IMPLEMENTATION OF GAMIFICATION FRAMEWORK ON ONLINE LEARNING OF PROCEDURAL PROGRAMMING

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ABSTRACT

Procedural Programming is one of many important materials for students of Computer Science and related majors, yet the learning suffers from lots of distractions when implemented by online means. The distractions impact the learning, such as lower motivation and achievement of the students. To improve online learning of the material, Octalysis gamification framework is proposed to improve the motivation and achievement of students while doing online learning of Procedural Programming. The framework puts certain gamification elements in the implementation through the presence of core drives in accordance to the online learning currently used. This research includes experiment to see the significance rate of proposed learning process, which is helped with ANCOVA analysis. The result shows that using gamification framework as learning companion can improve student motivation and achievement, and there is relationship between the motivation and achievement of students after the learning process.

Keywords: *Gamification of Learning, Octalysis Framework, Online Learning, Procedural Programming, ANCOVA Analysis*

1. INTRODUCTION

Procedural Programming is a programming paradigm that used single processor to sequentially execute instructions. The paradigm demands its users to solve problems systematically by presenting the used specifications and algorithms. Also, this programming paradigm can be used as the basic approach to understand other available paradigms, especially for students of Computer Science or any related majors [1].

Nevertheless, the online learning of Procedural Programming is not easy, especially with the presence of lots of distractions. The distractions can impact the learning, such as lower motivation that in turn will give lower achievement. Due to that, newer learning ways should be proposed in companion of conventional learning to improve motivation and achievement of the students.

There are many approaches that can be used to improve the effectiveness of learning, such as by using gamification as basis on the implementation. Gamification itself is a way to put game elements inside any non-game events. In higher education context, gamification is often used due to its ability to improve motivation and interest of students by the implementation of game elements in learning environment [2].

Gamification also has many frameworks available to use, such as Mechanics Dynamics Aesthetics (MDA) and Octalysis. MDA is a gamification framework that focuses on the harmony of mechanics, dynamics, and aesthetics used to give gameful experience during the activities [3]. On the other hand, Octalysis is a gamification framework that implements eight core drives as the basis. The core drives serve the user with many ways in order to achieve fun experience in certain activities [4].

In this paper, Octalysis gamification framework is proposed as basis of online learning companion of Procedural Programming. The implementation itself aims to accompany conventional learning of Procedural Programming, which in turn will also improve the motivation and achievement of students through fun learning. Also, this paper will enable broader access to anyone who wants to learn Procedural Programming at ease from anywhere.

2. RELATED WORKS

In this section, the related works regarding the previous learning methods of Procedural Programming and the implementation of gamification in learning are reviewed. The reviews will serve better insights on how the gamification framework should be implemented in online learning of Procedural Programming.

First thing to discuss is the related works of previous learning methods of Procedural Programming. The papers reviewed will be used to compare with the gamification framework as the proposed method here.

Procedural Programming is a material that needs to be learned since young, even for elementary school students. Therefore, it is used as the main factor in [5]. The paper focuses on the usage of Scratch application as a media to introduce Logics and Programming Algorithm for students of Model Mataram State Elementary School. The learning was done face-to-face which demanded exploration to enable fully creative environment without using specific frameworks. To validate the learning method, each student was asked to fill questionnaire and it gave overall reception of greater than 80%. Through the questionnaire, it can be concluded that the proposed learning method is eligible to implemented.

Other than conventional face-to-face learning, there are many learning methods proposed for Procedural Programming material. [6] also discussed about the method by proposing blended learning model in Information Technology learning. The blended learning combines face-to-face learning with lots of activities revolving around the integration of digital medias such as computer, internet, and among other things. This paper also shows the use of learning system design based on ARCS model (*Attention, Relevance, Confidence, Satisfaction*), which shows that blended learning has good reception with 81% of the participants liked the implementation. Therefore, the application of blended learning can be used as a more interesting way to learn Procedural Programming compared to conventional face-to-face learning.

Of all the seven publications that are reviewed, no paper proposed gamification as innovative learning method for Procedural Programming material. Therefore, papers with focus of usage of gamification and its frameworks in learning are reviewed to give better insights for the proposed method in this paper.

Gamification itself can be implemented in almost any case, especially to support learning method of certain higher education. Such case is discussed in [7] that focuses on implementation of gamification framework in Programming material on higher education. The framework is presented as a learning strategy that aims to motivate students through fun activities to reach learning goals from lecturer. The paper did not show the detailed framework, but it used certain game elements such as *Quest*, *Point*, *Badge*, *Level*, *Challenge*, *Leaderboard*, *Reward*, and *Onboarding*. Its implementation gave promising result when compared with the conventional learning technique through experiment of two classes with different learning methods. The class that used gamification gave better mean score by 15 to 25 than the one that used conventional learning method.

Gamification also has framework that can be used to implement in any case, such as MDA which is used in [8] to improve learning results on English material. MDA is mainly used to define gamification elements for fun learning, with 6-11 framework is also used for deeper analysis of gamification elements based on similar literatures. The paper shows that English learning with the help of MDA gamification framework effectively gave more motivation for students, which in turn resulted in better learning achievement.

Other than MDA, Octalysis is another gamification framework than can also be used to implement in any activities, including learning. Such framework is then discussed in [9], which focuses in implementation of the framework to support Java programming language learning. The paper gave product of Android mobile application called Java Hero. While it didn't deeply show the implementation of Octalysis in the application development, it explained the gamification elements used, such as *Point*, *Hint*, *Quest*, *Challenge*, *Level*, and *Virtual Goods*. The application was also tested through questionnaire based on *Unified Theory of Acceptance and Use of Technology* (UTAUT). The result of questionnaire shows that Java Hero is well-accepted, signifying the mobile learning application is eligible in public use.

Based on the related works, it can be implied that there is still no research that focused on implementation of gamification on Procedural Programming learning. Also, Octalysis is believed to be more capable in delivering interactive learning for students through the presence of core drives and game elements suitable on online learning. Furthermore, the usage of newer learning strategy hoped to improve the motivation and achievement of students in the learning process. There are also different gamification elements put in each of cited paper regarding the implementation of gamification

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shown on Table 1, which will be taken as consideration in implementing the gamification of the proposed Procedural Programming learning system in this research.

Table 1: Implemented gamification elements across the cited papers of gamification of learning

Publication	Gamification Element
[7]	Quest, point, level, badge, challenge, leaderboard, reward, and onboarding.
[8]	Point, level, badge, leaderboard, challenge, quest, and engagement loop.
[9]	Point, hint, avatar, friending, leaderboard, and quest.
[10]	Badge, leaderboard, progress bar, stage, level, countdown, and avatar.
[11]	Point, level, badge, quest, and onboarding.
[12]	Storyline, level, and challenge.
[13]	Level, point, award, and leaderboard

3. RESEARCH METHOD

This section will explain on the methodology used during the research. It will focus on the proposed gamification framework used in online learning of Procedural Programming, continued with the experiment involving comparation of conventional online learning and the same method with enhancement by gamification framework. The experiment results will then be presented through statistical analysis, such as Pearson correlation and Alpha Cronbach to analyze the validity and reliability of questionnaire, Analysis of Covariance (ANCOVA) to prove the significance result between pre-experiment and post-experiment, and linear correlation to prove the relationship between motivation and achievement of student.

3.1 Gamification Framework

The attempts to offer gamified learning for Procedural Programming mainly focused on the use of Octalysis gamification framework during the implementation of online learning system. The overview of the framework is shown in Figure 1.

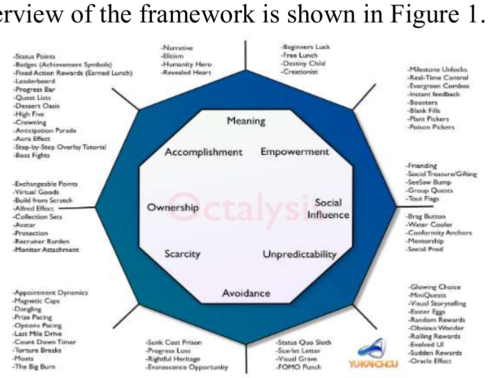

Figure 1: Octalysis gamification framework [4]

Based on Figure 1, Octalysis has eight core drives as basis on implementation of gamification elements used in the learning system. Each of the core drives has its own purpose that will be beneficial in the learning process.

Epic Meaning and Calling involves around how gamification element can drive people to do things for greater good, even with no reward offered upfront. *Development & Accomplishment* is related to personal desire to always improve and encourages commitment to gain more power to the cause. *Empowerment of Creativity and Feedback* revolves with creative activities done in repeat along with the feedback to achieve better results. *Ownership & Possession* is tied to the sense of belonging that triggers the desire to control anything that certain people possess.

Social Influence & Relatedness focuses on presence of social elements capable of giving motivation. *Scarcity & Impatience* gives concern on people's desire to own something almost unachievable by any means and demands impatience to the people. *Unpredictability & Curiosity* relates to the curiosity of people with happenings in the future given different patterns in certain cases. *Loss & Avoidance* involves people with the motivation to prevent possible bad events, mostly related to fear of losing.

3.2 Proposed Learning System

The implementation itself will not take all core drives in the system, but only few select elements present in the gamification application of Procedural Programming learning. The highlighted elements from the system are *Leaderboard* and *Instant Feedback*.

Leaderboard shows the overall statistics of problems completion during the learning process. Through this element, student can see how their team performs during the online learning process. It also shows the status of assignment done by the students, whether the submitted answer is correct or needs correction. The implementation of the gamification element can be seen on Figure 2.

Figure 2: Implementation of Leaderboard element

On the other hand, *Instant Feedback* is the other gamification element used in the proposed learning system. The element itself points out the

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error found in the submitted answer of the students. Through it, students can take direct action to correct or further improve their answers. The implementation of the element can be seen on Figure 3.

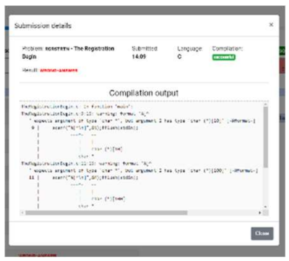

Figure 3: Implementation of Instant Feedback element

3.3 Research Hypotheses

This research in gamification of learning tries to prove certain hypotheses regarding the learning of Procedural Programming learning. The flow of hypotheses is shown in Figure 4.

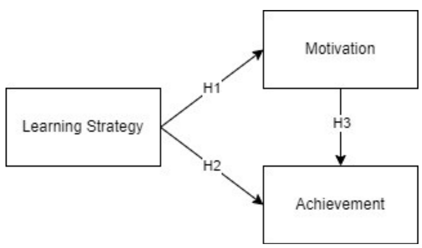

Figure 4: Diagram of research hypotheses

H1 states that using gamification framework as companion of Procedural Programming online learning significantly improve the student learning motivation. To prove the hypothesis, this research uses ANCOVA to find the significance value during the experiment.

H2 states that student achievement can be improved with the implementation of gamification framework during the Procedural Programming learning process. ANCOVA is used as the statistical basis to compare between the student achievement of different learning strategies.

On the other hand, H3 states that Procedural Programming learning motivation that is measured through ARCS model can be used to predict the student achievement. The hypothesis used linear correlation as the statistical way to its significance value.

3.4 Evaluation Procedure

During the research, there are evaluation procedure to ensure the data and experiment factors are eligible to generate the intended results. This section covers four procedures done in the experiment, such as sample selection, group treatment, validity and reliability test, and data preprocessing.

Sample selection involves the definition of criteria regarding the sample used during evaluation process. There are several conditions to select the sample, which the first one is an undergraduate student majoring in Computer Science. To enhance the evaluation, the student chosen to participate in the experiment should be in their first year since Procedural Programming subject is put as one of the main materials for Computer Science freshmen. After the sample is gathered, they are put in certain group that will be further discussed in the section.

Group treatment is discussed firsthand before the experiment. The experiment itself involves 32 students divided into two groups, which is called Control Group and Experimental Group. Control Group is given conventional online learning as the treatment, whilst Experimental Group is also given conventional online learning with the additional usage of gamification framework system as the learning companion.

The second step of evaluation is called validity and reliability test. Validity test is done to validate the results gained from each point of the questionnaire with the help of Pearson correlation formula, while reliability test aims to see if the overall questionnaire is reliable using Alpha Cronbach formula.

The experiment features 28 motivation questions given in pre-experiment and post-experiment scaled from 1 to 5 which shows the agreement level of student to each point of questionnaire, where the list of questions shown on Table 2. The questionnaire is featured in two separate online forms, which can be accessed on **Appendix 1** and **Appendix 2**. Pearson correlation formula is then used to compare the validity of each point from the questionnaire, while on the other hand Alpha Cronbach formula is used to define the reliability of the whole questionnaire.

Table 2: Points of Motivation Evaluation

Motivation Aspect	ID	Question
Attention	1	There is something that made me interested in the start of learning.
	2	The delivery of programming concept helps me stay focused during the learning.
	3	I can concentrate in learning the concepts of programming.
	4	The configuration of information in each page helps me stay focused during the learning.
	5	Themes from concept of programming learning interests me.

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Motivation Aspect	ID	Question
	6	I learn unexpected things during the learning.
	7	The variation of narration, trial, illustration, and other things helps me stay focused during the learning.
Relevance	8	Activities of concepts of programming language comprehension helps me a lot.
	9	Finishing the learning well is important for me.
	10	Contents provided in the material is relevant with my field of interest.
	11	There is explanation or real-life implementation of the learning material.
	12	Contents of learning is priceless and worth to be learned.
	13	I can connect the learning contents with things I frequently found.
	14	Contents of learning will be useful for me.
Confidence	15	The first time I see the learning, I feel it easy to learn it.
	16	After reading the introduction info, I believe I know what should be learnt during the learning.
	17	In the learning process, I believe I can learn the contents.
	18	After learning for a while, I believe I can complete the test.
	19	The good content placement makes me believe that I can learn the materials.
	20	The progressive method of learning activity fulfills my expectation.
	21	I believe I can complete the whole learning activity.
Satisfaction	22	Completing the trial in the learning give me satisfaction thereafter.
	23	I really enjoy the learning and drives me to dig the topic deeper.
	24	I really enjoy the learning of programming language material.
	25	Feedback and other comments during the learning makes me feel that my efforts are appreciated.
	26	I feel happy when the learning is completed.
	27	It's a pride to learn in the well-designed learning system.
	28	I am satisfied with the achievement I got in the learning.

Validity and reliability test is done twice, where the first one covers the pre-experiment results of student motivation. The first part of pre-experiment validity test involves on the result checking of each point of questionnaire, where correlation score should be more than **0.349**. The **valid** ones will then be included, where the **invalid** will be excluded. From the validity test, there are 27 points of questionnaire deemed **valid**, with only one **invalid** point present during the test. The whole result of validity test in pre-experiment motivation can be seen on Table 3.

Table 3: Result of Validity Test in Pre-Experiment Motivation

Motivation Aspect	ID	ID r	Table r	Result
Attention	1	0.468	0.349	Valid
	2	0.670	0.349	Valid
	3	0.625	0.349	Valid
	4	0.644	0.349	Valid
	5	0.457	0.349	Valid
	6	0.453	0.349	Valid
	7	0.599	0.349	Valid
Relevance	8	0.692	0.349	Valid
	9	0.708	0.349	Valid
	10	0.540	0.349	Valid
	11	0.505	0.349	Valid
	12	0.531	0.349	Valid
	13	0.716	0.349	Valid
	14	0.589	0.349	Valid
Confidence	15	0.524	0.349	Valid
	16	0.538	0.349	Valid
	17	0.588	0.349	Valid
	18	0.202	0.349	Invalid
	19	0.574	0.349	Valid
	20	0.852	0.349	Valid
	21	0.533	0.349	Valid
Satisfaction	22	0.657	0.349	Valid
	23	0.734	0.349	Valid
	24	0.817	0.349	Valid
	25	0.620	0.349	Valid
	26	0.788	0.349	Valid
	27	0.541	0.349	Valid
	28	0.676	0.349	Valid

When the validity test of pre-experiment is done, the evaluation continues with reliability test. The test is done to check whether the whole questionnaire is reliable to be analyzed, where the Alpha Cronbach score should be ranging from **0.6** to **1** to be deemed reliable. The result of reliability test in pre-experiment motivation gives score of 0.927, which makes the whole questionnaire of pre-experiment motivation is **reliable**. The summary of reliability test in pre-experiment motivation result can be seen on Table 4.

Table 4: Result of Reliability Test in Pre-Experiment Motivation

Student Number	Questionnaire Variance	Student Total Variance	Alpha Cronbach Score
32	19.695	193.080	**0.927**

After the validity and reliability test of pre-experiment motivation result is done, the evaluation continues to the second part which involves the post-experiment motivation result. The part starts with validity test, where the correlation score of a questionnaire should be more than **0.349** to be called **valid**. The validity test in post-experiment motivation shows that all 28 points of questionnaire

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is **valid**, made those points can be used for further analysis during the experiment. Some of the validity test results can be seen on Table 5.

Table 5: Result of Validity Test in Post-Experiment Motivation

Motivation Aspect	ID	ID r	Table r	Result
Attention	1	0.632	0.349	Valid
	2	0.782	0.349	Valid
	3	0.705	0.349	Valid
	4	0.750	0.349	Valid
	5	0.671	0.349	Valid
	6	0.703	0.349	Valid
	7	0.694	0.349	Valid
Relevance	8	0.804	0.349	Valid
	9	0.659	0.349	Valid
	10	0.730	0.349	Valid
	11	0.644	0.349	Valid
	12	0.608	0.349	Valid
	13	0.711	0.349	Valid
	14	0.703	0.349	Valid
Confidence	15	0.534	0.349	Valid
	16	0.714	0.349	Valid
	17	0.660	0.349	Valid
	18	0.621	0.349	Valid
	19	0.656	0.349	Valid
	20	0.876	0.349	Valid
	21	0.659	0.349	Valid
Satisfaction	22	0.772	0.349	Valid
	23	0.704	0.349	Valid
	24	0.835	0.349	Valid
	25	0.750	0.349	Valid
	26	0.723	0.349	Valid
	27	0.824	0.349	Valid
	28	0.718	0.349	Valid

Similar with the former part, there is also reliability test done on post-experiment motivation result. This test tries to prove whether the whole questionnaire is reliable, where the score of Alpha Cronbach should be in range of **0.6** to **1** to be deemed **reliable**. The reliability test gives Alpha Cronbach score of **0.957**, which makes the questionnaire of motivation in post-experiment **reliable**. The summary of reliability test in post-experiment motivation result is shown on Table 6.

Table 6: Result of Reliability Test in Post-Experiment Motivation

Student Number	Questionnaire Variance	Student Total Variance	Alpha Cronbach Score
32	12.925	177.157	**0.957**

Student motivation and achievement are two main data analyzed during this research, where the motivation result shows different result during the pre-experiment and post-experiment phase. Due to that, the difference in data emerged before the main evaluation procedure occurs. To make the evaluation process easier, those data need to be normalized before being put into evaluation phase. The data normalization considers two factors like number of questions and point of scale. The number of questions used during data normalization is also needed to comply with former phase, such as validity and reliability test for the motivation result. The whole formula for data preprocessing can be seen on Table 7.

Table 7: Data Preprocessing Formula

	Question	*Point of Scale*	*Conversion Formula*
Motivation Pre-Experiment	27	5	Total_score/27/5*100
Motivation Post-Experiment	28	5	Total_score/28/5*100
Test Result	15	1	Total_score /15*100

4. RESULTS

This section gives attention to each hypothesis set in the research. To prove the hypotheses, ANCOVA is used to gauge the significance value revolving around the student motivation and achievement around pre-experiment and post-experiment. Aside from ANCOVA, linear correlation is used to seek the significance value of relationship between student motivation and achievement after the experiment.

4.1 Motivation Analysis of Gamification Framework Usage in Procedural Programming Online Learning

H1 states that the motivation of students will improve after using gamification framework. To prove the hypothesis, data is preprocessed using the formula from Table 7. The preprocessed motivation data is then used in descriptive statistical analysis, which will give broader picture of the statistical changes during the pre-experiment and post-experiment. The comparison of group results in motivation during learning of Procedural Programming can be seen on Table 8.

Table 8: Comparison of Group Results in Motivation

PID	*Pre-Experiment*		*Post-Experiment*	
	Control	*Experiment*	*Control*	*Experiment*
1	96	79	84	83
2	84	64	84	80
3	87	82	85	81
4	82	85	81	80
5	78	74	96	86
6	72	67	66	83
7	77	100	84	100
8	87	82	98	99
9	76	100	84	100
10	84	97	84	88

PID	Pre-Experiment		Post-Experiment	
	Control	Experiment	Control	Experiment
11	68	72	60	80
12	76	64	70	82
13	87	82	81	81
14	84	75	81	84
15	74	100	76	100
16	76	69	70	84
Mean	81	81	80	87
Median	80	81	83	83
Max	96	100	98	100
Min	68	64	60	80
Std Dev	7	13	10	8
Variance	51	163	100	63

From Table 8, the students from both groups have almost the same motivation in pre-experiment, where the difference lies on the higher variance on students from Experiment group. On the other hand, the motivation during post-experiment changes in certain gap, due to the higher mean and lower variance shown in the results of students in Experiment group. Nevertheless, the data cannot be summarized yet and should be analyzed deeper to be put conclusion on.

Table 8 is further used in ANCOVA to find its significance value. ANCOVA in this section puts learning strategy as the factor variable, pre-experiment motivation as the covariate, and post-experiment motivation as the response variable. Results of ANCOVA implementation can be seen on Table 9.

Table 9: ANCOVA of Motivation Questionnaire Result

Variation	SS	df	MS	F	P
Post	342.1969	1	342.1969	6.905844	**0.0135591**
Pre	1006.238	1	1006.238	20.3068	9.98E-05
Within	1437.002	29	49.55178		
Total	2801.977				

Table 9 states that the ***p-value*** (significance rate) of motivation in the post-experiment is **0.01**. From the perspective of statistics theory, hypothesis is accepted when the significance rate is less than **0.05**. Therefore, H1 which states that using gamification framework as companion of Procedural Programming online learning significantly improve the student learning motivation can be **accepted**.

4.2 Achievement Analysis of Gamification Framework Usage in Procedural Programming Online Learning

Whilst H1 uses validity and reliability test in the first part, H2 requires ANCOVA as the sole statistical formula to analyze the hypothesis. Similar to H1, this test compares the results gathered from participant answers during pre-experiment and post-experiment. Similar with the previous part, the descriptive statistical analysis is used on the preprocessed data of the students achievement result. The purpose of descriptive statistical analysis in students achievement result is to show broader picture of changes happened during the experiment phases. The comparison is shown on Table 10.

Table 10: Comparison of Group Results in Achievement

PID	Pre-Experiment		Post-Experiment	
	Control	Experiment	Control	Experiment
1	80	20	80	80
2	80	73	67	80
3	73	93	87	93
4	73	60	87	80
5	73	93	87	87
6	93	93	93	93
7	73	80	93	87
8	100	80	100	87
9	87	80	80	87
10	80	87	93	100
11	73	27	73	80
12	73	27	73	80
13	73	80	67	87
14	100	80	80	87
15	73	27	73	80
16	73	100	73	100
Mean	80	69	82	87
Median	73	80	80	87
Max	100	100	100	100
Min	73	20	67	80
Std Dev	10	28	10	7
Variance	95	769	104	47

Table 8 shows that the students from Control group gives better results compared to Experiment group students during pre-experiment, where the variance of Experiment group is noticeably huge due to broader range of minimum and maximum score. But, the post-experiment shows different results where the Experiment group gives higher mean than the other group. The post-experiment result also shows that the variance of Experiment group is low due to the less gap of minimum and maximum score. Nevertheless, those changes cannot be used to conclude H2 yet.

Table 8 is then used in ANCOVA to find the significance value. The section involves the learning strategy as factor variable, pre-experiment test result as covariate, and post-experiment test result as response variable. Results of ANCOVA in student achievement is shown on Table 11.

Table 11: ANCOVA of Student Achievement

Variation	***SS***	***df***	***MS***	***F***	***P-value***
Post	409.831	1	409.831	7.153695	**0.012164**
Pre	605.276	1	605.276	10.56524	
Within	1661.39	29	57.289		
Total	2466.67				

Table 11 shows that the *p-value* of student achievement during the post-experiment is **0.01**, which is lower than the standard **0.05**. From that, it can be concluded that H2 is **accepted**, signifying that student achievement can be improved with the implementation of gamification framework during the Procedural Programming learning process.

4.3 Relationship of Motivation and Student Achievement

To prove H3, the step is different from H1 and H2. The data used in the section is the motivation result and test result gathered from post-experiment. The data processing is also different, where it uses linear correlation that combines concept of linear regression and correlation. The result of analysis of relationship between motivation and student achievement post-experiment is shown on Table 12.

Table 12: Linear Correlation of Relationship Between Motivation and Student Achievement

	df	***SS***	***MS***	***F***	***sigF***
Regression	1	305.4	305.3647	4.2386	**0.0483**
Residual	30	2161.3	72.0434		
Total	31	2466.7			

To prove the hypothesis, the significance value of analysis should be less than the standard significance rate of **0.05**. Table 10 shows that the significance rate reaches **0.0483**, which is less than the standard significance rate. Therefore, H3 that states there is relationship between motivation and student achievement can be accepted.

5. CONCLUSION AND FUTURE WORKS

The usage of gamification framework as companion in Procedural Programming online learning is tested through certain steps of statistical analysis. The experiment gauges the motivation and student achievement during the learning, and the motivation gathered from post-learning is somewhat related to the test result achieved by the students.

This research successfully shows that gamification framework as companion material of learning can improve motivation and student achievement through the implementation of certain elements such as *Leaderboard* and *Instant Feedback*. The implementation of gamification framework itself is also tested with steps of statistical analysis during the experiment process, which measures the motivation and achievement of students in online learning of Procedural Programming through ANCOVA and linear correlation. Based on the experiment results, the hypotheses are all accepted, where the motivation and achievement of students can be enhanced by the usage of gamification framework in Procedural Programming online learning through ANCOVA. Furthermore, the motivation of students can be used to predict the achievement of students during the learning of Procedural Programming albeit in a slight value through linear correlation test.

In the future, this research can be expanded further by researchers. There are still plenty of gamification elements that can be put to enhance the online learning with the same or even different gamification frameworks. For experimental purposes, giving many options of learning can be done in the research. Combined with many different treatments in each group, the result can be more effective to be implemented in real-life learning situation, either online or offline.

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APPENDICES

Appendix 1: Link to questionnaire in pre-experiment (in Bahasa)

https://docs.google.com/forms/d/e/1FAIpQLSczEO-QTldaBftQvbk5Ads_LD67bD0yapQgcYQuY1x5mXjbCQ/viewform?usp=sf_link

Appendix 2: Link to questionnaire in post-experiment (in Bahasa)

https://docs.google.com/forms/d/e/1FAIpQLSd6wGylAXRDSz_OAOH05Qc1gskBo3mgNp2CcyEGRv5wUN7znw/viewform?usp=sf_link