Maths Camp: motivation based on personalized progress feedback

BSc Software Development

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STADS code: BIBAPRO1PE

August 15, 2022

Abstract

This project examine various approaches on how to implement personal progress feedback through gamification. The purpose is to identify how to encourage elementary school students' engagement with digital learning exercises. Based on the analysis of relevant research, different sketches and prototypes are made in order to design the final solution. The usability and functionality of the final product is evaluated through user tests, questionnaires and activity monitoring. The evaluation shows that visualising personal progress has a short-term impact on the students engagement. However, it does not influence long-term motivation. The project is based on the educational web application, Maths Camp, developed by two master students from ITU, as a part of their final thesis. The problem statement of this project is inspired by the final evaluation of their thesis.

Keywords: Digital Education, Online Learning, Game-Based Learning, Web Application, Mathematics, Motivation, Progress, Progress Feedback.

Contents

1 Introduction

Tools for digital education is advancing at a rapid pace and online learning (e-learning) has become one of the most utilised among teachers in elementary school. A study made by *Ramböll* for *The danish ministry of education (2018)* shows that 49% of elementary school teachers was using digital resources as part of their teaching on a daily basis. Additionally 33% were highly aware of the digital resources available and aimed at using these as often as possible [1]. The percentage has undoubtedly increased since the study was conducted, especially in the aftermath of the recent COVID-19 pandemic, where all educational institutions was forced to do online education solely.

With the normalisation of e-learning in elementary school, the need for motivating and encouraging tools is essential. This need is often accommodated by using gamification when designing and developing educational applications. The term defines the act of using components known from the gaming industry in applications and platforms were the focus is not game centered. One example of gamification in education is *Duolingo*[2]. The application is using badges and crowns as achievements and levels and scoreboards for social comparison which all are components know from gaming. Many positive effects such as enjoyment and increased motivation comes with gamification but it is important to be aware of the negative aspects as well. Especially in relation to institutional education, such as teaching elementary school, where the students are young, have individual levels and skills and meet physically almost daily. The majority of all gamification components centers around competition and progress. These can be great motivators but in order to maintain a healthy classroom environment they should not be the main focus of learning or draw attention away from the taught subjects.

One way to encourage students to engage with the current material and focus on the subject, is by providing effective progress feedback. Progress feedback is an important part of strengthening motivation and self-efficacy[3] and can be given without encouraging competitive behaviour. The focus of this research is to examine how to motivate students to engage with exercises in a particular subject, rather than rewards and competition, by implementing personal progress feedback in a digital learning application for mathematics.

1.1 Problem domain

Last year (2021), two students from ITU developed a web-based learning application called Maths Camp. The purpose of the app was to teach year six students in elementary school maths by creating a learning experience that adapts to each student's individual level. The practice mode is similar to a multiple choice quiz. A student is presented with a randomised question within the categories of either Number, Algebra, Measurement and Geometry. With each question comes five possible answers, which the student have to choose from. The practice mode adapts to the students skill level by advancing the difficulty of the questions each time seven questions has been answered correctly within a category.

Each student registers with a personal login. The application utilises game-based components such as a personal mascot, point-reward system and the possibility of earning badges. Points are earned every time a student answers a questions. 5 points is given for a wrong answer and 10 points are given for a correct answer. During the final evaluation both students and teachers expressed general excitement towards the game-inspired elements. However, the data collected during the user tests showed that some students had a tendency to focus more on the points and rewards than the given exercises[4]. This triggered the interest for how to maintain the students focus on the exercises without removing the implemented game-components, which lead to the problem statement:

"How can personalised progress feedback motivate the students engagement with the exercises of Maths Camp?"

This project will explore how the students can familiarize with the curriculum by emphasizing the goal of learning and how gamification can be used without disturbing the intended learning outcome.

The thesis will introduce previous research analysed prior to the development of the final solution. The changes made will be evaluated in order to determine effect of the advancements. For the visual design, many choices was made for the initial version of Maths Camp. The solution extends this version and therefore follows the same visual identity. The following section presents the related work that shaped the final solution.

2 Related Work

2.1 Definition of Progress

A review of school effectiveness[5] presents a list of 11 key characteristics that defines the effectiveness of a school. Monitoring and presenting student progress is one of the 11 factors which characterises an effective school, however they fail to provide a clear example of what exactly is meant with progress. There is no doubt about the central role progress plays from an educational perspective. Nevertheless, it is hard to find a common definition of the term. I have therefore turned to the literary definition of the noun progress:

|NOUN|

"Development towards an improved or more advanced condition: we are making progress towards equal rights."[6]

Based on this definition, progress is a continuous process towards some enhanced state. From a teachers perspective this state could be defined by the purpose of teaching such as the students becoming good at maths. We can then create the statement: "We are making progress towards becoming good at maths". For a young student to know that they are making progress, feedback is necessary. The state of progress can be presented in many ways depending on how the progress is evaluated. If it is by a teacher it can be given verbally or by grading a hand-in. How this feedback can be provided will be examined in the following sections.

2.2 Reliability of Feedback

In order to provide useful feedback on the current progress of a student, it is necessary to make sure that the source it comes from is valid to the student. The article *Designing for Kids in the Digital Age*[7] presents tips and research findings on how to design digital resources in an entertaining and educational way for kids. They emphasize the importance of recognisable characters and personalities. When designing a character they recommend making the character as expressive as possible while still being mindful of when the character intervenes. During an activity the goal of the character is not to distract but to be helpful. The best way to make a believable character is to create a consistent personality. If the character speaks about a subject it should continue providing and holding knowledge about this.

In the paper, *The persona effect: affective impact of animated pedagogical agents*[8] the use of animated characters for educational purposes is examined and accentuated. The paper describes the formal controlled study of a pool of students and their interactions with the animated pedagogical agent: *Herman the Bug*. Five versions of Herman the Bug is developed and tested within an interactive learning environment. All versions have identical appearance but different explanatory behaviors and was each tested with a group of 20 children. The findings conclude that animated characters are perceived as being very helpful, credible, and entertaining and also creates motivation to increase skills. The major focus of the paper is animated pedagogical agents, however, it reports that even the presence of a non-interactive character also can have a strong effect on the students perception of the learning experience. Some of the same attributes, such as credible, are also assigned the non-interactive character.

2.3 Different types of Feedback

The first chapter of the book *Feedback for Learning*[9] introduces a framework for analysing feedback for learning (see Appendix A). The framework examines what type of feedback discourse that should be used in relation to the way of teaching and the associated view of learning. Three different models of teaching and related views of learning are presented.

The first model, the receptive-transmission model, defines the way of teaching as *the transfer of knowledge from an expert to an inexperienced*. The view of learning is that it involves improved understanding of new ideas and new skills based only on new information. The feedback discourse associated with this model is characterised by the primary goal being the evaluation and that feedback is perceived as a gift.

The second model, the constructive model, defines the way of teaching as *knowledge being constructed by the learner through activities such as participatory learning, discussion and discovery learning*. The view of learning is that it involves making connections between new and old skills by extending already established schemas. Th feedback discourse associated is defined by the primary goal being to share and discuss and that feedback is a two-way process.

The third model, the co-constructive model, defines the way of teaching as *collaborative, where the discovery of new knowledge is facilitated by self-reflection and collective dialog*. The view of teaching includes the social and emotional dimensions of learning and takes the reflection on the learning process itself into account. The primary goal of the feedback discourse associated with this model is to illuminate

learning for all. In this model feedback is a conversation created by loops relating the participants.

From these three models it is possible to determine the suitable type of feedback for given situations. Some circumstances will find one model fitting, but often a combination will be found most suitable in order to fit a particular learning environment.

In another book, *How To Give Effective Feedback To Your Students*[10], Brookhart dedicated a chapter (chapter 2) to define different types of content and strategies for feedback. The feedback strategies depends on elements such as timing, amount, mode and audience. The content of the feedback varies based on the choice of focus, function, comparison and valence. In order to determine the right strategy and content, the purpose of the feedback must be identified. In this context, purpose can be understood as what Askew & Askew[9] referred to as *the primary goal for feedback*. The purpose is decided upon by the teacher. The teacher must therefore have a clear intention for the feedback in order to choose a suitable type and strategy.

2.4 Presenting Progress Feedback through Gamification

To adhere with the positive responses to the game-based components included in Maths Camp, it makes sense to explore how personalised feedback on student progress can be provided through elements known from gaming. The article, *Psychological Perspectives on Motivation through Gamification*[11], addresses how and why different game elements invokes different motivational mechanisms. A list of the seven most common game elements are discussed together with their functions and motivational pull. Four out of seven elements are relevant in terms of progress and will be presented below (for the full list, see Appendix B).

Badges are described as a visual representation of achievements. The motivational influence depends on the complexity of the badges and their system. A badge is often awarded when some action has been completed enough times in a row. This accommodates the players need for success and provides a visual status of their progress. The badge itself works as a goal setting function and can either directly or indirectly inform the student about their progress. This can be used for individual purposes but also as a social status if shared with other students.

Leaderboards visualise the students success and progress in relation to others. The use of leaderboards have a strong motivational effects, but are often criticised due to the motivational pull towards competition. The students in the top of the

leaderboard are most likely to feel increased encouragement while the students in the bottom might find it difficult to stay motivated. However, if the students is not entirely demotivated, it is a useful way to show the individual progress of a student relatively to others in a social context.

Progress Bars & Performance Graphs are both components that centers around the progress of the individual student. Progress bars are a way to visualise the current status of a student in relation to a goal, whereas performance graphs shows the current status in relation to previous performance. Both types of visualisation is a way to provide the student with direct feedback and they are likely to enhance the motivational pull by providing a clear goal.

Avatars & Profile Development are ways to visualise personal development. An emotional bond might emerge from the opportunity to chose a personal avatar. Through progressive development of the avatar the student is provided with direct feedback on their progress every time they acquire new avatars or features for their avatar. With this approach, progress is incorporated in the game-play instead of being represented as a visually individual component.

3 Solution

This project has strived to explore how the implementation of personal progress feedback can changes the students focus from the competitive elements of Maths Camp to the initial intended learning experience. The following sections describes the process of defining and analysing the problem domain, redesigning and refactoring the current product and finally the implementation of the new version of Maths Camp.

3.1 Defining the Problem Domain

The main focus of this project was personalised progress feedback in relation to the digital learning platform Maths Camp. A review of the section *Findings* from the final thesis of Therkildsen & Schjødt-Pedersen[4] was done in order to narrow down the problem domain and create a clear definition of which parts of Maths Camp to redesign. During the review, a list of the students interaction patterns caught my attention. The list specified some interesting findings, especially one concerning the genuine factor behind some of the students motivation for using the platform. The finding revealed a tendency amongst the students to spend only a minimal amount of time on each question, not caring for whether the given answer was correct or incorrect. This finding showed that the element of competition overshadowed the intended learning experience. Another interesting observation was that the provided hints often was ignored by the students in favor for getting help from the teacher present in the classroom.

I found these tendencies standing out because they, opposite the rest of the listed reflections, was centered around the actual learning experience of the platform. In addition to this they defined a solid frame for future research on how to improve Maths Camp by incorporating and implementing personal progress feedback. In the following section the initial ideas to the redesign of Maths Camps is presented.

3.2 Research analysis

It was important to build a fundamental understanding of the definitions of both progress and feedback in order to begin the design process. Through analysis of previous research, possible solutions to the problem domain was examined.

The Teacher

The role of the teacher was explored through analysis of how to provide reliable feedback. It became evident that the presence of a character with pedagogical features would be perceived as creditable amongst the students. In the current version of Maths Camp, feedback is provided by the students own chosen mascot. I found that by introducing the character of a teacher, the feedback provided in Maths Camp might be recognised as more valid, than provided by the mascot. Hopefully, this could lead to the students relying on the help from the hints provided rather than turning to their present teacher.

Feedback Type

To make sure that the provided feedback was being presented in a useful way, analysis of different types of feedback was necessary. By exploring various strategies and types of feedback it was clear that, it is the purpose of the feedback that dictates what kind of feedback to make use of. The feedback given in Maths Camp has several purposes depending on the focus. From the perspective of progress the main goal of giving feedback is to evaluate and present the current status of a student in a way that encourages them to advance their skills in maths. This type of feedback is one-directional, meaning that the purpose is answering the students questions about how they are doing and what they can improve.

From the perspective of providing hints the main goal of giving feedback is to share helpful information with the students. The strategy for this information depends on elements such as amount and mode. Here the optimal approach differs from student to student, it can therefore be hard to provide feedback that are equally useful for all. For this type of feedback, a two-way process would be optimal since it would evoke conversation and elaboration. In order to create this learning experience the teacher-character would have to be interactive which, unfortunately, reaches beyond the scope of this project. To accommodate this problem, I thought of implementing a feature that allows the students to give feedback to the teacher while practicing. This does not support permit response, but it allows the teacher to gather the information and possibly make changes to the provided feedback.

The Progress Bar

Various game-based elements can be used to show progress, however, I found some more suitable than others for this project. The four most relevant elements are stated in Section 2 about related work. Some of the elements are already present

in Maths Camp. Avatars are represented by mascots which can be bought for the points collected when answering questions. The implementation of mascots does not support personal profile development and is therefor not an optimal way of representing progress. This leaves room for a better implementation of progress feedback. Badges are used to visualise the streaks of a student in regards to active days, answered questions, checked explanations and the amount of required mascots. This game element represents progress to some degree, but the highlighted progress does not reveal anything about the students learning process. The previous research suggested leaderboards as an element to display progress, but I found that this component might indulge the competitive spirit rather than create a motivational pull towards learning. In contrast to this, I found the progress bar to be a befitting way to visualise the students personal progress. Hopefully, the implementation of this game component could help increase the students motivation towards the exercises.

Many specifications regarding the functionality of the progress bar was still undefined. I sought inspiration for the final functionalities of the progress bar by examining already exciting progress bars at interfaceingames.com[1], a website for exploring all the fragments and components that make up video games. This gave me an idea of what information could be displayed through this component. One thing came to my attention: close to 100% of all progress bars was advancing from one level to another. A specific example can be seen below.

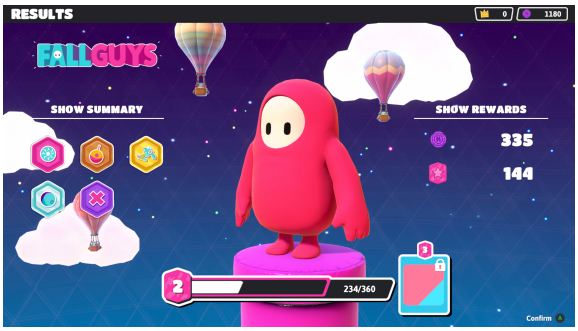
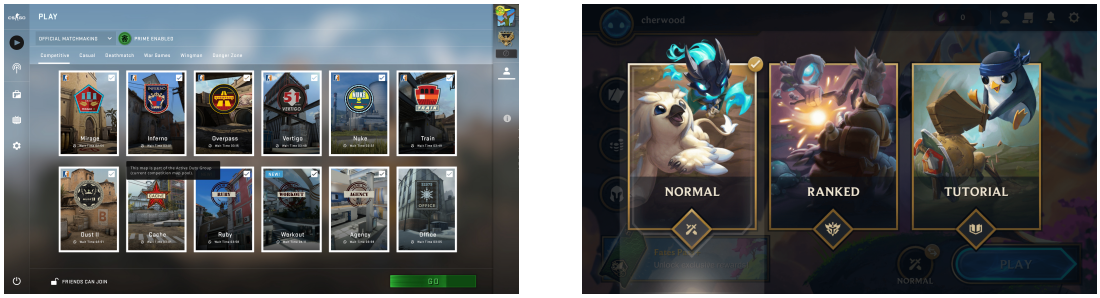


Figure 1: Progress bar from one level to another

Besides this I recognised that many games allowed the player to choose between different modes whether it be difficulty or location (Figure 2). This made me consider the possibility of incorporating some type of mode selection in the progress bar.

[1] https://interfaceingame.com/screenshots/?elements=progress. *Visited 10-6-2022*



(a) Select Map (b) Select Difficulty

Figure 2: Different modes

Based on the data model of Maths Camp, I knew that questions was already associated with a level attribute, but it was not showed when a student was practicing. It was only used in the database. When reviewing the ER diagram of the database, I remembered that questions was also associated with a category attribute. This inspired me to think that in order for the progress feedback to be even more accurate, it should be shown in relation to a specific category. Then the student would know which categories they found more troubling than others. The visual design of the progress bar will be explored in the following section about the redesign of the user interface (section 3.5)

3.3 Requirements

Based on the knowledge gained from the above analysis, it was possible to create a list of functional requirements for the new version of Maths Camp. These requirements relates only to the implementation of personalised progress feedback and not to other functionalities of Maths Camp.

3.3.1 Functional Requirements

Users can select a specific category to practice.
Users can see their current level in each category.
Users can see their own progress towards reaching a new level within each category.
Users can provide feedback for their teacher while in practice mode.

3.4 Refactoring of System Architecture

To implement the above stated functional requirements, a refactoring of the current system architecture was necessary. This section will cover the changes made to the data model and the architecture of the code.

3.4.1 The Data Model

The initial decisions regarding tools used to represent the data model was a fundamental part of the functionality of Maths Camp. The same tools was therefore used to implement the new version of Maths Camp. The back-end of Maths Camp was build with the open-source Parse Platform and hosted on Back4app. To carry out the refactoring of the data model without destroying the initial mode, a copy of the database was made.

The old data model consisted of four entities: *User, Questions, Reward and Mascot* (see Appendix C). The *User* entity held attributes regarding the users level in each category, which meant that a lot of functional duplication was stored in the entity. To avoid this duplication a *Category* entity was introduced. The entity was used to create tables that represented each category available in Maths Camp. In the final solution to this project only four categories was available, but the entity enables easy scaling in case a future need for adding more categories should occur. With the *Category* entity, complexity was reduced from the *User* entity, but in order to properly visualise the progress of a student within each category, a dedicated entity for this information was needed. This was done by introducing the *Progress* entity. This entity had two many-to-one relations with the *User* and *Category* entities. A single *Progress*-table was created for each existing category and was related to one single user. The *Progress*-tables held information about the current level of the user and how many correct questions they had answered in the related category. The needed information in order to implement a progress bar was held in this entity. Below is a figure showing the new data model of Maths Camp.

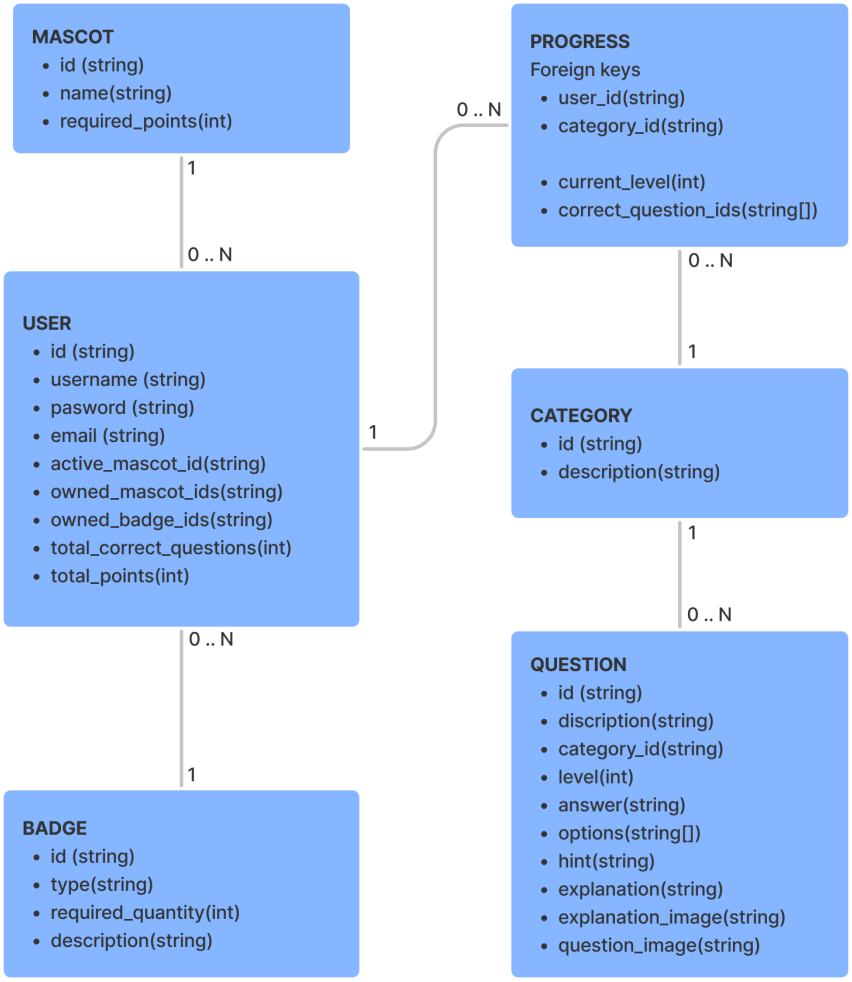


Figure 3: Data model of Maths Camp (ER diagram)

3.4.2 The Code Architecture

Just as the first version of Maths Camp, this version was developed in React.js. The complete code for the new version of Maths Camp can be found in this GitHub repository[2]. Comments are added in order to clearly identify the specific changes and additions.

While reviewing the Maths Camp source code it became apparent that plenty of restructuring could be done, especially the MultipleChoice.js component which expanded over 800 lines of code. This would have been a great improvement of the code architecture however, due do the limited time for this project, this was not prioritised, since it would not impact the functionality of the application. The biggest additions to the new version was the components: *CategoryButton* and *UserInfoTeacher*. I will briefly present their main functionalities.

The CategoryButton is used to visualise the students progress. It shows their current level, how many correct questions they have answered within this level and how many questions they need to answer in order to reach next level. Additionally the component is a button that takes the student to the practice page displaying only questions within the chosen category. The component is showed once per category.

The UserInfoTeacher is the new front page component of Maths Camp. It consists of the refactored version of the sidebar, a welcome message from the teacher-character and the students progress presented through four *CategoryButton* components.

Besides the new components, various changes has been made to already existing components. The *Sidebar* has been modified to display most of the personal information of the student such as their mascot, strikes and owned badges. The *MultipleChoice* component has been altered to show only questions within the chosen category and support the students feedback functionality. Besides this, it is now the teacher character that provides hints instead of the students mascot. No visible changes has been made to the *Register* component, but functionality in relation to the data model has been updated. Each time a student registers, progress tables for each category are added to the database. Figure 4 shows a diagram of the new code architecture. The footer and the navigation bar has been omitted due to the fact that they show on all pages.

To compare with the old architecture see Appendix D.

[2] https://github.com/tamaraputriv/MathsCamp.git

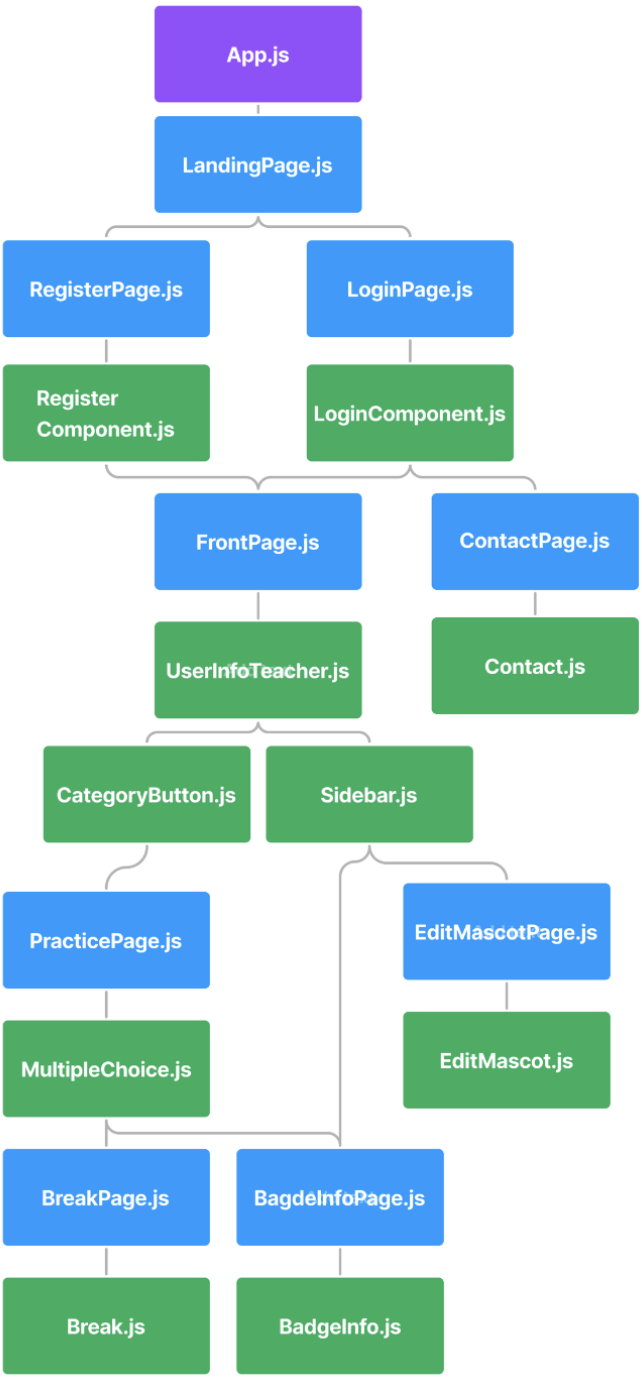


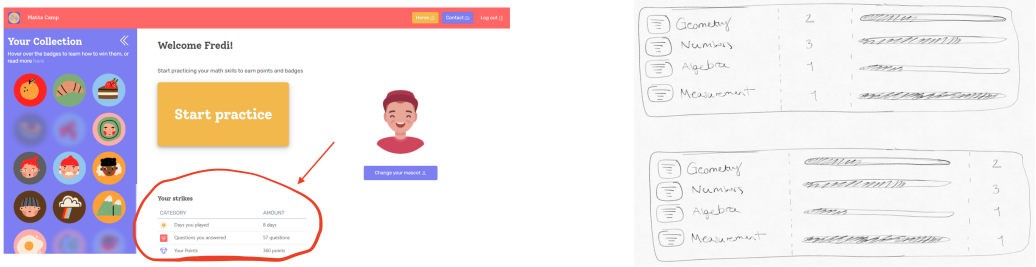
Figure 4: Code Architecture of Maths Camp

3.5 Redesign of User Interface

Now that the technical implementation of the refactoring has been covered the only thing missing from the final solution is the redesign of the user interface. This section will cover the design process from sketching to final product. An overview of the different prototypes and the final ui can be found in this Figma link.

3.5.1 Sketching & Prototyping

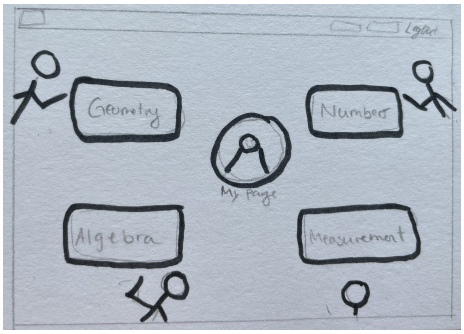
The most decisive part to design was the progress bar, since this component should visualise the key aspects of personal progress feedback. My first thought was to create a table similar to the *user info table* displayed on the front page of the first version of Maths Camp (figure 5a). This way it would follow the design guidelines of the initial thesis. The table would present the individual progress for each category by showing current level and a bar indicating current advancement towards next level (figure 5b).



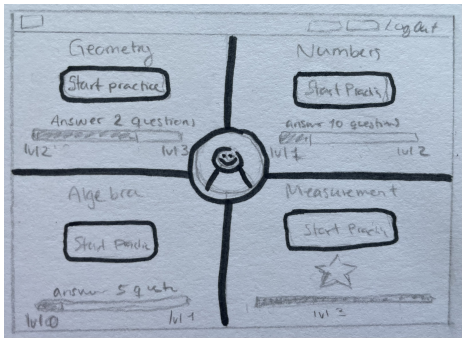
(a) First version of Maths Camp (b) Sketch of user info table as progress bar

Figure 5: First iteration of progress bar

One could argue that this solution would have been sufficient, however, it did not support the functional requirement of choosing a specific category to practice. It was therefore decided to separate the progress bars in order to turn them into buttons. Sketches of how to fit category buttons into the front page was made, in order to define the format of the, now, progress bar button (figure 6 & 7). The size of the buttons seen in figure 6b allowed more space to present the progress of a student. A prototype of this version can be seen here. Since the progress bar was identified as the main component for the redesign, this version seemed optimal, however, from a future perspective the size of the buttons did not support much scaling. If more categories were to be added it would extend the front page and introduce a lot of scrolling. To avoid this, several prototypes of more narrow progress bar buttons was explored and can be seen here.

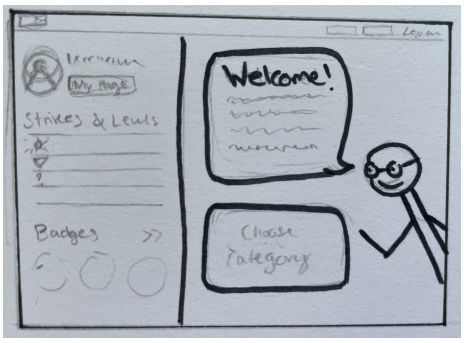


(a)



(b)

Figure 6: Sketches of front page with category buttons (1/2).



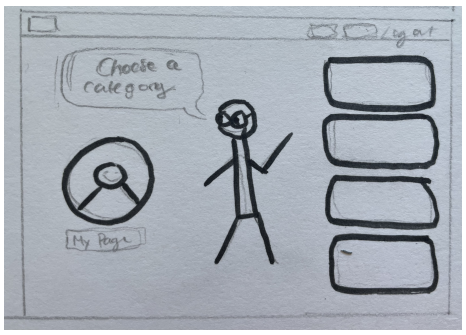


Figure 7: Sketches of front page with category buttons (2/2).

By comparing the different versions of the narrow progress bar, it was evident that version 2 (figure 8) was providing the student with the most accurate feedback. It showed their current status and progress. Each piece in the split progress bar was used to represent one question in a category. This design allowed the student to know the specific amount of questions answered with in a level. It also showed the accurate number of questions needed in order to reach next level.

Figure 8: Split progress bar

3.5.2 The Final User Interface

To access the new version of the Maths Camp web application click here[3]. It shows a landing page from where it is possible to either *register* or *login*.

The final user interface demanded a redesign of the sidebar in order to fit the category buttons. I wanted to draw the students attention to the progress bars and away from the badges. The badge section was therefore reduced to take up a third of the sidebar. The students mascot together with the strike-table was placed in the sidebar, to allow the teacher character more space. The sidebar now contained most of the personal information about the student, while the main focus was on the progress bar buttons in center of the front page (figure 9).

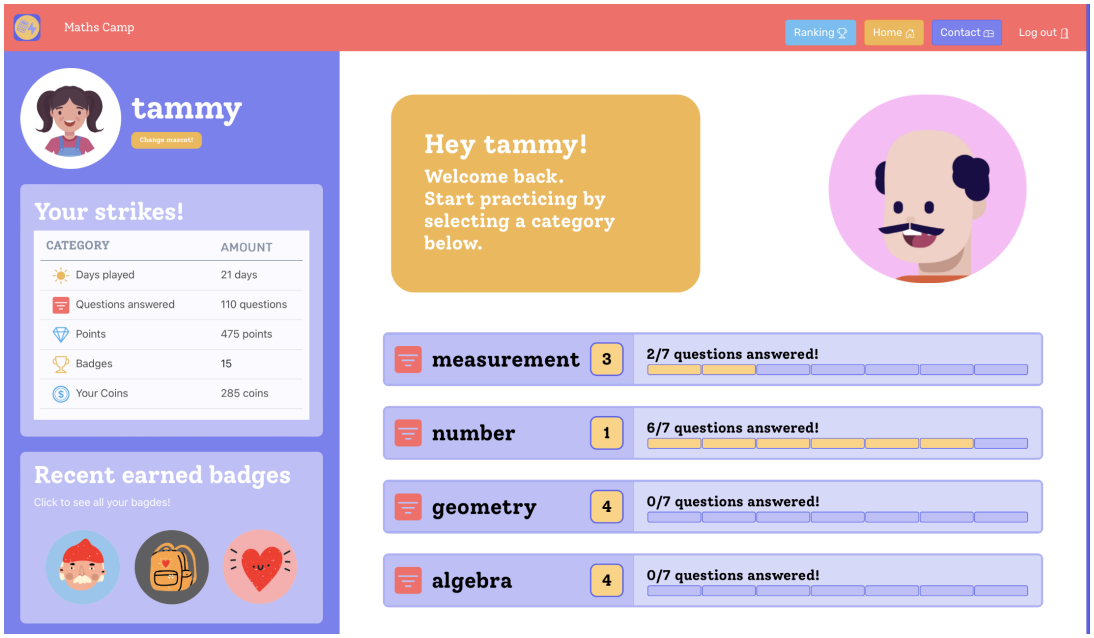


Figure 9: Final front page

On the practice page the student mascot was substituted with the teacher character, so that hints now was presented by the teacher instead of the mascot (figure 10).

[3] https://mathscamp.org/#/

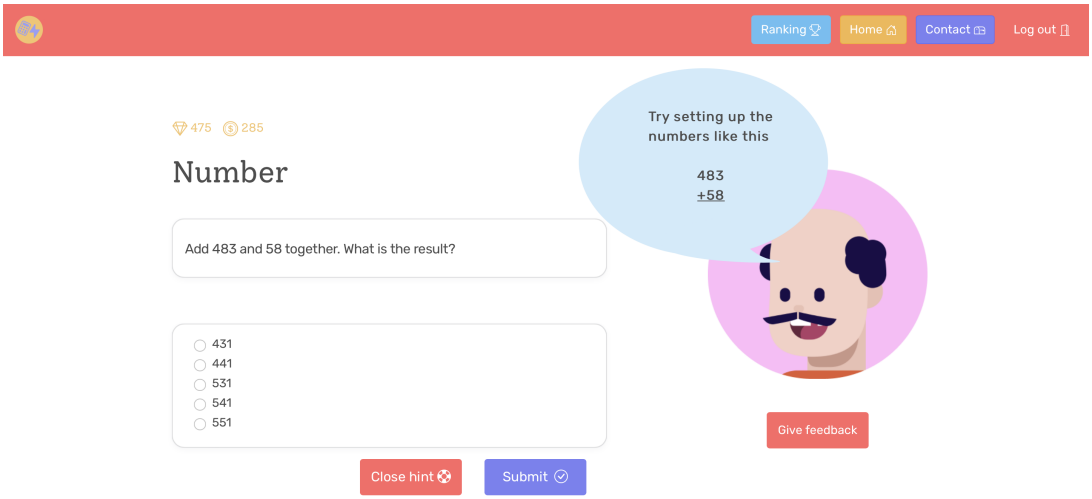


Figure 10: Final practice page

In the final version of Maths Camp several changes can been seen which are not stated in this project. This is due to that fact that a master student was doing their thesis based on Maths camp concurrently with the conduction of this project. There are no overlaps between the two projects, the separate changes can therefore easily be identified.

4 Evaluation

In this section the new version of Maths Camp will be examined and discussed. This will be done in order to determine if the implemented changes has had any impact on the students engagement with the exercises of Maths Camp. The evaluation will be done by analysing the feedback data collected from the involved students and then the gained knowledge will be compared to findings derived from the first version of Maths Camp (from now on references at the old version).

The feedback data has been collected by using two methods:

1. User test and follow-up questionnaire given to all involved students.
2. Monitoring of user activity through the database.

The following sections will present the methods used and related findings one by one.

4.1 User Test & Questionnaire

When doing qualitative research for comparison, the test group should preferably be the same each time data is collected. It was therefore decided to reach out to the same schools in order to test with the same students.

4.1.1 Approach

When reaching out to the teacher at Rygaards International School in Hellerup, Denmark, they, luckily, agreed to test the new version of Maths Camp with the same students. The teacher from Halstead Preparatory School for Girls in Woking, England, also agreed to test the new version. She was, however, not able to provide the same students used for the first test of Maths Camp. The English user test is therefore conducted with two new classes. In total, Maths Camp was tested with 22 International students and 30 English students at the age of 10 – 12.

The introduction of the user test in Denmark was done on site at Rygaards International School and online on Zoom for the English students. After the introduction the students was given the remaining time of a lesson (30 - 35 minutes) to try the new version of the application. Besides the allocated time during class, the students was encouraged to use the application outside of school. Both groups of students was given a test period of eight days before they were provided with a questionnaire regarding the new features of Maths Camp. The goal of the questionnaire was to get

concrete feedback on the newly implemented features mainly: separate categories and the progress bar. It was chosen to do a questionnaire to ease the process of comparing old findings with the new results. Most questions was followed by a number of predefined answers but some questions were open, encouraging the students to elaborate on their given answers. This combination allowed the students to provide personal answers supported by answers easy to analyse. The questions can be found in Appendix E.

4.1.2 Results & Reflections

The following results are based on the answers from the 22 students from Rygaards International School. The questionnaire was, unfortunately, never answered by the English students from Halstead Preparatory School. Fortunately, the international students had tested the old version of Maths Camp. Their answers were therefore reliable for comparison. A total list of all answers can be found in Appendix F.

When asked how satisfied the students were with the design of Maths Camp, 50% were either satisfied or very satisfied. The remaining 50% were neutral, which gives the impression of the students being generally satisfied with the design (Question 3, Appendix F). It was clear that the majority of the students were happy for the possibility of choosing between categories. When asked about what they thought of this feature 54,5% found is useful and 27,2% found it either motivating or great. 36,4% did not think about the change, but no one found the feature annoying (Question 7, Appendix F). The results of Question 5 and 6 showed that there was a tendency amongst the students to choose their favorite category as the first category to practice (see Appendix F).

The students were asked how much they enjoyed seeing their own progress on a scale from 1 – 5, with 1 being not at all and 5 being very much. 86,4% enjoyed the ability to see their own progress by answering within the range of 3 – 5 (Question 10, Appendix F). This was an important observation in regards to the possible increase in exercise engagement. Also, 54,6% found it either very or slightly motivating to see their own progress. However, one student (4,5%) found this feature demotivating (Question 12, Appendix F). This could be due to the level of the students maths skills. With the visibility of personal progress, a student is also presented with the lack of progress which can have a demotivating influence. This is one of the risks taken the implementation of a progress bar. The students were also asked an open question about their thoughts on the progress bars on the front page. Once again the majority of the answers showed a positive attitude towards the feature with

15 students saying it was either useful, motivating or cool (Question 9, Appendix F).

The students showed excitement towards the visibility of levels. On a scale from 1 – 5, 94,7% enjoyed the feature of leveling up (Question 14, Appendix F). When asked to choose between winning a badge and reaching a new level 63,6% said answered they preferred to reach a higher level (Question 15, Appendix F). This observation helped to understand which features that might produce the most motivational impact.

Finally the students were asked if they would continue using Maths Camp, and if yes, for how long. 15 out of 22 students answered yes or maybe (Question 16, Appendix F). Since a similar questions was included in the questionnaire of the old version, this data could be used to make a direct comparison on the students future encouragement.

4.2 Monitored User Activity

During the testing period from the 2nd until the 13th of May, 52 users was registered. Data based on their interactions with Maths Camp is analysed in the following session.

4.2.1 Approach

Each *User* entity in the database was associated with an attribute counting the numbers of active days. In addition to this, Back4app tracks each time a user has either registered or logged in. This data permitted the specific calculation of things such as how many students actually used Maths Camp more than once and how many questions they answered in total. The results could be used to compare the activity observed during test period of the old version. Besides the attributes related to the *User* entity, the *Progress* entity tables could be used to track if there was any patterns in the categories chosen by each student.

4.2.2 Results & Reflections

More than half (68%) of the students used Maths Camp for only one day. 28% was active somewhere in between 2 – 4 days while two students (4%) were active for 5 days. The tracked sessions showed that some of the students already returned to Maths Camp later on the same day of the introduction of the test. Specifically, 18% of the international students and 43,3% of the English students. Many external

factors can have caused that less than half of the students returned to Maths Camp for more that one day. However, from the perspective of this project we have to consider the possibility of the questions being too hard so that students weren't able to experience enough progress and therefore stopped playing.

A contradictory observation to this assumption was seen during the analysis of the amount of correctly answered questions. This shows that close to 100% of the students have been able to experience their own progress visualised through the progress bars. The distribution of the the amount of correctly answered questions can be seen in the table below.

Correctly answered questions	**Percentage**
0	2,1%
1 – 10	23%
11 – 20	17,3%
21 – 30	23%
31 – 40	19,2%
41 – 50	7,7%
50+	7,7%

The data shows that over half of the students answered more than 20 questions correct. If 21 questions are answered correctly within a category, this category is regarded as completed since the highest level would have been finished (level 3). Based on this fact it could be assumed that some amount of students might have completed at least one category. Data from the progress tables showed that 3 students (5,8%) managed to complete level three in one category, while 22 students (42,3%) managed to reach level 3 but not complete it. Only 11,5% of the students got to try out all the categories. The data showed that the most common pattern was for the students to try out one or two categories which was done by 62%.

4.3 Comparison & Findings

Based on the results presented above we can now make a comparison with the results of the old version of Maths Camp and present the final findings.

4.3.1 The teacher character

During the testing session with the students from Rygaards International School, many questions was asked the teacher verbally. Even when reminded about the options of the hints and the feedback button, the amount of questions to the physical teacher were still noticeable. After the session was concluded, not a single student had made use of the feedback feature on the practice page. The English students used the feedback feature more commonly. 15 students provided feedback during the test period. Most of the feedback was about the application in general and not so much about specific questions. This, unfortunately, does not say much about the impact of the teacher character. One way to have gained knowledge about the students liking of the character would have been by including clarifying questions in the questionnaire. In addition to this a counter for each time the hint button was clicked should have been implemented.

4.3.2 Active Days

When the students were asked if they were going to continue using Maths Camp 68% answered perhaps or yes, which is a slightly bit higher than the results from the old questionnaire. This stated that approximately 62% would continue. This, however, was not reflected in the tracked activity.

A direct comparison can be made with the data regarding the amount of active days. Therkildsen & Schjødt-Pedersen states: *"Most users (56%) played for 1 day only. 33% played for 2-3 days. The longest a user played was 7 days"*[4]. It is clear from these numbers, that the students has been less active during the test period of this project. As mentioned above, one reason for the decrease in activity could be that the questions were too hard. One of the English students had told their teacher that: *"I love this app but some of the questions are a bit hard i think for my age group but i am in year 6"*. This is the only mentioning the difficulty of the questions, but it is easy to imagine that several student might share the same experience without being vocal about it. Another reason could be that the exercises simply weren't challenging enough, and that the learning experience therefore became boring. If this was the reason, then it can be assumed that the visual elements of progress was not encouraging enough for the students to continue solving problems. It is, however, hard to conclude when no collected data supports either of the statements.

4.3.3 Correct answers

The comparison showing the most contrasting data regards the amount of correctly answered questions. In the final thesis of Therkildsen & Schjødt-Pedersen it is stated that *"29% of all users answered more than 50% of their questions correct"*[4]. The data derived from the *User* tables of this project shows that 52% of the students answered more than 50% of their total answered questions correct, which is close to a doubling. This increase indicates that the students were more likely to take the time needed in order to answer the questions correctly in the new version of Maths Camp. Several changes can have impacted this result. Based on the positive reactions towards the progress bars it could be assumed that it had a fairly significant impact on the effort put in the answering of questions. It is, however, also important to have in mind that the students might have sensed the focus on the progress bar and therefore have provided positive feedback in order to satisfy the purpose of this project. Another change to have in mind is the elimination of points received when answering questions wrong. Before, the students was given 5 questions for an incorrect answer. Now, they are only given points when they answer correctly. This can also impacted the positive increase of correctly answered questions.

5 Conclusion

The focus of this project was to explore different ways of introducing personalised progress feedback to the web application Maths Camp. The purpose was to minimize the focus on the competitive gamification elements such as points and badges and enhance the engagement with the exercises.

The final implementation supported the ability to keep track of personal progress through progress bars divided into separate categories and aimed at enhancing personal association by introducing the familiar character of a teacher. This solution accommodated the issues of missing visualisation of levels and categories stated in the conclusion of the initial thesis[4]. They main takeaways are stated below.

First, it can be concluded that the introduction of a teacher character had little to no influence on the students perception of the provided feedback. Were it to change the learning experience, it could be argued that the character should be interactive in order to have a significant impact.

Secondly, the majority of the students stopped using Maths Camp after the introduction and the few that continued stopped within a week. This indicates that the implemented changes only had a temporary impact on students' motivation.

Third and last the evaluation showed the contrary impact on short-term engagement. The implemented changes has resulted in a higher percentage of correct questions compared to previous tests. From this perspective, the introduction of categories and visual progress can be regarded as successful. The increased amount of correct answers shows that students now spend the time necessary to answer correctly and therefore were more engaged with the exercises.

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