

Using GeoMaSchool To Link Between Creativity and Performance for Students In Higher Education

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Abstract. Developing creativity and increasing student performance in learning activities is essential but is not easy to implement. For this reason, through the use of Geogebra, Maple, and Schoology (GeoMaSchool) in further calculus lectures, students are expected to be able to show their best creativity and performance. With design research carried out in stages, namely preparation for experiments, conducting experiments in classrooms, and conducting retrospective analyzes. This research activity designs learning that involves Geogebra and maple devices and structured learning material in the Schoology learning management system. The subjects in this study were 32 students of mathematics education who programmed Advanced Calculus courses. The results showed that with the knowledge and mastery of Geogebra or Maple devices, students build their calculus knowledge creatively. Then, Schoology recorded students' performance and the learning progress authentically.

Keywords: GeoMaSchool, Creativity, Performance, Higher Education

1 Introduction

The exploration of creativity and improving student performance is essential in lecturing activities so that they not only have their knowledge and become memorizing learners [1]. The investigation is not only a challenge for mathematics education, but the existence of technology and its involvement in learning activities have a positive impact on student understanding [2]. Contextualization of ideas with the interpretation of mathematical models and proofing with algorithms is an activity that is commonly done by students in lecturing activities. With the support of computer technology and software, the next action is to lead students to be involved in developing their ideas by utilizing technology in mathematics education.

In mathematics education technology, Maple or MuPAD and Dynamic Geometry software such as Geometer's Sketchpad are some computer-based tools. These applications are useful for supporting teaching mathematics. The features of the app allow users to experiment [3] and develop mathematical ideas both in algebra and geometry in classroom activities. More complicated than that like multi-platform software, open-source dynamics mathematics like Geogebra [4]. This app can be used and work for not only the domain of algebra and geometry but also calculus so that this application is not only useful for students at the college level. Those who are studying mathematics at the junior and senior high school level can explore their mathematical ideas through these tools [3].

Besides Geogebra, another mathematical software is Maple. According to Kilicman et al. [5], the use of software in the mathematics curriculum at the college level presents challenges that are not easy and strenuous, especially those who are beginners. Software involvement in student lecture activities is useful for building the ability to experiment [3] and enriching their academic skills [5]. Like Geogebra, Maple used to explore various kinds of properties found in Linear Algebra studies directs its users to review it didactically and scientifically. That way, learning activities can present material that links mathematics, and so on by making the learning process more realistic in various contexts [6].

One of the facilities provided by involving technology in learning is the presentation of work. To find out how student performance needs space or media for the submission of work results so that the series of learning processes that they follow provide authentication to what they are doing. Learning management systems, Schoology is one of the authentication media presenting students' work, even influencing positively on students' reasoning and communication skills in mathematics learning [7]. This such e-learning is a learning approach well developed so that students can independently create learning objects sequentially based on content [8]. However, it needs a foundation in directing the learning sequence that will be pursued by the learner.

The foundation in the form of learning design is a path that can direct students to achieve the specified learning goals. Also, performance and creativity targets can be the accompanying effect of the learning process. For this reason, a learning design that coordinates how Geogebra or Maple used by students in solving the problems of a given activity is a series that is involved in the process. To use these two tools will lead students to be more creative or to use technology to help them evaluate, improve themselves, and most importantly, the progress of conceptualization [5]. Furthermore, activities for structured and sequentially activities will be authenticated with Schoology so that each stage will show what is learned, learning progress, and the development of learning outcomes.

There is no doubt that the decline in the level of mathematical competence of students occurs over time [9]. One of them caused by the unpreparedness of students is facing the expansion of competency targets and the novelty of methods to achieve the learning objectives. Therefore, mathematics becomes one of the requirements to measure workers' readiness to compete in addition to science, technology, and engineering [10]. As an example, the problem looked at calculus courses in which almost all calculus courses are no students who have no difficulty in understanding them. Students' understanding of calculus is an ongoing part of the recognition they get when they become high school students [11]. Studying mathematics education and learning the concept of Calculus is built, if it is not complete, then they become students to struggle to replenish the incomplete knowledge.

For this reason, similar to Awang, et al. [2] Integrating Maple in learning gives a positive effect in increasing students' understanding of engineering technology for Integral Calculus. More interestingly, student performance also experienced significantly better progress compared to students who were not involved in the use of software for mathematics.

Therefore, to achieve the objectives, learning design is used to emphasize and place a series of learning activities on the expected path and the circulation supports an active and interpretative learning environment. Then, the learning process considered as constructs of understanding rather than just remembering facts [12], [13]. A technology-based approach was providing various opportunities for constructive learning with systems in which resources arranged in student-centred and active learning activities related to context and practice (e.g., [14], [15]). Besides, a learning management system offers the concept of a learning environment

and learning space flexibly that learners get the opportunity to gather information and interpret it through a process of collaborative interaction [16].

This kind of freedom is very supportive of students' imagination so they can happily try various variations of the algorithm that they are trying to build tested. It will not happen if it exists, as stated by Awang et al. [2] where calculus lecturers tend to simplify complex mathematical topics into several small components. While it takes a logical ability to relate to each other so that it becomes meaningful knowledge.

Creativity needs to be built with activities that focus on not only discovery but also all actions and thoughts based on critical and responsible thinking [17]. Moreover, the creativity that needs to be built in complementing student competencies is creative skills that make them useful in the workplace [13]. Jensen (in [18]) argued that mathematical creativity could be exhibited by asking mathematical questions or problems in the specified learning design and showing the way to solve or simulate the problem. Another opinion from Silver [19], with the discovery-oriented instruction of students, can be directed to develop more creative approaches to mathematics through involving in completing assignments and lecture activities provided.

Talking about creativity in this study can be seen in 2 things, namely involvement in learning activities and how to build mathematical concepts that are used to solve the given problem. These two things are commonly known as schoolwork engagement and academic self-concept [20]. By using advanced calculus learning activities, students involved in these activities will compile their work based on the content of the activities given into Schoology. Later, each activity load has its objectives and students are expected to work within the framework of these objectives. Whatever they do and their work becomes an indicator in stating the student's performance.

Subsequently, this study is the result of research to show the involvement of mathematics education technology coupled with implementing the use of Geogebra and Maple in supporting students' mathematical, experimental activities. Also, presenting how Geogebra, Maple, and Schoology (GeoMaSchool) used to connect creativity and performance of students in using an algorithm to build model, especially in Advanced Calculus learning.

2 Method

The type of this study is design research which is conducted to obtain data into three steps, namely preparation of experiments, conducting experiments, and conducting retrospective analyses [21]. This study involved 32 students who programed Advanced Calculus courses in Study Program of Mathematics Education, Mathematics Department, Universitas Negeri Makassar. As for what observed in the implementation of this study was the creativity and performance of students in solving problems given during further calculus lectures. Creativity intended in this study is an imaginative activity in which students can simulate mathematical formulations into a form found in everyday life. While for student performance referred to in this study is the ability of students to construct Calculus concepts into an appropriate solution to the given problem.

For collecting data, there were 16 lecture meetings held in which 2 of them were the implementation of exams, both midterm and end of semester exams. However, the focus in gathering information for this study is what each did before the test carried out — all of the activities of students conducted by the Learning Management System (LMS). Schoology is a free online LMS to support designing a series of activities undertaken by students [22], as well

as the medium to portfolio the solutions worked on by students. It is what is called a student performance portfolio. This portfolio is used to support the creation and creative ideas about Advanced Calculus. That way, the contents in the collection stored in Schoology are the result of construction developed using Geogebra or Maple.

The implementation of the experiment, this study was also supported by instruments of observation of student creativity and performance. For observing creativity, there are two indicators proposed to find out the level achieved, namely, 1) novelty (original, unique, new, fresh, different creations) and 2) usefulness (Determined, valuable, meaningful, relevant, and useful creations) [23]. For assessing performance, there are three indicators used, namely what they do, the results of their work during the lecture activities, and what affective changes shown during the working in the LMS.

3 Result and Discussion

Lecture meetings always begin by conveying what the learning outcomes are and how to achieve them. The learning outcomes that are expected to be performed by students are to have a conceptual understanding and necessary skills regarding the topics studied in advanced calculus courses. The issues in question are Functions of Two or More Variables, Partial Derivatives, Limits and Continuity, Differentiability, Directional Derivatives and Gradient, The Chain Rule, Maxima and Minima, The Method of Lagrange Multipliers, Double Integrals over Rectangles, Iterated Integrals, Double Integrals over Nonrectangular Regions, Application of Double Integrals, Surface Area, Triple Integrals in Cartesian Coordinates, Triples Integral in Cylindrical and Spherical Coordinates, Change of Variables in Multiple Integrals, and Double Integrals in Polar Coordinates.

In gaining conceptual understanding, face-to-face activities are carried out, and students are allowed to study and work on questions related to the given topic. In the end, students can compile a settlement algorithm based on a given problem. In addition to using reference books and sourcebooks, students can also explore other reference sources available through the internet network.

Furthermore, to equip students about necessary skills, in addition to being able to compile problem-solving algorithms with mathematical modelling, they are also able to simulate visually. For this reason, the activities carried out in meeting these targets are in the form of activities using Geogebra and or Maple. To fulfil necessary skills, students arrange their knowledge through simulation of mathematical education technology devices based on computer applications. One of the challenges given in the series of activities is the simulation related to objects in everyday life. The exciting thing from this activity is to allow them to think creatively and show their creativity by simulating the Functions of Two or More Variables.

Likewise, the improvement of student performance through preparing a series of learning activities, Schoology is ready where the learning environment has been arranged learning atmosphere into the contextual-based system. With a Schoology-based learning management system, components such as time, the format of collection, revenue structure, and assessment components have managed through the system.

Overall activity-based lecture meetings were held 14 times, even though a total of 16 times included, 2 of which were course examinations. The activities contain the following aspects:

1. Brainstorming: At this stage, students conduct brainstorming through discussions with friends in their groups. Through discussion, students explore ideas through

reading and studying reference books, not only accept the knowledge but process it as ideas or materials to be reprocessed to produce experience.

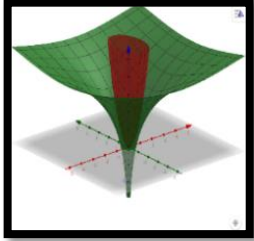
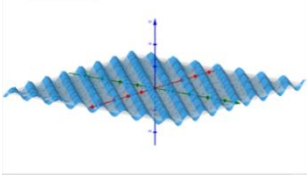
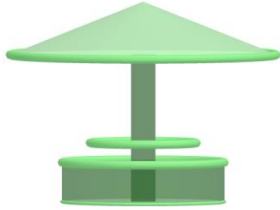
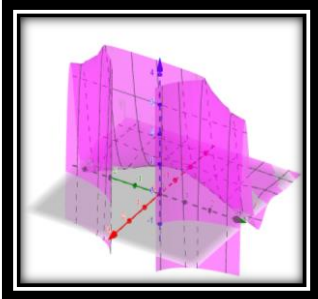
2. **Constructing Algorithm:** At this stage, students show how mathematicians work where prototypes mathematically generated ahead of the simulation process. The activity of creating algorithm is enjoyable since students try to construct mathematical models manually and then to simulate it using technology applications in mathematics education. With this process, students show that they understand the concepts that build mathematical models so that when reproducing them, they know the ideas created for the simulation model.
3. **Experiment:** At this stage, students begin to experiment with mathematical model algorithms. Following this, Geogebra and Maple software used in exploring forms that are under previously constructed mathematical models. Not infrequently students try it over and over again so the software must work to process the input of information provided. Therefore, at this stage also, there is an experimental pattern shown by students, namely determining, inputting, processing, analyzing, and concluding.
4. **Production:** At this stage, students have successfully reached the end of the experimental activity that is producing mathematical model images using the selected software. The success of students achieving this stage is part of the learning process targeted in the implementation of learning. Although what appears is only an animated image simulated by Geogebra or Maple, not only understands the concept of Calculus and algorithms in the construction but also how to affects using tools of them.

Based on the illustration of the stages, starting with the brainstorming and constructing algorithms, then conducting experiments and producing. Connections facilitated through the use of Geogebra and Maple allow students to expand their ideas about mathematical models. Previously, the contextualization of ideas with the interpretation of mathematical models and proving with algorithms was a routine activity in Advanced Calculus lectures. However, the use of the Geogebra and Maple application provides opportunities for students to be creative and develop creative thinking skills. With this activity, the students' expression space about their ideas towards the concept of Advanced Calculus grew and became more sophisticated — some creations as follows, shown in Table 1.

To make the trumpet flower model above, the student group I modified two functions, i.e. $f(x) = \ln(4x^2 + 4y^2)$ dan $f(x) = 5x^2 + 2y^2$. Look at their explanation below.

In the process of creating this function graph, we manipulate various functions to form a familiar object. We find the trumpet flower shape, which the first function we use is: $f(x) = \ln(4x^2 + 4y^2)$ and this function takes the form of flower petals using green. The second function we use, namely: $f(x) = 5x^2 + 2y^2$. This function is in the way of stamens using red. Then another explanation given by the group of students II who made the zinc building model above is as follows. "In this assignment, we chose an object in the form of zinc to find its function formula using Geogebra. Our reason is quite simple because zinc resembles the waveform like $\sin x$ on trigonometry." Student group III did a combination of several building spaces to show the shape of wake in everyday life, specifically Gazebo. To be able to construct the gazebo, students explain the following methods.

Table 1. Stage of activities & output.

Name of Figure	Mathematics Formula	Model
Trumpet Flower with Equation 1 and 2)	$f(x) = \ln(4x^2 + 4y^2)$ $f(x) = 5x^2 + 2y^2$	
House Roof (shown with Equation 3)	$f(x, y) = \sin(x - y)$	
Gazebo	<pre> Cone a: 28.65 Conic c: X = (0, 0, 4.5) + (4.1 cos(t), 4.1 sin(t), 0) d: X = (0, 0, 6.13) e: X = (0, 0, 0) + (0.37 cos(t), 0.37 sin(t), 0) f: X = (0, 0, 4.5) + (0.37 cos(t), 0.37 sin(t), 0) g: X = (0, 0, 1.8) + (1.64 cos(t), 1.64 sin(t), 0) p: X = (0, 0, 0) + (2.5 cos(t), 2.5 sin(t), 0) q: X = (0, 0, 1.2) + (2.5 cos(t), 2.5 sin(t), 0) Cylinder f: 1.99 q: 23.56 Point A = (0, 0, 0) B = (0, 0, 4.5) C = (0, 0, 1.8) D = (0.3, -0.22, 0) E = (2.48, -3.27, 4.5) F = (0.47, -1.57, 1.0) G = (2.5, 0, 0) H = (0, -2.3, -2) Surface b: 56.81 f: 10.6 q: 18.85 </pre>	
Model (shown with Equation 4)	Blazer with $f(x, y) = 3e^{2x} \cos(xy)$	

"The object we made is" Gazebo "which is a combination of two types of building space, namely the tube and the cone. There is also a flat shape, which is a circle. The cone-shaped

gazebo roof, while for the pole and chair are tubes that both have different diameters. For the gazebo table, a circle that has a diameter longer than the diameter of the gazebo pole used. "

The last picture introduced by students group III, they called it the female Blazer. The model, the modification process was carried out by trying several functions and some arithmetic operations. More details explained in the following explanation.

"In this case, we use the method of determining functions and then associating with objects in the surrounding environment. We enter various functions in the Geogebra application to find out what shape formed from that function. Until we tried " $f(x,y) = 3e^{2x}Cos(xy)$ ". The function " $f(x,y) = 3e^{2x}Cos(xy)$ " is obtained from some of the functions that we modified. The function " $f(x,y) = 3e^{2x}$ " and the function " $f(x,y) = Cos(xy)$ " cannot describe an object that exists in the real world. So we try to add, subtract, divide until finally, we multiply the two functions. The results of the multiplication of the two functions form an object that becomes one of the Fashion Style, that is, an object that resembles a female blazer. Where this function " $f(x,y) = 3e^{2x}$ " forms the back frame of the blazer. While the function " $f(x,y) = Cos(xy)$ " perfects the shape of the blazer. "

What has been explained by students above is in their efforts to build building models. The challenge to make models of objects in everyday life with mathematical modelling is a functional problem in developing students' creative thinking abilities. The process begins by tracing various functions considered to be related to the idea of the model of what to construct. Not infrequently this activity does not produce the results as expected, and this is an exciting challenge for these students. Such is the case when there is not only one function that they are trying to get the right capacity for the planned model. Understanding of the concepts, principles and operations of functions in this process is essential, especially multi-variable functions. The trial process is becoming increasingly interesting and challenging with the support of applications such as Geogebra and Maple. With this tool, students are free to try various functions they know, then modify, combine, combine, and synthesise part by part to form the expected model. This process is known as transferring abstract concepts into realistic ones [24], even though they are computer-based. More than that, this kind of skill is a creativity that can complement student competencies in such a way that they are useful in the workplace [13]. Another is the ability to connect the real world with mathematical modelling, is part of an important learning strategy in preparing and completing the competencies of prospective teachers, facilitators, instructors, and tutors in learning mathematics in the world of mathematics education [25].

To implement schoolwork engagement and academic self-concept [20]. The learning environment improved through the Learning Management System Schoology arrangement. This environment includes the time, collection format, revenue structure, and assessment components that have been set up through the system. With this system provides an authentic effect on what done and how they work, as shown in **Figure 1**.

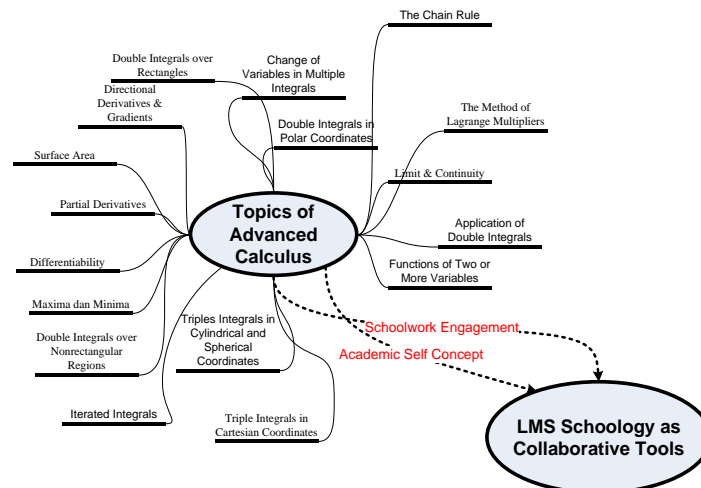


Fig. 1. Connecting among advanced calculus topic, performance, and schoology.

In the learning management system that is set up for further calculus lectures, students are directed to study material covering topics as illustrated above. The improvement of student performance during the lecture activities carried out. Two principles developed, namely schoolwork engagement and academic self-concept [20]. Student activities are directed to be involved using LMS Schoology so that all assignments will be given and collected through the system. Since the working method consists computer of the settings are done based on the rules embedded in the system device.

The change observed with the use of Schoology in lecturing activities is the involvement with the activities provided. The composition of the material that is revealed earlier in the system offers a more concrete perspective than there is no prior notification about what will be studied during the lecture or for the next meeting. Although some always prepare themselves to read and look for references reviewed, at least the material presentation of the system provides an overview and curiosity has raised. Also, it is not uncommon for their tasks to do before the deadline set ends. There are not many students who are curious about the lecture material that has just held, so they need space to continue their learning activities. With the existence of Schoology, virtual space becomes an attractive alternative to continue learning activities either self-taught or with instructions from the lecturer. The presence of involvement from these students occurs with slight changes made, namely moving the lecture activities. It can be done not only in the classroom [26], [27], but also technological education support activities learning can take place at home, in the park, or a coffee shop.

4 Conclusion

Mathematics education students are prospective educators for learning mathematics in schools or other educational institutions, although not a few of them work in fields other than mathematics education. However, they must be creative and high-performance educators. Each course should contain activities that direct them to this, including advanced calculus courses.

From the results, this study shows that the involvement of technologies such as Geogebra and Maple, motivate students to develop as demonstrate through mathematical model simulation in the form of diverse building models. Such as trumpet flower, house roof, gazebo, and women's blazer. To do this, not only understand concepts, principles, and operations in mathematics learning met, but also the ability to modify, combine, combine, and synthesise part by part to form the desired model.

To involve Geogebra, Maple, and Schoology (GeoMaSchool) embedded in the principles of schoolwork engagement and academic self-concept is also used to improve student performance. Based on observations, many positive changes occur indicated through involvement in carrying out the tasks given to be more responsible, timely, and driven by curiosity. The curiosity appears to bring lecture activities to continue in another time and place, specifically a virtual classroom.

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