 - July 2020, and data processing was carried out in August 2020 - September 2020. The research samples were taken from the Department of Mathematics and Statistics, Guangxi Normal University, China.
Table 1. Course data were taken as the sample

| No | Name of courses                                      | Credit | Number of students |
|----|------------------------------------------------------|--------|-------------------|
| 1  | Data analysis and statistics software                | 3      | 27                |
| 2  | Selected cases of education statistics application projects | 3      | 27                |

In this study, data were collected from the students and lecturer who took and taught the two courses above. Technology integration data used by the lecturers in teaching was collected through preliminary observations, document reviews, and interviews to two international students. The questions asked in the interview was short questions about four types of technology that the lecturer used (devices, learning platforms, learning media, social media, and software). The teacher used technology integration data in the 2 courses and how the technology was used and were analyzed using the SAMR model to conclude.

3. Result and discussion

3.1. The technology used by teachers when teaching

Research data from observations of technology use in 2 courses and interviews to confirm what technology was used by teachers to teach when the coronavirus pandemic, data was seen in table 1. Table 1 showed 2 statistics courses from the department of mathematics and statistics using various technologies. For devices, lecturers used their computers, tablets, and laptops at home to prepare learning media and install the Voov Meeting application for teaching. The Smartphone was used to send data and exercises to students via the QQ or WeChat application. The QQ and WeChat were also used by students to send assignments to lecturers, or discuss in groups when they encountered problems. Students also used cellphones to take online classes.

Table 2. Technology used for teaching and learning activities

| Name of courses                                      | Technology                        | Teacher                              |
|------------------------------------------------------|-----------------------------------|--------------------------------------|
| Data analysis and statistics software                | Devices                           | Computer, laptop, tablet, cellphone   |
| &                                                    | Learning platform                 | Superstar, BiliBili, Zhihuishu, Voov Meeting |
| Selected cases of education statistics application projects | Learning media                    | Microsoft PowerPoint, video learning WeChat, QQ |
|                                                      | Social media                      | SPSS 22.00, AMOS                      |

When the coronavirus pandemic, teachers used the Zhihuishu application to support student learning. Zhihuishu or Superstar application was designed with the SPOC (Small Private Online Course) system. Students could log in every week on the Zhihuishu and Superstar platforms and then followed the course that the teacher had provided. On this SPOC platform, teachers could see students’ activeness, how long it took students to be online to study, and other supporting data. The software used in this statistics course was statistical data processing software that students must master.

3.2. Technology integration in higher education based on SAMR model

This study aims to analyze all types of technology used by teachers to teach during the coronavirus pandemic based on SAMR model. The results of the analysis can be seen in Table 3.
Table 3. Technology Integration in the statistics course based on SAMR model

| SAMR       | Teacher's ability to use technology                                      |
|------------|------------------------------------------------------------------------|
| Substitution | ● WeChat and QQ to assign the assignments and collect assignments       |
|            | ● Using the Wenjuanxing application to provide practice questions       |
| Augmentation | ● Preparing a learning material using PPT                                |
|            | ● Online teaching using a computer/laptop                               |
|            | ● The use of Camtasia studio to make teaching materials                 |
|            | ● Preparing a video learning for lesson review                           |
| Modification | ● The use of statistical data processing software of SPSS and AMOS       |
|            | ● Assessing students to learn through the Zhihuishu and Superstar platforms |
| Redefinition | ● Using SPOC to teach                                                  |
|            | ● Applying a blended learning                                           |

3.2.1 Substitution
At the substitution level, statistics material during the coronavirus pandemic was carried out with the Wenjuanxing application. The teacher prepared practice questions for students to review lessons after students had finished taking online classes with the Voov Meeting application. In the Wenjuanxing application, students could immediately find out their scores. The teacher could also log in to the Wenjuanxing application and pull data to see students' mistakes and weaknesses when they worked on questions. At the substitution level, teachers who usually collected assignments manually, with the QQ group and WeChat, teachers could assign the assignments and collect student work results.

3.2.2 Augmentation
At the augmentation level, the teacher prepared a course using a PPT. When the teachers taught via Voov Meeting, they could use a PPT to replace teaching using the blackboard. The teacher made learning videos using Camtasia studio, how to solve problems, and examples of cases that could be solved with SPSS and AMOS. The teacher could provide the learning video via SPOC or the QQ group. When students had difficulty following the lesson, they could repeat the video and follow the steps.

3.2.3 Modification
A modification level is the ability of teachers to change teaching and learning activities with technology integration. SPOC can give students the freedom to find their own study time. During the coronavirus pandemic, students were at home and only those who knew when the best time to study was. While the teacher uploaded the PPT to the SPOC platform, students could go online and complete assignments given by the teacher. By the SPOC, the teacher could also see the honesty of students and their independence. On the SPOC platform, teachers could see how long it took students online to learn, interacted with students, and how long it took students to complete the course.

3.2.4 Redefinition
Redefinition is the highest level of SAMR. During the coronavirus pandemic, teachers gave lectures with a blended learning approach [19]. Students completed the course that the teacher on the SPOC platform provided. After that, at the next class meeting, the teacher used a Voov Meeting for online classes. Students could ask what difficulties they found when completing courses on the SPOC platform, discussing, and providing comments and suggestions for learning during the online class. Several studies have proven that blended learning with SPOC has a good effect. The coronavirus pandemic has brought the world of education to use MOOC or SPOC with blended learning.
Overall, the lecturer had used technology in teaching the course of data analysis and statistics software and the course of selected cases of education statistics application projects. The use of technology to teach both courses was mostly at the level of Augmentation. It can be concluded that the lecturer and students could integrate technology to in mathematics learning. There are many technologies besides Zoom. The results of this study are in line with the results of other studies that technology integration can increase students’ learning motivation and students feel easier to understand learning materials [20,21].

4. Conclusion
Coronavirus pandemic prevents students from going to school to study. Statistics lesson, which was usually in the classroom, turned into online class with SPOC and blended learning. This was the positive side of the coronavirus pandemic, where teachers’ ability to integrate technology could be trained and improved. The results of the teacher's ability which was analyzed using the SAMR model showed that the class of statistics turned out to be very interesting and fun through blended learning and SPOC. The lecturer had integrated many technologies from the level Substitution to the level of Redefinition so that learning during coronavirus pandemic can be more effective. As a positive result, this method could continue when the coronavirus pandemic had ended. Further research can be carried out by analyzing data with a quantitative approach to see the increase in student abilities when teachers integrate technology in the classroom during the coronavirus pandemic.

5. References
[1] Liu L, Ma C and Wang Y 2021 The Cultivating Strategies of Pre-Service Teachers ’ Informatization Teaching Ability Oriented to Wisdom Generation Int. J. Emerg. Technol. Learn. 16 57–71
[2] la Aca A, Sulisworo D and Maruto G 2020 The validity of flipped classroom learning videos on the material of parabolic motion Univers. J. Educ. Res. 8 4863–9
[3] Wijaya T T, Ying Z and Suan L 2020 Using Geogebra in Teaching Plane Vector J. Innov. Math. Learn. 3 15–23
[4] Wijaya T T, Jianlan T and Purnama A 2020 Developing an Interactive Mathematical Learning Media Based on the TPACK Framework Using the Hawgent Dynamic Mathematics Software Emerging Technologies in Computing (Springer International Publishing) pp 318–28
[5] Wijaya T T, Ying Z and Purnama A 2020 Using Hawgent Dynamic Mathematics Software in Teaching Trigonometry Int. J. Emerg. Technol. Learn. 15 215–22
[6] Zhang L, Zhou Y and Wijaya T T 2020 Hawgent dynamic mathematics software to improve problem-solving ability in teaching triangles J. Phys. Conf. Ser. 1663
[7] Tan S, Wijaya T T, Zou L and Hermita N 2020 Proving the Formula for the Area of a Circle using Hawgent Dynamic Mathematics Software J. Phys. Conf. Ser. 1655 012052
[8] Hermita N, Ningsih H S, Alim J A, Alpusari M, Putra Z H and Wijaya T T 2020 Developing Science Comics for Elementary School Students on Animal Diversity Solid State Technol. 63
[9] Tondeur J, Scherer R, Siddiq F and Baran E 2020 Enhancing pre-service teachers’ technological pedagogical content knowledge (TPACK): a mixed-method study Educ. Technol. Res. Dev. 68 319–43
[10] Harisman Y, Kusumah Y S and Kusnandi K 2019 The attitude of senior high school teachers on mathematical problem solving J. Phys. Conf. Ser. 1318
[11] Calder N and Larkin K 2018 Using Mobile Technologies in the Teaching and Learning of Mathematics Math. Educ. Digit. Era 12 12
[12] Castéra J, Marre C C, Yok M C K, Sherab K, Impedovo M A, Sarapuu T, Pedregosa A D, Malik S K and Armand H 2020 Self-reported TPACK of teacher educators across six countries in Asia and Europe Educ. Inf. Technol. 3003–19
[13] Redmond P and Lock J 2019 Secondary pre-service teachers’ perceptions of technological pedagogical content knowledge (TPACK): What do they really think? Australas. J. Educ. Technol. 35 45–54
[14] Aprinaldi A, Widiaty I and Abdullah A G 2018 Integrating SAMR learning model in vocational education IOP Conf. Ser. Mater. Sci. Eng. 434
[15] Wahyuni S, Mujiyanto J, Rukmini D and Fitriati S W 2020 Teachers’ Technology Integration Into English Instructions: SAMR Model Adv. Soc. Sci. Educ. Humanit. Res. 443 546–50
[16] Jude L, Kajura M and Birevu M 2014 Adoption of the SAMR Model to Asses ICT Pedagogical Adoption: A Case of Makerere University Int. J. e-Education, e-Business, e-Management e-Learning 4
[17] Wijaya T T 2021 How chinese students learn mathematics during the coronavirus pandemic Int. J. Educ. Res. Innov. 15 1–16
[18] Murphy M P A 2020 COVID-19 and emergency eLearning: Consequences of the securitization of higher education for post-pandemic pedagogy Contemp. Secur. Policy 0 1–14
[19] Lapitan L D, Tiangco C E, Sumalinog D A G, Sabarillo N S and Diaz J M 2021 An effective blended online teaching and learning strategy during the COVID-19 pandemic Educ. Chem. Eng. 35 116–31
[20] Wijaya T T, Li L, Hermita N, Putra Z H and Alim J A 2021 Helping Junior High School Student to Learn Fibonacci Sequence with Video-Based Learning Int. J. Interact. Mob. Technol. 15 183–91
[21] Chai C S, Lim C P and Tan C M 2016 Developing Teachers’ Technological Pedagogical Mathematics Knowledge (TPMK) to Build Students’ Capacity to Think and Communicate in Mathematics Classrooms Futur. Learn. Prim. Sch. A Singapore Perspect. 130–45