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Research paper

Development of MOOCs in Civil Engineering Education through Gamification Implementation

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ABSTRACT

Background: Massive Open Online Courses (MOOCs) represent an accessible online learning platform open to everyone without specific conditions. The prominence of MOOCs has surged, particularly following the Covid-19 pandemic. Despite this global trend, the development of MOOCs in Indonesia faces challenges such as community unpreparedness and inadequate infrastructure. Traditional education perceptions persist, with many Indonesians believing in the necessity of formal education. Gamification, involving the incorporation of enjoyable and engaging game elements into non-game activities, presents an innovative approach. Given the relatively low demand for MOOCs in Indonesia, gamification is employed to enhance user motivation and retention, with the expectation of increasing student interest in utilizing MOOCs.
Methods: The research methodology employed is Research and Development (R&D), utilizing the Four D-Models model and gamification analysis through the Octa lysis Gamification Framework. This framework serves as the foundation for the selection of gamification elements.
Results: Media validation results demonstrate an 86% feasibility rating for gamification-based MOOC products in Engineering Mechanics 1 courses, categorizing it as "Very Decent." Overall, the MOOC platform achieves a 92% feasibility rating, also falling into the "Very Decent" category.
Conclusion: In conclusion, the research affirms that the development of gamification-based MOOCs in Engineering Mechanics 1 courses is viable for integration into the learning process. This is supported by the positive results from media validation and trials, both categorized as "Very Decent."

INTRODUCTION

The development of technology in various fields has transformed people's daily lives. The presence of information and communication systems is a crucial element inseparable from the

world of education. Educational institutions must be prepared for ongoing technological changes both within and outside the education system. The learning methods and media applied are no longer in line with the characteristics of today's students, who tend to be opportunistic and omnivorous (Putri et al., 2019). If this continues to the next generation, there is an increasing likelihood that the role of teachers will be replaced by robots due to the repetitive nature of teaching each year (Rafiqo & Indrajit, 2022).

MOOC (Massive Open Online Courses) is an open class accessible to anyone online without any special conditions (Wang & Zhu, 2019). The MOOC phenomenon has surged after the Covid-19 pandemic. Data released by Class Central reveals that the number of participants from five well-known MOOC providers worldwide doubled in 2019-2020. However, the growth of MOOCs in Indonesia has not been matched by widespread participation. In addition to societal unpreparedness and inadequate infrastructure in Indonesia, many Indonesians still perceive education as something to be pursued formally. One key reason why MOOCs attract numerous participants abroad is their innovative class design that captures the interest of users, fostering the creativity and innovation of educators in developing new learning methods or approaches (Borras-Gene et al., 2016; Deng & Benckendorff, 2021). MOOCs have even started to integrate into higher education as a novel learning method, providing access to those facing challenges in conventional learning (blended learning) (Bralić & Divjak, 2018; Stracke et al., 2019).

Support systems for technology in education must keep pace with the times. A robust support system can aid teachers in the learning process (Tambunan, 2021). Millennial teachers benefit from support systems such as cyber pedagogy, gamification, e-learning, virtual reality/augmented reality, big data, internet of things (IOT), and cloud computing (Rafiqo & Indrajit, 2022).

Gamification involves incorporating fun and addictive game elements into a genuine and productive (non-game) activity (Alsaad & Durugbo, 2021; Chou, 2019; Kim et al., 2018; Mazarakis, 2021). It can be directed towards skill enhancement, motivation, or knowledge transfer. Numerous elements, such as Points, Badges, Levels, Leaderboards, Challenges, Rewards, Onboarding, and Engagement loops, can be applied to the learning process (Turner et al., 2018). According to data from We Are Social, Indonesia ranks third globally in terms of the number of video game players, with 94.5% of internet users playing video games (Dihni, 2022). Meanwhile, the 2021 Statista report states that gamers in Indonesia spend an average of 4-7 hours per week playing games (Annur, 2021).

Gamification provides an answer to why today's children may spend more time playing games than studying, as the primary goal of a game is to engage users and encourage continued

gameplay (Liew et al., 2018; Thomas et al., 2021). The implementation of gamification has resulted in a significant increase in the interest of engaged learners (Alsaad & Durugbo, 2021; Prasad, 2021).

Based on Suyetno's research (Suyetno, 2020), t is stated that MOOC is feasible for use in learning, with a percentage of 83.22%. MOOC proves to be highly helpful when faced with limitations in face-to-face learning. In contrast, Alghifari's earlier research (Alghifari, 2020) yielded unsatisfactory results, with the course process, material management, and features considered unsatisfactory but acceptable. Both studies share a common aspect in the development of MOOC within a classroom context, testing the product on the involved students. The divergence between this research and the two aforementioned studies lies in material and feature management. Suyetno's research (2020) focuses solely on material delivery, while Alghifari's study (2020) prioritizes the discussion method with the material presented. The present research incorporates gamification elements, which will subsequently become a feature on the MOOC Platform and serve as a learning model in the classroom, also accommodating tutors using the peer tutor method to create and manage their classes.

Building Engineering Education (PTB) is a study program at the Faculty of Engineering (FT), Universitas Negeri Jakarta. The learning model applied before the COVID-19 pandemic was Project-Based Learning (PJBL) and the peer tutor method. However, during the pandemic, implementing these learning models and methods became impossible due to social distancing. The launch of the UNJ LMS should have been an opportunity to digitalize engineering mechanics learning, but it faced difficulties due to a lack of readiness in designing the learning. According to the "Analysis of Learning Needs for Engineering Mechanics Course 1" questionnaire distributed to PTB UNJ students who took Engineering Mechanics Course 1, the Project-Based Learning (PJBL) model is highly suitable if paired with the peer tutor learning method. Students express a significant need for alternative learning in Engineering Mechanics course 1, with 92% agreeing, and 89% stating that learning media in this course needs development. Post-pandemic challenges must be considered as the influence of digitalization and cyber pedagogy during the pandemic implies that the post-pandemic way of learning will not be the same as before, rendering these learning models and methods less effective. Teachers' creativity is essential for the learning process to continually evolve with the times. Additionally, learners need to be facilitated with various methods and alternatives to access learning materials (Putra & Hariyanto, 2021).

From the above explanation, it can be concluded that MOOC needs development as an effort to digitize today's education post-COVID-19 pandemic. Considering the dynamic

characteristics of students and the effects of two years of distance learning, this research aims to develop MOOCs by implementing Gamification for Civil Engineering Education as a new learning alternative. To narrow the focus of this research, the problem is delimited to the design of gamification-based MOOCs integrated into engineering mechanics courses, specifically focusing on structural analysis material in buildings. The resulting product is a MOOC platform accessible via the internet.

METHODS

This research was conducted in Engineering Mechanics 1, within the Building Engineering Education Study Programme at the Faculty of Engineering, Universitas Negeri Jakarta. The participants in this study included lecturers of Engineering Mechanics 1, students enrolled in the course, and media experts who served as validators to evaluate the final product—a gamification-based MOOC platform in Engineering Mechanics 1.

The research method employed was research and development (R&D), utilizing the Four D-Models model, with gamification analysis conducted using the Octa lysis Gamification Framework. The Octa lysis gamification framework was chosen as the foundation for gamification due to its unique feature of analysing gamification based on user behaviour. This framework elucidates the application of gamification based on user motivation (Chou, 2019). The development model in this study comprises four stages: the defining stage (define), the design stage (design), the development stage (development), and the dissemination stage (disseminate) (Thiagarajan et al., 1974). The define stage encompasses five main steps, including front-end analysis, student analysis, concept analysis, task analysis, and concept generation objective. Level 1 Octa lysis was incorporated in this study to guide the application of gamification in the designed MOOC. The design stage involves four steps: preparing test standards, selecting media, choosing a format, and creating initial designs. The development stage encompasses two steps: crafting product assessment instruments and conducting Expert Validation. The final stage in product development is the dissemination stage, divided into three sub-stages: validation testing, packaging, and diffusion or adoption, according to Thiagarajan's framework.

In this study, the primary data collection method utilized a questionnaire, while secondary data was obtained from documentation. The questionnaire, a data collection technique involving questions or written statements provided to research subjects, employed a graded scale, specifically the Likert scale. This scale measured the attitudes, opinions, and perceptions

of individuals or groups regarding social phenomena. The Likert scale was applied to translate variables into measurable indicators (Hamzah, 2019: 108).

Instrumentation was employed for product validation by both experts and users. The instruments for expert and user validation were prepared based on Pustekkom's assessment aspects by Chaeruman (2019), "Instrumen Evaluasi Media Pembelajaran," adapted from McAlpine & Weston (1994).

In the feasibility test, the assessment considered a minimum value of ≥ 61% as "Feasible." Therefore, if the results from the assessment by media experts and the average student responses are ≥ 61%, the development of the gamification-based MOOC in the Engineering Mechanics Course is deemed "Feasible" as an alternative for learning Engineering Mechanics 1.

Table 1.
Score and Criteria

Percentage	Criteria
81%-100%	Very Decent
61%-80%	Feasible
41%-60%	Decent
21%-40%	Not Decent
0%-20%	Very Inadequate

RESULTS AND DISCUSSION

The developed product is an open online class platform or MOOC named "MOOC PTB UNJ," based on gamification in the Engineering Mechanics 1 course. This development encompasses learning materials, MOOC gamification features, and platform interfaces. The presented material aligns with the learning outcomes of the Engineering Mechanics 1 course. Gamification features used are derived from the analysis of the Octa lysis gamification framework. The platform interface of "MOOC PTB UNJ" includes Front Page/Site Home, Dashboard, My Power, Course List, Enrolled Course, My Course, Instructor List, About MOOC, About Us, Contact Us, and Login/Logout. An additional feature in the platform allows users/students to create their own online classes.

Define stage

1. Concept Analysis

   At this stage, the material concept for presentation on the gamification-based MOOC platform is established, specifically CPMK 1 to 3. The class content will be divided into three categories and categorized into two different levels: beginner and intermediate.

2. Task Analysis

   This stage involves determining and consulting with the supervisor about the tasks and activities to be presented in the MOOC class. Tasks are categorized into in-content and

out-of-content tasks. The first task is presented during the learning video, while the second task is performed outside the learning video.

3. Level 1 Octa lysis Analysis

At this stage, a Level 1 Octa lysis analysis is conducted, specifically analysing gamification elements to understand the characteristics of the developed product based on user behaviour. Each element is scored with a maximum of 10 points, with the total points listed in Table 4 for the elements used in the MOOC platform.

Table 2.
Game Elements Implemented Based on Core Drive

Core Drive	Game Element		Point
Epic Meaning & Calling	*1.*	*Narrative*	*4*
	2.	*Free Lunch*	
	3.	*Co-Creationist*	
	4.	*Course*	
Development & Accomplishment	*1.*	*Progress bar*	*6*
	2.	*Badges (Achievement)*	
	3.	*Quest List*	
	4.	*Step by Step Tutorial*	
	5.	*Leaderboard*	
	6.	*Weekly Leaderboard*	
Empowerment of Creativity & Feedback	*1.*	*Real-time Control*	*3*
	2.	*Dynamic Feedback*	
	3.	*Feedback Form*	
Ownership & Possession	*1.*	*Avatar*	*5*
	2.	*Account Profile*	
	3.	*Collection Sets*	
	4.	*Point*	
	5.	*Grades*	
Social Influence & Relatedness	*1.*	*Friending*	*4*
	2.	*Trophy Self*	
	3.	*Mentoring*	
	4.	*Social Prod*	
Scarcity & Impatience			*0*
Unpredictability & Curiosity	*1.*	*Level*	*5*
	2.	*Mini Quest*	
	3.	*Daily reward*	
	4.	*Times based reward*	
	5.	*Visual Storytelling*	
Loss & Avoidance	*1.*	*Point Loss*	*1*

After selecting the elements to be applied, the researcher then input them into the Octa lysis tool to determine the conclusion of the product to be developed.

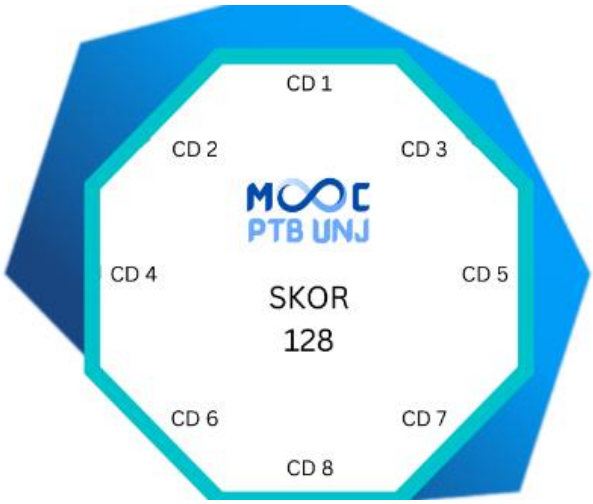

Figure 1. Level 1 Octa lysis Analysis Results

The Level 1 Octa lysis analysis results indicate a score of 128, suggesting that the use of gamification tends to lean towards white hat and maintains a balance between intrinsic and extrinsic motivation. According to Octa lysis Tools, the designed product primarily focuses on the white hat core drive, resulting in users/students feeling empowered. However, a potential downside is that users/students may lack a sense of urgency to take the desired action. Furthermore, the product demonstrates a good balance between Left Brain and Right Brain Core Drives, indicating a harmonious blend of intrinsic and extrinsic motivation. The identified game elements resulting from this analysis will be incorporated into the MOOC platform, serving as features in the platform or supporting learning materials.

4. Concept Generation Objective

At this stage, the results of the task, concept, learner, and Octa lysis analyses are formulated into a platform design plan (pre-prototype). The platform design plan is then consulted with the supervisor before the actual design phase begins.

Design Stage

After establishing the objectives in the defining stage, the subsequent step was the design stage, where the initial design (prototype 1) was developed.

1. Test Standardisation

In this stage, standardized tests were developed based on the specifications of learning objectives and student analysis. The formative test scores are presented in the platform class, specifically in the graduation test section.

2. Media Selection

At this juncture, the selection of features and plugins for the gamification-based MOOC platform took place. The choice of in-class media, such as learning videos and interactive content, aimed to optimize the learning experience. The learning video utilized was authored by Laila Rahmawati Aprilia and applied in a previous Engineering Mechanics 1 course.

Applied features were aligned with the results of the needs analysis and Octa lysis, supplemented by additional features using third-party plugins on the developed website.

3. Format Selection

The format selection for MOOC design was undertaken at this stage, encompassing layout design, fonts, colours, and images or videos. The layout was crafted based on the default theme provided by the plugin and tailored to meet specific requirements.

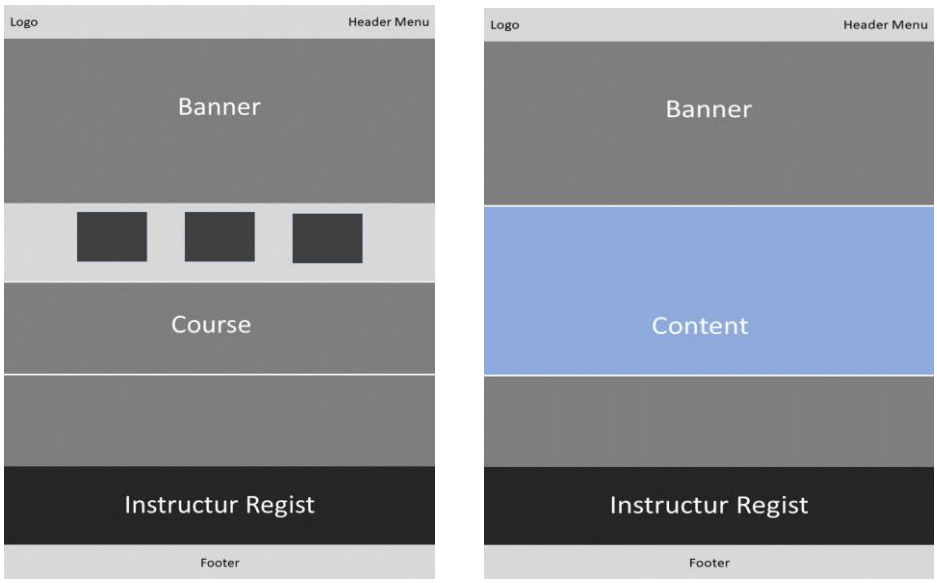

Figure 2. Product Design Layout

The font employed throughout the platform is of the "Laila" type, and the chosen colour for the MOOC platform design is blue with blue-black variations.

Figure 3. Font and colour selection

4. Initial Design

At this stage, an initial design/prototype 1 was created, subject to consultation with the supervisor before validation by media and material experts.

Development Stage

The product development process includes product validation tests by experts, divided into three stages.

1. Making Product Assessment Instruments

In this stage, product assessment instruments were created, comprising a media expert questionnaire and a user assessment questionnaire. Before distribution, the questionnaire underwent consultation with an expert (Judgment Expert) to ensure the instrument's feasibility.

2. Expert Validation

Product validation involved three media experts. The results of media validation indicated that the three validators awarded the gamification-based MOOC products in the Engineering Mechanics 1 course a percentage of 86%, placing it in the "Very Decent" category.

Table 3.
Expert Validation Results

No	Indicator	Percentage	Category
1	Quality of graphical and visual utilization (tables, diagrams, charts).	87%	Very Decent
2	Appropriateness of the use of graphics and visuals (tables, diagrams, charts) with the objectives, content, and characteristics of users.	87%	Very Decent
3	Quality of audio and narration utilization.	93%	Very Decent
4	Appropriateness of audio and narration with objectives, content, and user characteristics.	93%	Very Decent
5	Quality of video utilization as learning media.	87%	Very Decent
6	Appropriateness of video utilization as learning media with objectives, content, and user characteristics.	87%	Very Decent
7	Quality of interactive content utilization.	80%	Feasible
8	Appropriateness of interactive content utilization with objectives, content, and user characteristics.	80%	Feasible
9	Appropriateness of the use of communication language by the objectives, content of the material, and user characteristics.	87%	Very Decent
10	Ease of navigation on the PTB UNJ MOOC platform.	80%	Feasible
11	Loading speed of PTB UNJ MOOC platform.	93%	Very Decent
12	Accuracy of information & pages on the MOOC PTB UNJ platform as a whole.	87%	Very Decent
13	The level of interactivity of the PTB UNJ MOOC with the user/users.	87%	Very Decent
14	Attractiveness and harmony of font selection/typology.	87%	Very Decent
15	Attractiveness and harmony of color selection.	80%	Feasible

No	Indicator	Percentage	Category
16	The attractiveness of the selection of illustrations (images, videos, icons).	80%	Feasible
17	The attractiveness of the use of game elements (points, coins, and achievements) on the MOOC platform.	80%	Feasible
18	The overall attractiveness of the PTB UNJ MOOC platform features.	87%	Very Decent
19	The overall attractiveness of the MOOC layout.	87%	Very Decent
20	The overall attractiveness of the class layout on the MOOC.	87%	Very Decent
	Total Score	**86%**	**Very Decent**

Dissemination Stage

At this stage, the validated product undergoes testing on a broader scale, including limited trials and field trials.

1. Limited Trial

The limited trial process involved gathering 10 PTB UNJ students who had previously taken Engineering Mechanics 1, specifically students from the 2018 class. Subsequently, registered students were added to a chat group to facilitate communication during the trial period. The trial spanned 1 week, after which participating students completed a user assessment questionnaire. The results of the limited trial indicated that the gamification-based MOOC platform in the Engineering Mechanics 1 course achieved a rating of "Very Decent," with a percentage of 92%.

Table 4.
Limited Trial Results

No	Indicator	Percentage	Category
1	The navigation of PTB UNJ MOOC is user-friendly.	98%	Very Decent
2	The information on each page of PTB UNJ MOOC is informative.	94%	Very Decent
3	The features of PTB UNJ MOOC are interesting.	98%	Very Decent
4	The layout of PTB UNJ MOOC is interesting.	96%	Very Decent
5	The class layout on PTB UNJ MOOC is interesting.	94%	Very Decent
6	Increases user interest in learning.	94%	Very Decent
7	Increases user learning motivation.	88%	Very Decent
8	Can be used as an alternative for learning.	90%	Very Decent
9	Can be used as a learning aid.	86%	Very Decent
10	Encourages users' critical thinking skills.	86%	Very Decent
11	Encourages users' problem-solving skills.	86%	Very Decent
12	Contextuality in PTB UNJ MOOC is appropriate.	88%	Very Decent
13	Makes it easy to understand the content of the material.	94%	Very Decent
14	Makes it easy to access material online.	98%	Very Decent
15	Improves skills according to related topics.	92%	Very Decent
	Total Score	**92%**	**Very Decent**

2. Field Trial

The field trial process was conducted with one of the Engineering Mechanics 1 classes. The product was tested for two weeks, and students who participated in the trial filled out a user assessment questionnaire. The results of the field trial indicated that the gamification-based MOOC platform in the Engineering Mechanics 1 course achieved a rating of "Very Decent," with a percentage of 92%.

Table 5.
Field Trial Results

No	Indicator	Percentage	Category
1	The navigation of PTB UNJ MOOC is user-friendly.	84%	Very Decent
2	The information on each page of PTB UNJ MOOC is informative.	87%	Very Decent
3	The features in PTB UNJ MOOC are interesting.	92%	Very Decent
4	The layout of PTB UNJ MOOC is interesting.	85%	Very Decent
5	The class layout on PTB UNJ MOOC is interesting.	87%	Very Decent
6	Increases user interest in learning.	83%	Very Decent
7	Increases user learning motivation.	87%	Very Decent
8	Can be used as an alternative for learning.	97%	Very Decent
9	Can be used as a learning aid.	92%	Very Decent
10	Encourages users' critical thinking skills.	84%	Very Decent
11	Encourages users' problem-solving skills.	91%	Very Decent
12	Contextuality in PTB UNJ MOOC is appropriate.	88%	Very Decent
13	Makes it easy to understand the content of the material.	92%	Very Decent
14	Makes it easy to access material online.	95%	Very Decent
15	Improves skills according to related topics.	92%	Very Decent
Total Score		**92%**	**Very Decent**

CONCLUSION

Based on the research results outlined above, it can be concluded that the development of MOOC by implementing Gamification for Civil Engineering Education is feasible for use in the learning process. The validation and media trial results fall within the "Very Feasible" category.

The implementation of gamification in MOOCs has the potential to enhance interest and user experience in MOOCs. However, it is noteworthy that this research primarily focuses on the design of MOOC development and does not assess the effectiveness of implementing gamification in MOOCs.

In light of the presented findings, the researchers recommend expanding the use of MOOCs on a larger scale by integrating multiple courses or categories. Additionally, further research is encouraged to explore the impact of gamification in MOOCs on increasing interest in learning. Gamification can be incorporated into MOOCs either as a feature in the platform or as support for learning materials.

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