NANYANG TECHNOLOGICAL UNIVERSITY

WEE KIM WEE SCHOOL OF COMMUNICATION AND INFORMATION

CI6220 - USABILITY ENGINEERING

Usability Project

Submitted by Team SaShiMi

Jason Lee Jie Shen (G1701844A)

Juan Paolo De Torres Mirano (G1701324F)

Nah Zheng Xiang, Philson (G1701513D)

Xue Fei (G1701182G)

Ya Min Oo (G1701265D)

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1. Introduction

1.1 Background

The Internet has progressively developed into a pervasive and ubiquitous tool for learning. Today, many parents and educators are turning to online platforms as a means of helping young children improve their learning and cognitive skills (Couse & Chen, 2010). In fact, Docebo predicts that the e-learning market is projected to grow to $240 billon by the end of 2023 (Docebo, 2016). Increasingly, these websites are also being used to target younger children as early as the preschool and kindergarten ages (Miller & Warschauer). The effects of technology have been extensively recognized in the area of education and have proven to be a positive force for the development of young children (Tahir & Arif, 2015). However, not all educational websites are effective. In reality, educational platforms that are poorly designed, have been shown to not only produce no improvement on learning but may have negative implications on learner motivation (Van Merriënboer & Ayres, 2005). Research have shown that the ages of 1 through 8 are the most important formative years of a child's education. It is therefore of paramount significance that these children are exposed to thoughtfully designed systems in order to facilitate the effectiveness of their learning (Wohlwend, 2010). IXL is an educational service provider that provides mathematics and language practices for children from Kindergarten to High school through their web platform, iOS, and Android apps. The website also provides analysis tools for parents and teachers to track the progress of students and measure their performance to work on their academic results. The IXL service is used by one in nine students in America and has been adopted by over 200,000 teachers worldwide (District Administration, 2014). To date, IXL has served over 40 billion questions to its 6 million subscriber base, in the United States and across 190 countries around the world (IXL, 2018). This puts it as one of the premier learning websites, as is hence worthy of our study.

1.2 Objectives

Given the popularity of the IXL website, our team took to conducting several rounds of informal evaluations on their website using cognitive walkthroughs. Our preliminary investigations revealed that the IXL website exhibited numerous usability issues. Upon further comparisons with rival learning platforms, we also discovered several areas for improvement. With the importance effective usability design in learning systems, and particularly the significant impacts it has on the younger children which IXL targets, the objective of our research is to therefore study the needs of IXL's target users and propose a redesign of their system to more effectively facilitate the learning process of their users. In the first portion of this paper, we shall begin by examining related systems and the features utilized by IXL's competitors, to form a basis of comparison to guide our design efforts. Next, we shall delve deeper into the requirements gathering process in order to better understand the needs of IXL's intended audience. Once these requirements have been established, we shall proceed with a walkthrough of our design process and propose a solution prototype designed to effectively encompass these requirements. Lastly, we shall conduct a thorough heuristic evaluation to validate our proposed prototype against established fundamental usability principles to determine the efficacy of our suggested design.

2. Related Work

In this section of the report we'll be discussing similar applications that will be used as a point of comparison. The comparison will highlight aspects of the design differences between IXL and 2 other E-learning applications Sumdog and Khan Academy. We shall then attempt to incorporate some of the positive design aspects from these applications into our new prototype.

2.1 Similar Applications

Sumdog

Sumdog is an online learning service that helps children enjoy learning Math, English and spelling. They primarily target children from ages 5 to 14 for math and ages 5 to 11 for literacy. They primarily use gamification to improve a child's motivation in learning. Data and reports from the application is then sent to the teachers so they may pinpoint the appropriate areas to address with regards to the child's learning.

Khan Academy

Khan Academy shares similarities to Sumdog and IXL however they are aimed not at specific age groups instead their goal is to be a personalized learning resource for people of all ages. They've also partnered with institutions such as NASA, Massachusetts Institute of Technology and The Museum of Modern Art to offer more specialized content.

2.2 Key Comparisons

Sumdog's approach to E-learning provides more interaction and social aspects compared to IXL's approach. Sumdog's approach uses competition between players in answering questions as a main form of gamification and it also provides rewards such as cosmetic items to players. Compared to the basic quiz type that IXL provides this method gives more motivation for users to keep going and trying. The competitive aspect fosters a desire to improve and surpass your friends which can also serve as a form of motivation for kids.

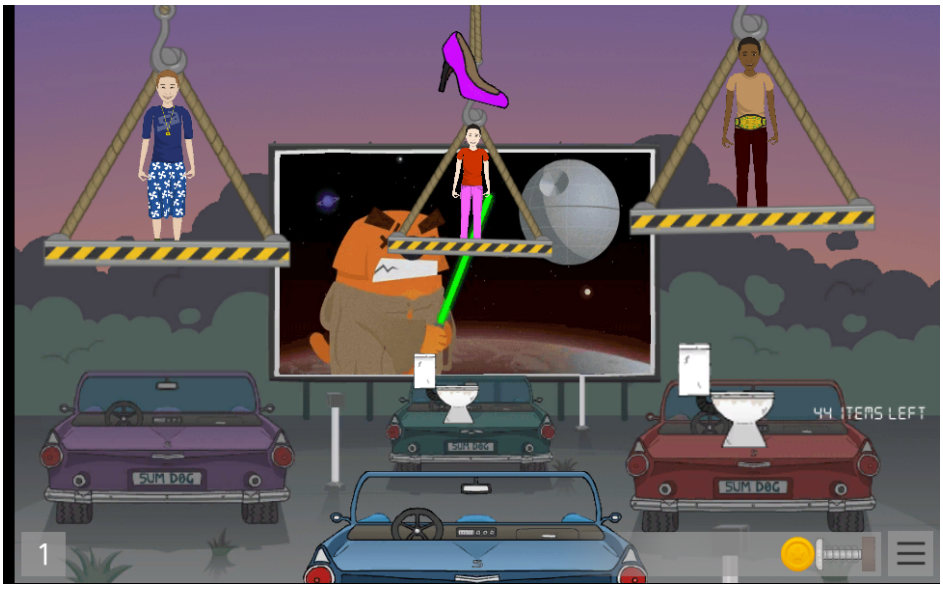

Figure 1. Sumdog sample game screenshot

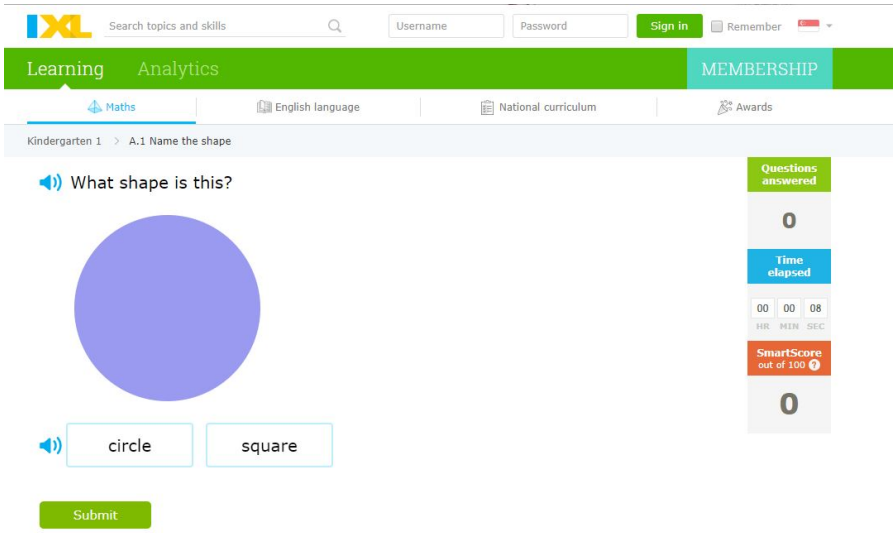

Figure 2. IXL Sample Quiz Screenshot

For Khan Academy we compare the overall UI design. The UI Khan Academy uses is more appropriate for children since it uses icons rather than simply bombarding the user with text and the overall aesthetic for the UI is a lot cleaner and pleasing to the eyes. It also conveys clearer instructions with a back button since most children don't use the browser back button. Analytics and tracking of learning progression of the student in each topic is clearly shown when viewing the UI.

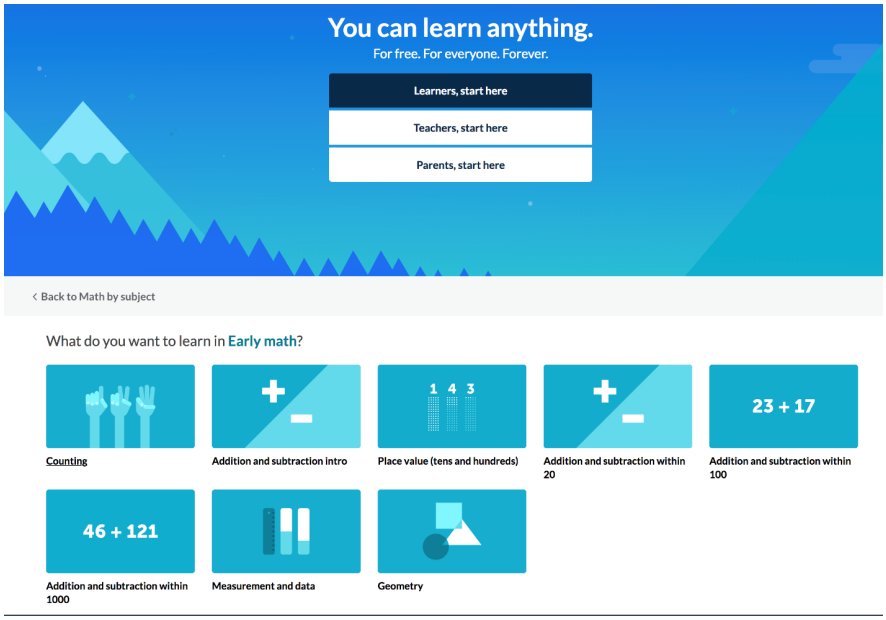

Figure 3. Khan Academy Sample UI Screenshot 1

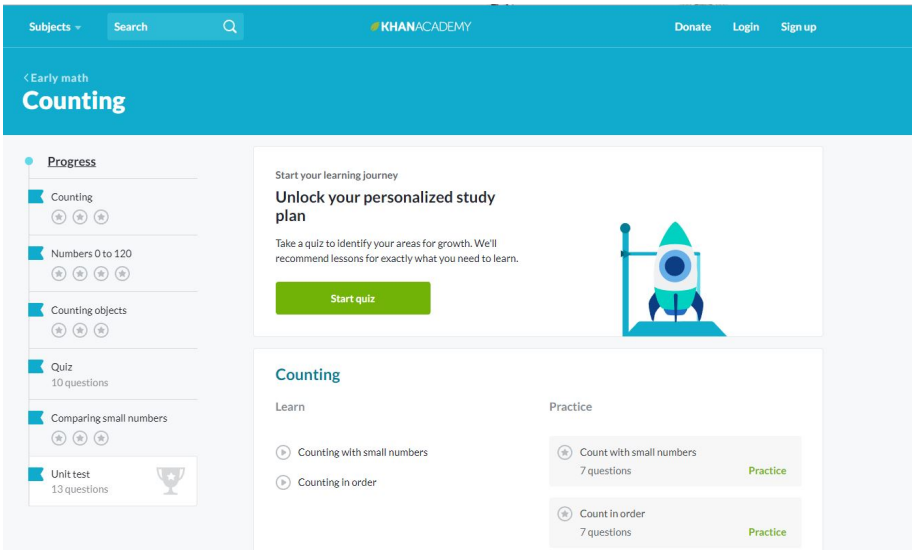

Figure 4. Khan Academy Sample UI Screenshot 2

Figure 5. IXL Sample UI Screenshot 2

It is hence clear that when stacking up to the competition, there are many areas in usability design where the IXL website is lacking. Given that the website is primarily targeted at kids, there are several key considerations that need to be factored in when designing the service. For example, more attention should be paid to designing an interface that elicits and retains the attention of children. Sumdog has shown us hints of how this can be achieved through Gamification. Furthermore, a clean and minimalist UI as shown in the Khan Academy example, would likely do better than IXL's example of text dominant menus. These factors will be taken into consideration and serve to guide our design process.

3. Requirements Gathering

3.1 Personas

The first Persona of our project is a 10-year-old girl, Katie who is currently studying in primary 4 in Singapore. She is always friendly with everyone, hardworking, and likes painting and reading. Katie got her first mobile phone when she was 7 years old. She likes to check some websites and socialize with friends online during the weekends. Her objectives of using the IXL website are to improve her Math and English, take part in online exercises and outperform her classmates. However, Katie is concerned that she can only spend one hour on laptop during weekend, has a curfew to go to sleep by 9pm every night, and hates doing offline homework.

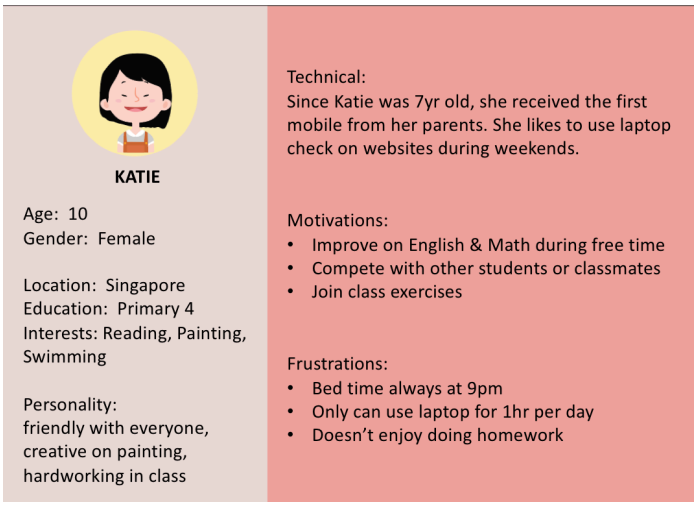

Figure 6. Persona 1: Katie

Our second Persona is a 12-year-old boy, Mike who has a cheerful and outgoing personality. He is currently studying in Secondary 1 in Singapore. He likes to play computer games and football after school. After finishing his homework, Mike always plays computer games for 1 hour and he has 6 years of experience using laptop and tablet devices. He wants to use the IXL website to improve his studies and analyze his academic performance. However, the frustrations of Mike are that he does not like to do homework, has lost interest in Math, and he is forced to finish homework before using the laptop.

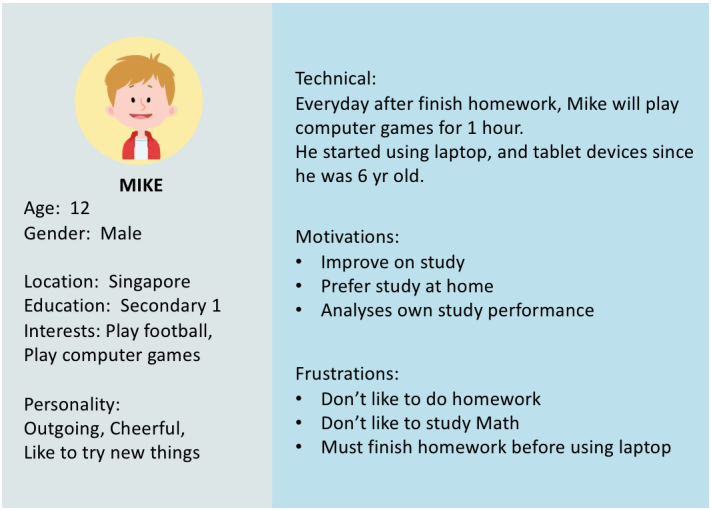

Figure 7. Persona 2: Mike

3.2 Scenarios

Scenario 1

"One day, KATIE finishes school and went back home. She shows her parents the Math test results, but her parents are not satisfied with her grades. After KATIE finishes her homework, her mum asks KATIE to do some extra Math exercises on the IXL website. KATIE finishes 20 questions on "converting time units" and 15 questions on "probability" topics under the Primary 4 learning categories. After completing the questions, KATIE checks the ranking board, and surprisingly she is #14 on the overall ranking. Afterwards, her mum, who has access to KATIE's performance on IXL, checks her progress. Under the Math subject, KATIE has increased her accuracy score to 95%. Her parents are happy about the improvement and they believe that KATIE can get better results in school next time."

Scenario 2

"One day, English teacher Emily is setting up an online quiz for her Secondary 1 students inside the computer room. The duration of quiz is 30 minutes and the questions are MCQ based. All the students are required to log in to the IXL website using their account and the system can count the time when students start the quiz. After the completion of the quiz, Emily logs into the website with her teacher account and checks on the students' performance. She can see the students' total marks, accuracy rates, rankings and each students' historical performance in previous quizzes. She realizes that Mike (the 12-year-old boy) performed badly for the recent class exercises and decides to provide Mike some extra help."

3.3 Requirements

By establishing the personas and scenarios we want to design for, we are hence able to better understand our target users and establish empathic relationships with these personas. Generalizing the key elements of our requirements, we have organized them into three broad design themes that out team shall focus on, as summarized in Figure 8.

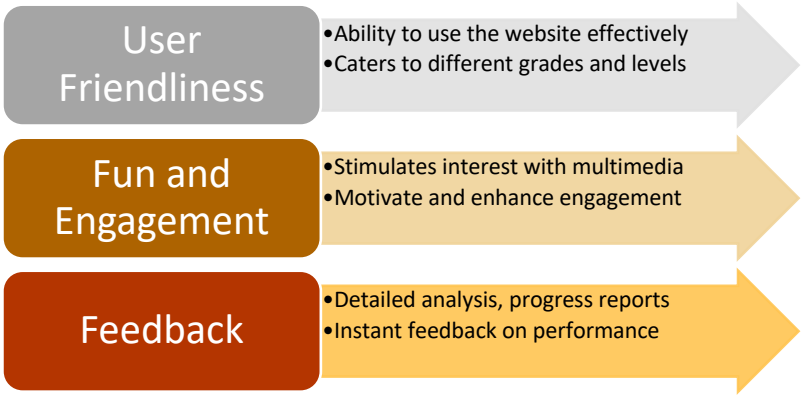

Figure 8. Requirements - 3 Themes for Design

First, it is important users of the website to be able to navigate efficiently and effectively. Subjects and topics should be arranged accordingly so that different students can access and start their online learning quickly with minimum hassle. Second, students need to be able to engage in fun learning activities on the website. Possible ways to achieve this include the use of gamification, images, sound and animation to stimulate interest and engagement. Third, students should be able to receive instant feedback to associate their results to the task in which they have just completed. Where required, more detailed analysis should also be provided.

4. Prototype Design

When designing the prototype for the redesigned website, we took into consideration that the users playing the learning games are children, who have very different user requirements from adults. These include: minimizing text, less familiarity with technology conventions, less inclination to search for things, slow typing, and liking of animations and sound (Nielsen, 2010). However, some of the users would also be teachers. These teachers will use our website to manage their classroom and track students. These users have very different requirements and purposes for using the website. We thus split the website into two: one for students and one for teachers. For the purpose of this report, we will only be focusing on the student part of the website. A full copy of each page in our prototype can be found in Appendix 1.

Our users consist of school kids with varying ages and come from different school grades. However, these kids will also have varying levels of mental processing and reading ability, as well as different exposures to technology. When designing for children, it is important to use age-targeted design, and not a 'one-size fits all' approach (Nielsen, 2010). Thus, our design needs to be adjusted to cater to each of these age groups. To do so, we decided to create two separate designs, one for kids in primary and secondary school, who have relatively more developed mental processing abilities and experience in technology, and one for kindergarten kids, who have relatively less developed mental processing abilities. The two designs are as shown below:

Figure 9. Difference in design in the home page between kindergarten and primary/secondary

The design for kindergarten kids takes into account that they are very unfamiliar with technology, and do not really know how to use computers and tablets. Furthermore, kids in kindergarten level have limited reading abilities, and would be more attracted to images and colors. Thus, the kindergarten design makes extensive use of large images and one-word text labels, with different colors for different topics so kindergarteners can easily differentiate the topics. The lesson page also reflects this, incorporating more images rather than text. (Appendix 1 - Figure 10). The aim of such an approach, is to make navigation more intuitive and easy to learn for the kindergarten kids.

This hence improves on the original 'one-size fits all' approach, which did not cater to individual needs and abilities of the users. Furthermore, the original website included too much information and text regarding each school level (Shown in Figure 10 below). To improve on this, the new redesign will automatically direct users to their appropriate page, based on the user's specified level or age given at registration. Users can retroactively change these levels easily if they are incorrect. This drastically reduces the amount of information and text displayed on the homepage.

Figure 10. Original website's homepage with cluttered information

Another methodology we used while designing the prototype is gamification. As children need instant gratification for their work, and want to be entertained, introducing the gamification elements to the website serves as a good way of encouraging children to continue using the website and play the games (Large, Nesset, Beheshti, & Bowler, 2004). The first element of gamification used is the points system. When users finish playing games, they earn a certain amount of points. These points can then be used to compete against friends, as shown by the ranking board (Appendix 1 - Figure 4). Furthermore, users will also gain coins when completing games, which can be used to purchase virtual items in the avatar shop to personalize their profile page and their avatar. This can also be used for friendly competition among friends by seeing whose avatar has the best equipment.

Another feature we wanted to improve on was the score analytics in the original website. In the original version, there was a 'SmartScore' system. (shown in Figure 11) However, this system is very confusing and ambiguous, there was inadequate information regarding it, and users could not relate the SmartScore to what they were learning and how they were progressing, which is the main aim of the website. Thus, we designed and improved the score analytics page (Appendix 1 – Figure 5). The redesign informs users of their scores in each category and subject in an easy-to-read graph. It also informs users of their progression in each category over time. These analytics allow users to easily track their progress through the games, getting instant gratification of how they are performing, hence motivating them to play more.

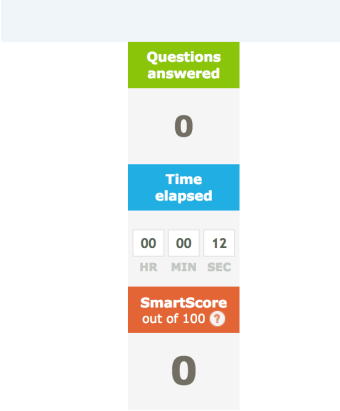

Figure 11. SmartScore system in the original design

During the game, users should also feel like they are in control. This means knowing how long the game will last and the ability to exit the game if they want. This was not present in the original design. Thus, we included this ability in our redesign by informing users the number of questions, what question they were on, the number of points awarded for each question, and the ability to exit the game if desired. (Appendix 1 – Figure 7). The aesthetics of the redesign was kept in line with the original design, using the same color palette and backgrounds. This reinforces familiarity, and ensures that there is consistency in the pages, and lets users know what website they are on when playing the games. Finally, as kids nowadays use mobile devices such as tablets and phones very often, the design of the website was also designed with mobile use in mind. This meant that buttons have to be big enough to tapped on with a finger, and that gestures can be used. A full interactive version of the prototype can be accessed at the following link: https://xd.adobe.com/view/211eb27e-5d78-4b88-843a-4ca6a37e1940/.

5. Evaluation

5.1 Evaluation Methods

The design of our prototype was guided with several principles in mind. As IXL is an e-learning website which is designed for children, we applied the (Hanna, Risden, Czerwinski, & Alexander, 1999) guidelines for designing multimedia environments for children to drive our design. Furthermore, in our design process we also consciously adapted Nielsen's Web usability for children guidelines (Nielsen J. , 2010), which highlighted the important differences between children and adults. However, for the purposes of this evaluation we have

chosen to adopt Nielsen's ten heuristic principles as a basis of assessment, as it has been widely accepted as a fundamental framework for validating design usability and usefulness (Nielsen J. , 1995). Nielsen suggests, that the number of evaluators required for this process should be between three to five in order to identify different usability effectiveness and design issues (Nielsen J. , 1995). Therefore, we have assigned three evaluators who possess adequate knowledge in establishing usability guidelines and with domain expertise in children education systems, to conduct the evaluation.

Regarding the evaluation process, the initial stages began with a briefing session that was conducted to standardize expectations and ensure the evaluators understood their tasks clearly. Thereafter, each evaluator conducted independent design analysis of the prototype based on the principle guidelines. During the evaluation, evaluators were required to provide reports on any design usability and effectiveness issues detected. Finally, a debriefing session was conducted. During the debriefing session, the evaluators discussed about their findings and suggestions on the potential solutions based on the heuristic evaluation design guidelines. The following sections detail the analysis provided on the evaluation of the usability and effectiveness of our website prototype design.

5.2 Visibility of System Status

The prototype design provides information instantly regarding a user's game levels, collected points, perceived reward coins and ranking among the other players. The system also allows users to exchange their rewards/coins for a variety of accessories for their avatars which makes learning more interesting and motivates participation. As the system categorized the lessons according to the user's age, the content and instruction of the lesson page displays in an age-appropriate format. For young students, age between 3 to 6 years old, the lesson instruction was designed in a simple and easy to comprehend way instead of overloading with points and rewards. In contrast, for students older than 7 years of age, the lesson page provides more information such as what questions they are currently on and how many questions are left to answer. Furthermore, the system also provides incentives such as rewards and points once they accomplish the tasks, to enhance motivation.

5.3 Match Between System and the Real World

The prototype design is mainly intended for the practice of mathematics and English learning for students including young children. Therefore, the design icons and lesson's contents are presented in cartoon like characters which represent the real-world scenarios to attract children attentions. In the avatar shop page, the accessories provided by the system (e.g. clothing, sunglass) match with the real-world objects. The website contexts and icons such as coins, avatar shopping cart etc., are also carefully designed to map to the physical world contexts. However, these elements were further incorporated with animations and sound effects in the design can enhance learner's interest.

5.4 User Control and Freedom

According to (Strommen, 1994), compared to adults, young children have difficulty holding down the mouse button for some extended periods of time, performing a dragging motion and performing other types of actions such as double-click. Therefore, the prototype is designed to ensure that the interactions are kept with just point-and-click rather than drag-and-drop actions. To optimize the interactions with the system, the design also provides clear and big icons, since

younger children eye-hand coordination may be more limited. And the system allows users to exit from the game anytime without going through any extended dialogue.

5.5 Consistency and Standards

The consistency of the website design, contents and actions are crucial for efficiency when users interact with the system. The prototype layouts are consistent across all the pages and contents are categorized based on the lesson's similarities. A simple and bright color theme is used across the system. And the placement of the contents such as the points, avatar, lesson tabs and buttons are consistent.

5.6 Error Prevention

Since the children have playful and spontaneous nature and it is difficult to predict their interactions with the system, there should be robust error handling and simple feedback. The lesson page in the prototype, enables the submit button only when users enter a valid value. E.g. During mathematics lessons, when users enter invalid values (e.g. blank, characters or symbols) in the answer box, the system prompts a confirmation option before they commit the actions. In the avatar personalization page, the system greys out the accessories when the amount of coins required to claim are more than what the users have collected. Therefore, the system can eliminate and prevent confusion and errors.

5.7 Recognition Rather than Recall

In the prototype design, user's status such as points, levels and brain analytics are provided and therefore users do not need to recall the levels and scores they have. The smart analytics page automatically provides information such as the areas they need more practice in and improvements made during the course.

5.8 Flexibility and Efficiency of Use

(Hanna, Risden, Czerwinski, & Alexander, 1999) suggest that the system should allow control and access to instructional information. The prototype design allows users to choose the type of learning materials such as mathematics or English from the section tabs easily. And the lesson pages are categorized for different age groups, which require relatively different interactions for learning efficiently. In addition, the system allows users to choose the level they want and can opt out easily.

5.9 Aesthetic and Minimalist Design

(Nielsen & Gilutz, 2002) mentioned that children chose to interact with the elements that were immediately visible as they rarely scrolled down to find the contents of the website. Therefore, the prototype design system reduces scrolling effort by always displaying relevant and pertinent contents. In addition, children attention spans are brief as they can hold only one thing in memory at a time (HCI FOR KIDS, 2009). Hence, the prototype design limits the use of wordy instructions and text to provide better interactions.

5.10 Help Users Recognize, Diagnose, and Recover from Errors

In the lesson page of prototype design, when users choose the wrong answers, the system provides explanations with the correct answer displayed in the same screen. During mathematics lesson, when users type characters or symbols rather than numbers, the system

prompts a dialog that the input should only allow numbers. When user click ok then the system will bring the user back to the lesson page. By doing so, the system helps users recognize and recover from the errors.

5.11 Help and Documentation

The prototype is designed with a symmetric layout and an appropriate balance between text and graphics, so that users can easily search and navigate the desired information in the system. In the main page, by providing the separate sections for student and teacher confusion is minimized and users can focus on their relevant tasks.

6. Conclusion

In today's increasingly digital and connected environment, many parents and instructors are turning to e-learning as a means to enhance the learning experience of children. We see more and more of these online learning platforms being targeted at children of younger ages, some still in their formative years. While the positive impacts of technology on learning are well understood, improperly designed systems have also been shown to harm learner motivation. Hence, given the rising adoption of such systems, there exists an urgent need to establish a better understanding on how to design learning systems targeted at children across the different age groups. In this paper, we have chosen to work on the case of IXL, which is a prominent online learning platform that has many subscribers across the world and would likely impact many young learners. Our initial investigations and comparisons showed that there were several areas where IXL could improve on. We then followed up with the requirements gathering process using personas to establish empathic relationships with the users, in order to find out what they truly wanted. We therefore identified 3 key design themes to focus on: User Friendliness, Fun and Engagement, and Feedback. Based on these major themes, as well as with fundamental design frameworks in mind, we then proposed a redesigned prototype to improve upon and enhance the effectiveness of IXL's website.

Following the redesigning efforts, we then subjected the prototype to a panel of evaluators adopting Nielsen's ten heuristic principles. Such an approach allowed for a validation of the efficacy of the design prototype against an established usability design framework. Key findings of the evaluation include the fact that the Gamification features played a big part in the facilitation of Visibility of System Status, and that our reorganization of the whole process flow for indicating a learner's educational level helped to avoid confusion and ensure Flexibility and Efficiency of Use. In general, the evaluators found the redesign to be effective and that the system was overall pleasing to use. However, given the limited timeframe of this research, we were unable to conduct actual real-world experiments with the users to further test out the practical implications of our proposed design. Future research may wish to continue on the iteration of this interaction design cycle, by conducting empirical studies with users to identify areas for the adjustment and finetuning of the design prototype. Such studies would likely yield useful insights that could culminate in a final design proposal to be submitted to IXL for consideration. Furthermore, a follow up discussion of the findings identified in this entire design process is recommended to draw out general insights that may be applicable to future e-learning platform design efforts.

Group Profile

Name	Matriculation Number	Roles
Jason Lee Jie Shen	G1701844A	UI Design
Juan Paolo De Torres Mirano	G1701324F	Design Evaluation
Nah Zheng Xiang, Philson	G1701513D	Design Evaluation, Analysis
Xue Fei	G1701182G	Requirements Gathering
Ya Min Oo	G1701265D	Design Evaluation

Appendices

Appendix 1: Prototype Designs

Figure 1. Log-in page

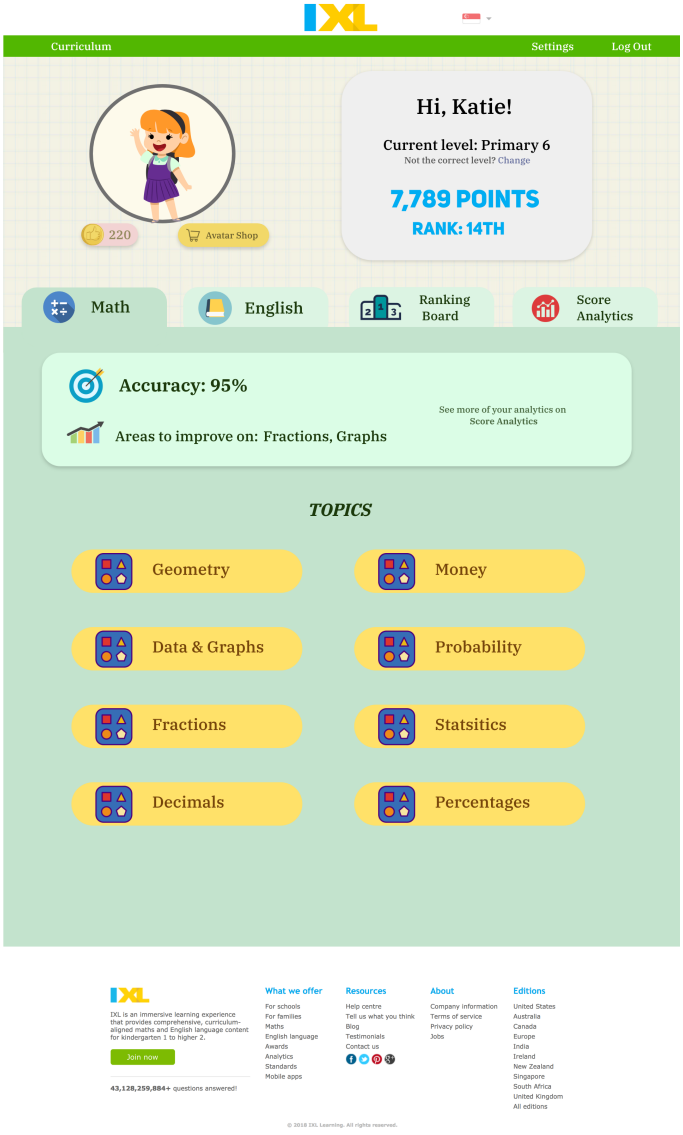

Figure 2. Math page for Primary and Secondary Students showing user profile and math topics

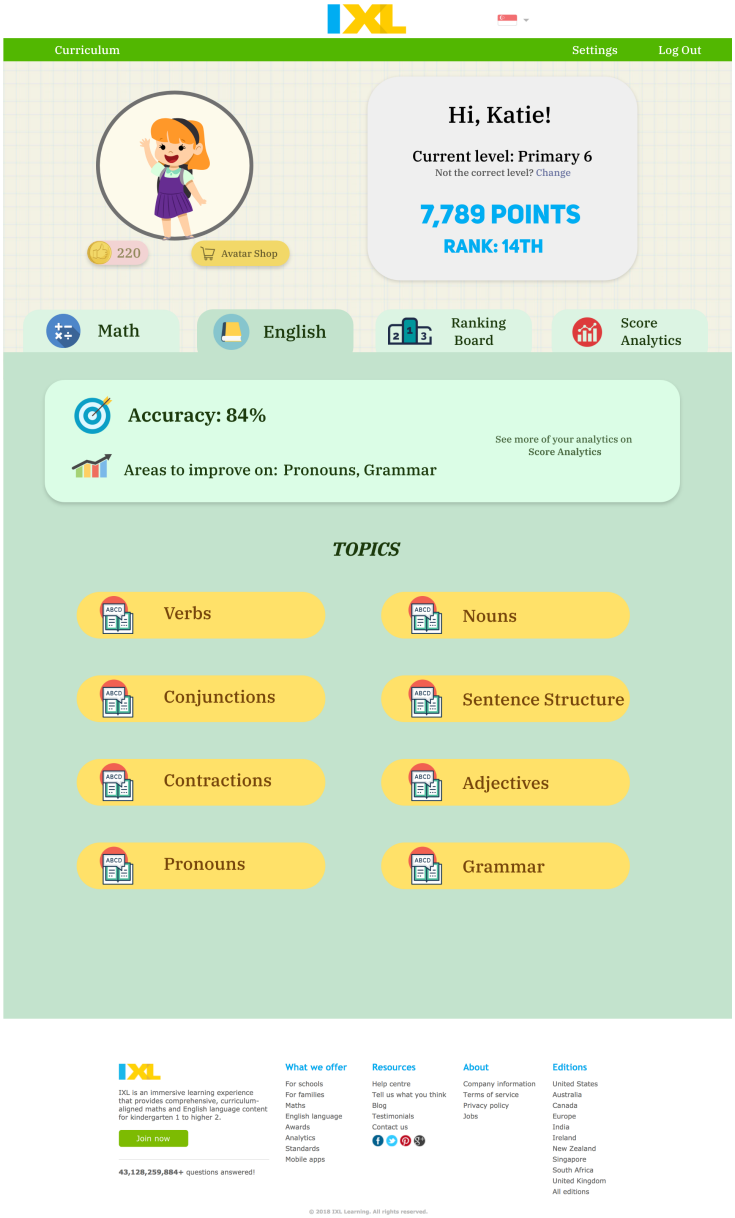

Figure 3. English page for Primary and Secondary Students showing user profile and math topics

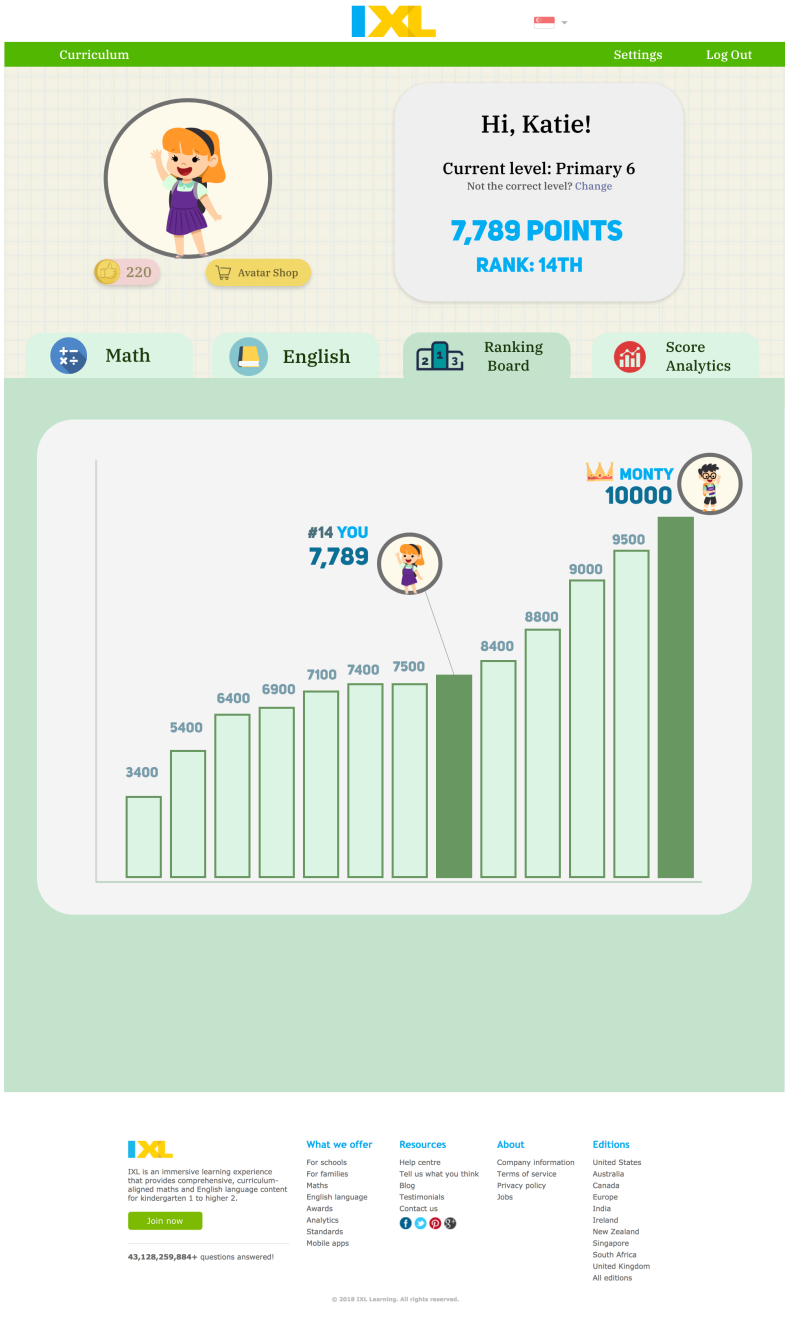

Figure 4. Ranking page

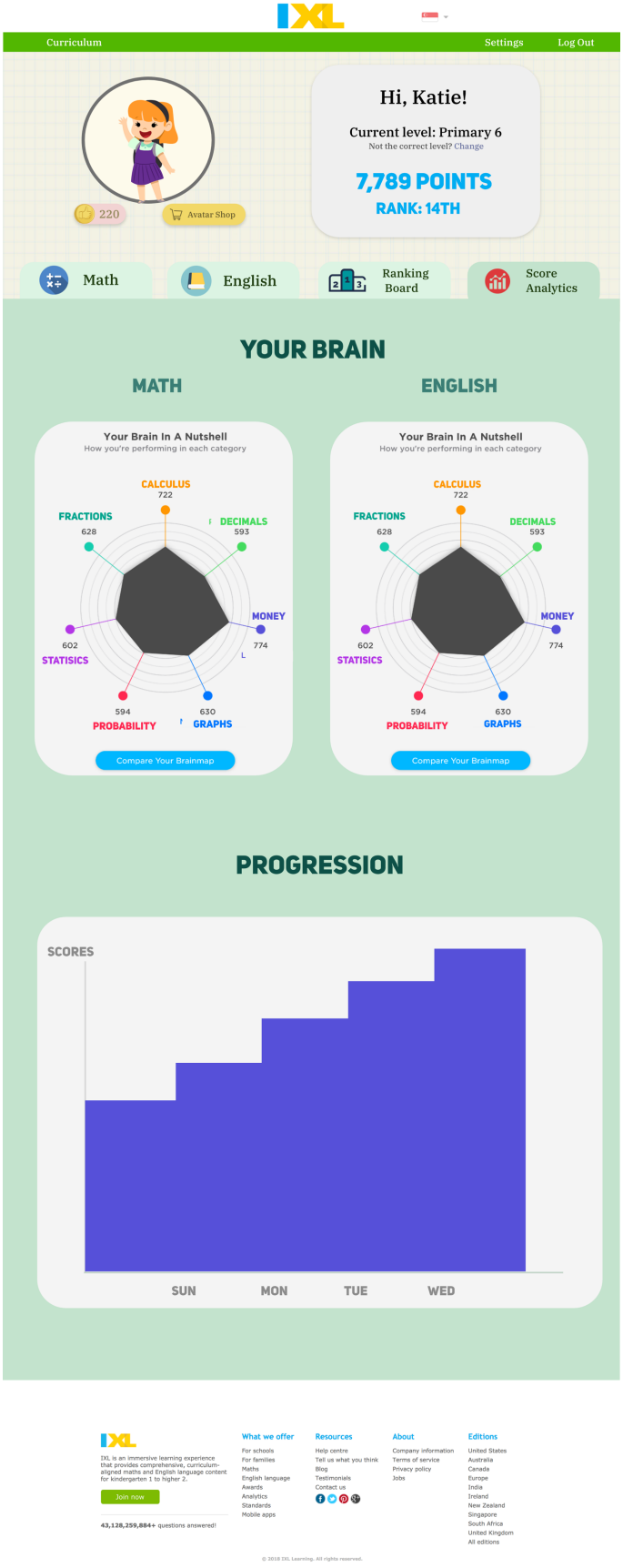

Figure 5. Score analytics page

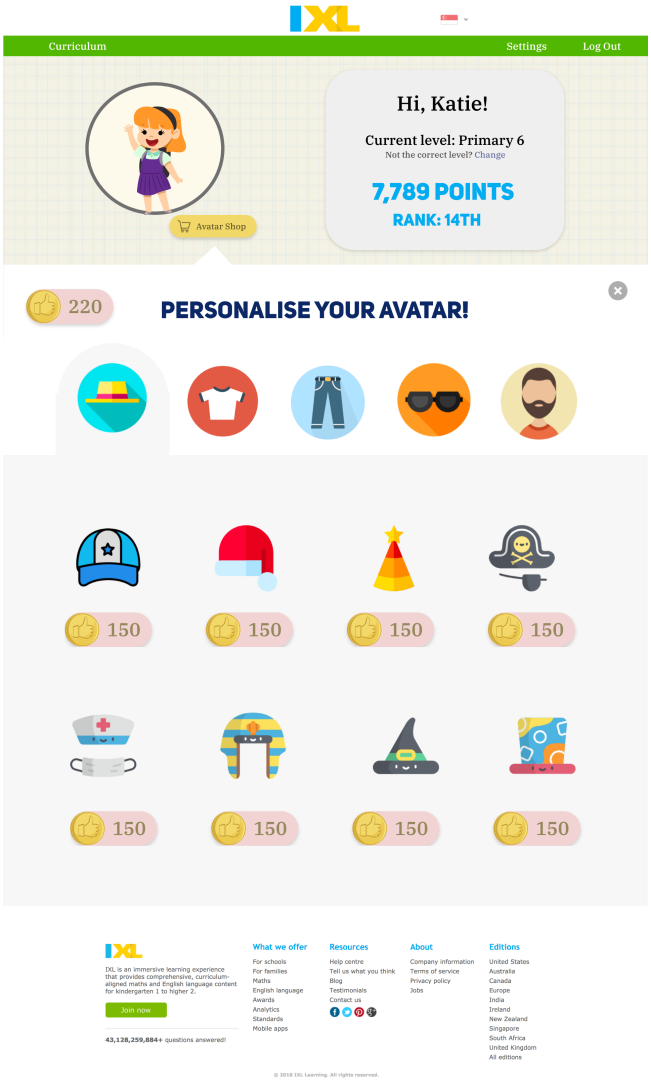

Figure 6. Avatar Shop

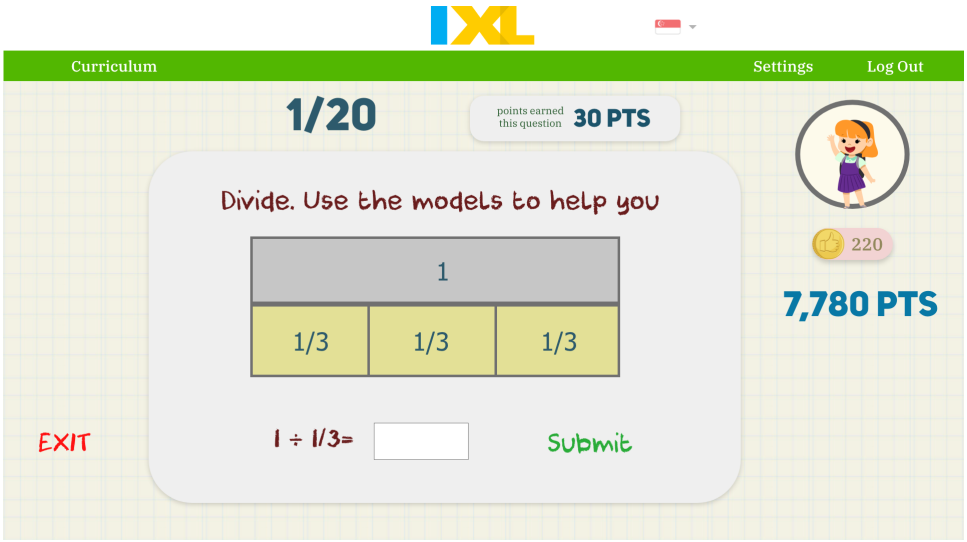

Figure 7. Lesson page

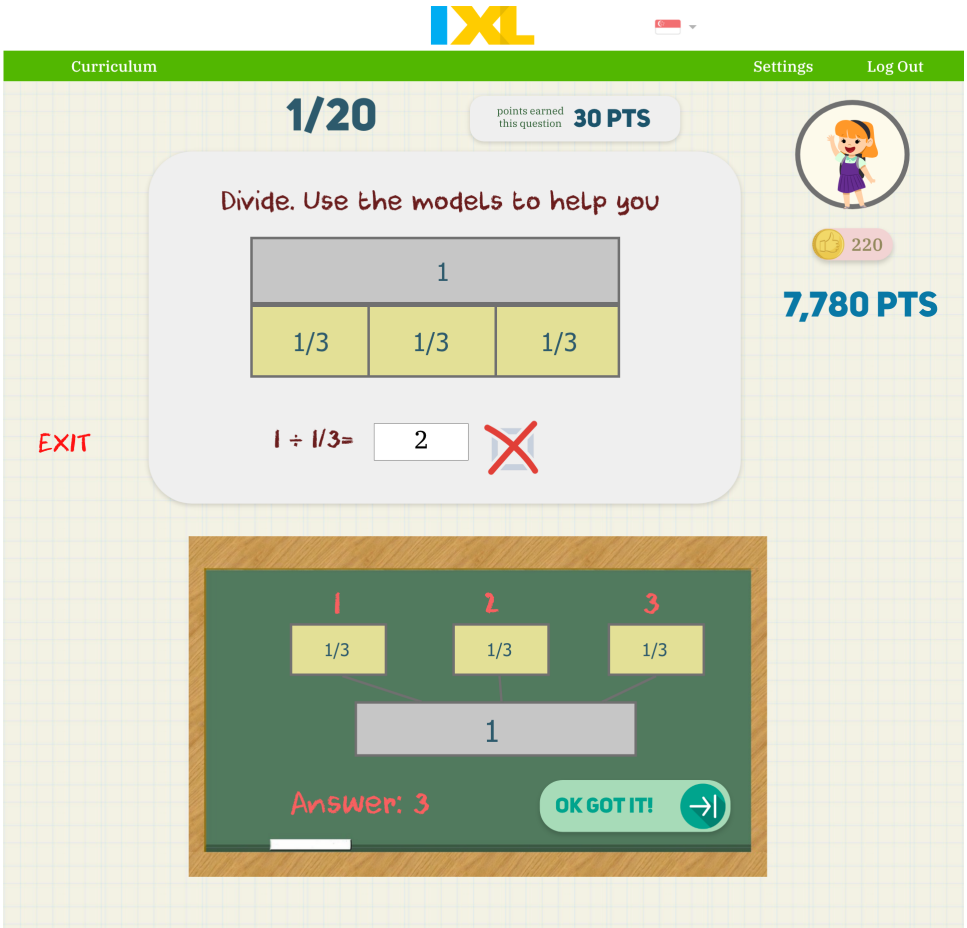

Figure 8. Lesson page with instructions on the correct answer

Figure 9. Math and English page for Kindergarten kids

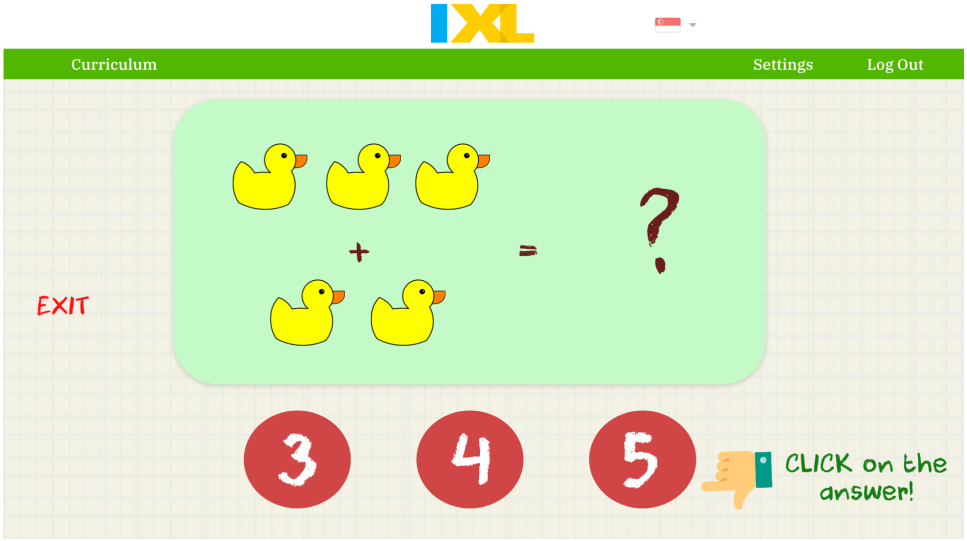

Figure 10. Lesson page for kindergarten

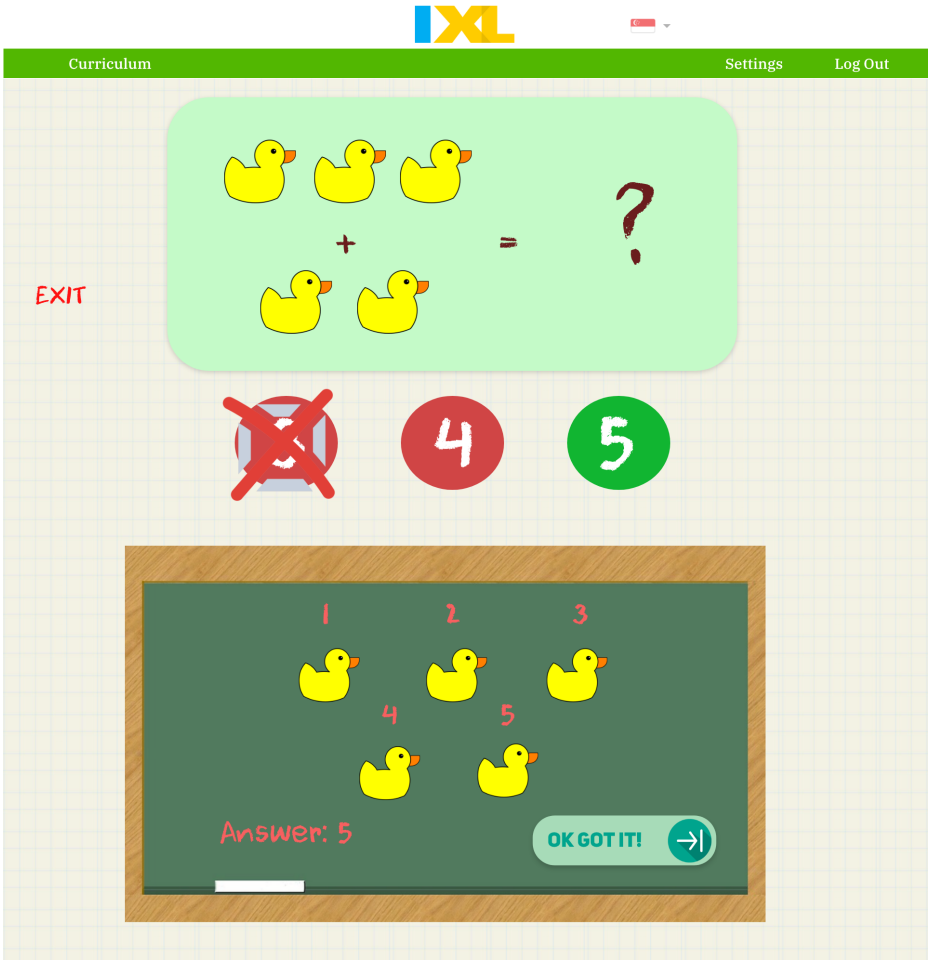

Figure 11. Kindergarten lesson page with instructions for correct answer

Bibliography

1. Couse, L. J., & Chen, D. W. (2010). A tablet computer for young children? Exploring its viability for early childhood education. *Journal of research on technology in education, 43*(1), 75-96.
2. Tahir, R., & Arif, F. (2015). Mobile technology in children education: Analyzing parents' attitude towards mobile technology for children. *Science and Information Conference (SAI)*, 410-420.
3. Van Merriënboer, J. J., & Ayres, P. (2005). Research on cognitive load theory and its design implications for e-learning. *Educational Technology Research and Development, 53*(3), 5-13.
4. Docebo. (2016). *Docebo.* Retrieved from ELEARNING MARKET TRENDS AND FORECAST 2017-2021: https://eclass.teicrete.gr/modules/document/file.php/TP271/Additional%20material/docebo-elearning-trends-report-2017.pdf
5. Wohlwend, K. E. (2010). A is for avatar: Young children in literacy 2.0 worlds and literacy 1.0 schools. *Language Arts, 88*(2), 144.
6. Miller, E. B., & Warschauer, M. (n.d.). Young children and e-reading: research to date and questions for the future. *Learning, Media and Technology, 39*(3), 283-305.
7. District Administration. (2014). *District Administration*. Retrieved from Personalized recommendations system introduced: https://www.districtadministration.com/news/personalized-rcommendations-system-introduced
8. IXL. (2018). *IXL Learning*. Retrieved from OUR STATS: https://sg.ixl.com/company/stats
9. Nielsen, J. (1995). *Severity Ratings for Usability Problems*. Retrieved from Nielsen Norman Group: https://www.nngroup.com/articles/how-to-rate-the-severity-of-usability-problems/
10. Hanna, L., Risden, K., Czerwinski, M., & Alexander, K. (1999). The role of usability research in designing children's computer products. In *The Design of Children's Technology* (pp. 4-26).
11. Nielsen, J. (2010, September 13). *Children's Websites: Usability Issues in Designing for Young People*. Retrieved 2018, from Nielsen Norman Group: https://www.nngroup.com/articles/childrens-websites-usability-issues/
12. Nielsen, J. (1995, Janauary 1). *How to Conduct a Heuristic Evaluation*. Retrieved 2018, from Nielsen Norman Group: https://www.nngroup.com/articles/how-to-conduct-a-heuristic-evaluation/
13. Strommen, E. (1994). Children's use of mouse-based interfaces to control virtual travel. *ACM Conference on Human Factors in Computing Systems* (pp. 34-46). New York: ACM.
14. Nielsen, J., & Gilutz, S. (2002). *Usability of websites for children: 70 design guidelines based on usability studies with kids.* Nielsen Norman Group Report.

15. HCI FOR KIDS. (2009). In A. Bruckman, A. Bandlow, & A. Forte, *Human-Computer Interaction: Designing for Diverse Users and Domains* (pp. 33-46).

16. Nielsen, J. (2010, September 13). *Children's Websites: Usability Issues in Designing for Young People*. Retrieved from Nielsen Norman Group: https://www.nngroup.com/articles/childrens-websites-usability-issues/

17. Large, A., Nesset, V., Beheshti, J., & Bowler, L. (2004). Criteria for Children's Web Portals: A Comparison of Two Studies. *Canadian Journal of Information & Library Sciences*.