Online Learning Collaborative to Increase Knowledge and Skills of Prospective Mathematics Teachers

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Abstract: *Online learning collaborative as a form of technological transformation in the world of education in higher education. Providing opportunities for students to obtain the broadest possible knowledge and increasing student competencies as a learning outcome as well as providing opportunities for students to develop competencies by studying outside of higher education through a collaborative, collective approach, utilizing science and technology. This research aims to determine the effectiveness and increase the knowledge and skills of prospective mathematics teachers using a online learning collaborative system. Researchers used quantitative methods with a descriptive quantitative approach. The subjects in this research were 19 prospective mathematics teacher from different universities who studied collaboratively using a learning management system. Data analysis was carried out using multiple linear regression. The research results show that the implementation of online learning collaborative has a significant positive impact on increasing the knowledge and skills of prospective mathematics teacher. Students can solve the problems given, and students are skilled in applying information technology in learning. To support effective online learning collaborative, can use learning object materials in the form of learning videos, material slides, infographic media, live chat discussions and interactive games.*

Key Words*:* Online learning collaborative, mathematics knowledge, mathematic skills, prospective mathematics teacher

Introduction

Digital technology has developed rapidly in the last few decades, affecting various aspects of life, including the world of education. Advances such as the internet, smartphones, and online learning applications have provided new potential to improve the quality and accessibility of the teaching and learning process. Today's young generation grew up with technology and are accustomed to using digital devices every day. They are more interested in learning methods that are interactive, communicative, and can be accessed flexibly via digital platforms. The existence of a digital platform provides students with effective and efficient learning access.

Post-COVID-19 pandemic conditions have limited direct interaction in learning and resulted in student involvement in class and understanding of learning material also decreasing significantly. COVID-19, which has occurred in recent years, has made inevitable changes to all aspects of life, including education, which has opened up opportunities to enter digital learning (Ramadhan et al., 2023). This situation challenges academics, especially teachers, to be able to maintain the quality of the profile of study program graduates regarding the lecture material provided by creating an online learning atmosphere by utilizing e-learning platforms. Technological developments in online learning have changed the human paradigm in obtaining information and communicating, which is no longer limited by the

dimensions of space and time. Universities have utilized information and communication technology to empower e-learning as a means of online learning after the Covid-19 pandemic.

The development of technology is a necessity for every university in order to develop learning systems. These technological developments are adapted to the needs of graduate users in order to create a link and match between graduates and the world of work. The development of modern digital learning not only changes contemporary teaching but also changes the concept of education in general by bringing new ways of instructional learning which can generally be accessed via computers or adequate smart devices (Zhang, 2024). The existence of learning innovations that involve collaborative assignments is one practical approach that can be taken to improve online learning outcomes. The pervasive effect of the online medium creates a unique environment for teaching and learning (Anderson, 2000).

Online learning collaborative provides learning opportunities outside the study program as an implementation of the independent campus learning policy. Learning that increasingly follows the development of modern science and technology along with the massive use of the internet and information technology in teaching practice has resulted in the development of various digital learning (Geißler et al., 2023). With this, there is interaction and collaboration with partner universities. This collaboration supports the development of lecture competency in preparing online learning content that is in line with technological developments.

Online learning collaborative through e-learning platforms has shown great potential in the skills and knowledge of both lecturers and students. Collaboration could enhance adult learners self-development and self growth (Crosta, 2016). In implementing online learning collaborative, many people are currently participating in online learning collaborative, including the use of learning videos and digital modules as digital learning media through e-learning. Learning collaborative ls are very important when working collaboratively mostly because it isnecessary to take into account the dive sity of the experience of each participant (Crosta, 2016).

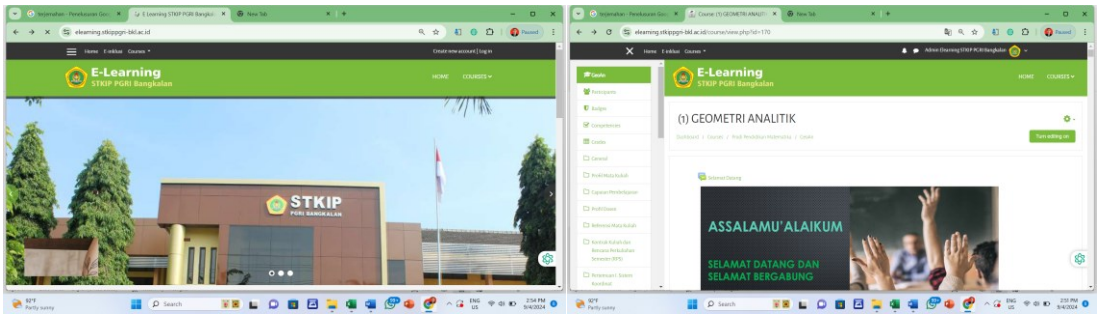

Figure 1. learning management system as an e-learning platform in online learning collaborative

This Online learning collaborative aims to increase student access to learning both at implementing universities and at partner universities. Collaborative learning holds the promise of active construction of knowledge, enhanced problem articulation, and benefits in exploring and sharing information and knowledge gained from peer-to-peer communication (Haythornthwaite, 2019). In its implementation, online learning is supported by a learning

management system (LSM) as a learning tool. The online concept here is packaged with hybrid synchronous and asynchronous learning.

Method

This research is research using mixed methods, namely quantitative-qualitative. Quantitative analysis aims to see the influence of online learning collaborative on student learning outcomes, while a qualitative approach is used to analyze online learning collaborative designs. The sample in this study was 18 prospective mathematics teacher students consisting of 9 students from implementing universities and 9 students from partner universities. All samples studied together collaboratively in analytical geometry courses using a learning management system platform. The learning was carried out over 16 meetings synchronously and asynchronously. Quantitative data in the form of student learning outcomes tests and response questionnaires regarding the use of the learning management system. Meanwhile, qualitative data was collected by observing the learning process and the content of the learning management system in analytical geometry courses. The quantitative data analysis process uses multiple linear regression, and qualitative analysis is carried out using interactive analysis of observation results, presentation and reduction of data and drawing conclusions.

Results and Discussion

Impact Online Learning Collaboration of Mathematics Learning Achievement

This online learning collaborative was participated in by 2 different universities. students from this college collaborate in 1 analytical geometry course. A total of 19 students took this course using the learning management system as a learning platform. Learning outcome data was collected using learning test instruments and collaborative learning implementation data was collected using questionnaires. Data on learning outcomes and questionnaire scores for implementing online learning collaborative were then analyzed using a linear regression test. Quantitative data results are presented in Table 1.

Table 1. Statistics of online learning collaborative and learning achievement

Variable	N	Min	Max	Mean	Standard (Std) Dev
Learning achievement	19	71.00	88.00	80.84	7.37
OLC	19	71.00	88.00	80.11	7.05
Valid N	19				

Descriptive Statistics of Online Learning Collaborative and Learning achievement

Based on Table 1, it is known that the average learning achievement of prospective mathematics teachers is in the high category. The average standard deviation of learning outcomes for prospective mathematics teacher students is 7.37. The average learning outcomes and standard deviation obtained are a categorization of the learning outcomes of 19 prospective mathematics teacher students using a online learning collaborative system from 2 universities who study together using a learning management system. A total of 11

were in the high category, in the medium category there were 8 people. Meanwhile, the average student response to the online learning collaborative system for prospective mathematics teacher students was 80.11 with a standard deviation of 7.05. These results show that prospective mathematics teacher students responded well to the use of the learning management system as a means of collaborative learning.

The Effect of online learning collaboratiom on Mathematics Learning achievement

A simple regression analysis was carried out to see the effect of online learning collaborative (independent variable) on the learning outcomes of prospective mathematics teacher students (dependent variable). Simple regression test using SPSS data analysis. The results of the online learning collaborative (OLC) regression test for prospective mathematics teachers and their learning outcomes are presented in Table 2.

Table 2. Summary output of regression analysis mathematics learning achievement and online learning collaborative

Model	Multiple R	R^2	Adjusted R^2	Std. Error	Observations
1	0.993	0.987	0.986	0.852	19

Table 3. Mathematics learning achievement and online learning collaborative, analysis of variance (anova) from regression analysis

Model	df	SS	M.S	F	Significance F
Regression	1	966.172	966.172	1329.581	1.3903
Residual	17	12.353	0.726		
Total	18	978.526			

The given output shows the summary statistics and regression analysis for the data set. The regression model has an R-squared value of 0.9874, which indicates that around 98.74% of the variation in the dependent variable can be explained by the independent variable. The ANOVA table shows that the regression model is significant, with a very small p value (1.3904E-17), indicating that at least one of the predictors has a non-zero coefficient. The coefficient table provides estimates of the intercept and Variable X 1, along with their standard errors, t-statistics, and p-values. The intercept is not statistically significant (p = 0.319), while Variable X 1 is very significant (p = 1.3904E-17). Overall, this analysis shows that Variable X 1 has a strong linear relationship with the dependent variable in this data set. The determinant coefficient or R^2 measures the suitability of the regression equation. R^2 of 0.987 indicates that online learning collaborative as an independent variable has an influence on learning outcomes as a dependent variable. In this case, the learning achievement obtained was 98.7%, while the rest was influenced by other factors.

Table 4. Coefficients output of online learning collaborative and mathematics learning achievement

	Coefficients	Standard Error	t Stat	p-value
Intercept	-2.350646298	2.28990601	-1.0265252	0.31902974
OLC	1.038542891	0.028481771	36.4634246	1.3904E-17

Based on the information in Table 4. The coefficients table provides estimates for the intercept and the independent variable "online learning collaborative." The intercept has an estimated value of -2.3506 with a standard error of 2.2899, resulting in a t-statistic of -1.0265 and a p-value of .319, indicating that it is not statistically significant. The coefficient for "online learning collaborative" is estimated to be 1.0385 with a standard error of .0285, yielding a t-statistic of 36.4634 and an extremely low p-value (1.3904E-17), suggesting high statistical significance. In conclusion, the analysis indicates that the variable "online learning collaborative" exhibits a significant linear relationship with the mathematics Learning achievement in this model while the intercept does not show statistical significance at common levels (e.g., $\alpha = .05$). According to Wicks et al., (2015) that online students' ability to self-regulate led to more focused attention and time on task, and in turn, these skills could lead to better learning.

Online learning collaborative design

Online learning collaborative was developed to encourage active participation by lecturers and students through the use of various media such as learning videos, animated images or interactive simulations. This method can build student interest and motivation in the lecture process. In a global context that is increasingly connected technologically, digital learning developed in online learning collaborative can increase learning collaboration between students and partner universities. This opportunity opens up opportunities to exchange knowledge and understanding between students with diverse backgrounds. This course provided evidence that online courses can support deep learning about content, open sharing about personal experiences, and the development of a sense of camaraderie among participants (Barab et al., 2001). The implementation of online learning collaborative also supports updating the study program curriculum which is more responsive to scientific developments and the increasingly complex needs of the world of work.

In addition, further analysis shows that online learning collaborative not only contributes to improving mathematics learning achievement, but also builds social skills and communication skills between students. This can be seen from the interactions that occur during the learning process, where students share ideas and strategies in solving mathematical problems. The implementation of online learning collaborative cannot be separated from the role of course lecturer creativity. Lecturers are required to create course content in accordance with the substance of the material to be taught. The first step in the process involves specifying the explicit learning goals one wants to achieve through collaborative activities. It is important here to choose goals deemed critical to the success of the desired learning activity, and to consider both content learning and the development of collaborative skills, process and outcome goals, individual and group learning (Swan et al., 2019).

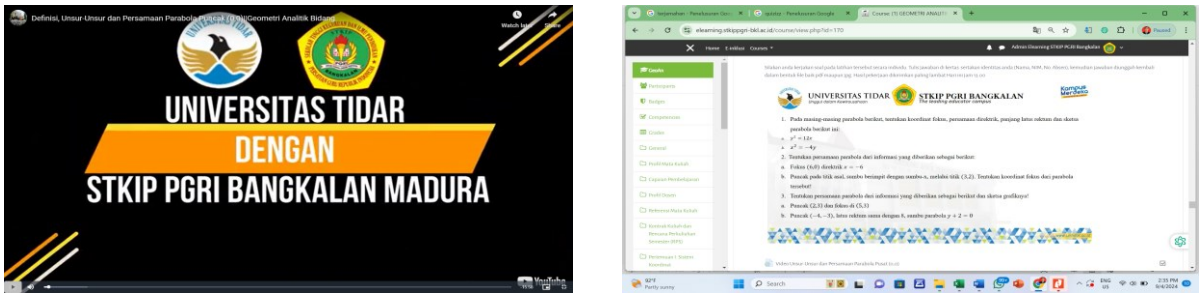

Figure 3. Learning together STKIP PGRI Bangkalan

The picture shows collaboration between universities to implement online learning collaborative. Collaboration is carried out starting from learning planning, preparing learning materials, creating learning material objects and learning evaluation instruments. Design and organization of the learning experience that takes place both before the establishment of the learning community and during its operation (Anderson, 2000). Learning material objects that need to be developed in online learning collaborative include; learning videos, power point material slides, graphic info media and assessment instruments.

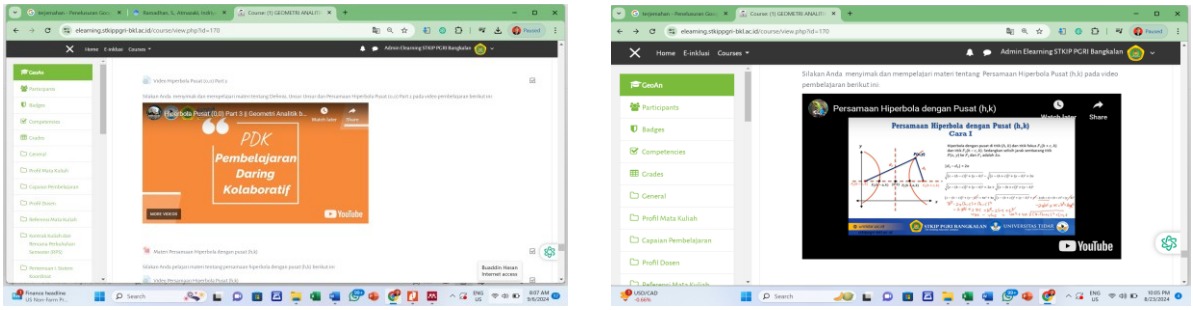

Figure 4. Learning object material as learning videos

Learning videos in online learning collaborative have several benefits, including; Concept visualization: Videos can help visualize concepts that are difficult to understand through text or static images. Practice Independent learning: Students can play videos at their desired pace and time, enabling independent learning. Project-based learning, students can create videos as part of a learning project that develops presentation skills and understanding of the material. Content availability: learning videos are widely available via online platforms, allowing easy access for students in various locations. Interactive Experience: interactive learning videos that incorporate exams immediately after the material is presented, increasing student engagement. Flexibility of time and place, students can access videos anytime and anywhere according to their needs.

Apart from learning videos developed in online learning collaborative, there are other learning material objects that need to be provided by lecturers, namely material slides, graphic information media, live chat discussions and interactive games as well as assessment instruments.

Material slides can help facilitate student understanding by presenting information in a visual and structured manner. Material slides can be used as a tool for collaboration between

students and teachers, allowing them to share ideas, information and knowledge. Students can access material slides from anywhere. and at any time according to their needs, thereby providing flexibility in learning. Material slides allow the use of images, diagrams, graphs and videos to help visualize complex concepts. By paying attention to these benefits, the use of material slides in online learning collaborative can be an effective method for improving learning outcomes through better interaction between lecturers and students and among their classmates. Apart from that, there is also learning object material that needs to be developed, namely graphic info media. Graphic info media helps to visualize complex information clearly and attractively, making it easier for students to understand. The use of attractive information graphic media can increase students' interest in learning and motivate them to be more active in the learning process. Apart from that, it is no less important in online learning collaborative that the collaboration function needs to be developed through discussion forums, these forums allow students to collaborate with lecturers and fellow students, share opinions, exchange information, and provide feedback to each other. Besides that, it also increases active involvement in the learning process by participating in relevant discussions. Discussion forums can help in forming learning communities where students can support each other and learn from each other's experiences. The use of graphic info media and discussion forums is an effective strategy for improving the quality of online learning collaborative by combining strong information visualization with interaction between fellow students and lecturers.

As a form of digital assessment instrument in online learning collaborative, interactive games need to be developed. Interactive games can make the learning process more interesting and fun, thereby increasing student involvement in the learning process. A commonly used technique in formal online education is to require students to post comments as a component of the student assessment (Anderson, 2000). With interactive games, students are invited to be actively involved in solving problems and completing challenges presented in the game, thereby increasing their understanding of the lecture material. Interactive games are designed to enable collaboration between fellow students or teams, thereby encouraging cooperation and communication between them. Suggestions for evaluation techniques are also presented, as are questions for further research (Misanchuk & Anderson, 2001). Thus, the use of interactive games in online learning collaborative can be an effective means to help create a more interesting and participatory learning experience for students..

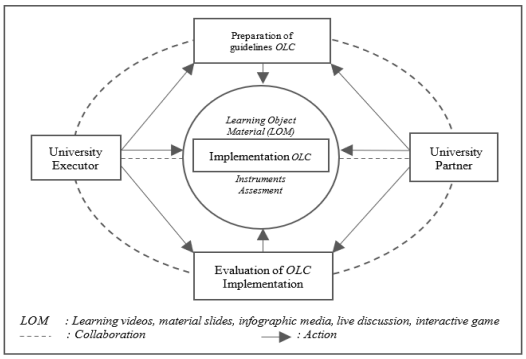

Figure 5. Schematic implementation leraning object material

The image shows a schematic of the implementation of online learning collaborative between universities. The implementing universities collaborated in creating a online learning collaborative guidebook as an implementation design. Furthermore, the two universities collaborated in implementing online learning collaborative by developing learning material objects as learning content. Then, to ensure the quality of the implementation of online learning collaborative, implementing universities and partner universities collaborate to develop evaluation instruments and carry out joint monitoring. This was done to evaluate and develop the implementation of online learning collaborative in the next year.

Conclussion

Implementation of online learning collaborative has a significant positive impact on increasing the knowledge and skills of prospective mathematics teacher. Students can solve the problems given, and students are skilled in applying information technology in learning. To support effective online learning collaborative, can use learning object materials in the form of learning videos, material slides, infographic media, live chat discussions and interactive games.

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