Gamification using Octalysis Framework in Knowledge Management System for Vocational High Schools during the Covid-19 Pandemic

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***Abstract*—Knowledge management systems enable teachers and students to interact directly in the knowledge transfer process during the Covid-19 pandemic. In addition, applying the gamification concept in vocational disciplines could enhance the quality of teaching to increase motivation and student learning outcomes which tend to decline. Octalysis Framework, which supports the gamification concept, consists of eight cores that focus on creativity, self-expression, social dynamics, logic, thinking, and ownership depicted in an octagon making an application more fun and helpful to motivate users to enjoy and be involved in an activity. This condition is crucial and urgent in the Covid-19 pandemic that requires online and student-centered learning. This study discussed the application of Octalysis Framework-based Gamification in a Computer Learning Knowledge Management system in Vocational High Schools during the Covid-19 Pandemic. The Gamification concept with the Octalysis Framework was implemented in the Knowledge Management System. Some game mechanics in a non-game context consisting of four phases, namely the Discovery, Onboarding, Scaffolding, and Endgame was applied to improve student performance and motivation in learning. Meanwhile, The Knowledge Management System software achieved an overall quality score of 5.14 out of 6 (85.6 percent of quality achieved) covering functionality, reliability, usability, efficiency, maintainability, and portability characteristics of the ISO 9126 quality indicator.**

Keywords—knowledge management system, gamification, octalysis framework, vocational high school, covid-19, software quality

I. INTRODUCTION

The Covid-19 pandemic has greatly affected various fields in Indonesia. Since the World Health Organization (WHO) stated COVID-19 as a Pandemic on March 11, 2020, the Government of Indonesia has issued many policies related to Activity Restrictions in various fields, starting with the existence of Large-Scale Social Restrictions (PSBB) at the end of March 2020 [1] and The Implementation of Community Activities Restrictions until September 2022 [2]. These restrictions include implementation of learning, office activities, activities in the essential sector, industry, markets, construction, worship, public areas, arts, culture and social activities, meeting activities, seminars and offline meetings, and many others [1], [2].

Several previous studies have discussed impacts and the efforts that can optimize the implementation of activities within the restrictions carried out, including health activities [3], counseling and community assistance [4], learning in schools and work [5], [6] and others. Educational institutions, especially vocational high schools (in Indonesia it is called Sekolah Menengah Kejuruan-SMK), are expected to produce high-quality vocational graduates relevant to the needs of the business world and industry (DUDI) and can respond to global and regional competition, such as the implementation of the ASEAN economic community [7]. It requires technological innovation to support during learning hours or after learning hours, especially when there are restrictions on learning activities during the COVID-19 pandemic. In addition, efforts to increase motivation and student learning outcomes which tend to decline [6] due to the Covid-19 pandemic became urgent.

Implementing a knowledge management system enable teachers and students interact directly in the knowledge transfer process. Applying the concept of gamification [8], [9] in vocational disciplines enhance the quality of teaching [10], increase motivation and student learning outcomes. Implementing the Octalysis Framework in gamification make an application more fun and useful to motivate users to enjoy and involved in an activity [11], provide more interesting, more educative, and less boring user engagement and increasing interest in learning. This condition is very important and urgent in the Covid-19 pandemic that requires online and student-centered learning [12].

The Octalysis Framework includes ten of the most cited frameworks of gamification across the eight Core Drives, making it the most comprehensive. It also emphasizes emotions, making it simpler to assimilate by those who have little experience with games [13]. Octalysis Framework focus on creativity, self-expression, social dynamics, logic, thinking, and ownership depicted in an octagon to make an application more fun and useful to motivate users to enjoy and involved in an activity [11], provide more interesting, more

educative, and less boring user engagement and increasing interest in learning.

Software quality is a concern in software engineering. Gamification in software engineering tasks can improve product quality [14]. In evaluating the application of gamification, a specific quality model of software is required, one of which is using the International Standard Organization (ISO) [15]. ISO 9126 model and its new version 25010 are selected as the most suitable model to evaluate the Gamification frameworks among software quality models studied.[14]. The ISO 9126 quality standard involves functionality, reliability, usability, efficiency, maintainability, portability, and quality-in-use. [16].

This paper discusses the application of Octalysis Framework-based Gamification in a Computer Learning Knowledge Management system in Vocational High Schools during the Covid-19 Pandemic and Software Quality Measurement using IS0 9126.

II. METHOD

A. *Implementing Octalysis Framework in KMS*

This study refers to the gamification mechanism that refers to the Octalysis Framework [11] which has eight core drives by embedding game mechanics in each core shown in Fig.1.

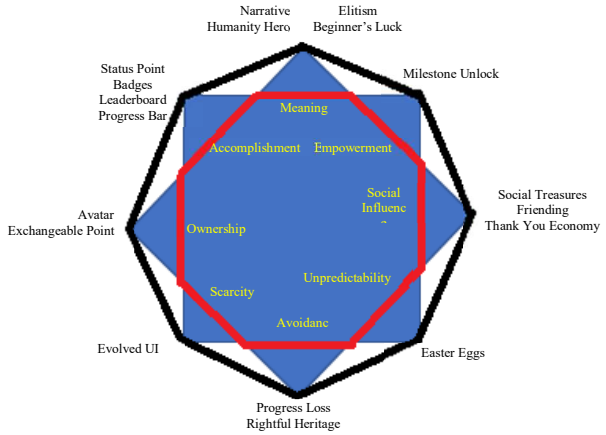

Fig. 1. Octalysis Framework with Game Mechanics [11]

The explanation of the Octalysis Framework and Game Mechanics used is shown in Fig 1 as follows:

Core 1: Epic Meaning and Calling

This value implemented through the narrative contained in the software by providing information related to missions and challenges and providing starting points before starting the mission. This value consists of elements in the form of:

1) Narrative

This element aims to introduce something new to users by introducing a challenge in the concept of learning. Narrative is implemented with an introduction when the user starts using the application.

2) Humanity Hero

This element is a prefix before starting a challenge or adventure in the concept of learning by providing an introduction to the application such as only the user who can complete this mission or like a game prefix providing information that "only you (the prince) can save the king's daughter."

3) Elitism

This element is the application of the group concept in learning, users can choose their group with certain specified conditions and capacities, and users who have entered the group will also compete with other groups.

4) Beginner's Luck

This element is the start of the game, where the user will be given an initial role (in the form of an avatar) which will make the user feel he is chosen for that role.

5) Free Lunch

Free Lunch is an element used at the start of the application by providing starting points before entering the challenge, users can save starting points, and later points will increased by adjusting the user's progress.

Core 2: Development and Accomplishment

This value is applied through the daily mission feature that will give points and badges if completed in a certain amount. The points earned will also affect the user's position to continue to compete on the leader board.

1) Status Points

This element is applied in the application instead of student grades. Points are earned after the user completes a mission (Quest). The knowledge entered by the user will be validated first by the teacher to get points. The level of points given is shown in Table I.

TABLE I. POINT RATE

No	Type of Knowledge	Points
1	Adding Tacit Knowledge	5
2	Adding Explicit Knowledge	5
3	Sharing Knowledge	3
4	Accessing Knowledge	1

2) Badges

This element is implemented by displaying trophies to students who have achieved achievements. The badges can be adjusted according to existing provisions. The level of badges obtained affects the number of points owned by the user. In this study the user uses the level of badges that applied to the online learning application, namely brainly.co.id, which is stated in Table II.

TABLE II. BADGE RANK

No	Badge	Title	Requirement
1		Beginner	0
2		Likes to Help	20
3		Ambitius	50
4		Educated	70
5		Expert	100

No	Badge	Title	Requirement
6		The Great	150
7		Genius	250

3) Leader board

This element is implemented by displaying achievement boards from all students, with the leader board expected to create a sense of competition to be better and increase student motivation to continue learning and sharing.

4) Progress Bar

This element is implemented and combined with the leader board by displaying the progress line of students involved in the mission.

Core 3: Empowerment of Creativity and Feedback

This value is applied to the user's ability to set goals for each individual in order to achieve optimal results. Different goals can produce different results for each user, the game mechanic used in this core is Milestone Unlock.

Milestones Unlock used to unlock locked avatars/badges. Users will get a certain avatar or badge without having to exchange points, if they have reached the target.

Core 4: Ownership & Possession

This value applied in points and user profile which can be updated which includes avatar, name and title. The application of game mechanics to this core is as follows:

1) Avatars
This element gives the user the freedom to change the avatar they want to use. Avatars obtained random when creating an account. The users can get avatars by completing certain missions or exchanging points that have been obtained.

2) Exchangeable Points
Exchangeable Points are elements used to activate avatars or certain items by exchanging points.

Core 5: Social Influence and Relatedness

This value is applied to the profile view feature on the leader board. Through this feature, users can see each other's name, title, and badges collection for each user.

1) Social Treasures
Social Treasures are elements used in the function of an avatar that has the ability to receive points awarded by other users.

2) Friends
This feature is a game element that allows users to add friends into the application. By adding friends, users can chat with each other.

3) Thank-You Economy
This feature is a game element that allows users to give/transfer points they have to help other users by sacrificing their own points without affecting their level and badges.

Core 6: Scarcity and Impatience

This value applied to the opportunity limit in using the exercise mode feature where this feature can only be used 2 (two) times a day and will not increase every day if it is not used. Likewise, the daily mission steps that can only be claimed after completing certain missions.

Game Mechanics used in this grade is Evolved UI. Evolved UI is an element that provides character evolution when reaching a certain level, characters will have their own abilities that can help users progress such as providing additional points in carrying out a mission.

Core 7: Unpredictability and Impatience

This value is applied to the exercise coupon redeem feature, where each goal and duration of the exercise mode has a different multiplication value, which is not known by the user so that the unpredictability value exists.

Easter Eggs are elements that are used when the user reaches a certain level, the user can evolve which has a big impact on the character by increasing the point value or unlocking special characters (this can be supported by additional points given by the teacher).

Core 8: Loss and Avoidance

This value is applied to overcome Rightful Heritage, namely inducing a sense of ownership of students towards status points and students do not want to lose points after they are given, and if students do not carry out activities at the specified time for some time, they will lose all points as sanctions.

1) Progress Loss
Progress Loss is an element that will be able to display a history when the user lost points in a case, thus making the user more careful when carrying out activities so as not to lose the points they have.

2) Rightful Heritage
This element used for the Free Lunch at the beginning, which can create a sense of ownership of the user to the status point, and so that the user does not want to lose the point after it is given.

B. Software Quality Measurement

The measurement method carried out in this study uses a metric function oriented by calculating the numerical computational value of the data that has been collected using ISO 9126 quality indicators which include the values of the indicators of reliability, functionality, efficiency, usability, maintainability and portability with the observations and calculations.

III. Results and Discussion

A. Octalysis Framework

The implementation of this KMS application based on the theory of Octalysis Framework second level consists of the Discovery, Onboarding, Scaffolding and Endgame phases. The author also adjusts several stages and the implementation of game mechanics in each phase as follows:

1) Discovery Phase
In the Discovery phase, new students enter the application system by registering / logging in and entering the dashboard page. In the discovery phase, the author will use a number of game mechanics that the author will implement in the KMS software, namely Humanity Hero, Narrative, Free Lunch and Beginner's Luck.

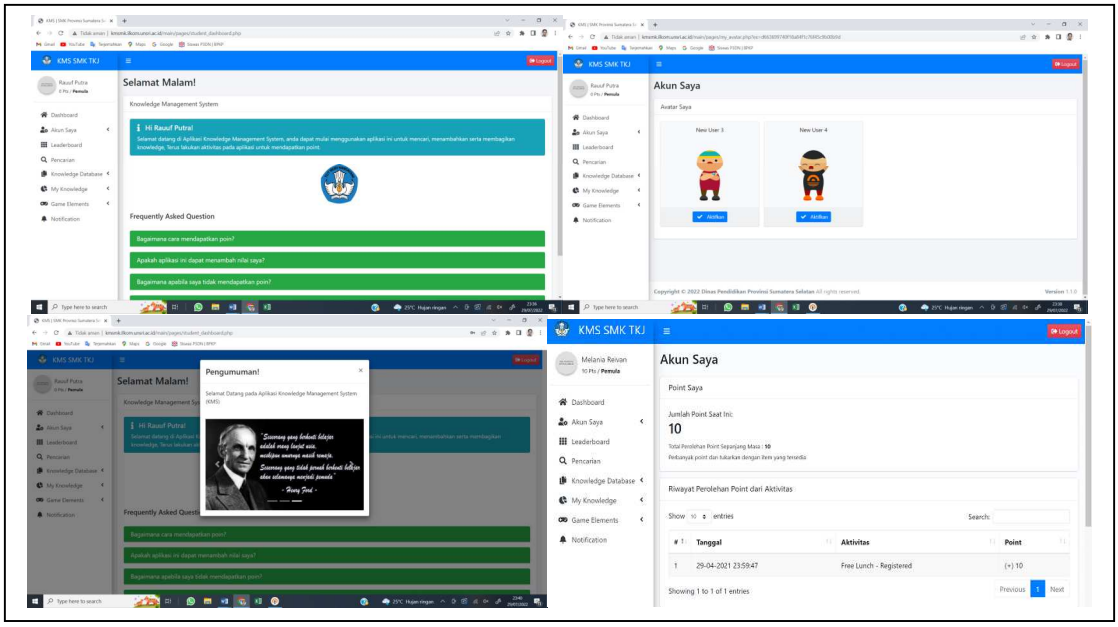

Fig. 2 Implementation of Game Elements in the Discovery Phase: Humanity Hero (top left), Beginner's Luck (top right), Narrative (bottom left) and Free Lunch (bottom right)

The Humanity Hero used in the application to present a motivation to students to take part in the knowledge management process in their competency skills. Humanity Hero will be implemented in the form of an introduction when students successfully enter the system / successfully log in and before entering the main menu of the software.

Beginner's Luck is an initial role selection obtained by students. The students will get a random role when they first access the KMS application, then students will compete to collect all the items.

Narrative is an introduction in the KMS application, this introduction will always appear after students log into the KMS application. The introduction can be in the form of a floating banner containing instructions or announcements to students before using the application.

Free Lunch is an initial point award after the student successfully registers / logs into the application for the first time.

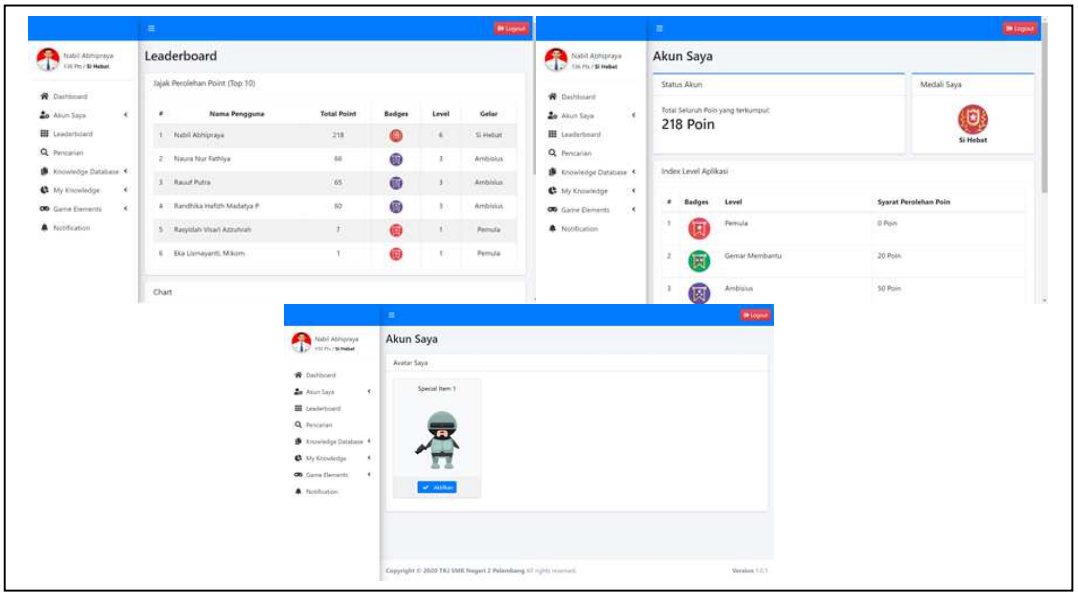

Fig. 3 Implementation of Game Elements in the Discovery Phase: Progress Bar (top left), Badges and Status Points (top right), Evolved UI (bottom)

2) Onboarding Phase

This phase is the initial stage where students begin to understand the main flow of the application and the rules set in the application. The implementation of game mechanisms used in this phase are Badges, Status Points, Progress Bars, and Evolved UI.

a. Progress Bar

The progress bar element is used in the KMS application to display the attributes and total points that have been collected by students, the Leaderboard will only display as many as 10 (students) with the most total points earned in each semester, the Leaderboard can be seen progress and progress at any time.

The badges element is displayed as achievements achieved by students and converted into icons that initialize the levels achieved by students based on the value of points earned. The status Points implemented in this application adjusted to the badges achieved by students ranging from Beginners to Likes to Help.

Evolved UI element that is meant in this application is an avatar that can be collected by students, apart from Free-Lunch / Beginner's Luck, students can collect as many avatars as possible by exchanging points they have from doing activities in the application.

3) Scaffolding Phase

At this phase, students will begin to enter the KMS system and use software. The game elements used in this stage are Competitions, Exchangeable Points, Elitism, Social Treasure and Thank-You Economy.

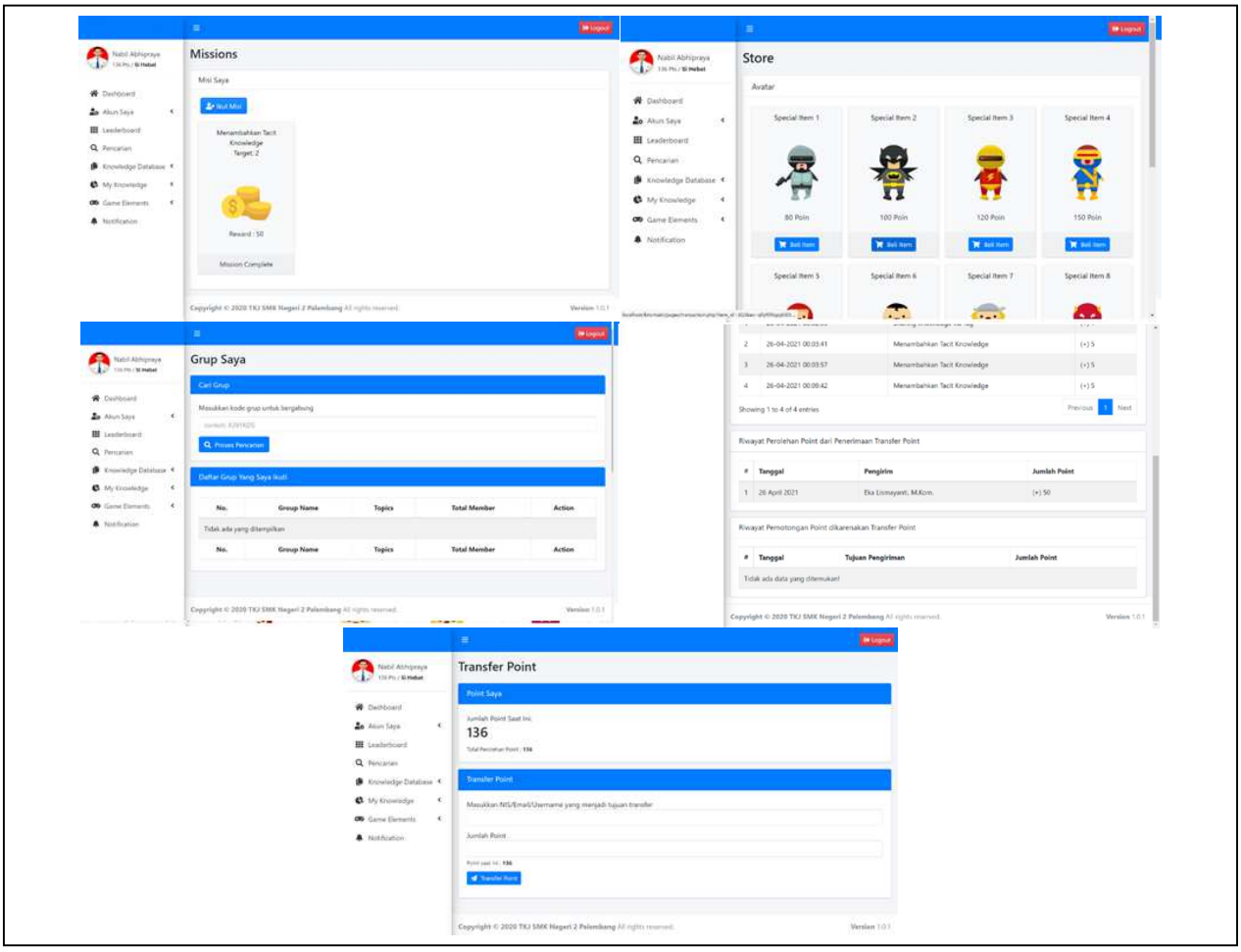

Fig. 4 Implementation of Game Elements in the Scaffolding Phase: Competition (top left), Exchangeable Point (top right), Elitism (middle left), Social Treasure (middle right), Transfer Point (bottom)

Competition element in the KMS application presented in the form of missions to collect points from adding knowledge or doing activities. Students can join missions so that students can collect more points as rewards for completing missions.

Exchangeable Points element is used in this KMS application to allow students to exchange their points for various available items and compete with other friends to collect available items.

Elitism element in the KMS application are used so that students can choose and join a group with other students, then these students can communicate with each other in the group.

Social Treasure element is a form of Game Element that is used in applications that allow students to receive points given by other students and will increase the total point ownership of students who receive them.

Social Treasure is a form of Game Element used in applications that allow students to give gifts to other students by sacrificing their own points.

2) End Game Phase

This phase aims to make students continue to use the application after the set goals or missions have been achieved, by applying The Sunk Cost Prison element which allows the application to reset points and delete the number of points previously owned by students if detected by the system, do not carry out activities at the appointed time.

The Sunk Cost Prison is a Game Element that will make students inactive for some time so that students cannot log into the application, besides that as a punishment student can also lose the points they have.

3.1 Software Quality Measurement

a) Observation Results

Based on the results of observations made on the software, the data obtained is shown in Table III.

b) Numerical Computing

The numerical computational calculation is a calculation of the value that is drawn based on the value of the functional measurement on the system as a normalized value. Because functional value cannot be measured directly, the functional value must draw value from other direct measurements. This function-oriented metric calculation was created by Alan J. Albrecht in 1976 which is called the Function Point (FP) value. The Function Point (FP) value can be calculated using the rating scale shown in Table IV.

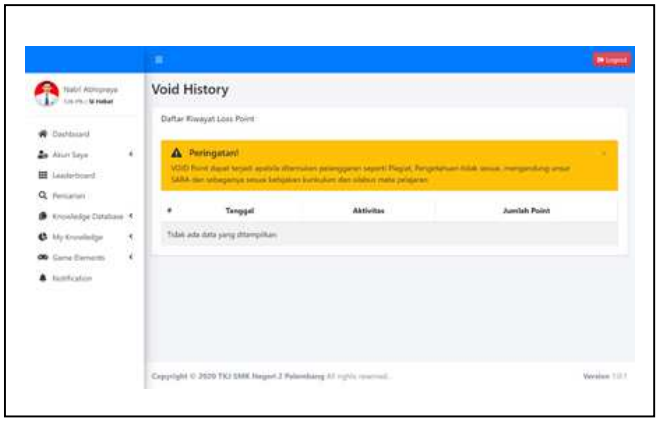

Fig. 5 Implementation of Game Elements in the End Game Phase

TABLE III. OBSERVATION RESULTS

Data Name	Item	Quantity
User Input	New Student Input, New Teacher Input, New Subject Input, Input Tacit Knowledge, Input Explicit Knowledge, Input Comment, Input Transfer Point, Search Input, Enter New Friend List, New Group Input, New Mission Input, Password Change, Tacit Knowledge Transformation, Changing Explicit Knowledge, Profile Photo Changing, Profile Information Change, Comment Modification	17
User Output	Student List, Teacher List, List of Subjects, List of Knowledge, Knowledge list not verified, Friendlist List of Point Earning History, Display Total Knowledge, Display Number of Students, View Detail Knowledge, Display Number of Likes, View Number of Comments, Leaderboard Display, User Profile Information Display, Avatar Selection Display, Badges Display, Display Frequenty Asked Questions, Void Point Display, Confirm User Data Deletion, Login Error Message. Friendlist, Message Input Data To Server, Message Edit Data To Server, QR Code Sharing Knowledge, Leaderboard Display with Bar Chart	25
User Request	Menu Home, My Account Menu, My Point Menu, Avatar Menu, Menu Badges, Leaderboard Menu, Search Menu, Menu Tacit Knowledge Database, Menu Explicit Knowledge Database, My Tacit Knowledge Menu, My Explicit Knowledge Menu, Menu Store, Menu Friends+, Group Menu, Missions . Menu, Transfer Point Menu, Menu Void History, Logout Button, Login Button, Change Password Button, Change Photo Button, Add Knowledge Button, Change Profile Information Button, User Block Button, Approve Knowledge button, Knowledge Reject Button	26
Files	File Explicit Knowledge, Lesson Plan File, Learning Module File, Student List File, Teacher List File, Subject List File	6
External Interface	TCP/IP	1
Current Program Module	Student Account Management, Teacher Account Management, Knowledge Management, Student Account Bulk Entry, Generate QR Code, Point Award Settings, Badges Settings	7
Replaced Module	Point Award Settings, Generate QR Code	2
Removed Module	-	0
Programming Language	PHP 7	1
Failure	Sharing knowledge does not add point, the leaderboard chart calculation does not match the total points	2

C. Calculation of Software Quality Indicator Values Based on ISO 9126

After observing and collecting existing data, the next step is to determine the value of ISO 9126 quality indicators, namely the value of functionality, usability, reliability, efficiency, maintainability and portability.

1. Functionality

The value of the functionality indicator can be taken based on the Function Point (FP) value. To calculate the function point value, it takes some data such as Input, Output, User Request, File and External Interface with a general level of complexity, namely Low, Medium and High. As for the data held, it was obtained the calculation to find the Function Point (FP) value shows in Table IV.

To get the factor value of the complexity variable, an evaluation of the 14 attributes available in the software was carried out. The evaluation was conducted by distributing questionnaires to some teachers to get the value for each complexity variable on using the software. This attribute was then used as a factor to normalize the function point (FP) calculation. The calculation of the complexity variable factor is shown in Table V.

TABLE IV. NUMERICAL COMPUTING CALCULATION TABLE

Measurement Parameters	Quantity	Weighting Factors			
		Low	Medium	High	Quantity
User Input	17	4 x 3	10 x 4	3 x 6	70
User Output	25	8 x 4	11 x 5	6 x 7	129
User Request	26	17 x 3	5 x 4	4 x 6	95
Files	6		6 x 10		60
External Interface	1			1 x 10	10
Total					364

TABLE V. COMPLEXITY VARIABLES

Number	Variable	Value
1	Backup and Recovery	0 1 2 **3** 4 5
2	Data Communication	0 1 **2** 3 4 5
3	Data Processing Distribution	0 1 **2** 3 4 5
4	Performance	0 1 2 **3** 4 5
5	Operational Configuration	0 1 2 **3** 4 5
6	Online entry	0 1 2 **3** 4 5
7	Online update	0 1 **2** 3 4 5
8	Data transaction rate	0 1 2 **3** 4 5
9	User efficiencies	0 1 2 3 **4** 5
10	Processing complexity	0 1 2 **3** 4 5
11	Reusability	0 1 2 **3** 4 5
12	Conversion and Installation	0 1 2 **3** 4 5
13	Installation Duplication	0 1 2 **3** 4 5
14	Facilitate Change	0 1 2 3 **4** 5
	Total **(∑ Fi)**	**41**

The formula for determining the maximum Function Point (FP) and Function Point (FP_{max}) values is as follows:

$$FP = Total\ Number\ x\ (0.65 + 0.01\ Fi) \quad (1)$$

$$FP_{max} = 1.35\ x\ Total\ number \quad (2)$$

Which FP is Function Point, FP_{max} is Maximum Function Point, Total Number is Information Domain Total and ∑ Fi is Total Facility Change cost.

Based on calculation using (1), the Function Point (FP) value is 385,8 and the maximum Function Point value (2) is 491,4, after obtaining this value, the level of achievement of functionality can be calculated using (3).

Which FP is Function Point, FP_{max} is Maximum Function Point, Total Number is Information Domain Total and ∑ Fi is Total Facility Change cost. Based on the calculation, the Function Point (FP) value is 385,8 and the maximum Function Point value is 491,4, after obtaining this value, the level of achievement of functionality can be calculated using (3).

$$Functionality = \frac{FP}{FP_{max}} \quad (3)$$

Based on (3), the Functionality is 0.785

2. Reliability

The next step is to calculate the reliability indicator or the level of software reliability that can be measured using the Metric Rate of Failure Occurrence (ROCOF) value. To be able to calculate the value of the Rate of Failure Occurrence, it is necessary to have the value of the Function Point (FP) and the number of failures that occur in the use of the system (Failure).

$$ROCOF = \frac{Failure}{Fuction\ Point} \quad (4)$$

$$Reliability\ value = 1 - Rate\ of\ Failure\ Occurence \quad (5)$$

After measuring (4) and (5), the software ROCOF value is 0,00518 and the reliability value is 0,9948, which means that in 1.000 operations performed on the software, the software can work correctly 994 times, and it is assumed that a system error can occur 6 times.

3. Usability

To get the Usability value, the value of the speed of operation metric is needed. The faster the speed of operation is close to 0, it indicates that the usability of the software is increasing. On the other hand, the higher the speed of operation metric value is away from 0, the software usability will decrease.

$$Speed\ of\ Operation = \frac{User\ Input + User\ Request}{Function\ Point} \quad (6)$$

$$Usability = 1 - Speed\ of\ Operation \quad (7)$$

After the calculation (6) and (7), the software usability value is 0,889. which means that in a job that should have been done by humans in 1.000 jobs, now it can be replaced or assisted systematically as many as 889 times the job.

4. Efficiency

Efficiency in software is directly related to performance, resources and savings obtained from using the software.

$$Estimated\ Metric\ (E) = -13{,}39 + 0{,}0545\ FP \quad (8)$$

Based on (8), the Estimated Metric (E) is 7.6361.

5. Maintenance (Maintainability)

In software, if many changes occur, it will be increasingly difficult to perform maintenance on the software. The metric used to find the maintenance value is the software maturity index (SMI) metric value. If the SMI value is close to 1, it means the software is more stable, and vice versa if the SMI value is far from 1, it means the software is not in a stable state. To calculate the SMI value, several variables are needed,

namely the number of active modules (MT), the number of modules added (Fa), the number of modules that have changed (Fc), and the number of modules removed since the initial design. (Fd).

$$SMI = \frac{MT-(Fa+Fc+Fd)}{MT} \quad (9)$$

After the calculation (9) is complete, the maintenance value obtained is 0.7142 which indicates that of the 10 program modules, there are 7 modules that are estimated to be stable, which means that no major changes are required, while the other 3 modules will experience changes during the maintenance phase.

6. Portability

Software portability is divided into three levels, namely source code portability, intermediate code, and runnable code. The programming language used in the software developed in this research is PHP programming language. The portability indicator values are Source Code 1; Intermediate Code 0.66; Runnable Code 0.33. Due to the portability nature of the developed Knowledge Management System (KMS) software, the portability indicator value is 1.

Software Quality Generalization

After getting the value of the ISO 9126 quality indicator which consists of the value of functionality, usability, reliability, maintenance and portability, the next step is to generalize in the form of an overall assessment of the values obtained to calculate the achievement of software quality shown in Table IV.

TABLE VI. GENERALIZATION OF SOFTWARE QUALITY

Number	Characteristic	Value
1	Functionality	0,785
2	Reliability	0,994
3	Usability	0,889
4	Efficiency	0,763
5	Maintainability	0,714
6	Portability	1
	Total Quality	**5,14**

Ideally, the value of each software quality characteristic indicator should be equal to or close to a value of 1 to obtain a final total quality score of = 6, which is the best value. However, the Knowledge Management System software achieved a quality score of 5,14. When converted into percent form, the value of software quality is obtained as follows.

$$\%\ of\ Quality\ Achievement\ = \frac{Qualitity\ Achievement}{Maximum\ Quality} \times 100\% \quad (10)$$

The final result of software quality achieved (10) for the Knowledge Management System with the concept of Gamification based on the Octalysis Framework is 85.6%.

IV. CONCLUSION

The Gamification concept with the Octalysis Framework was implemented in the Knowledge Management System. Some game mechanics in a non-game context consisting of four phases, namely the Discovery, Onboarding, Scaffolding, and Endgame was applied to improve student performance and motivation in learning; the Knowledge Management System software achieved an overall quality score of 5.14 out of 6 (85.6 percent of quality achieved) covering functionality, reliability, usability, efficiency, maintainability, and portability characteristics of the ISO 9126 quality indicator.

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