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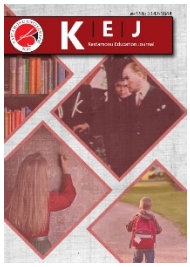

| Research Article / Araştırma Makalesi |

# Gamified Lesson Design Model Proposal for Mathematics Instruction

# Matematik Öğretimi için Oyunlaştırılmış Ders Tasarımı Model Önerisi [1]

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**Keywords**

1. Mathematics instruction
2. Instructional design
3. Gamification
4. Model proposal
5. Design principles

**Anahtar Kelimeler**

1. Matematik öğretimi
2. Öğretim tasarımı
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## Abstract

*Purpose:* This study aims to present a gamified lesson design model proposal for mathematics instruction and to determine the design principles of this model. Apart from the general models in the literature, the lack of a gamification design model that meets the needs of the field of mathematics instruction is the main motivating factor in the study.

*Design/Methodology/Approach:* The educational design research carried out for this purpose, the Gamification Development Model, Mathematical Knowledge for Teaching Model, and the process of designing a gamified mathematics lesson of 8 pre-service teachers, who constitute the participants of the research, were discussed together. In the study, which was completed in 6 phases and 14 sessions in total, data were collected through video and audio recordings, weekly reflection reports, general evaluation reports, and the Gamified Mathematics Lesson Checklist created by researchers.

*Findings:* Based on the content analysis and the literature, the gamification design steps that are aimed to guide teachers and/or instructional designers for mathematics teaching are proposed as a model. This model has a spiral structure in which each step affects the previous or next step. The current model includes goal analysis, design, development, implementation, and evaluation-improvement steps. Each of these steps includes gamification elements and what needs to be done within the scope of Mathematical Knowledge for Teaching as design principles.

*Highlights:* The current study proposes a new and detailed gamified lesson design model for mathematics instruction (GLDMfMath). The model proposal is expected to contribute to the field of mathematics teaching, especially with the guiding principles it offers and gamified lesson design examples to be created through these principles. Given that the motivation, participation, and achievement of learners increase in the teaching environments, where gamification is used, designs that can be created with the model presented by the current study can offer similar contributions to the mathematics education literature.

## Öz

*Çalışmanın amacı:* Makalenin özeti, Mevcut araştırma matematik öğretimi için oyunlaştırılmış ders tasarımına yönelik bir model önerisi sunmayı ve bu modele ait tasarım ilkelerini belirlemeyi amaçlamaktadır. Alanyazında yer alan genel modellerin dışında matematik öğretimine yönelik alanın ihtiyaçlarını karşılayan bir oyunlaştırma geliştirme modelinin olmaması çalışmanın yapılmasındaki temel motivasyon unsurudur.

*Materyal ve Yöntem:* Yürütülen eğitsel tasarım araştırmasında, alanyazında yer alan Oyunlaştırma Geliştirme Modeli, Öğretmek için Matematik Bilgisi Modeli ve araştırmanın katılımcılarını oluşturan 8 öğretmen adayının oyunlaştırılmış matematik dersi tasarlama süreçleri birlikte ele alınmıştır. Toplam 6 aşamada ve 14 oturumda tamamlanan çalışmada veriler video ve ses kayıtları, haftalık yansıma raporları, genel değerlendirme raporları ve araştırmacılar tarafından oluşturulan Oyunlaştırılmış Matematik Dersi Kontrol Listesi aracılığıyla toplanmıştır.

*Bulgular:* İçerik analizine tabi tutulan verilerden ve alanyazından yola çıkılarak, matematik öğretimi için öğretmen ve/veya öğretim tasarımcılarına kılavuzluk etmesi hedeflenen oyunlaştırma tasarım adımları belirlenmiş ve bu adımlar bütünü bir model olarak önerilmiştir. Bu model spiral bir yapıya sahip olup, her bir adım önceki veya sonraki adımı etkilemektedir. Model hedef analizi, tasarım, geliştirme, uygulama ve değerlendirme-iyileştirme adımlarından oluşmaktadır. Bu adımlardan her biri tasarım ilkeleri olarak oyunlaştırma unsurlarını ve Öğretmek için Matematik Bilgisi kapsamında yapılması gerekenleri içermektedir.

*Önemli Vurgular:* Bu çalışma, matematik öğretimi için yeni ve ayrıntılı oyunlaştırılmış bir ders tasarım modeli önermektedir. Model önerisinin, özellikle sunduğu yol gösterici ilkeler ve bu ilkeler üzerinden oluşturulacak oyunlaştırılmış ders tasarım örnekleri ile matematik öğretimi alanına katkı sağlaması beklenmektedir. Oyunlaştırmanın kullanıldığı öğretim ortamlarında öğrenenlerin motivasyonu, katılımı ve başarısının arttığı göz önüne alındığında, bu çalışmada sunulan modelle oluşturulabilecek tasarımlar matematik eğitimi literatürüne benzer katkılar sağlayabilir.

[1] It is derived from PhD dissertation of Nilüfer Zeybek conducted under the supervision of Elif Saygı.

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## INTRODUCTION

*"Effective mathematics teaching requires understanding what students know and need to learn, then encourage and support them to learn what they need well."* (NCTM, 2000, p.11). Teachers are one of those who play the main role in achieving this. Ball, Thames, and Phelps (2008) state that a mathematics teacher has responsibilities such as presenting mathematical ideas in the learning environment, choosing appropriate examples and representations, making connections between topics, and organizing activities to proceed from the easy to the difficult. In addition to these stated responsibilities, it is necessary for the teacher to have knowledge about the student, instruction, and the curriculum and to put this knowledge into practice for effective mathematics teaching to occur (Ball et al., 2008).

When the roles and responsibilities of teachers in teaching are considered, it is seen that the teacher no longer assumes the role of transferring knowledge, but the roles of organizing learning and designing teaching (Hoogveld, Pass, & Jochems, 2005). Moreover, Darwin (2004) states that it is a necessity for a teacher to be an instructional designer because of changing teaching goals, student characteristics, and expectations. In this context, for effective mathematics teaching to occur, the teacher should assume the role of the instructional designer going beyond the roles of knowledge transmitter and practitioner. Instructional design in the broadest sense is defined as the creation of ideal conditions for improving teaching, facilitating learning, and accomplishing effective teaching (Arslan & Sağlam Arslan, 2016). As an instructional designer, the teacher should determine the current situation of the students, and make teaching effective, attractive, and efficient through practices and theories proposed to reinforce teaching (Malamed, 2010; Merrill, Drake, Lacy, Pratt, & $ID_2$ Research Group 1996). All of these can be achieved through instructional designs in which the objectives are clearly stated, the practices designed in accordance with the objectives, informative feedback, and strong intrinsic and/or extrinsic motivation (Perkins, 1992).

The fact that it contains objectives, applications complying with the objectives, feedback, and motivation (Zichermann & Cunningham, 2011; Werbach & Hunter, 2012) shows that gamification can be used as an instrument in instructional design. Defined as "*the use of game elements in non-game environments*" (Deterding, Dixon, Khaled, & Nacke, 2011; p.1), gamification is grounded on the concept of the game and motivates the individual to act, learn or solve the problem situation by including game elements in the process. In cases where gamification is employed, the objectives are presented to the individual desirably and interestingly, and feedback is given throughout the process so that the person can live positive experiences such as fun, success, and progress (Simões, Redondo, & Vilas, 2013). Gamification, which is frequently used in the fields of marketing, health, and sports in recent years, has the potential to meet the needs of students and teaching in the design of teaching. The studies on gamification in the field of education have revealed that the use of gamification method in learning environments positively affects the motivation, participation, and academic achievement of learners (Begosso, Cunha, Pinto, de Lemos, & Nunes, 2018; Çağlar & Kocadere, 2015; Dominguez, Saenz-de-Navarrete, de-Marcos, Fernández-Sanz, Pagés, & Martínez-Herráiz, 2013; Featherstone, 2018; Glover, 2013; Goehle, 2013; Gulinna & Lee, 2020; Haman, Pinciroli, & von Mammen, 2018; Hanus & Fox, 2015; Muntean, 2011; Putz, Hofbauer, & Treiblmaier, 2020; Sarı & Altun, 2016; Sezgin, Bozkurt, Yılmaz, & van der Linden, 2018). In addition to the contributions mentioned in the studies in the literature, the gamification method also allows the learner to receive feedback throughout the process and to have learning environments suitable for his/her differences (Çağlar & Kocadere, 2015).

If we look at gamification in more detail, we can see that the game elements included in the definition of gamification are story, dynamics, mechanics, and technology (Kim, Song, Lockee, & Burton, 2018). While the *story* is expressed as an artificial situation in which the characters, objectives, and struggle are presented to individuals who experience the gamification process, *dynamics* are the feelings and experiences that the individual will be engaged in during the process. *Mechanics*, on the other hand, are expressed as the toolbox of gamification and are all of the rules, missions, rewards, and status indicators that enable the dynamics to be experienced. Finally, *technology* refers to the concrete materials, information, and communication technologies employed for the gamification process to occur.

In gamification, one or all of the elements mentioned above are included depending on the needs of the design. The presence of these elements should not mean that gamification is performed accurately; the design of these elements and how they will be used for what purposes should be determined within a certain system (Werbach & Hunter, 2012). In education and instruction, Kim et al. (2018) and Reiners and Wood (2015) presented models containing design principles for the creation of gamified content. *The Gamification Development Model* (Kim et al., 2018), one of these models, argues that an educational gamification content can be created by following the phases of target analysis, design, development, implementation, and evaluation-improvement. The phases of the mentioned model and the design principles to be followed in these phases are listed in Table 1:

**Table 1. Phases of the gamification development model and design principles (Kim et al., 2018)**

| Design Phases | Design Principles |
|---|---|
| Target Analysis | Defining needs, goals, and scope<br>Analyzing the characteristics of students and learning environments |
| Design | Design of motivation strategies<br>Story and dynamics design<br>The design of the mechanics |
| Development | Deciding on the game type<br>Creating material<br>Testing the material |
| Implementation | Distribution<br>Implementation<br>Observing teaching |
| Evaluation-Improvement | Evaluating the learning achievement and the fun element of teaching<br>Improvement |

As can be seen in Table 1, the steps to be taken for gamification development and the design principles explaining how to take these steps draw a general framework and are not defined specifically for any learning area. When the study of the gamification development model in education offered by Kim et al. (2018) is examined, it is seen that the study gives detailed information about the definition of the elements in gamification and the use of these elements. However, this study kept the focus on game elements and did not include topics such as how to integrate instructional content and instructional needs and teaching methods in the design principles. Similarly, Prash and Rao (2015) in their study on how to use gamification in education, just like Kim et al. (2018), focused on game elements, ignoring educational and instructional aspects. Pirker and Gült (2015), on the other hand, defined the steps of gamification development in science teaching and stated that they addressed definitions in the context of the objectives, teaching methods, and content of science teaching. Although the studies have pointed out that gamification can offer opportunities for effective mathematics teaching, the fact that gamification in education is a new subject and that the gamification development models in the literature draw a general framework causes various difficulties in the creation of gamified content. Just as in science teaching, there are field-specific requirements, knowledge, reasoning styles, learning processes, and teaching methods involved in mathematics teaching. When the needs specific to this field are considered, it is thought that the gamification development models created for education and the design principles offered by these models may be insufficient to meet the needs of mathematics teaching and give rise to various uncertainties. Moreover, besides the gamification development model and the structure of the content to be gamified, one of the important factors that will affect the design is the designer. As an instructional designer, the teacher/pre-service teacher employing the knowledge and skills specific to the above-mentioned field in a gamified lesson design process will shape the structure and content of this design. At this stage, the Mathematics Knowledge for Teaching, which the teacher has in the context of teaching mathematics, comes to the fore. The Mathematics Knowledge for Teaching refers to the knowledge a teacher should have for teaching mathematics, regardless of any context (such as country or culture) (Ball et al., 2008). This knowledge includes content and pedagogical content knowledge. Content knowledge refers to the knowledge possessed by the teacher about his/her subject area and the subjects addressed in the related curriculum while pedagogical content knowledge includes student knowledge, teaching techniques knowledge, and curriculum knowledge that the teacher uses while designing and delivering mathematics instruction (Ball et al., 2008).

To summarize, given the reasons such as the role of mathematics teaching knowledge in the creation of gamified lesson content as an instructional design, the inadequacies and uncertainties that arise due to the lack of detailed description of the steps to be taken to employ gamification in existing models and the lack of instructional elements and the limited sample gamification applications for mathematics teaching, it is a need to create a gamification design model specific to mathematics teaching and design principles detailing this model. For these reasons, the present study aims to propose a new model for mathematics teaching that can guide teachers and/or instructional designers for the design of gamification, which has a recent history in education and rare samples in mathematics teaching and that can meet the needs of the field. With the educational design research conducted to reveal this model, the theoretical knowledge regarding gamification design in the literature and the gamified mathematics lesson designs of the pre-service middle school mathematics teachers developed within the context of the current study were analyzed. With the data obtained from this theoretical construct and practical process, answers to the following research question and sub-questions were sought:

1. What is the gamified lesson design model for mathematics instruction (GLDMfMath)?
    a. What is the structure of the gamified lesson design model for mathematics instruction?
    b. What are the phases of the gamified lesson design model for mathematics instruction?

## METHOD/MATERIALS

### Research Model and Procedure

In the current study, the educational design research model was used to create the design model for a gamified mathematics lesson. *"Educational design research can be defined as a type of research that provides repeatable solutions to practical and complex educational problems and provides a theoretical understanding that contributes to the literature"* (McKenney & Reeves, 2012, p. 7). Educational products, processes, programs, or policies can be created in educational design research; moreover, this research process is adaptable, collaborative, context-oriented, flexible, interactive, and benefit-oriented (Kelly, 2003; van den Akker, Gravemeijer, McKenney, & Nieveen, 2006). Linn, Davis, and Bell (2004) and van den Akker (1999) state that educational design research provides benefits such as providing guiding principles for designs and identifying key features. The determination of these principles and features provides information on how to make similar designs for similar environments/situations, especially for education designers (Nieveen & Folmer, 2013). In the present study, gamified lesson designs that can be expressed as educational products were created by the pre-service teachers through educational design research. The process of creating these lesson designs was investigated within the context of both gamification and Mathematics Knowledge for Teaching. As a result of this investigation, it was aimed to create a design model by determining the guiding principles and key points for gamified lesson design in mathematics instruction. In the current study, data were collected using both qualitative and quantitative methods, and answers were sought to the research question and sub-questions. The pre-service teachers' processes of designing a gamified lesson were examined with qualitative methods, and the gamified lesson designs formed as a result of the process were examined with quantitative methods.

In the present study, the stages defined as the core processes of educational design research by McKenney and Reeves (2012) and customized in the context of the study as in Figure 1 were employed. During the Analysis and Exploration stage, which is the first of these stages, the researchers conducted a literature review for gamification and geometry teaching (a sub-learning area of mathematics instruction), which is the content to be gamified. After the literature review, a five-week gamification training was given to the pre-service teachers to design gamification work in the second stage - that is, to move to the Design Stage. The content of this training includes the introduction of gamification, motivation, engagement, elements of gamification, and player types. In the third stage, the pre-service teachers were asked to get into 2 groups of 4 and to design a gamified lesson focused on the objectives set in the Geometry and Measurement Learning Area in the Mathematics Curriculum (MEB, 2018) by employing their knowledge of gamification and mathematics teaching together. These gamified lessons were created by the pre-service teachers employing the Target Analysis, Design, and Development phases, which are the steps of the Gamification Development Model, under the guidance of researchers, and this process was completed in five weeks.

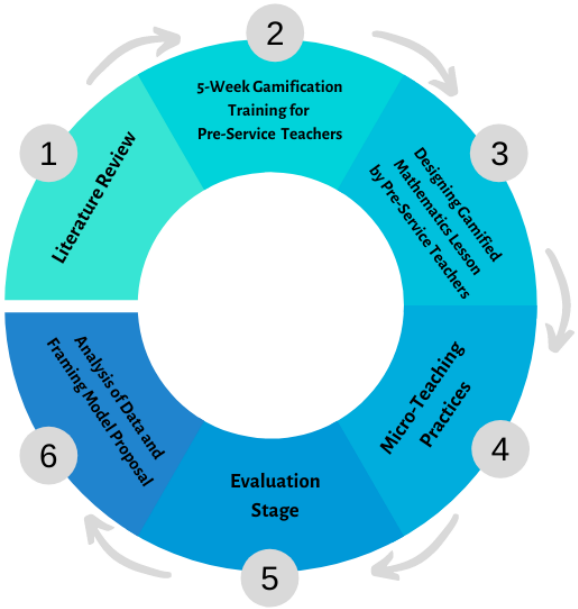


**Figure 1. Research procedure**

Following the completion of the designs, in the fourth stage, micro-teaching practices in which one pre-service teacher from each group took the role of teacher and the other pre-service teachers and the researchers took the role of learner, and the *Implementation Stage* of the educational design research was completed in two weeks. With a session held at the fifth stage, the pre-service teachers and researchers evaluated each implementation in terms of both gamification and mathematics teaching and made suggestions for improvement. In this way, the *Evaluation Stage* of the study was completed. In addition to these evaluations

and suggestions, the groups held another session to improve their designs, taking into account the experiences in micro-teaching practices. Thus, a fourteen-week process including five-week training, five-week design, two-week implementation, and two-week evaluation with the pre-service teachers was completed. In the last stage, the researchers analyzed the pre-service teachers' gamified mathematics lesson design processes together with the product that emerged as a result of this process, and the data obtained were combined with the literature and presented as a model proposal. Thus, the study was completed with the *Model Proposal Stage*, which is the last stage of the study.

## Study Group

The study group, which includes the participants who played a role in the gamified lesson design of the research and the evaluation of these designs, was determined by using the purposive sampling method, and consists of 6 females 2 males; a total of 8 senior pre-service middle school mathematics teachers attending a state university. One of the reasons why pre-service teachers were included in the study was the conviction that conducting a 14-week process within the context of a course with the participation of the pre-service teachers who were taking the course would minimize the loss of data and participants. Another reason is the pre-service teachers' level of *Mathematics Knowledge for Teaching*, which may be one of the factors that will affect the design. This level can be controlled through the courses taken by the pre-service teachers related to this knowledge. As Fraenkel, Wallen, and Hyun (2012) stated, in the selection of the participants, criteria were determined by the specific purpose of the research within the context of purposive sampling. This criterion was the pre-service teachers' having the necessary knowledge for the geometry learning area that the study focused on. The pre-service teachers' possession of this required knowledge was checked through their achievement in the following courses required in their undergraduate education; "Geometry", "Teaching Elementary School Mathematics", "Middle School Mathematics Curriculum" and "Special Instruction Methods II" focused on geometry teaching. Table 2 presents the grades of pre-service teachers in these courses.

**Table 2. The Grades of pre-service teachers in the courses determined as the criterion**

| Courses | PST1 | PST2 | PST3 | PST4 | PST5 | PST6 | PST7 | PST8 |
|---|---|---|---|---|---|---|---|---|
| Geometry | C1 | A1 | D | D | B2 | D | B2 | D |
| Teaching Elementary School Mathematics | A3 | A2 | B3 | B2 | B1 | A3 | A2 | A2 |
| Middle School Mathematics Curriculum | A3 | B2 | B2 | B3 | B3 | A3 | B3 | B1 |
| Special Instruction Methods II | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 |

*PST: Pre-Service Teacher

** A1=100-95 A2=94-90 A3=89-85 B1=84-80 B2=79-75 B3=74-70 C1=69-65 D=54-50

The grades taken from the " Special Instruction Methods II " course are the primary criterion in determining the participants in the study, and this course includes information about middle school students' perceptions of and development in the Geometry and Measurement Learning Area in mathematics teaching, learning and teaching approaches and instructional methods used in this area, which is focused on in the current study. The pre-service teachers were expected to have mastered the definitions and concepts in this learning area in the "Geometry" course and to have gained knowledge about the prior learning of middle school students in the " Teaching Elementary School Mathematics " course. The pre-service teachers were also expected to have gained knowledge about the objectives they would create for their designs and about the place of these objectives in the curriculum in the "Middle School Mathematics Curriculum" course. In this context, the success of the pre-service teachers in these courses is important for the lesson design that the pre-service teachers are expected to do.

From the participants in the study, two groups of 4 people were formed, each group consisting of 3 female pre-service teachers and 1 male pre-service teacher. While forming the groups, it was aimed to have parallelism between the groups in terms of gender and the grades taken from the courses determined as the criteria. The distribution of the pre-service teachers and their genders across the groups is shown in Table 3.

**Table 3. Groups and gender distribution**

| Groups | Female | Male |
|---|---|---|
| Group 1 | PST1, PST2, PST3 | PST4 |
| Group 2 | PST5, PST6, PST7 | PST8 |

## Data Collection Tools

In the present study, the data were obtained from the gamified lesson design process and the products formed as a result of this process. In addition to the video and audio recordings of the entire design process, weekly reflection reports and general evaluation reports prepared by the pre-service teachers were used as data sources. With their weekly reflection reports, the pre-service teachers were asked to summarize what they did in all the phases of the design process for each session. The general evaluation reports, on the other hand, included the opinions of the pre-service teachers about the overall process and gamification. Qualitative data of the research were obtained through these sources. Whether the pre-service teachers' designs

contained the necessary elements or not was determined through the "Gamified Mathematics Lesson Checklist" developed by the researchers. This checklist enabled quantitative data to be collected in the study and in the development of the checklist, the Gamification Development Model developed by Kim et al. (2018) and the Mathematics Knowledge for Teaching that should be possessed for mathematics teaching and is defined by Ball et al. (2008) were taken as the basis. In the checklist grounded on the literature, there are 50 items subsumed under 4 dimensions. In the first of these dimensions called “Target Analysis”, there are 12 items; in the second dimension called “Design”, there are 26 items; in the third dimension called “Development”, there are 6 items and in the fourth dimension called “Implementation”, there are 6 items. The developed checklist was submitted for expert review to ensure content validity, and thus the final version of the checklist was given. Each item is scored with "1" or "0" depending on whether the process evaluated has satisfied the corresponding statement. The dimensions in the checklist and sample items from these dimensions are given below.

1. Target Analysis:
    a. Was the design suitable for having the student think about the concept focused on?
    b. Was the prior learning of students taken into consideration in the design?
2. Design:
    a. Could the story and the elements of the story answer the question “Which knowledge of mine can I use to overcome this problem?”
    b. Did the experiences lived through the dynamics involved in the design create a sense of progress?
3. Development:
    a. Were materials created for the design (digital or concrete)?
    b. Was a feedback system established for the levels included in the design?
4. Implementation:
    a. Could the gamified lesson design be implemented in the planned time?
    b. Did the design create the instructional opportunities planned during the implementation?

### Data Analysis

The qualitative data obtained from the pre-service teachers' processes of designing the gamified mathematics lesson and the product produced as a result of this process through video, audio recordings, and weekly reports were subjected to content analysis. Content analysis refers to the analysis of qualitative data in various forms (such as text, audio and/or video recordings, observation notes, interview transcripts, etc.) and interpretation and presentation of them in the most convenient way (Creswell, 1998). While conducting the content analysis in the current study, the analytical strategy defined by Creswell (1998) was used. According to this analytical strategy, all data collected are reviewed and preliminary notes are taken. Then the researcher starts the data reduction process by converting ideas and/or actions into metaphors, thus a temporary code list is obtained. Later, the data are reviewed and the code list is arranged and the related codes are collected under categories. Finally, by making a comparison with the related literature, necessary arrangements are made regarding the codes, categories, and themes and the structure obtained is visualized.

In the current study, the above-mentioned procedures were carried out using the MAXQDA 2018 Qualitative Data Analysis software. The data obtained from two different groups were first analyzed in the context of the groups, and then a construct was obtained by comparing the obtained data (codes, categories, and themes). After the process was completed, the data were rearranged and finalized by comparing with the literature. Also, 40% of the data randomly selected were examined by 2 field experts and the inter-coder reliability was found to be over 80%.

The gamified mathematics lesson designs of the pre-service teachers were evaluated through the "Gamified Mathematics Lesson Checklist". Both participants and researchers individually evaluated the designs through this checklist. The means of the scores which made up the quantitative data obtained with this checklist were calculated for each item and thus mean scores for both the sub-dimensions of the checklist and the whole checklist were found. Through the calculations made scores to be taken from both the sub-dimensions and the whole checklist, success percentages of the participants were determined.

## FINDINGS

In this section, the data that led to the emergence of the gamified lesson design model proposal for mathematics teaching aimed at the current study are presented. First, it was investigated whether the gamified mathematics lesson contents created by the pre-service teachers had the necessary design elements. Then, the design process of these course contents was analyzed and the actions taken by the pre-service teachers in the process were determined. In this analysis, the focus was not on describing how the design processes were, but on the basic principles and elements employed while producing the design. In the conclusion part of the study, based on the data in this section and the information in the literature, a gamified lesson design model proposal for mathematics teaching is presented.

One of the data sources in the study is the gamified mathematics lesson contents. These lesson contents were designed by the pre-service teachers and then implemented via micro-teaching. After the implementation, the contents were evaluated by both the pre-service teachers and researchers through the Gamified Mathematics Lesson Checklist. The purpose of this evaluation was to check whether the necessary teaching elements were included in each step of the pre-service teachers' designs and whether the basic gamification processes were fulfilled. With this evaluation, it was tried to predict the adequacy of the existing content to create a model from the gamified lesson content and the design process of this content. For example, the minimum number of things to be done in the design phase was determined to be 26 items in the checklist. Through the scores taken from these items, the adequacy level in the design dimension was attempted to be determined. In this context, the design of each group was evaluated for each measurement dimension separately and as a whole. The mean scores and success percentages of the two gamified lesson contents whose adequacies were investigated with the checklist in 4 dimensions are given below.

When the scores and percentages of the designs of the groups in Figure 2 are examined, according to the results obtained by the average of the scores of all raters in each dimension, the designs of the groups are 11.1 and 10.6 out of 12 points in the target analysis dimension; 24.8 and 22.3 points out of 26 points in the design dimension; 6 and 5.9 points out of 6 in the development dimension and 5.6 and 4.9 points out of 6 points in the implementation dimension. Looking at the total score average, it was determined that the designs got 47.5 and 43.7 points out of 50 points. When these scores are converted into percentages in each dimension and in general, it is seen that the values obtained are above 80%. This gives the knowledge that pre-service teachers' designs have a high rate of gamification and contain the necessary elements for mathematics teaching, and set the ground for the creation of a gamified lesson design model proposal for mathematics teaching based on the design process of these products and these products.

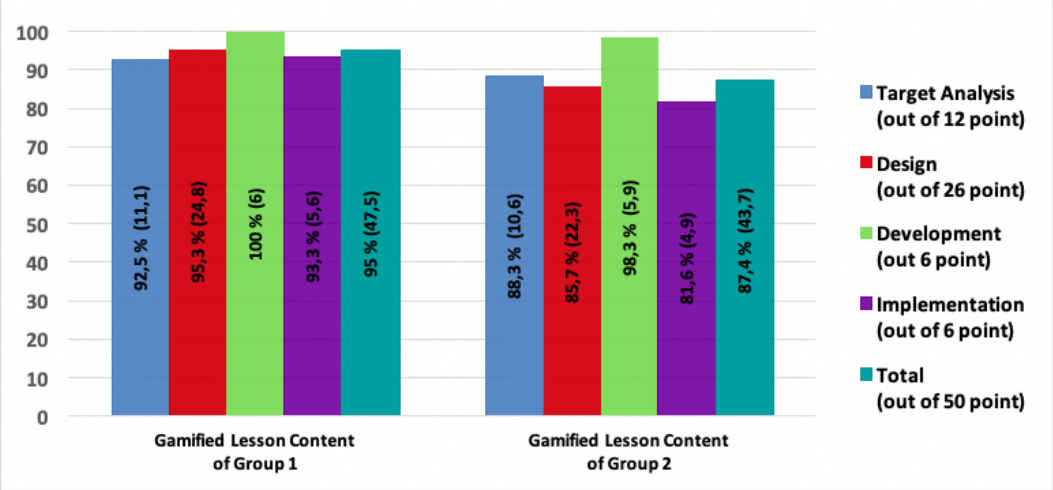


**Figure 2. Mean scores and success percentages of the pre-service teachers' designs obtained with the Gamified Mathematics Lesson Checklist**

Another data source of the current study is the processes followed by the pre-service teachers in creating their gamified mathematics lesson contents. The data about these processes were collected through video, audio recordings, and weekly reflection reports. The target analysis, design, implementation, and evaluation-improvement phases (Figure 1: Research Procedure Phases 3, 4, and 5) followed until the design reached its final form were handled and analyzed as the process of creating gamified lesson content. The phases of the Gamification Development Model (Kim et al., 2018), which formed the basis of the current study, were determined as themes because they shaped the study. These themes are *target analysis, design, development, implementation,* and *evaluation-improvement*. The codes and subcodes subsumed under these themes are given in Table 4.

**Table 4. Themes involved in the analysis of the pre-service teachers' processes of developing the gamified lesson and the codes and sub-codes subsumed under these themes**

| Themes | Codes | Sub-Codes |
|---|---|---|
| Target Analysis | Content | *Objectives*<br>*Place in the Curriculum*<br>*Concept* |
| | Learner | *Prior Learning*<br>*Misconceptions and Their Possible Causes*<br>*Common Mistakes*<br>*Student Strategies* |
| | Tools | *Concrete Materials*<br>*Information and Communication Technologies* |
| Design | Motivational Elements | *Intrinsic Elements*<br>*Extrinsic Elements* |
| | Story | *The Situation*<br>*Characters*<br>*Goals, Performance Goals, In Order to Chain*<br>*Metrics*<br>*Barriers and Conflicts* |
| | Dynamics | *Control*<br>*Predictable Unexpected*<br>*Competition*<br>*Completion*<br>*Fellowship*<br>*Other dynamics in the FunPLEX Model* |
| | Mechanics | *Rewards*<br>*Reward Schedules*<br>*Avoidance*<br>*Status*<br>*Quest* |
| Development | Mathematical Content | *Organization of Story Elements According to the Subject and Curriculum*<br>*Choosing the Appropriate Activities for Dynamics*<br>*Structuring the Mechanics According to The Subject Content*<br>*Preparing Generative Mathematical Questions* |
| | Use of Technology / Materials | *Determination of Technology and Materials Suitable for The Subject*<br>*Designing / Selecting Appropriate Technology and Materials for The Subject*<br>*Use / Selection of Subject-Specific Model and Visual* |
| | Feedback | *Designing Feedback to Show Progress*<br>*Design of Feedback to Highlight Difficulties and Errors*<br>*Design of Feedback to Provide Mathematical Explanations* |
| Implementation | Learning Environment | *Physical Preparation of the Learning Environment*<br>*Technical and Technological Preparation of The Learning Environment*<br>*Providing Materials* |
| | Duration | *Use of Duration*<br>*Completion of Sub-processes*<br>*Flow* |
| | Unexpected Situations | *Functioning of Gamification Elements*<br>*Instructional Content*<br>*Student Thoughts*<br>*Deviation from The Plan* |
| Evaluation- Improvement | Criteria | *Gamification Elements*<br>*Instructional Content*<br>*Learning Needs* |
| | Problems / Drawbacks | *Problems*<br>*Missing Aspects*<br>*Aspects That Need Improvement* |
| | Suggestions | *Suggestions for changes*<br>*Improvement suggestions* |
| | Implementation of the Suggestions | *Choosing the Appropriate one from the Suggestions*<br>*Fulfill the Suggestions* |

As can be seen in the table above describing the data analysis, the pre-service teachers were able to bring together the information they obtained from their training about gamification and their *Mathematics Knowledge for Teaching*, which includes the content knowledge and pedagogical content knowledge they have obtained in their undergraduate education. It is seen that the codes under the themes determined in the processes of creating gamified mathematics lesson contents by the pre-service teachers are not only about gamification or teaching mathematics. These codes include the amalgam of information about mathematics teaching and gamification. The sub-codes are detailed as elements included in each code.

In the target analysis phases, the pre-service teachers were asked to examine the content of the lesson they would gamify according to the *Gamification Development Model* defined by Kim et al. (2018) in the context of the target, scope, student, and learning environments. At this stage, both groups first discussed the place of the lesson content to be gamified in the curriculum. Then, they examined the objective they dealt with both between classes and at the same class level and focused on the concepts included in the outcome. With these examinations, the pre-service teachers stated that they aimed to determine the objectives that students would achieve with gamification, and that they determined which concepts and how their designs should be limited. In light of these statements of the pre-service teachers, it can be stated that they used their subject area and curriculum knowledge included in the scope of pedagogical content knowledge. In this context, a content code emphasizing the goal and scope of the design was created under the theme of target analysis, and based on the statements of the pre-service teachers, *the objectives, place in the curriculum,* and *concept* sub-codes were included. It was observed that the pre-service teachers examined the dimension of "analysis of student characteristics" in the context of the *Gamification Development Model*, without giving many details, in terms of prior learning, misconceptions, mistakes, and student strategies by using their subject area and student knowledge within the scope of pedagogical content knowledge. For this reason, *prior learning*, *misconceptions and their possible causes, common mistakes,* and *student strategies* sub-codes are included under the *learner* code.

During the design phase, firstly, with group discussions, both Group 1 and Group 2 discussed the elements that could motivate the student. Group 1 stated that they chose the feeling of *curiosity* to foster motivation in students, while Group 2 stated that they chose the feeling of *struggle*. One of the members of Group 1, PST4 emphasized the importance of curiosity by stating that *"If there is no curiosity, the student does not want to continue through the process. The next step, the next part of the story or the next action should make them feel curious."* In the discussion conducted by Group 2, all the group members emphasized the importance of the sense of struggle and in this regard, one group member PST6 stated that *"Who does not want to win?, think about it, you are progressing through a process getting gradually more challenging; you want to be successful, even to manage the more difficult; this motivates the student."* while another member of Group 2 PST7 said the following; *"It is not enough to be successful; it is necessary to show this, such as points, badges. A student can even stay in the process just to get all the badges."* From these discussions of the pre-service teachers, motivational elements and this motivation's being intrinsic (such as sense of curiosity, struggle) or extrinsic (such as points, badges) were determined as sub-codes.

In the story design, the story template proposed by Kapp (2013) for gamification was taken as the basis. Kapp (2013) stated that in the design of gamification in education and instruction, a goal-based story should be designed and the following elements should be included in this story: *the situation, characters, goals, performance goals, in order to chain, metrics, barriers and conflicts, control,* and *predictable unexpected*. These elements can be briefly explained as follows:

- *The Situation* refers to the existing conditions
- *Characters* refers to the roles that can be taken by students in the story
- *Goals* refers to the point aimed to be reached in the gamified process within the context of the story
- *Performance Goals* refers to the sub-targets that should be achieved to reach the main target in the story
- *In order to Chain* refers to the fulfillment of the previous goal to be able to accomplish the next goal to progress and reach the target
- *Metrics* refers to the indicators of success; indicators showing whether the target has been reached
- *Barriers and Conflicts* refers to elements that make the story exciting and it difficult for the character to reach the target
- *Control* refers to what the character can do in the story and his/her limitations
- *Predictable Unexpected* refers to events that are expected to happen in the story but are unexpected for the character.

The pre-service teachers designed stories that included these elements in the design process. For example, Group 2 summarized the story elements they formed as a result of the group discussions in their weekly reports as follows:

*"The Situation: The people of Cibutta change their country's borders every night to protect it from enemy attacks. The week in the country consists of 6 days and the borders of the country change to one of 6 geometric shapes every night without changing the surface area.*

*Characters: You, as a night watchman, will draw the borders of the country every night.*

*Goals: The main objective of the watchman is to draw the country in an appropriate geometric shape, without distorting the surface area.*

*Performance Goals and In order to Chain: The country should be rectangular on day 1, square on day 2, parallelogram on day 3, triangle on day 4, rhombus on day 5, and trapezoid on day 6. In order to move on to the next day, it is necessary to draw the shape correctly that night.*

*Metrics: The indicator of success is that night turns to day, resulting from correct drawing. For each correct drawing, a certain amount of gold will be deposited on the watchman's account.*

*Barriers and conflicts: The drawing process must be completed within the specified time at night. Otherwise, there will be a decrease in the surface area of the country and certain structures will be lost. For these structures to be rebuilt, a reduction will be made from the wage of the watchman.*

*Control: The watchman has no other way of fighting enemy attacks. The only action that can be taken is to draw the borders of the country by making the necessary calculations.*

*Predictable unexpected: To prevent the enemy attack, the match between the day and the shape planned for that day can be changed by the state and the new plan must be followed."*

In the design of the dynamics, the elements of the FunPLEX model (Kim, 2013), which are expressed as struggling, completion, and stakeholder experiences and experiences that provide entertainment to the individual, were suggested to be included in the gamification during the gamification training. For example, Group 1 stated that in the story that they designed as including a group of mathematicians who would determine the boundaries of the fields after the flood of the Nile in Ancient Egypt, and that students would work together as mathematicians and would experience cooperation. Also, the same group stated that the success achieved by measuring all fields with the elements they included in the story would provide students with feelings and experiences such as complementing and relaxation, exploring by working in different regions, and competition with other mathematician groups.

In the design of mechanics, the groups were asked to include mechanical elements compiled by Kim et al. (2018) from the literature in their designs. Kim et al. (2018) mentioned the existence of many mechanical elements and classified these elements according to their intended use. This classification is as follows: *rewards, reward schedules, avoidance, status,* and *quest*. In this context;

- *Rewards* refers to elements to be given in return for success
- *Reward Schedules* refers to the frequency and amount of rewards
- *Avoidance* refers to the elements that will lead to rewards loss
- *Status* refers to the leader boards to be formed based on the received rewards, rankings, or the factors that will make people superior to others.
- *Quest* refers to the works to be completed to receive rewards.

However, there are dozens of different mechanical elements within these mechanical classes. For example, rewards include many different types of rewards such as mechanic class badges, points, levels, progression, virtual items, physical items, virtual money, and jewels. Considering all these, the pre-service teachers were asked to choose and include the mechanical elements from these mechanical classes in their designs that would be appropriate for their designs. Below is given the discussion between the members of Group 2 about their design:

*PST8: "There is a shape specified for each night; 6 shapes for 6 nights. Then, let's take them as our levels; there are 6 levels. The wage they get at the end of each night is kind of the point. It's okay so far, isn't it?"*

*PST5: "Yeah I think we can give badges to those who draw fast. He/she can even turn this badge into a wage if he/she wants."*

*PST6: "Then let's not forget that there will be a reduction from his/her wage to compensate for the loss of land. Will he/she earn the same amount of wage every day?"*

*PST8: "Yes, but as the level progresses, I think the reduction to be made when they make mistakes should be increased."*

*PST7: "I think we need to show the wins and reductions in a table. So, we can see their state compared to others."*

When the above-given discussion is examined in terms of the mechanical elements defined by Kim et al. (2018), it is seen that the group included elements such as levels, points, and badges as rewards and that they planned to give these rewards at fixed rates and fixed intervals within the context of the reward schedule. They also included a table of earnings as status and wage reductions as avoidance in case of failure. Finally, they determined the quest by establishing a structure defined as locked content where the countdown takes place and one step cannot be passed before the next step has been completed.

The groups that worked intensively on gamification elements until the development phase continued their designs with the integration of mathematical content in this phase. Both groups, based on the report they had prepared in the target analysis, focused on the targeted objective again. From the target analysis phase, Group 1 addressed the objectives of "determines the diagonals, interior and exterior angles of polygons; calculates the sum of interior angles and exterior angles" in the "Polygons Sub-Learning Area" in the 7$^{th}$ grade and Group 2 addressed the objective of "Solves problems related to the area". Within the context of these objectives, they matched the performance objectives with the outcome objectives in their stories, and they prepared problems considering the sequencing in the curriculum and prior learning of students to be presented from easy problems towards difficult problems. The discussion carried out by Group 2 in the development phase shows that the pre-service teachers used their *Mathematics Knowledge for Teaching* (curriculum, student, etc.) and their knowledge about gamification together and resulted in the coding of the actions performed as "*Organization of story elements according to the subject and curriculum*".

*PST5: "In the story design, we already set performance goals as a geometric shape for each day. According to our plan, we will give a problem that includes the geometric shape determined in each performance objective."*

*PST6: "Consider the curriculum, in the 5$^{th}$ grade, he/she learns to calculate the area of the square and rectangle. The area of a triangle and parallelogram in the 6$^{th}$ grade; the area of a rhombus and trapezoid in the 7$^{th}$ grade … So, we can say that it is easiest for the student to calculate the area of a rectangle. For the student, starting the level with the easy ones was also important in terms of gamification. Thus, we will set the first performance goals; that is, the first-night borders of the country as rectangular."*

*PST8: "Namely, he/she will solve the problem of a rectangle to draw the borders of the country."*

In the process, within the other phases of the model, the pre-service teachers' design processes, discussions, research, examinations, and actions were analyzed. The pre-service teachers used their *Mathematics Knowledge for Teaching* intensively in the target analysis phase, their knowledge of games and gamification in the design phase, and both types of knowledge in the development, implementation, and evaluation-improvement phases. By following the systematic in the examples given above, these types of knowledge and the way they were used were determined with codes and sub-codes, and Table 4 was created.

In addition to the data obtained, the general evaluation reports written by the pre-service teachers at the end of the process were analyzed. In these reports, the pre-service teachers summarized the processes of developing gamified mathematics lessons content. When the general structure of this process was examined, it was seen that the pre-service teachers stated that the process of designing gamified mathematics lessons had a spiral structure and that they should use their knowledge of gamification and teaching mathematics in this structure. When the statements of the pre-service teachers in their general reports and the actions they had undertaken were examined, it was seen that while the actions undertaken at each phase laid the foundations of the other phase, there was a need for arrangements and additions in the dimensions of gamification and mathematical content in each phase. The statements of PST2, PST4, and PST7 regarding this process are given below:

*PST*2: *"When I think about the whole process we designed, I can realize that we established a huge system by starting with what we would teach from the very basic, what kind of mathematical content we would use at the beginning. We designed the story and mechanics and blended them with our objectives. We always updated something until we arrived at the implementation phase. For example, we did not consider prior learning in the target analysis phase; we realized this while writing the story because we had to establish the chain of goals. Our design process was very active and some improvements continuously occurred in each phase. We both took what we did before into consideration and eliminated our past shortcomings as we progressed."*

*PST*4: *"It is impossible to separate the story, dynamics, and mechanics from each other. Even if you try to do this, it requires going back and revising them as the design progresses. When we integrate the mathematical content, a design that is built on top of each other and is constantly updated emerges."*

*PST*7: *"It was necessary to carry out the whole process by connecting its parts. We combined the mechanics we determined with mathematical content in the next phase. In this phase, we shouldn't ignore students' knowledge. The relationship between all these had to be considered at every step."*

## CONCLUSION

A gamified lesson design model proposal for mathematics instruction was put forward by conducting educational design research in the present study. The study aimed to make the gamification development process given in the literature specific to the field. To this end, the *Gamification Development Model* defined by Kim et al. (2018) and *Mathematics Knowledge for Teaching* (Ball et al., 2008) were brought together both in theory and in practice with pre-service teachers' designs by using the educational design model. The data obtained from the pre-service teachers' gamified lesson design processes were analyzed by using theory and the themes, codes, and sub-codes given in Table 4 were reached. Themes formed the design steps; codes and subcodes formed the design principles. The data obtained from this process revealed the relationship between the *Gamification Development Model* and *Mathematics Knowledge for Teaching*, and as a result, a gamified lesson design model proposal for mathematics instruction was developed.

The proposed model has a spiral structure due to the design process's nature (Figure 3). This structure shows that each next phase was built on the previous phase. However, the transition between these phases was intermittent and not rigid. On the contrary, each phase developed and changed with what was done in the previous and/or next phase. Thus, the design became dynamic and variable, providing flexibility to the design. As a result of the data collated from the review of the literature on gamification and the data collected from the pre-service teachers' gamified lesson design processes, the phases of the gamified lesson design process for mathematics instruction and the design principles involved in these phases can be expressed as follows:

1. ***Target Analysis:*** It is the phase in which educational and instructional needs are determined. In this phase, the levels of learners at the beginning of the process and their expected / targeted levels should be examined from various perspectives. This phase includes three sub-stages.
    a. *Investigation of instructional content:* It entails the customization of the instructional scope of the design. For this, the subject/objective of the lesson to be gamified should be determined. It is also necessary to reveal the vertical and horizontal placement of this objective in the mathematics curriculum and determine the concepts covered by the objective and the relationship of these concepts with other concepts. These data will be effective in determining the points, subjects, and mathematical concepts that gamification design should focus on.
    b. *Analysis of learner characteristics:* An instructional designer must have certain knowledge about the learner. While performing gamification design, learners' prior learning about the mathematical subject, common mistakes, misconceptions, knowledge of situations that can cause these mistakes, and learning strategies should be taken into

consideration. Besides, the general characteristics of learners (age, gender, etc.) should be known and reflected in the design.

c. *Examination of the tools-equipment to be used in the instruction:* Concrete materials and information and communication technologies suitable for the subject should be determined before the design process. In this sense, concrete materials and information and communication technologies that can be included in the design should be examined in the context of the opportunities they will provide in the teaching of the subject.

2. ***Design:*** This phase refers to the design of gamification elements. How students will be motivated and how the story, dynamics, and mechanical elements will be included in the design are determined in this phase.

   a. *Determination of motivational strategies:* Motivation is of great importance for learners to participate and stay in the process. For this reason, what the intrinsic and extrinsic motivations of learners are, the factors affecting motivation, and learning theories related to motivation should be examined. Then, it should be determined how these elements of motivation will be included in the design.

   b. *Design of the story (optional):* The existence of the story element is optional in the gamification design process. However, if the story element is to be included in the design, the designed story must have the goal-based scenario elements. These elements include the situation, characters, goals, performance goals, in order to chain, metrics, barriers and conflicts, control, and predictable unexpected. Moreover, the elements included in the story should allow the learner to find answers to questions the learner will ask himself/herself such as “Why is it important to achieve this?”, “Which problem can I solve with this knowledge?”, “Which knowledge of mine should I use to solve this problem?”, “Where did I make a mistake and how can I correct it?”.

   c. *Design of the dynamics:* Dynamics refers to the feelings and experiences that learners will be engaged in during the process. These feelings and experiences should motivate learners and keep them engaged. In this context, dynamics such as competition, completion, and fellowship that are directly related to the motivation of learners should be included in the design.

   d. *Design of the mechanics:* The main purpose of mechanics is to create tools for experiencing dynamics. In other words, mechanics are the toolbox of the gamification process. The mechanics that define rewards, status, and the quest should be included in the design.

3. ***Development:*** It is the phase where the mathematical content is integrated by considering the target analysis and the design phase. In this phase, the scope of the subject that the design focuses on can be narrowed or expanded or the things done in the design phase can be updated. In these updates, the mathematics curriculum should be taken into consideration, and the subject/concept should be examined horizontally and vertically in the curriculum. In particular, level mechanics should be structured by considering these examinations and student knowledge. Following the operations made by focusing on the curriculum and learner characteristics, the information and communication technologies and/or concrete materials that will contribute to the provision of effective mathematics education should be determined, employed, or developed. Finally, the feedback system that will help students evaluate their progress, difficulties, and mistakes and will present the mathematical knowledge and explanations to be required by students in the implementation phase of the gamified lesson content should be constructed and thus the design should be finalized.

4. ***Implementation:*** It is the transfer of the developed gamification project to the learning environment. For this, first of all, the learning environment should be prepared for implementation. Then learners, instructional designers, and/or teachers should participate in the implementation phase and experience the gamification project. Attention should be paid to the duration planned for the implementation of the project and the flow that can be defined as the progress of the operations. In addition, unexpected situations related to instructional content and/or gamification elements should be addressed and resolved instantly by capitalizing on the information on teaching mathematics and gamification. All this implementation process should be videotaped to capture the opportunities for evaluation and improvement, and it should be supported with field notes to be taken by the implementer.

5. ***Evaluation-Improvement:*** It is the evaluation and improvement of the gamification elements and instructional content with the data obtained in the implementation phase. First of all, evaluation criteria that take into account the objectives of the design such as whether the gamification elements are working, their deficiencies, the extent to which the instructional design meets the learning needs should be determined. Tools such as checklists and rubrics based on these criteria should be created/selected and evaluated. After the completion of the evaluation, instructional designers and practitioners should identify the problems and offer solutions. Finally, the design should be finalized by reflecting the solution suggestions to the design.

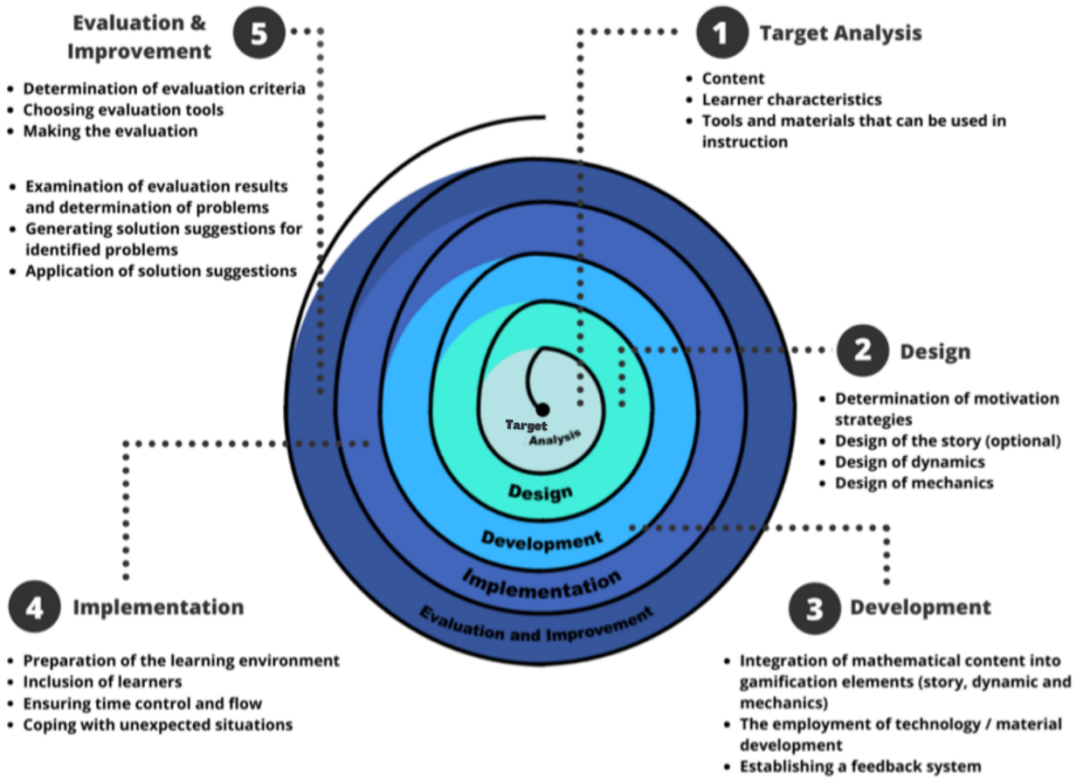


**Figure 3. Gamified lesson design model proposal for mathematics teaching**

## DISCUSSION AND RECOMMENDATIONS

When the literature is reviewed, it is seen that many studies define gamification, explain the elements and functions of gamification or present examples of gamification. However, it is seen that studies on gamification in the field of education are limited; one of the reasons for this is that gamification is a new subject in the field of education. This naturally leads to the emergence of limited studies in the literature in which principles for the design of gamification in education are determined. Although researchers such as Kim et al. (2018) and Reiners and Wood (2015) have determined design principles for the development of gamification in the education dimension, these models need to be customized in various fields such as mathematics, foreign languages, and science because they form a general framework. Given that each field has its unique structure, learning and teaching processes, and differences from other fields, different methods such as gamification should be made specific to the field. Considering that the focus of the current study is mathematics education, it is a necessity to create a gamified lesson design model for mathematics instruction due to the specific requirements of this field.

With all these in mind, the current study proposes a new and detailed gamified lesson design model for mathematics teaching. This model includes field-specific design principles for teachers and instructional designers. While determining these design principles, the teacher knowledge model named *Mathematics Knowledge for Teaching* (Ball et al., 2008), which has a major role in the design and implementation of a lesson, the *Gamification Development Model* (Kim et al., 2018), which provides a general framework for the development of gamification, and the gamification development processes the pre-service teachers were involved in in the current study were taken as the basis. The emerging model proposal includes field-specific elements for design as different from the extant gamification development models in the literature. The model proposal, whose structure and general outline are given in Figure 3, is expected to contribute to the field of mathematics teaching, especially with the guiding principles it offers and gamified lesson design examples to be created through these principles. Given that the motivation, participation, and success of learners increase in the teaching environments where gamification is used (Çağlar & Kocadere, 2015; Begosso et al., 2018; Dominguez, Saenz-de-Navarrete, de-Marcos, Fernández-Sanz, Pagés, & Martínez-Herráiz, 2013; Considering Foster et al., 2012; Haman et al., 2018), designs that can be created with the model presented by the current study can offer similar contributions to the literature.

Moreover, as the model proposal put forward in the current study is based on *Mathematics Knowledge for Teaching*, it emphasizes teacher duties and teacher knowledge. By trying to include the elements that a teacher should focus on while designing a lesson (such as student knowledge, teaching knowledge, and curriculum knowledge) in the model, it was aimed that

teachers should pay attention to these elements while designing a gamified lesson. The Target Analysis, which is the first phase of the model, by focusing on the student, content, and tools before the design, was attempted to draw attention to the very basic but necessary elements for effective mathematics teaching. In other phases, it was aimed to make a correct integration by fulfilling the special requirements of mathematics teaching and to increase the quality of the created gamified mathematics lesson.

Two main factors are affecting the shaping of this model proposed in the present study. The first of these elements is the pre-service teachers' Mathematics Knowledge for Teaching emphasized above. The control of the content and pedagogical content knowledge of the pre-service teachers involved in this type of knowledge was made with the courses they took during their undergraduate education. The second element is the pre-service teachers' knowledge about gamification. This knowledge was provided by the training given by the researchers. However, it should not be forgotten that the lack of these two elements will affect the designs. Although the model created emphasizes what knowledge teachers or instructional designers should have, the level of this knowledge is important in shaping the designs. In this context, it is thought that the quality of designs can be enhanced with evaluation tools such as checklists and micro-teaching practices. Moreover, as can be seen in Figure 3, the end of the model has been left open, and if necessary, after the evaluation and improvement phase, the sixth and seventh phases can be added as re-implementation, re-evaluation, and improvement. It is thought that these phases to be added may be effective in eliminating the problems and/or deficiencies caused by various reasons.

Finally, the emphasis on information and communication technologies is very limited in the model. In the design process, although they focused on information and communication technologies for teaching the subject and the use of these technologies, the pre-service teachers expressed their concern that the technological infrastructure of the institutions they would teach in the future would be weak. In line with these concerns, they emphasized the role of concrete materials and teachers, rather than digital platforms, especially in the implementation process. However, although they expressed their thoughts that in-class interaction would be stronger after the implementation, they stated that the whole process could be transferred to a digital platform and the process could be easier in terms of classroom management in the digital environment. The opinion of PST4 regarding the inclusion of information and communication technologies in the design is as follows:

> *PST4: "When we started designing, I thought we could make everything digitally. I even researched Web 2.0 tools that I could use after the lesson. But while working with my friends, we realized that such a design requires a computer and internet connection for all students. Considering the schools, we are doing our practicum teaching now, this seems to be impossible even in big cities of Turkey because of the poor infrastructure of schools. What we did would be unrealistic when we thought that the places where most of us would be appointed would be small cities. Therefore, using concrete materials and building the structure controlling and guiding the process over the teacher made it more logical and feasible. But it would have been easier for the teacher to carry out the process if the infrastructure had been more suitable."*

Although the pre-service teachers' thoughts are parallel to the studies in the literature (Denmeade, 2015; Gachkova, Somova, & Gaftandzhieva, 2020), many researchers have emphasized digital platforms and teaching management systems where gamification can be carried out and their benefits (Pastor-Pina, Satorre-Cuerda, Molina-Carmona, Gallego-Durán, & Llorens-Largo, 2020; Zaric, Gottschlich, Roepke, & Schroeder, 2020). In this context, the Design, Development, and Implementation phases of the model can be carried out through learning management systems such as Moodle, which can enable the creation of gamification designs.


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## Statements of publication ethics

We hereby declare that the study has no unethical issues and that research and publication ethics have been observed carefully.

## Author contribution statements

This study was prepared from the first author's PhD dissertation under supervision by the second author. For this reason, the study was conducted and reported with equal collaboration of the researchers.

## Ethics Committee Approval Information

This study was prepared from the first author's PhD dissertation and the dissertation has ethical approval.

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