

# Gamification of E-Learning Apps via Acceptance Requirements Analysis

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**Keywords:** Requirements Engineering, Acceptance Requirements, Gamification, Goal Models, Goal Modeling Analysis, Software Engineering.

**Abstract:** In the last few years, and particularly during and after the COVID-19 pandemic, E-Learning has become a very important and strategic asset for our society, relevant both for academic and industry settings, involving participants ranging from students to professionals. Different applications have been developed to support E-Learning to be an effective tool, particularly in relation to the software engineering and programming areas. However, in order to be effective, in particular within academic settings, such tools require students to be continuously engaged and motivated to learn both practical and theoretical aspects. The integration of gamification in educational environments has gained considerable prominence as a potential mean to augment students' motivation and involvement, providing them with immediate feedback and reinforcement, bolstering their sense of accomplishment and motivation to persist in their studies. However, to design gamified applications that can effectively engage and motivate users, as the literature has demonstrated, it is required to consider psychological, sociological, and human behavioural aspects, often referred to as Acceptance Requirements. This study presents a case study, where a Goal Modeling-based, Systematic, Acceptance Requirements Analysis and Gamification Design process, has been applied, by using the Agon framework, to prototype a gamified tool, aiming at engaging students towards learning both theory and practice related to a "Web-Based Mobile App Development" university module. To evaluate our proposed prototype, students were involved to use our proposed gamified prototype. The results show that our gamification solution can engage and motivate students towards learning both theoretical and practical aspects of the module.

## 1 INTRODUCTION

With the increasing demand for technology-related skills in the workforce, computing courses have gained significant popularity among students. However, despite this surge in enrolment, critical challenges persist in the form of student participation and engagement during the learning process. Studies reveal that educators in schools and universities grapple with this issue, striving to enhance students' involvement in their educational journey (Saleem et al., 2022; Toda et al., 2019; Zainuddin et al., 2020). In computing studies, students exhibit noticeable lack of interest and engagement in the theoretical aspects (Saleem et al., 2022; Toda et al., 2019; Zainuddin et al., 2020).

The effectiveness of teaching methods employed

by educational institutions plays a pivotal role in shaping students' engagement. The recent introduction of Gamification and E-Learning applications, as additional tools to "more traditional" educational approaches, offers potential for increasing user engagement (Saleem et al., 2022; Zainuddin et al., 2020; Andrade et al., 2020). When teaching methods are engaging and effective, students are more likely to be motivated and interested in learning. Conversely, ineffective approaches may lead to disinterest or disengagement among students, undermining the learning experience (Toda et al., 2019; Ding et al., 2018; Ge, 2018). Owing to the practical nature of their courses or modules, many computer science students tend to concentrate primarily on hands-on experiences, overlooking a thorough understanding of the theoretical

aspects. They may perceive practical learning as more enjoyable, and engaging, while traditional lectures, or classroom activities, aimed at theoretical comprehension, may seem less appealing (Zainuddin et al., 2020; Kyewski and Krämer, 2018).

This paper aims to address the crucial need of offering a balanced approach to learning, by effectively engaging students in both theoretical and practical aspects of their computing modules, via Gamification and E-Learning applications. Furthermore, in order to address that, educators, as designers of such applications, need supporting strategies, frameworks and processes enabling them to analyse, design, and prototype such applications in a way that can effectively engage and motivate the student.

To achieve such goals, we consider the concept of “Gamification”, and the usage of related supporting analysis and design frameworks. Gamification involves the application of “game design elements and principles to non-gaming contexts” to enhance engagement, motivation, and learning outcomes (Zichermann and Cunningham, 2011; Deterding et al., 2011; Bassanelli et al., 2022). Various studies have demonstrated positive impacts of gamification elements, such as points, badges, and leaderboards, on students’ motivation and involvement (Bouchrika et al., 2021; Kyewski and Krämer, 2018; Yildirim, 2017; Ding et al., 2018). Primary objective of gamifying education is to make learning experiences more enjoyable and stimulating for students. Gamification can enhance students’ enjoyment and intrinsic motivation in the learning process (Saleem et al., 2022; Bouchrika et al., 2021).

In summary, different gamified E-Learning applications have shown promising results (Saleem et al., 2022; Bouchrika et al., 2021). Therefore, integrating gamification principles into E-Learning applications for education has the potential to create a more dynamic and interactive learning environment, further engaging students, and bridging the gap between theoretical knowledge and practical application. However, to create effective gamified software it is necessary to consider not only the “pure” technological and technical aspects, but also human science crucial areas such as psychological, sociological and human behavioural (Simperl et al., 2013; Zichermann and Cunningham, 2011; Deterding et al., 2011; Piras et al., 2017a). Moreover, it is necessary to identify the most suitable engagement strategies to implement within the software functionalities (Piras et al., 2016a; Piras et al., 2017a; Zichermann and Cunningham, 2011). Accordingly, this paper aims: **(i)** to address the crucial need for a balanced approach to learning, by effectively engaging students in both the-

oretical and practical aspects of their computing modules, and **(ii)** to individuate strategies for supporting the creation of tools able to encapsulate and foster such approaches. In this work, we identify and apply effective processes towards a systematic requirements analysis and design, which can support the designer in considering all the relevant aspects involved when creating such solutions.

In line with the aims outlined above, we considered a relevant computer science university module, titled “Web-based Mobile App Development”, and we individuated the next Research Question (RQ):

**RQ1.** How can we design a gamified solution, for a “Web-based Mobile App Development” university module prototype, able to engage and motivate students towards learning both theoretical and practical aspects of the module?

To answer **RQ1**, we performed a case study carrying out a systematic acceptance requirements analysis, using the Agon framework (Calabrese et al., 2022; Piras et al., 2020; Piras, 2018), for designing and prototyping a gamified E-Learning tool, to foster engagement and learning of the module (**RQ1**). We performed different phases: **(i) Context Characterisation.** Initial research steps with literature review for context characterisation, plus questionnaires (to students) to characterise the users to engage, and to collect the input required by the Agon Framework. **(ii) Acceptance Requirements Analysis and Gamification Design.** Based on the context information collected, analysis and design of a gamification solution for the module, by using the Agon framework. **(iii) Prototyping.** Based on the Agon gamification solution, prototype creation of the gamified E-Learning app for the module. **(iv) Prototype Evaluation.** Involvement of students for using the resulting gamified prototype, and evaluation via observations, and questionnaires to compile, in relation to their experience with the prototype. Evaluation results show that our gamification solution can engage and motivate students towards learning both theoretical and practical aspects of the module.

The rest of the paper is organised as follows: section 2 outlines background and initial research steps (according to point **(i)** above). Section 3 describes the acceptance requirements analysis and gamification design we performed by using the Agon framework, to design our gamification solution (point **(ii)** and **(iii)** above). Section 4 discusses our case study, evaluation, and results (point **(iv)** above). Section 5 outlines related works. Section 6 concludes the paper.

## 2 BACKGROUND AND INITIAL RESEARCH STEPS

In this section, we first outline relevant studies and concepts related to gamification of E-Learning apps; then, we list lessons learned on contextual aspects and gamification elements to consider when gamifying E-Learning apps. Such concepts are useful as contextual information to use as input for the Agon framework, and for analyst's decisions to take for the acceptance requirements analysis based on gamification, which we illustrate in section 3. In the last subsection, we discuss the Agon framework and motivations concerning its use within this work.

**Gamification of E-Learning Apps and Lessons Learned.** In recent years, gamification has been increasingly used in education as a mean to elevate student motivation and engagement as it holds the potential to combat disengagement among computer science students and improve their overall learning outcomes (Yildirim, 2017; Toda et al., 2019; Toda et al., 2019; Ge, 2018). Numerous studies underscore positive impacts of gamification elements like points, badges, and leaderboards on student motivation and engagement (Bouchrika et al., 2021; Kyewski and Krämer, 2018; Yildirim, 2017; Ding et al., 2018). Primary goal of integrating gamification in education is to enhance learning experience, making it more enjoyable and stimulating for students. This approach also increases students' enjoyment and intrinsic motivation (Saleem et al., 2022; Bouchrika et al., 2021). A key gamification advantage is its immediate feedback, which students find beneficial for understanding their progress and staying motivated to learn (Bouchrika et al., 2021; Toda et al., 2019). Gamification offers promising solutions to combat student disengagement and improve learning outcomes (Zainuddin et al., 2020; Calabrese et al., 2022; Piras et al., 2020; Piras, 2018). Incorporating gamification elements helps educators to cultivate environments conducive to higher engagement, motivation, and collaboration (Ding et al., 2018; Ding, 2019).

The gamification of education has become a popular strategy to enhance student engagement and motivation (Ge, 2018; Zainuddin et al., 2020). Six primary game design elements have been identified, drawing insights from existing systems and literature reviews (Saleem et al., 2022; Pedreira et al., 2015; Hamari et al., 2014). **(a) Points:** Points serve multiple purposes in educational applications, recognising student progress and providing feedback which award points upon completing tasks or lessons. **(b) Badges:** signify accomplishment and act as a tool to sustain mo-

tivation and competition. **(c) Progress Bars:** they encourage users to complete activities and track their progress, reminding them of their achievements and how far they have come. **(d) Levels and Stages:** motivate users to advance and fosters competitiveness. **(e) Social Leaderboards:** list individuals with the highest scores, encouraging users to complete tasks and boosting engagement. They create a competitive environment, driving students to work harder to climb the ranks. **(f) Rewards:** used to engage and motivate students. They have proven to be a successful approach to encourage learners. Such game items can significantly impact students' motivation and engagement in educational contexts. Incorporating such elements in e-learning apps, educators can create a more interactive and stimulating learning environment, fostering greater students' interest and involvement.

**Gamification Frameworks and the Acceptance Requirements Framework: Agon.** The selection of an appropriate gamification framework is crucial for conducting an effective analysis and designing a successful gamification solution. In the literature, it was observed that most gamification frameworks only partially address essential aspects related to participant characterisation and fail to adequately consider acceptance and social aspects while operationalising and selecting gamification strategies to engage users (Ge, 2018; Ding et al., 2018; Toda et al., 2019). In light of the identified gaps and of the need for a comprehensive acceptance requirements analysis, the Agon Framework (Calabrese et al., 2022; Piras et al., 2020; Piras, 2018) emerged as a candidate solution. Agon is composed of: **(i) Acceptance Meta-Model (AM):** which gathers user needs (requirements), enabling the analyst to identify factors and strategies from human sciences (e.g., Psychology, Sociology, Human Behaviour, Organisational Behaviour, etc.) which can encourage the target user to embrace and utilise a software system. **(ii) Tactical Meta-Model (TM):** allows the analyst to identify tactical goals as refinements for needs selected in AM. **(iii) Gamification Meta-Model (GM):** provides the analyst with readily available game design solutions, which translate tactical goals and, consequently, the needs chosen within the higher-level models (AM and TM).

The Agon Framework is a framework capable of performing a systematic acceptance requirements analysis specifically based on game principles and strategies (Calabrese et al., 2022; Piras et al., 2020; Piras, 2018). Furthermore, to the best of our knowledge, there are no other frameworks, at the requirements analysis level, which can support (as Agon does) the analyst by providing him with a systematic

acceptance requirements analysis based on gamification. In fact, most of the other gamification frameworks/engines/languages offer support mainly at the development and architectural levels (Herzig et al., 2013; Herzig et al., 2012; Sripada et al., 2016). Moreover, Agon has demonstrated successful application in various EU research projects and case studies, highlighting its practicality and effectiveness (Calabrese et al., 2022; Piras et al., 2020; Piras, 2018).

Accordingly, the decision to adopt the Agon Framework for this research is well-founded given it supports a complete acceptance requirements analysis (Egbikuadje et al., 2023a). Using the Agon Framework, designers holistically address participant characterization, acceptance, social aspects while strategically selecting game strategies to engage users, a successful gamification solution tailored to specific needs and preferences of the target audience (Calabrese et al., 2022; Piras et al., 2020; Piras, 2018).

In the next Section, we discuss briefly most important phases of the systematic Acceptance Requirements Analysis based on Gamification supported by Agon. Same phases had been applied within the case study of this paper, and are discussed in detail in section 3.1.

### 3 ANALYSIS AND DESIGN OF A GAMIFICATION SOLUTION FOR A WEB-BASED MOBILE APP DEVELOPMENT MODULE

The Agon framework encapsulates a wide range of gamification elements and strategies; this makes it a supporting tool for performing acceptance and gamification analysis and for designing gamification solutions enhanced with motivation and engagement aspects (Calabrese et al., 2022; Piras et al., 2020; Piras, 2018; Deterding, 2012; Bassanelli et al., 2022).

In the next, we summarise most important analysis and design phases we performed using the Agon framework to gamify a “Web-Based Mobile App Development” module as a E-Learning mobile app.

#### 3.1 Acceptance Requirements Analysis and Gamification Design Based on Goal Modeling

The use of Agon and its goal models (Piras et al., 2017b) provided essential guidance for the prototype design, allowing the integration of gamification elements and meeting users’ needs and preferences. We

had 12 participants, (3rd year) IT BSc students (at Middlesex University London, UK). Full models obtained within the analysis are available at (Egbikuadje et al., 2023a) while original full models of Agon are available at (Piras et al., 2016b).

#### Context Model Instantiation and Acceptance Requirements Analysis.

In terms of instantiating the context model of Agon, according to characterisation of our participants, most of the Users were male and young (18-25 years old) (Egbikuadje et al., 2023a). In examining student preferences and characteristics within the context of the gamified Web-Based Mobile App Module, most students exhibited traits of achievers and explorers, demonstrating a desire to explore various technologies while striving for success (Piras, 2018). Notably, many students are not currently employed. Regarding acceptance factors, participants possessed a high level of expertise and willingly engaged with the module, which is optional. The presence of existing e-learning platforms indicates competition within the domain. Communication effectiveness in conveying messages is high, yet user participation in defining goals is lower. However, goal clarity is deemed high due to participants’ familiarity with the module. Task variety is low but specificity and identification levels are high, reflecting participants’ specific skills and keen interest in achieving favorable outcomes. The social structure is hierarchical, with limited interaction expected among students, and potential engagement with the lecturer. The nature of the good being produced is considered a private good, as students use the app to enhance their knowledge and acquire personalized skills for individual growth.

By using the instantiation of the Agon context model (Egbikuadje et al., 2023a), acceptance analysis has progressed, enabling the identification of acceptance needs to be addressed by our gamification solution. A relevant example will be covered below. As

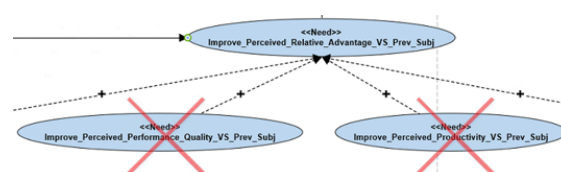


Figure 1: Example from the Acceptance Requirements Analysis model; full models at (Egbikuadje et al., 2023a).

for analysts’ decisions, we want a gamified app that’s quick to use (because students have different parallel modules), and more effective in improving their learning for both theoretical and practical aspects. Those are refined in the Acceptance Goals of Agon.



**Acceptance Requirements Refinement and Tactical Goal Decisions.** Based on acceptance needs proposed by Agon and by our analyst's decisions, Agon identified Tactical Goals (Egbikuadje et al., 2023a), to refine our acceptance requirements. The goal is to favour deeper strategies concerning support on skill improvement, then support on minor assistance due to the topic importance.

**Context-Based Operationalisation via Gamification.** Based on acceptance needs, and tactical goals identified, Agon automatically suggested *Training Elements* strategies and concepts to consider for the design of our gamification solution. This is because, even though that is a game strategy useful for other domains, we do not want to provide the possibility to skip quickly important learning parts. Students should achieve related knowledge through gamification strategies suggested by Agon.

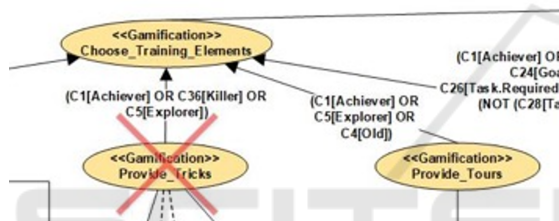


Figure 2: Example from the resulting Gamification Model; full Agon models available at (Egbikuadje et al., 2023a).

### 3.2 Gamified Prototype

Based on the acceptance requirements analysis and gamification design performed by using Agon, we had been able to create a gamified prototype, available at (Egbikuadje et al., 2023b), and described in the next. Our application incorporates Agon's concepts (Piras, 2018) to stimulate user motivation and engagement in educational contexts. Focusing on game elements, progress tracking, interactive challenges, and social interaction, the app design aims to provide an enjoyable and effective learning experience. The prototype illustrates key components of the learning experience, offering detailed curriculum information and enabling the exploration of various topics (Fig. 3). The app encourages consistent learning via streaks and rewards users with points for attending lectures regularly, fostering social interaction via user reviews and contributions. Achievements are displayed alongside users' progress; a Social Leaderboard promotes competition (Fig. 4). Social notifications keep users updated on messages and updates, contributing to collaborative learning. The comprehensive course on mobile app development, struc-



Figure 3: View of lesson's topic (Egbikuadje et al., 2023b).

tured into Agon Levels and Challenges, incorporates game elements (Piras et al., 2016b; Calabrese et al., 2022; Piras et al., 2020; Piras, 2018) such as badges, social leaderboards, and progress bars to enhance engagement and motivation, following the Agon framework for optimised learning and active participation.



Figure 4: Comprehensive view of Badges, Leaderboard, and Notifications (Egbikuadje et al., 2023b).

In summary, the implementation of our E-Learning app via the Agon framework (Piras, 2018) integrates a diverse array of core concepts to maximise user motivation and engagement. By leveraging game elements, the app provides an enjoyable and effective learning experience for students pursuing web-based mobile app development modules. The incorporation of Agon's concepts empowers users to pursue learning goals, fosters a sense of achievement,

creates a dynamic learning environment, encouraging collaboration and healthy competition among users.

## 4 EVALUATION AND DISCUSSION

To address our research question **RQ1** we performed a case study by carrying out a systematic acceptance requirements analysis, using the Agon framework (Calabrese et al., 2022; Piras et al., 2020; Piras, 2018), to analyse, design, and prototype a gamified E-Learning tool - resulting gamified app available at (Egbikuadje et al., 2023b) - to foster engagement and learning of a university module (**RQ1**). The module considered is a relevant computer science university module titled “Web-based Mobile App Development” at Middlesex University London. In relation to our research method, we performed different phases: (i) **Context Characterisation**. Initial research steps with literature review for context characterisation and lessons learned (discussed in section 2, with questionnaires (to students) to characterise the users to engage and to collect the input required by the Agon Framework (discussed in section 3.1). (ii) **Acceptance Requirements Analysis and Gamification Design**. Based on the context information collected, analysis and design of a gamification solution for the module, by using the Agon framework (discussed in section 3.1). (iii) **Prototyping**. Based on the Agon gamification solution, prototype creation of the gamified E-Learning app for the module (discussed in section 3.5). (iv) **Prototype Evaluation**. Involvement of students for using the resulting gamified prototype, and evaluation via observations of their usage, and questionnaires to compile, concerning their experience with the prototype (discussed in the following).

This evaluation involved 12 participants (3rd year BSc IT students at Middlesex University London). To gauge the effectiveness of our gamification solution, we developed a prototype of the app (section 3.5), and distributed it to the participants for use. After observing the students, we administered a questionnaire to extract valuable insights and feedback regarding their experience with the gamified version. We now summarise the findings and valuable elements derived from this evaluation process. In the questionnaire, we presented inquiries to gauge the participants’ perceptions regarding the gamified app.

Due to space constraints, in the next we discuss 2 of the most relevant questions: (**Q1**) “To what extent do you agree that the incorporation of transitions and game elements heightened the overall enjoyment and engagement of the app?”. The purpose of this

question was to assess the participants’ views on how the integration of transitions and game elements influenced their experience with the application. (**Q2**) “To what extent do you agree that this app effectively facilitated your acquisition of both theoretical knowledge and practical skills pertaining to the web-based mobile app development module?” This query aimed to discern the participants’ perspectives on the app’s efficacy in fostering their learning of theoretical concepts and practical proficiencies to the web-based mobile app development module. The outcomes of such questions are presented in Figure 5.

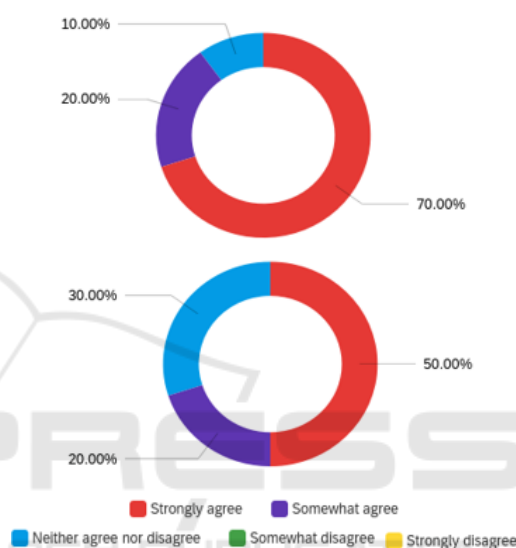


Figure 5: **Q1** results in the top, **Q2** ones in the bottom part.

**Q1** aimed to evaluate the app’s effectiveness in integrating game elements and transitions into the educational process to enhance the material’s quality. The feedback obtained from participants is valuable in identifying the most valued features, guiding the prioritisation of these aspects in future app iterations. According to the questionnaire results (Figure 5), 70% of participants strongly agreed that the inclusion of game elements and transitions made the app enjoyable, while 20% somewhat agreed. Consequently, it can be inferred that the incorporation of game elements and transitions successfully enhanced the app’s fun factor. **Q2** aimed to assess the app’s success in providing a comprehensive educational experience, encompassing theoretical knowledge and practical skills in web-based mobile app development. Feedback obtained from participants (Figure 5) shows that 50% strongly agreed, 30% were neutral, and 20% somewhat agreed with the app’s efficacy in achieving this educational goal. However, it is acknowledged that current prototype limitations (e.g., absence of actual lecture videos and authentic

learning materials) may have effected the perceived learning outcomes. Nevertheless, with all intended features implemented in a real scenario, it is expected that students' engagement in the learning process will improve, leading to effective knowledge acquisition.

To conclude, answering **RQ1**, according to our evaluation, observations of the use of our gamified prototype, and analysis results, the approach used to gamify the module and the final gamified prototype have been considered positively by the participants, and it can engage and motivate students towards learning both theoretical and practical aspects of the module. Therefore, our gamification solution has the potential to stimulate students when it becomes a full product. This will be re-evaluated on a larger scale as future work.

## 5 RELATED WORK

There are different contributions concerning gamified E-Learning apps. ParulKhurana et al. (ParulKhurana, 2012) emphasizes the importance of motivating students in learning programming, focusing on software development. Their proposed solution involves implementing gamification to create a motivating classroom environment, aiming for increased student engagement and improved outcomes. In contrast, our approach utilizes the Agon framework to comprehensively understand learners' diverse needs and preferences. By considering individual characteristics and motivations, we tailor gamification strategies to address specific challenges and interests, enhancing the effectiveness of learning applications. Ge et al. (Ge, 2018) explore the impact of a forfeit-or-prize gamified teaching approach in e-learning, aiming to understand its effects and inform the design of effective educational games for online learners. While existing research primarily focuses on reward strategies in traditional classroom settings, this study addresses the gap by investigating gamified teaching in online contexts. By utilizing a comprehensive framework and models, the researchers not only analyze user engagement but also identify and apply suitable gamification techniques. This approach offers valuable insights for designing and implementing engaging educational games tailored to the needs of e-learners.

Aguilos et al. (Aguilos V., 2022) explore undergraduate students' perceptions of gamification in tertiary education. Key findings suggest that effective design aligning with course content and learning outcomes is crucial for gamified online courses. Instant feedback strongly motivates students, particularly competitive ones, while non-competitive stu-

dents prioritize content and evaluation. Understanding game mechanics and peer interaction influences the effectiveness of game elements, with gamification's impact varying based on individual behavior and preferences. The study underscores the importance of user engagement and course design in gamified learning. Our approach distinguishes itself by employing a comprehensive framework and models to tailor gamification techniques to individual learner needs, thereby creating effective strategies that address specific challenges and interests.

## 6 CONCLUSION

Gamification in e-learning holds promise for boosting student engagement in software programming. The design's success hinges on understanding user needs and psychological aspects systematically. Tailoring gamification strategies to individual users is pivotal for motivation. Accordingly, in this work, we described and proposed the use of the Agon framework and its systematic acceptance requirements analysis based on gamification as a valuable candidate framework for the analysis and design of gamification solutions for e-learning systems. Agon advocates for systematic design and user-tailored solutions. Using Agon, we created a gamified solution for a mobile app supporting students in a "Web-Based Mobile App Development" Module at Middlesex University London. The resulting prototype, tested with 12 students, effectively engaged them in the theoretical and practical aspects of the module. Observations and questionnaires supported positive evaluation results. Future works aim to broaden the evaluation to a wider participant pool using a full product application.

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