Gamifying Learning Assignments with Micro Design Approach

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Abstract: There are convenient sets of design approaches that have been used to design different kinds of resources in Human-Computer Interaction (HCI). Many schools and educators are facing a formidable challenge that is how to make homework a valuable and interesting part of the learning process. This paper introduced a micro-design approach to support students in not only doing their homework, but also, learning from the assigned exercises that led to the extraction of the procedures for gamifying assignment with the approach, and a suggested conceptual design model called "Snowflake". The "Snowflake" model is based on the idea of integrating raw resources and behaviours with the elements of gamification to form a micro gamified experience, which combines many items that lead to gamified assignments on the macro level. The most obvious finding to emerge from the design is that micro-level analysis has a positive impact on gamified assignment, which begins with the identification of raw objects such as quizzes, lessons, learning objects, and tools. Moreover, the linking of raw objects and gamification elements reflecting in a micro-gamified task, operation, exercise and assignment.

1 INTRODUCTION

Design-based learning is a term that describes how learners absorb, process and retain knowledge during learning. In recent years, there has been an increasing interest in the development of gamification in almost every field. Gamification seeks to promote motivation and learning engagement with applying game features in a non-game context. A dynamic area of interest across all levels of global education is the use of technology to enhance the student learning experience. Education and training are fields in which gamification has taken a wide interest. The use of classroom gamification can turn a traditional class into an engaging and motivated one. There are two types of effect which result when learners utilize gamification software. Firstly, gamification provides an immersive learning experience using experience points, badges, avatars, and leaderboards. Secondly, it promotes additional learning experiences where learners can interact, collaborate, and take ownership of their learning.

The generalisability of much published research on gamification design included many approaches and frameworks. However, few of them are had a clear vision of the design aspects. The most known gamification design frameworks, MDA with the design components: Mechanics, Dynamics, and Aesthetics (Hunicke, Leblanc, & Zubek, 2004, p.23). Octalysis framework which included 8 Core Drives: (1) Epic Meaning & Calling, (2) Development & Accomplishment, (3) Empowerment of Creativity & Feedback, (4) Ownership & Possession, (5) Social Influence & Relatedness, (6) Scarcity & Impatience, (7) Unpredictability & Curiosity, (8) Loss & Avoidance (Chou, 2019). Besides, the 6D framework contains the following steps: defining business objectives, delineate target behaviours, describing the players, devising the activity loops with thinking of the fun, and finally, deploying the gamification system with the appropriate tools (Werbach & Hunter, 2012, p.86). SDT framework based on Self-Determination Theory is a common framework in gamification design with the following steps: discovering, identifying players' profiles and motivational drivers, setting up goals and objectives, describing skills, tracking and measuring, defining

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lenses of interest, desired outcomes, play-testing, and polishing. Given another example, the proposed approach of a conceptual framework for designing gamification structured in four phases: declaration, creation, execution, and learning (Mora, Zaharias, González, & Arnedo-Moreno, 2015). However, the number of gamification design frameworks in education is a matter of discussion (Mora, Riera, González, & Arnedo-Moreno, 2017). There is an urgent need to address designing issues and models for developing a more holistic understanding (Koivisto & Hamari, 2019).

This work aims at introducing the gamification micro design approach and promoting a proposed design conceptual model with presenting the results of the initial execution on students' assignments. We opt for Concept-Driven Approach as a well-established methodology in human-computer interaction and interaction design research that manifests theoretical concepts in definite designs, start from conceptual/theoretical rather than empirical (Stolterman & Wiberg, 2010). Thus, the contribution of this work provides an innovative and efficient design approach that can support developing gamification applications and integrate with the other design frameworks in the educational domain.

2 RELATED WORK

Different theories exist in the literature of gamification design for discovering the real situation of the gamification design processes and extracting the general themes of designing. Particular attention has focused on analysis the gamification models using MDA framework and proposed some strategies for an effective design according to Mechanics, Dynamics, and Aesthetics (Kusuma, Wigati, Utomo, & Putera Suryapranata, 2018). In this regard, Mora et al. (2017) revealed the main aspects and features in the analysed gamification design frameworks with significant findings: (1) the interaction basis is emphasising gamification as a user experience, (2) most of the frameworks are seen as user-centred designs, (3) the need for formal design processes that emerged from case studies instead of ad hoc experiences, indeed, they proposed three major approaches in the analysed gamification design processes which are: user-centered, game-cantered, and technology-centered.

The more significant findings to emerge from literature were that "the need for a conceptual specific learning framework for designing the process" (Mora, Zaharias, et al., 2015). The importance of designing successful gamification applications in education to support behavior changes (Dichev & Dicheva, 2017). Indeed, Ronsivalle & Metus (2005) indicated that the learning design process can be classified into two discrete phases: macro-design and micro-design, these two phases have different aims, different specific activities, different outputs. The microfoundational approach investigates the link between macrolevel constructs and microlevel constructs, which works when the relationships between constructs on a macro level are inapprehensible (Leclercq, Poncin, & Hammedi, 2020). There is a need for an innovative design approach like the micro design approach, which could increase motivation and engagement and contribute to the field of gamification design. Proposing this approach was a result of conducting previous design iterations for gamifying homework assignments and tracking the results (Metwally, Yousef, & Yining, 2019). We found that students tend to complete the short-gamified assignments and obtain the rewards, and dislike the long sequences of assignments which affect their engagement. We also noticed that there is an apparent lack of introducing this approach comprehensively and deeply to describe the procedures of this design approach. Moreover, the scarcity of the supported studies discussed the concept of micro gamification in general without addressing the aspects of the design.

3 THE GAMIFICATION MICRO DESIGN APPROACH

The specific objective of the micro design approach is designing gameful experience and overcoming the problematic issues with the previous design approaches. The idea of micro design approach came from the human being's preferences of achieving simple and small tasks besides the boredom feeling after dealing with routine tasks, especially if these kinds of tasks lacked the interest. The philosophy behind our thinking of the micro design approach emerged from the quote of Creighton Abrams: *"When eating an elephant take one bite at a time"*. Take a small portion to handle it. The micro design works on the same line to design on small-scale. Instead of doing the whole task on time, split the big task to micro tasks. The micro-level design is not a new concept which has been used many years ago and has been poorly defined (Snelson & Elison-Bowers, 2007). We argue that the micro design approach is the new direction in the track of gamification design;

with studying micro design strategies for persuasive game design that help the designers in gameplay establishing (Kors, 2015).

Applying gamification design approaches on the macro level includes the whole process of situation or context, it could cause the feeling of the heavy task even with applying the extrinsic motivation affordances. When implementing the gamification elements, the user interaction nature with the gameful experience requires long sequences of actions and responses for obtaining rewards. On one hand, for instance, at the beginning of the experience, the users are interacting with the treatment for discovering and achieving the goal; during their interaction and responses; the gamification system is rewarded them based on their activities. However, their expectation may exceed the capacity of the gamified system so they may decide to withdraw gradually. On the other hand, the micro level of instructional design, using small units of instruction is essential to reduce the cognitive load by placing "just in time" information within complex learning situations (Snelson & Elison-Bowers, 2007). Regarding User Experience (UX), micro (UX) concentrates on optimizing of UX in the following embodiment design stage by predicting the user's perception and processing; it can be achieved with less effort, short-term, with a sufficient outcome and without influencing existing development processes (Von Saucken, Michailidou, & Lindemann, 2013).

The implication of the success factors could be inspired by the successful practice of the app "TikTok" [1] for a short-form mobile video, which ranked as a most downloaded app in 2019 compared to YouTube. Both applications provide video services, but TikTok satisfies the users' expectations with an endless stream of short videos. It could be explained on the micro design approach that the users tend to the simplicity and shortage of spending time on watching the video clips as well. In addition, the curiosity of the unexpected short videos views. The process of designing using a collection of atoms (Mora, Riera, Gonzalez, & Arnedo-Moreno, 2015). This approach could be applied for gamifying education and motivating students to achieve complicated tasks or to keep their attention by innovative designs. With the micro design approach, the process is simple and more straightforward to divide the course into units or modules; which have small chunks of micro content. On the same note, Yousef, Chatti, & Schroeder (2014) highlighted the need to design "Self-Assessment utilized short quizzes to help participants formatively assess their own learning".

Thus, a good micro-design process requires a rigorous analysis of content (Ronsivalle & Metus, 2005). Micro content "relates to a single internet resource, which can be referenced directly by a URL, and may consist of a slide of a presentation, parts of an animation sequence, an interview, a test question….These contents all relate to entities below the course or lesson level" (Kerres, 2007). Every module may include some activities, mini tasks, learning objects, short assignments in which the gamification elements can be implemented in different ways. As an example, Butgereit (2016) aimed at gamifying mobile micro-learning through enabling the QR code to connect to a short mobile micro-lesson in less than two minutes to read on a mobile which included challenge or mission and game mechanics like onboarding, challenges, rewards, and competition.

The reward system considers awarding the students on the activity instead of the activities which are categorized and separated on different milestones instead of calculating the total points. The micro gamification design isolates units or items like grade book, assignment, mini-stories, syllabus, activity while behavior changes are limited to the unit/item level comparing to macro gamification which gamifies the environment or the activities (Jones, 2014).

This approach is working with the other design approaches accordingly and can be integrated with them to design gamification applications. It looks at the process from the microlens. This approach gives each unit a unique design. It means that the game elements may be varied in each unit or lesson besides the strategy of playing, dynamics, and mechanics. The design enforces the flow experience and perceptions of gamification elements that motivate and reward the response continuously and immediately after answering the small chunks of the assignment. It could reduce the cognitive load of students. The design is directed from down to up, from objects level to the course level counter to the typical design practices.

[1] https://www.tiktok.com

4 HOW TO APPLY MICRO DESIGN APPROACH TO GAMIFY ASSIGNMENT

This section demonstrates how to apply this approach when gamifying learning assignments according to the validated processes of gamification design. Most of the gamification design processes in the literature mainly include similar processes that emerged from the conventional model of instructional design ADDIE. Thus, we adopted the validate method with the seven phases, which is comprehensive and detailed of the main processes (Morschheuser, Hamari, Werder, & Abe, 2017). The design processes contain the following phases: (1) preparation, (2) analysis, (3) ideation, (4) design, (5) implementation, (6) evaluation, (7) monitoring. Gamifying specific and particular educational context like gamifying homework is one of the remarkable seeks which has been addressed in the literature (Metwally et al., 2019); (Goehle & Wagaman, 2015); (Hakulinen, Auvinen, & Korhonen, 2015). Thus, we demonstrate how to implement the micro design approach for students' assignments and showing the comparison between the micro and macro approach (see table 1) according to our experience in gamifying homework.

4.1 Preparation

This phase starts with identifying the problem which likely concerns with motivation and engagement that evolve, defining the goal of gamifying assignments besides the related conditions and the requirements. The general educational objectives should be divided into specific objectives (sub-objectives). The outcome of this process is the objectives list from the general objectives (macro level) to the specific objectives (micro level). Thus, the objectives of gamifying students' assignments are more concentrated and precisely defined to gamify an exercise by applying specific gamification elements.

4.2 Analysis

It aims at analysing the context and users. The context analysis in education will narrow down the analysis scope to include the module level regardless of the grade, semester, and course. The hierarchy analysis includes the small component of the assignments that likely is the target. The micro gamification approach recognizes the context of gamifying the assignments where gamification should be applied.

4.3 Ideation

The innovative and creative ideas are required to promote the micro design into gamification experience. It could necessitate developing new methods and techniques to generate the ideas of micro design when intending to design micro assignments and come up with the gamification elements in an attractive way.

Table 1: Comparing the Main Activities of the Design Processes between the Macro and Micro Level.

Activities of Macro level	Phase	Activities of Micro Level
General objectives	Preparation	Specific objectives
Start from user needs		Existing product design
The Macro analysis of context (Course)	Analysis	The micro analysis of context (module, concept, skill)
Using the methods and tools to find new ideas	Ideation	Developing the strategies and tools for generating ideas
Prototype of designing activities, tasks	Design	Prototype of designing micro activities, micro tasks
Educational Resources		Learning Objects
Designing the gameful experience with the gamification elements		Developing the gameful experience with the micro gamification elements
Unify gamification system	Implementation	Divergent gamification systems
Progression stairs cycle		Engagement loops cycle
Long cycles	Evaluation	Short cycles
Improvement list	Monitoring	Improvement list
Effective gamification apps.	Result	Efficient gamification apps.
Long term	Time Frame	Short term

4.4 Design

This phase is the core of the micro design approach.

Designing the prototype of the gamified assignments is a bit different as a result of changing the scope of the design to the microlens. Indeed, we can develop prototypes of micro tasks, micro activities, micro exercises, which would be simple with claiming short action of the students. It would be worthy of investing the learning objects in the design of micro assignments that have specific objectives and reusable in different contexts. Thinking of the ways of applying the gamification elements into the micro assignments should be applied in the design of prototypes, designing gamification mechanics in a different way to fit with these assignments. In this phase, it is crucial to come up with developing new elements or advancing the way of applying these elements, especially with a new approach. Planning the use cases will be varied from the common practices, including the users' activities, actions, and responses to the gamified system owing to the nature of the micro activities.

Regarding the gameful experience, it is expected that increasing the students' motivation when they answer the micro homework assignments, which is different from the gamified homework in the macro gamification systems. In other words, providing the assignment with the micro approach would reduce the cognitive load of students and perceptions of gamification elements that motivate and reward continuously and immediately after answering the small chunks of the assignment. It could support the learning achievement by completing the learning assignments. This approach will encourage developing new shapes of scenarios to serve the micro gameful experience. Moreover, human motivation and interaction, game design, gamification system design, and psychology are substantial knowledge for the instructional designer.

4.5 Implementation

In this phase, developing the prototype and use cases based on the iterative procedures in the development cycle, and thinking of the implementation tools are crucial. According to the prototype of gamified micro assignments, the development process will consider the type of resources as well. H5P[2] is a free tool based on JavaScript, aims to create, share and reuse interactive content which may be embedded in any platform that supports embedded content (iframes). Seppo[3] is a promising online tool for creating educational games to help the instructors for creating educational tasks and developing gamification experience for their students. These tools support developing the gamification applications especially with following the micro approach. It does not require programming skills so the teachers and the beginner users can create their applications easily. Regarding the activity cycles shown in figure 1, both of Werbach and Hunter mentioned that there are two kinds of cycles, the engagement loops which can be described at a micro level (what and why players do, and what the system does in response), and progression stairs which provide a macro insight on the player's journey of progression (Werbach & Hunter, 2012, p.94). Managing the implementation is pivotal to follow, and testing the design approach is essential. It can be achieved by conducting the usability tests and some experiments to detect the errors and bugs.

Figure 1: Activity Cycle (Werbach & Hunter, 2012).

4.6 Evaluation and Monitoring

It aims at assessing whether the developed gamification micro approach attained the defined objectives, and monitoring the implementation. It applies the quantitative and qualitative methods aside from the formative and summative evaluation methods with considering the scope of the micro level. According to the results of the empirical investigation, the design will be improved with iteration cycles.

5 THE PROPOSED MODEL "SNOWFLAKE"

Snowflake model is a proposed model inspired by the natural phenomenon "Snowfall" (Metwally, Yousef, & Yining, 2020). Simulating what is happening in this phenomenon could be embodied in the micro approach. The Snowflake is an essential part of the snow, which has different constituent shapes resulted from the occurred combination. According to the micro level analysis, the process of gamified

[2] https://h5p.org/
[3] https://seppo.io/

assignment starts in the first phase from recognizing the raw objects like quizzes, modules, learning objects, and resources. Planning of the gamification elements including mechanics, dynamics, and aesthetics is required in this phase for designing the prototypes which include the interfaces, functions, and game elements. The second phase is the result of combining the raw objects and gamification elements in light of the prototypes which lead to micro gamified task, activity, exercise, and assignment. At this phase, the micro gamified assignments have been composed. The micro gamified task or micro gamified activity is simple and short with a specific objective and reward mechanism. The central gamified system is distributed to sub-systems for managing the gamified assignments. The Snowflakes or the micro gamified assignments could entangle and form to another shape, which is the macro gamified assignments in the third phase. Assembling macro gamified items and objects could build a gamified course. The design and development cycle might work again if the snow melted and turned into the original items of the row objects as shown in figure 2. The proposed design model is not isolated from the other gamification design frameworks and models; it can be integrated with another approach like MDA framework. This approach is constant and flexible, it looks at the situation from the microlens with reconstructing the design to be shorter and more effective instead of long and monotonous.

6 FIRST IMPLEMENTATION

Based on the foregoing design principles, processes, and the model, we implemented a preliminary execution for gamifying students' homework regarding the micro gamification approach. We targeted gamifying the homework of sixth-grade primary schools in the English course of the first and second semesters of the academic year 2019/2020 in Egypt. We divided the homework of the course into independent and separate units, each unit divided into objects. The micro gamification design approach has been applied to unit five and unit six, which focused on the micro exercises of the homework. This implementation resulted from students' feedback of previous iterations of gamified homework exercises which indicated to the long players'journey of the gamified assignments. We achieved unit five and collected the feedback and reflections then we developed unit six in light of these concerns for improving the design, and for our desire of promoting the homework as an enjoyable task and simple to overcome the negative attitudes of perceiving homework assignments (as presented in figure 3). The gamification system of these units is independent of the primary system for each unit, where the calculation reward system is not connected and consecutive. The advantage of using this approach is that the students could answer the exercises without thinking of their score in the last units, especially the

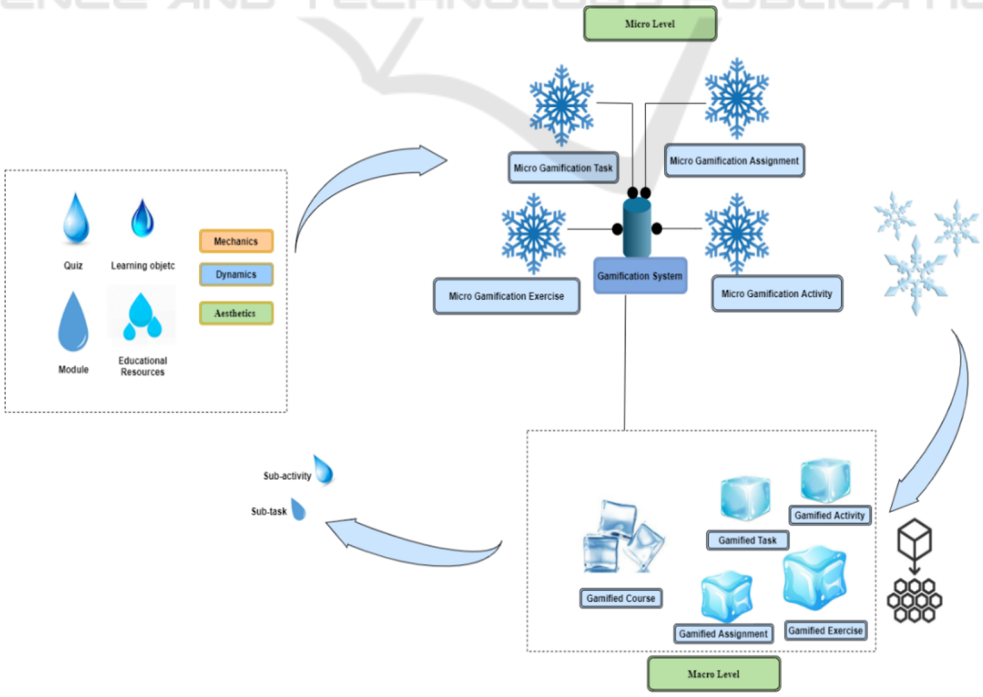

Figure 2: The Proposed Model "Snowflake" (Metwally et al., 2020, in press).

Figure 3: Examples of the micro gamified exercises.

low achievement students if they failed to collect points and badges. Completing the homework is more interesting because the micro assignments give the feeling of the easy task with the inspiration of collecting more points when answering more exercises, taking into consideration the availability of editing the answer for enhancing the score. The gamification elements like badges, leaderboard, levels, challenges, locked items, and feedback make the learning assignments more enjoyable. It can promote extrinsic and intrinsic motivation.

After developing the English units, we invited the English teachers and some researchers to use and test the treatment. This test was useful to track any possible errors during their use and for collecting feedback for enhancing the design. It has been observed that some researchers were enthusiastic about collecting the maximum number of points and keen to answer the questions many times to advance their score if they answered wrong.

As a result, they appreciated the design and expressed their positive comments in the gamified homework. The English teacher expressed an appreciation of the homework design. Thus, we achieved the implementation with (14) students of sixth-grade primary school. We invited them with supporting of the teachers to complete their homework on the platform and respond to the questionnaire. The findings resulted from students' feedback on the platform beside their responses to the questionnaire. The most significant finding showed that the micro design approach has reinforced the perception of motivation, enjoyment, and satisfaction with completing the gamified homework. Below are the positive comments made by the researchers, and the students.

"I liked these exercises. Especially their simplicity and attractive design. Questions in each unit were given accordingly matched for their topic."

"This app is very good I love it so much. I think I get all the badges. I had some fun while I did it. Thank you very much."

"It was very motivating and innovating. Keep adding more tasks."

"I like these exercises. I got badges. I really enjoy doing homework. I like all the parts."

"I liked very much. Badges were nice. I enjoyed doing the homework."

7 FINAL REMARKS

This work presented a micro design approach for designing gamification of learning assignments, resulted in extracting the procedures of gamifying the assignment with the micro design approach, and a proposing a conceptual design model called "Snowflake". The approach is based on the micro insight of designing and delivering the gameful experience besides the assumption that the motivation and achievement rates can be increased if we divided the gamified task into gamified small tasks. It gives a great value to the small components and simple units for achieving the objectives gradually. The "Snowflake" model is based on the notion of combining the raw resources and activities with the gamification elements to form a micro gamified experience, which combines many items that lead to gamified assignments on the macro level. Then, it could be moved to the raw shape again in a cycle. We followed our approach with a pilot and initial implementation of the gamified assignment. As future work, we consider the expansion of the execution of different learning activities and contexts. The validation through implementing the proposed approach and investigating the results is worthy of considering in the future.

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