A New 'App'roach to Enhance Learning and Improve Safety with Driving

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Abstract

Over the last year, COVID-19 has impacted many driving students. Lessons and tests have been cancelled, and many new drivers have forgotten aspects of what they have been taught. This brought about the concept of "A New 'App'roach to Enhance Learning and Improve Safety with Driving". The purpose of this project was the creation of a driving simulation app to teach users the controls of a car and the rules of the road in a simulated environment. The hypothesis was that a driving simulation app would effectively enhance learning, safety, and awareness while driving, by training the user to incorporate road rules without the use of a car and to begin forming procedural, rather than declarative, memory though repetitive action.

Initially, an interest survey was created to judge the community's response to the concept. The response was extremely positive, so development began using the Unity development platform. Throughout the app's alpha-testing, feedback was received which molded the app over time into its current beta-version. The app was then opened up to a larger pool of testers, whose feedback was used to gather the results of the app's effectiveness.

Overall, the feedback received was very positive, and supports that this app has improved driving awareness and enhanced student learning. In order to resolve the remaining factors of the hypothesis, further research will be required upon the app's full release. Should this app prove to aid new drivers, it will have many uses. It could be a valuable tool used by both driving centres and individual students looking for practice. It could also be used to rehabilitate car crash victims without risk, and to introduce the controls of a car to a younger audience before they are old enough for lessons.

Introduction

The COVID-19 outbreak has had a significant effect on those learning to drive. Due to the minimum time requirement between the conclusion of driving lessons and the taking of a G2 test, many people who took lessons before, or who were still taking lessons when lockdown hit, have been unable to take their tests. This has led to many forgetting the less well-known rules of the road that are required for a successful test. In a driving lesson these rules are driven into students minds by repetition and are pointed out when missed. However, there is currently little to no alternative to this method outside these lessons. This prompted the development of this project; a driving simulation app designed to teach new drivers the rules of the road by allowing them to drive a realistic feeling car around a simulated environment as might be seen when truly driving, where mistakes are pointed out as soon as they occur. The goal is that this app would greatly aid those impacted by COVID-19. It is also possible that the app could be used by driving centres such as Young Drivers, as part of the E-learning section of their course, should it prove to be effective. This could improve students' ability to handle a car even before stepping into one, improving safety.

The support towards the effectiveness of this app is gathered from the feedback received during the alpha and beta-stages of development, which gives great insight into how this app could be used. The version of the app mentioned in this report is far from the last, as there are many plans for further developments following BASEF, which should further improve its efficacy.

Driving is an important skill, but it is also dangerous, so it is extremely important to optimize the learning process to every extent, which is the goal of this app.

Hypothesis

A driving simulation app will effectively enhance learning, safety, and awareness while driving, by training the user to incorporate road rules without the use of a car and to begin forming procedural, rather than declarative, memory though repetitive action.

Background Information

When studying for a test, information is often placed in the student's declarative memory, as it is not repeatedly engrained. Declarative memories are memories that require a conscious effort to be recalled. Due to their nature, they are often forgotten once they are no longer required. In driving, this can be dangerous, as new drivers may memorize road rules to pass a test, but quickly lose many details of this information, resulting in improper driving habits. To improve safety, procedural memories must be formed. Procedural memories are memories formed through repetition. An example would be learning to walk or ride a bike. The brain learns from repeated attempts and mistakes, until eventually these actions become unconscious, and are very rarely forgotten [3, 7]. If the rules of the road are engrained into the procedural memories of new drivers through repetitive experiences and feedback, they will in theory be less likely to break those rules unintentionally in the future. Currently, these memories are not being formed due to the large gaps between lessons throughout COVID-19.

This brought about the idea of a driving simulation app designed to improve the awareness and understanding of drivers through the development of procedural memories. The app would provide a simulated environment and realistic car controls, in which mistakes are immediately displayed. This could allow users to begin forming these procedural memories prior to entering a vehicle for the first time.

A similar process has been proven to help new pilots. In 2016 an experiment was conducted on groups of pilots. One group used a realistic flight simulator that promoted repetition, while the other used a more general simulator. The first group were able to more quickly adapt to situations in their tests than the second, as the repetition had improved their procedural memories [5]. It is a fair assumption that perhaps a driving simulator encouraging repetition could have a similar effect.

This question prompted the creation of a survey to gauge community interest in such an app, and to inquire into preferences surrounding its development. The response to this concept was very positive. From a question on how people had studied for their G1 (road rules test) in the past, it was clear that the vast majority of drivers had not used a driving simulator to engrain these rules

(Figure 1). Additionally, a search for such apps on Google Play showed that while similar apps existed, they were uncommon, and did not focus on repetition. The survey also showed that around 85% of drivers would have used a simulator had one been available and its existence made clear (Figure 2). With this information, development began on an app that would fill these criteria.

How did you / will you study for your G1 driving test?
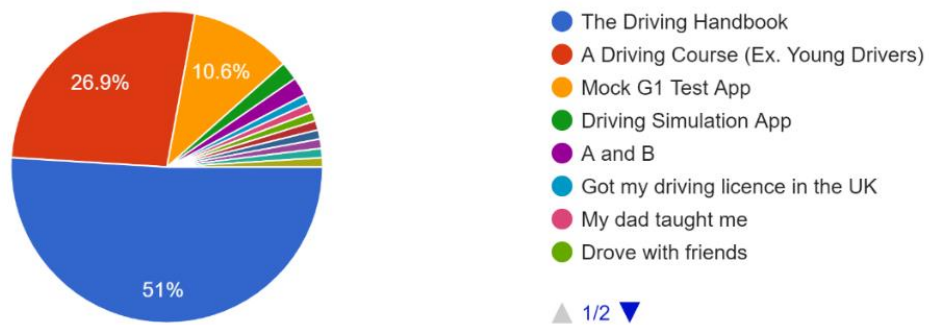104 responses

Figure 1: A pie chart showing the way new drivers studied for their G1 (road rules) test.

How likely would you be / would you have been, to use a driving simulation app that teaches the rules of the road?
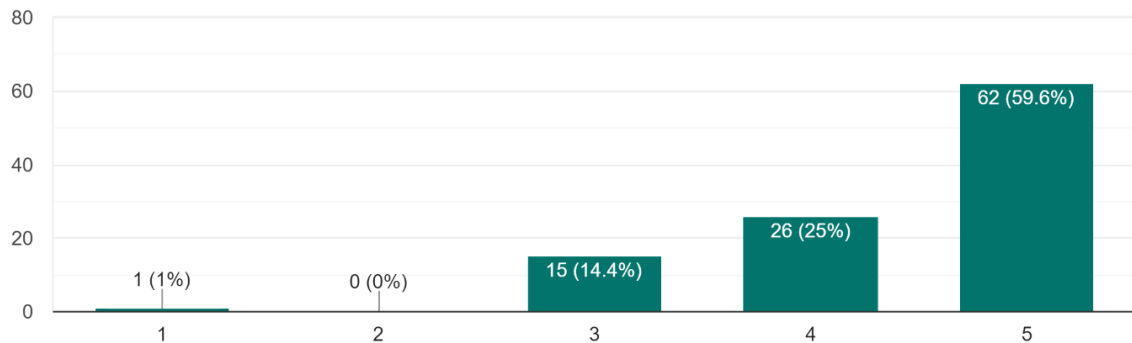104 responses

Figure 2: A bar graph showing community interest in a driving simulation app for teaching rules of the road. Ranges from not likely (1), to very likely (5).

Materials

Due to the nature of this project, there are no materials that can be measured, and it is entirely possible to create this project from scratch using nothing but a computer, a development platform, and a programming language. Despite this, in order to save time, many assets were taken from the Unity Asset Store. Care was taken to avoid any assets that could have copyright issues in the future. Additionally, low poly assets were used when possible, as they create less lag on mobile devices. A list of these assets and a brief explanation of each can be seen below.

Material	Description
Unity	A real-time development platform that contains a large number of useful features for game development, and can be used for publishing on PC, Android, and iPhone. It provides a 3D environment for creation, and an asset store containing many useful models. Unity supports C# as a programming language.
Visual Studio	An Integrated Development Platform (IDE) that supports the C# programming language, which is used in Unity. This IDE makes programming much simpler, by providing in depth explanations of commands and incorporating code completion, which saves a great deal of time.
Low Poly Destructible 2 Cars no. 8	An asset containing a single, unbranded car, for use as a player character. This car came with separate brake and reverse light materials for colour manipulation but had no indicators.
FREE Traffic Essentials Asset Pack	An asset containing a small selection of roadside objects, including pilons and some very basic speed signs. The current version of the app only uses the traffic lights from this pack.
Low Poly Road Pack	An asset containing a large selection of basic road types. These roads are used in the app's current version.
Ultimate Traffic Sign Collection	A paid asset that provides a large, detailed selection of every Canadian road sign, including all speed and warning signs. Many of these signs are currently used in the app.
Simple Input System	An asset that provides intricate buttons/controls for user input. The steering wheel used in the app is an example of one of these input methods.
ENGINES	An asset containing an assortment of looping car engine sounds, used for the apps sound effects.

Table 1: A list of materials, mostly consisting of Unity Assets, that were used in the creation of the driving simulation app. Brief descriptions of each material are also listed.

Procedure

After creating the interest survey for the app and receiving extremely positive feedback (see *Background Information)*, development of the app began. Before starting, an understanding of Unity was required. This was acquired from courses on Unity Learn [6]. Throughout this project, new commands and coding approaches were found using Unity's scripting API [12]. After this, the first step was to create a plan for the rest of the project and create an organized environment for coding. A list of requirements and potential user stories was created as a rough goal to work towards throughout the available time. Some of these goals were reached and some were not, due to either time restraints or lack of experience, but having a plan made the development process much clearer. For organization, a system architecture was chosen in order to keep control of the app's many scripts and the way they communicate. The layered approach was chosen, meaning that one main script manages a set of lower managers, which then manage the remaining scripts, much like an order of command in a company. This meant that no matter how much code was added, it was still possible to keep track of all the processes. Bug fixing throughout this project was aided by Unity Answers [13] and Stack Overflow [10].

The first goal was to incorporate some basic player control. To accomplish this, a ground object was added, along with a basic car asset to drive around on it. It took around a day to make the movement feel realistic by having the wheels turn to direct movement [1]. At this stage, the car was controlled by a keyboard. Some aspects such as speed and braking force were hard to judge due to the ground being untextured, so it became apparent that some form of roads would be needed to progress. A multitude of road assets were trialed, but many had issues such as different sections not linking together easily. The "Low Poly Road Pack" was eventually settled on, as it was modular, and made it much easier to create maps, while also causing less lag. The point of reference that these roads provided made it much simpler to improve the controls system by tweaking brake and accelerator force. The speedometer was also added at this stage.

When the player movement felt accurate, development moved towards the development of rules of the road. For each rule, a small scene was created, typically just one road with an

intersection. Over the next few days, stop signs, speed signs, and traffic lights were added. They functioned on a trigger system, meaning that when the player hit an invisible box next to them, the rules would be checked. These rules were taken from *The Driving Handbook* [8] and included all the parts associated with each sign and traffic light, including more complex ones such as the Point of No Return (PONR) rule for traffic lights, and easily forgotten ones such as waiting for 3 seconds at stop signs. At this stage, a GitHub repository was created for the app to ensure that all work was safely backed up. The project was pushed to this repository every day from this point forth.

With some basic rules in place, the next week of development was put into the creation of a map where all of these features could be displayed at once. This map was rather large and took many days to create and to populate with road signs and other features, such as winding roads and a car park. This new environment made many issues apparent. The trigger system for example, was flawed, as triggers are omnidirectional, meaning that driving past a stop sign from behind caused a "Did Not Stop at Stop Sign" error, despite there being no requirement to stop. This was fixed by adding additional triggers at the entrances and exits of the previous triggers and coding them to make the triggers one way only.

At this stage, work began on converting the app from PC to Android. This started with the addition of new controls to replace the keyboard ones, including a functioning steering wheel and an accelerator and brake button. Care was taken to ensure that the steering wheel functioned identically to one in a real car, by including aspects such as the wheel returning when released, causing oversteer. An attempt was then made to create a screenshot system that would, at the end of a play session, show the screen at the moment every rule was broken. While a good idea, it proved to be too complex for this project, as since the screenshots must be saved, file management was required. This made an upload to Google Play much more difficult, as user permissions were required. The idea was eventually put on hold in order to focus on more important areas. This provided helpful insight into what was and was not possible in Unity given the time constraints, improving the effectiveness of future work. The app was now converted to Android, and the process began for an upload to the Google Play Store. Before being added, the app had to be

reviewed, which took around a week. The original plan had been to also upload the project to the iPhone App Store, but this process turned out to be much more involved, so time constraints have forced this to be pushed back to a later date.

During the review process, the focus swung to the creation of a basic User Interface (UI). This included a title screen, controls screen, and settings screen, along with buttons for accessing the main menu/title screen while playing. In the initial interest survey, there was a question regarding the preferred view for the game. The response to this question was an almost 50/50 split between third and first-person perspectives. Due to this, the option to switch between third and first-person was added to make the experience better for everyone. Additionally, a rear mirror view was added to aid with reversing in either view. Finally, engine sound effects were added to the car, and programmed to adjust pitch based on speed.

When the app was reviewed and uploaded to Google Play, the first wave of testing began. A full beta release was not yet ready, so this wave simply consisted of four people, who provided their first impressions. This being the first test of the app on mobile, some issues immediately became clear from feedback. It was very easy to get stuck on the curb of the road hitboxes, or to fall off the map. The braking was also too slow, and it was difficult to be precise with the steering wheel. Using this feedback, theses issues were fixed by improving road hitboxes, increasing braking force, and enlarging the steering wheel to allow for more precision.

Running low on time, the final feature added were indicators. Since no indicators were present on the car asset in use, new ones were modelled and textured. Rules surrounding these indicators were also added. They must be active whenever turning at an intersection, and if the right indicator is active, right turns at red traffic lights are accepted. After another small test, feedback was received that the indicators were too sensitive in some areas, triggering for example when turning the wheels while still. This issue was fixed.

This left the app in its current state. At this stage, the app was ready for a full beta test, so testing was opened up to those who agreed to beta-test in the initial survey. The feedback from these testers, along with that of the initial testers, provided the information required for the results.

Results

The overall feedback given by the beta-testers for this driving simulation app was very positive, especially considering the fact that this app is far from complete. This supports the results received from the interest survey, in which 85% of people said that they would like such an app. Unfortunately, finding active beta-testers was difficult, since the app is so new, and it is currently unavailable on iPhones. Despite this, enough feedback was gathered to make a prediction on whether this app could meet its purpose.

The following are some quotes from the received feedback:

- "FYI I have 10 years driving experience and did driver training in class room and in person. […] Overall my impression is that this app would definitely have benefit to new drivers. At a minimum it demonstrates to new drivers the level of attention driving requires, as well as provides an opportunity to experiment with the way cars handle. […] the app definitely reminded me of how much you need to watch road signs in unfamiliar situations. The first while I missed speed limit changes or upcoming stops. This improved as I used the app." [11].

- "Great job! I think there's definitely a lot of potential here! The app as it stands can be helpful at practicing awareness, like attending to the driving and controls and speed which simulates a real driving experience in a way. […] It could be a great feature for driver's ed right now with the pandemic and social distancing restrictions where it's harder for drivers to be in the same vehicle as students." [2].

- "I think once it's fully developed it will be a great tool for beginner drivers!" [4].

There was also feedback surrounding aspects that testers did not like, or felt were missing from the app. However, all such issues were not related to the app's core and were rather aimed at aspects that are planned for refinement in future updates. They were mostly small issues such as no stop lines at stop signs and traffic lights, or difficulty seeing traffic light colour from a distance. Another aspect some testers struggled with was learning the controls, as they closely mimic those of a real car, which can be confusing at first. This should be easily fixed in a planned update that will introduce a few tutorials for car control.

It is clear from the positive feedback from testers that the app has the potential to be a helpful tool for new drivers. It is also shown that the testers' awareness improved throughout use of the app, meaning that this app may well enhance learning and safety.

Discussion

The results found during this project show that even while incomplete, this driving simulation app is able to improve a user's awareness and understanding of car controls. As more features are added, this app will likely become more effective, as users will be forced to keep track of many rules at once. This should prompt the development of procedural memories in order to manage every situation. This app points out every mistake, even small ones that many people miss, such as stopping for three seconds at stop signs, ensuring that all rules are followed.

It is too early yet to conclude whether this app can in fact promote these memories, or improve safety, but it can be predicted from feedback that it will. As development progresses, more feedback will be obtained, which will further refine results. Once the app is out of beta and released to the public, more informative research will be possible. The ideal test would be to take two groups of new drivers, one of which would use the app, while the other did not. The performance of these two groups could then be compared to discover the effects of the app, resulting in far more accurate results.

Should this app be proven to improve user's awareness, understanding of road rules, and/or safety, it could be implemented into the curriculum for driving centres to help new drivers. Many driving centres, such as Young Drivers of Canada, already incorporate an e-learning segment into their courses in order to teach some essential skills before a student takes their first lessons. However, these courses are not interactive, and mostly revolve around watching videos and answering questions regarding said videos. If these e-learning segments were to include a driving simulator similar to the one created in this project, it could test students on what they have learned by allowing them to drive in a realistic environment using real car controls. If interspersed throughout an e-learning course, segments using this app could provide a welcome change from other segments, and make the course feel less repetitive.

Outside of official courses, this app could also be kept available on both Google Play and the App Store. This would enable new drivers who find it, either through advertising or use in a larger course, to use it to prepare for both their G1 and G2 tests. This app could also be very helpful

to new drivers who don't yet own a car as it would allow them to practise, in a fashion, between lessons. This may improve the safety of instructors as well as students, as it could reduce the risk of accidents due to lack of practice.

This app could also aid those who have been involved in car accidents, and are afraid to return to driving, as it provides a risk-free environment to relearn any rules or control aspects that may have been forgotten. When this project was first presented to the community, one person stated, "I honestly think this is amazing. I need to reintegrate back to driving due to a car accident, having this type of program would really help a lot of people, not only people learning to drive, but others needing a refresher course or like me, getting back behind the wheel after a car accident." [9]. This shows that there are currently few known alternatives for people in this position, so this app could be extremely helpful.

Another member of the community stated, "I have an 8 yr old who would practice on this app for the next 8 years til she can get her license. It's all she has talked about since she was about 2!" [9]. This brings to light another use for this app. It can begin teaching children the controls of a car and the rules of the road before they are old enough take their lessons. Use of the app in this way could greatly improve the readiness and understanding of new drivers, as they would already have had experience controlling a car before ever getting behind a wheel. Most driving games present to a younger audience use oversimplified car controls. This can lead to the belief that steering is more difficult than it really is. This app could help solve this issue by more accurately representing a true driving experience.

Conclusion

The hypothesis for this project was that a driving simulation app could effectively enhance learning, safety, and awareness while driving, by training users to incorporate road rules without the use of a car and to begin forming procedural, rather than declarative, memory though repetitive action.

Parts of this hypothesis have been answered, others require more research. From feedback given by beta testers it appears that the app will likely enhance the learning and awareness of drivers, and it is even more likely to do so as it is further developed. Other aspects, such as improved safety, and the formation of procedural memories, could not be confirmed from the acquired feedback.

Overall, more testing is required to answer the initial hypothesis, but should the app be found to aid new drivers, it could be a valuable tool used by both driving centres and individual students looking for practice. It could also be used to rehabilitate car crash victims without risk, and to introduce the controls of a car to a younger audience before they are old enough for lessons.

Acknowledgements

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Appendix

Initial Interest Survey:

https://docs.google.com/forms/d/e/1FAIpQLScjNTQSBuJ3EI20YD6F3BggRPOSNZAXcdeipke gWt68PS2rDg/viewform?usp=sf_link