Rules on Wheels: A Serious Game for Teaching Traffic Signs

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***Abstract*—Serious games are games that not only entertain but also target solving real world problems. Despite the fact that serious games can be entertaining, the primary purpose behind a serious game, among other things, is to educate the user. In this paper, we report on the design, implementation and evaluation of a serious game for learning Egyptians' traffic laws. In Egypt, road accidents are a major cause of casualties and injury. *Rules on Wheels* is a game developed to enhance the traffic law knowledge of its players through a fun and engaging experience. A formal experiment has been conducted to evaluate the effectiveness of the game in teaching traffic signs. Results show that the game outperforms conventional methods, in both effectiveness and engagement. Thus, *Rules on Wheels* can successfully improve the traffic law knowledge of the general population. Moreover, since it is an engaging game, it could be the motivational factor needed for Egyptians to learn about traffic laws.**

Keywords*—serious games, educational games, civics games, traffic laws, human-computer interaction, flow.

I. Introduction

Road crashes is a major cause of death and injury around the world. Around 1.3 million people die in crashes and more than 20 million get injured [1]. Egypt was ranked in the top ten countries by the **W**orld **H**ealth **O**rganization(WHO) in terms of road deaths [4].

One of the important reasons behind increased road crashes is the fact that drivers do not follow traffic laws. Many of the traffic law violations are due to the lack of knowledge regarding the rules of the road. Vehicle handling skills and driver training have been the main focus of previous research, and limited attention has been given to the impact of traffic law knowledge [9]. A necessary step for drivers to drive safely is to have extensive knowledge of traffic laws [9], specially about traffic signs. Therefore, a significant and crucial factor in reducing driving violations is to motivate drivers to update and upgrade their knowledge [9].

In Egypt, the severity of violating traffic rules cannot be overestimated. One of the main contributing factors to this problem is the lack of knowledge regarding traffic signs. Egyptians are not motivated enough to enhance their awareness about traffic signs. This is caused by the obsolescence of traditional techniques used to teach these signs. These techniques mainly are printed pamphlets provided by the driving license examination office or using the Egyptian Ministry of Interior's website which displays traffic signs in a list format [19]. Therefore, a new engaging and effective method is needed to solve this problem.

There has been a growing interest in recent years in computer games that not only entertain but also target solving real world problems. Such games have been commonly referred to as serious games. Although it might seem like researchers have recently discovered serious games but this is not entirely true. Actually serious games have been used throughout history in military training [10]. Several works focusing on the use of serious games in education show that serious games can be an effective instructional tool [2].

Based on the considered related work, designing a serious game for teaching traffic rules could be classified into two main approaches. The first approach is to utilize **M**ultiple **C**hoice **Q**uestions(MCQ) format presented in a game context [15]–[17]. The second approach is to create a simulated environment, where the player drives a car and has to follow the traffic rules to gain points [11]–[14].

The first approach yields a simple game. Moreover, it is easy to include lots of information in the game. On the other hand, the produced game is not as engaging as games with more complex game mechanics.

The second approach has richer game mechanics yielding a more fun and engaging experience. However, designing a game for traffic rules using this approach is challenging due to the large number and different restrictions of traffic signs. This requires a game engine that contains a scenario covering each traffic sign which is very complex. Moreover, in any game design activity, a balance must be maintained between features replicating real life experience and fictional features which introduce fun in the game. Presenting traffic rules and signs in a list format, such as in an MCQ, results in a less enjoyable experience. Departing away from the actual laws and signs and introducing fictional features will make the game less effective. Hence, a balance must be maintained between realistic and fictional features.

The *Rules On Wheels* game presented in this paper was designed to be a mixture between the two approaches. The aim of this research is to investigate the effectiveness of teaching traffic signs through a game-driven interface.

The rest of the paper is organized as follows. Section II presents the implementation of the game including the game concept, theme, mechanics, features and signs used. Section III discusses the evaluation of the game. Finally, we conclude the paper with a summary and some future work in Section IV.

II. Rules On Wheels Game

The design strategy behind *Rules on Wheels* is to embed questions about the traffic laws in a goal-oriented car driving game. While playing the game, the user must answer MCQs presented at specific stages. Having the MCQ part embedded in the game facilitates including all the signs without affecting the game play. The car game concept ensures having a dominant gaming component.

Since the game consists of two separate modes (the quiz mode and the car game mode), finding the right theme and game mechanics was a crucial issue. The game mechanics and theme were chosen to make the game as engaging as possible, while ensuring the harmony between the two modes.

A. System Implementation

The game was developed using Phaser [5]. Phaser is an open source HTML5/JavaScript-based game engine. The game was embedded in a client/server web application which was implemented using Ruby on Rails [6].

B. Theme

The game takes place in a driving license exam area. The player needs to pass the exam to get his/her license. To do so, the player needs to impress the examiners. The player is required to drive examiners from one point to another. Each examiner will test two aspects; the player's driving skills and traffic signs' knowledge. The player's practical assignment is to drive the examiners to their destinations. Once an examiner reaches the desired destination, this examiner asks the player questions related to traffic signs, and the player's assignment would be to answer these questions.

The examiners working in this area are short tempered and are concerned mainly with the traffic law background of the applicants. Thus, the faster the player drives, and the more questions answered correctly by the player, the more the examiners are satisfied. Once an examiner leaves the car, another examiner requests the player to come and pick him up.

C. Mechanics

The design of the testing area (see Figure 1) where the game takes place is inspired by the design of Mcity [18]. MCity is a test facility designed to evaluate the capabilities of connected and automated vehicles and systems.

As shown in Figure 1, the top bar of the game displays several items: the current score of the player, session timer, assignment timer, current speed of the car, and nitrous tank. The session timer displays the remaining time left until the game ends. The assignment timer on the other hand displays the time left for the assignment at hand to end. The assignment will be either driving the examiner to a certain destination or answering the questions of the examiner.

The scenario in the game works as follows. A yellow halo will appear in a random location. Next, the player is required to move the car and stop inside the halo to pick up the examiner. Afterwards, a green halo will appear in another random location. At that point, the assignment timer will display the number of seconds given to reach the green halo. The player is then required to move the car and stop in the green halo to drop off the examiner. The player is rewarded for every second left in the assignment timer. If the time expires, no score will be added. Forty seconds are then added to the assignment timer and the quiz panel appears containing a question (see Figure 2). The player then answers the questions as fast as possible. Each time a question is answered correctly, the player gains score. After the time in the assignment timer expires, the quiz panel disappears and a yellow halo will appear at another random location. The scenario repeats afterwards.

Fig. 1. Car game mode: dropping off the examiner

Fig. 2. MCQ quiz mode: player asked questions by examiner

The following features are also available in the game:

- Pilot runs of the game showed that it took the users up to fifteen minutes to see all the traffic signs. Thus fifteen minutes was set as the time of one session in the game.
- As shown in Figure 1, Whenever an assignment starts, several alarm clocks will appear. Each of these clocks will be positioned randomly in one of thirty predetermined locations. Whenever the player collects one of them, two seconds are added to the assignment time.
- As time passes, the time given per assignment de-

Fig. 3. MCQ quiz mode: feedback on giving wrong answer

creases and the number of alarm clocks appearing decreases, thus increasing the difficulty of the game.

- Throughout the game, the player can use the nitrous to speed up the car. Whenever the player is using nitrous, the gas in the tank is being consumed. Once the tank is empty, the player can no longer use the nitrous.
- Entering green areas slows down the speed of the car.
- The game has achievements in the form of medals. Whenever the player's score reaches a certain limit, the player wins a medal accordingly.
- There is a leader board to motivate the players to try to achieve higher scores and beat other players.
- All incorrect choices offered per question were related to traffic signs.
- To ensure the player is exposed to the maximum number of signs per session, no traffic sign will be repeated unless the player has already went through the entire set of traffic signs.
- As shown in Figure 3, whenever the player answers a question, the game would display whether it was a correct or incorrect answer. If the player selected a wrong answer, the correct answer is highlighted.
- Whenever the correct answer is highlighted, shifting to the next question is delayed for a few seconds allowing the player to know the correct answer. The feedback time in both cases (in case the player answered correctly or incorrectly) was determined by getting few users to try the game and record the time needed for them to get the answer. The average of these timings is the feedback time used.

D. Sign Acquisition

The traffic signs used in the game are the traffic signs offered by the Egyptian Ministry of Interior on their official website [19]. All one hundred eleven traffic signs were included. All pictures of the signs and their corresponding definitions were retrieved from the website.

III. Evaluation

In this section, the game evaluation details are presented and discussed.

A. Research Questions

We had two research questions to address in the evaluation phase. The first was to find which interface(game or website) is more effective in teaching traffic signs. The second research question was to investigate the effect of increasing play time on user knowledge of traffic signs. We conducted two experiments; each focusing on one question.

B. Methodology

The evaluation of a serious game could be divided into two main phases [2]:

- Determining if the learning objectives are actually being met.
- Determining if the game is engaging and enjoyable.

Measuring if an educational serious game increases the knowledge of the players is a necessary step to prove its effectiveness. Educational studies that aim to measure differences in educational outcomes between gamified and non-gamified techniques usually use a pretest-posttest between group design [2]. In such studies, participants are assigned randomly to either a "treatment" group or a "control" group [2]. The treatment group plays the serious game and the control group is exposed to alternative instructional methods [2]. Both groups answer a post-test after finishing the experiment. Then, significant differences between the test scores are credited to the serious game [2]. Exposing participants to a pre-test might introduce confounding effects into the experiment [2], [3]. Another problem exists in the between group design that it is almost impossible to completely isolate all of the participants [2], [3].

The first problem mentioned can be avoided by not administering a pre-test. However, since not all users have the same knowledge in traffic signs, the pre-test score is a crucial measurement. As for the second problem, it can be avoided by using a within group design, during which each participant is exposed to the two techniques. However, using this design has a high learning effect [3]. Since learning traffic signs is not a complex task, we followed the between group design.

The same MCQ test was used as both the pre-test and post-test. The test contained all the traffic signs provided by the government website. In order to minimize the disadvantages mentioned before, increase the consistency of the experiment and enhance the accuracy and reliability of the results, a control procedure was adopted. There was no feedback provided during tests to minimize any confounding effects. Participants using different techniques were separated in the experiment sessions. The experiment took place in a controlled environment, where the experimenter always monitored the participants for the entire duration of the experiment. There was only one experimenter conducting the experiment to reduce the chance of bias [3]. The experiment was conducted using the same hardware and software setup.

Measuring the level of engagement is a crucial measurement due to the fact that it is one of the main characteristics of any successful game design. Moreover, academic achievement has been correlated with high levels of engagement [2]. Therefore, the level of engagement could also be used as an indicator to the learning level a serious game is capable of conveying [2]. To measure the engagement of the players, we utilized the flow theory. Flow was described by Csikszentmihalyi as 'the holistic sensation that people feel when they can act with total involvement' [7]. Several scales were used in the experiment to measure flow. The scales used and their analysis are discussed later in the flow analysis section.

C. Experiment 1

1) Participants: Thirty-six unpaid university students, 21 males and 15 females, performed the experiment (age range = 18-23, μ=18.63). Participants did not receive compensation for participation.

2) Design and Measures: There was one manipulated condition, *interface type*, with two levels; *website* and *game*. A between subject design was chosen to avoid learning effects between trials since the same signs were used in the two levels. We computed two dependent variables. First was the post-test score, which is defined as the percentage of trials with a correct answer and it represents the level of knowledge a participant has after the experiment. Second, was the gain, which is defined as the difference between the pre- and post-test scores.

3) Tasks: In the *website* interface, the user is presented with the complete set of signs displayed in a list format to study for 15 minutes, followed by the MCQ post-test. In the *game* interface, the participant plays the game covering all signs for one session of 15 minutes. Next, the participant answers the MCQ post-test.

4) Hypothesis:

- $H1$: Participants who have played the *Rules on Wheels* game will have a better understanding of the traffic signs compared to that of the participants who used the website for the same period of time.

5) Results: An independent sample t-test was conducted to compare the means of the post-test scores of the participants using the *website* (M = 74.83, SD = 13.81) and those using the *game* (M = 85.56, SD = 16.68). There was a significant difference between the two levels; t(34) = 2.10, $p < .05$. A second independent sample t-test was conducted to compare the means of the gain in scores for the two groups. There was also a significant difference between the gain of the participants using the *website* (M = 19.11, SD = 11.00) and the gain of the participants using the *game* (M = 38.22, SD = 9.87); t(34) = 5.49, $p < .001$. Thus, the nullification of $H1$ is rejected.

Table I illustrates the average post-score and gain for all participants. The biggest score and gain were achieved by the group using the *game*.

TABLE I. WEBSITE INTERFACE VERSUS GAME INTERFACE

Score	Website Mean (SD)	Game Mean (SD)
Pre-test	55.72 (12.60)	47.33 (13.85)
Post-test	74.83 (13.81)	85.56 (16.68)
Gain	19.11 (11.00)	38.22 (9.87)

D. Experiment 2

1) Participants: Eighteen unpaid university students, 11 males and 7 females, performed the experiment (age range = 18-24, μ=18.78). Participants did not receive compensation for participation. Data from the set of 18 participants using the *game* interface in experiment 1 was utilized.

2) Design and Measures: There was one manipulated condition, *game sessions count*, with two levels; play *once* and play *twice*. Similar to experiment 1, a between subject design was chosen and we computed two dependent variables, the post-test score and the gain.

3) Tasks: In the play *twice* group, the participant plays the game covering all signs for two sessions consisting of 15 minutes each. Afterwards, the participant answers the MCQ post-test.

4) Hypothesis:

- $H2$: Participants who have played the game twice will have a better understanding of the traffic signs compared to that of the participants who played the game once.

5) Results: An independent sample t-test was conducted to compare the means of the post-test of the participants playing the game *once* (M = 85.56, SD = 16.68) and the participants playing the game *twice* (M = 96.27, SD = 7.24)). There was a significant difference between the two levels; t(34) = 2.10, $p < .05$. A second independent sample t-test was conducted to compare the means of the gain in scores of the two groups. There was also a significant difference between the gain of the participants playing the game *once* (M = 38.22, SD = 9.87) and the participants playing the game *twice* (M = 45.27, SD = 10.27); t(34) = 2.50, $p < .05$. Thus, the nullification of $H2$ is rejected.

TABLE II. PLAYING ONCE VERSUS PLAYING TWICE

Score	Play Once Mean (SD)	Play Twice Mean (SD)
Pre-test	47.33 (13.85)	51.00 (13.11)
Post-test	85.56 (16.68)	96.27 (7.24)
Gain	38.22 (9.87)	45.27 (10.27)

Table II illustrates the average post-score and gain for all participants. The biggest score and gain were achieved by the group playing the game *twice*.

E. Flow Analysis

As mentioned in the previous section, the participants of the experiment answered questionnaires related to flow.

The first scale, which was answered by all participants, involves reporting the self perception of skill and challenge

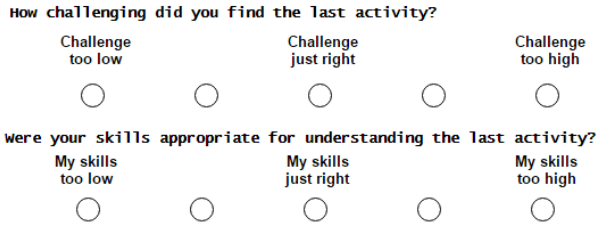

Fig. 4. Challenge-Skill questionnaire

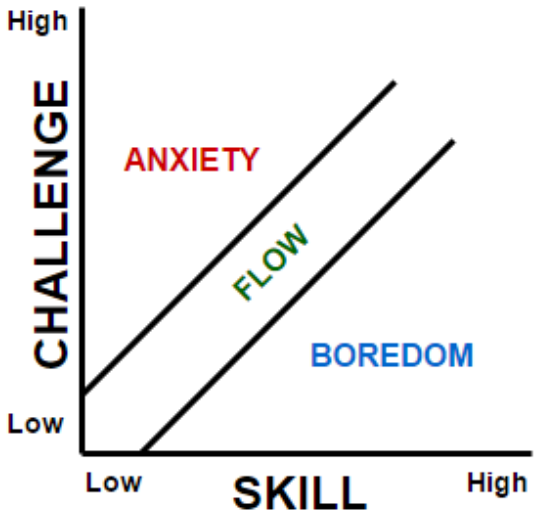

Fig. 5. Csikszentmihalyi's original three-channel flow model

levels (see Figure 4). These two markers have been found to be reliable indicators for being in the flow [7].

According to Csikszentmihalyi's early work, flow was predicted as one channel separating the two states of anxiety and boredom (Figure 5) [7]. The analysis of the skill and challenge measurements is done using this model [7]. According to this model, flow occurs when there is balance between skill and challenge (challenge-skill ratio is 1:1) [7]. This model will be referred to as the challenge-skill scale for the rest of the paper. The challenge-skill scale will be used alongside other scales to measure the flow of the techniques investigated.

1) Hypothesis:

- $H3$: The level of engagement of the participants who have played the *Rules on Wheels* game will be better compared to that of the participants using the website.

2) Website Flow: The results of the skill-challenge scale (see Figure 6 and Figure 7), indicate that the users of the website experience the three states, anxiety (38.89%), flow (27.78%) and boredom (33.33%), almost evenly distributed, with the flow being the least frequent state experienced.

In addition to using the skill-challenge scale, the flow-final scale [7] was used to measure the flow of the participants exposed to the website. The flow-final scale measures the flow of e-learning experience through two main factors: Enjoyment and Control [7]. Five-point Likert-type scales were used to

Fig. 6. Likert scale measures for challenge-skill of website users

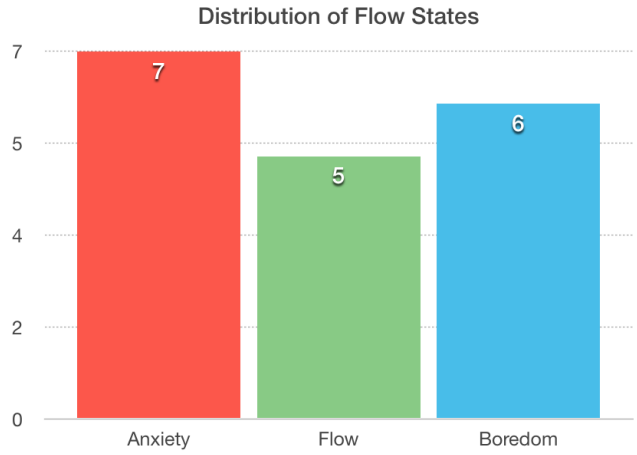

Fig. 7. Frequency of flow experiences of website users

TABLE III. FLOW-FINAL RESULTS

Factor	Mean	SD
Control	0.18	0.47
Enjoyment	-0.22	0.52

present all the items in the flow-final scale, with -1 and 1 representing the lowest and highest level to which participants agree with the items, respectively.

The flow-final overall score was calculated by summing the scores of the two factors (see Table III) [7]. The overall score was -0.04. Based on the fact that the overall score is below 0, we can state that the participants using the website did not experience flow. The two factors of the scale, control and enjoyment, have different scores. The control factor of the scale is positive, indicating that the users felt a sense of control over the task of learning using the website. This was expected, since using a website presenting the content in a list format, whilst simple, does aid in learning. The enjoyment factor on the other hand, yielded a low result of -0.22, which is also predictable, since reading and memorizing traffic signs is potentially boring.

These results indicate that the participants using the website felt a sense of control over the activity, but neither enjoyed nor felt engaged, thus did not experience flow, and this obviously supports *H3*.

Fig. 8. Likert scale measures for challenge-skill of game users

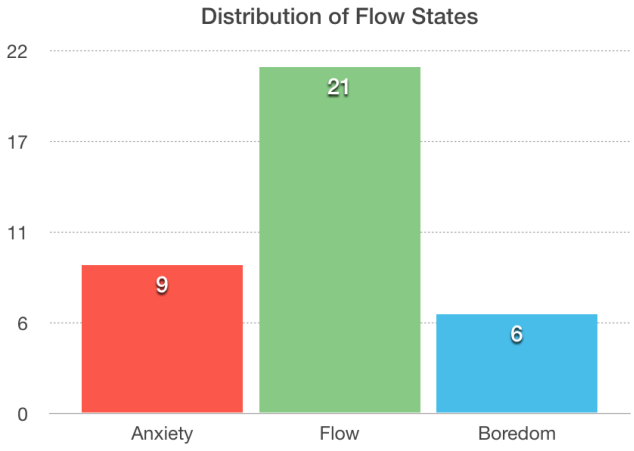

Fig. 9. Frequency of flow experience of game users

3) Game Flow: First, the results of the skill-challenge scale (see Figure 8 and Figure 9), indicate that the majority of the players, 58.33%, experienced flow, 25% of the players were anxious and only 16.67% players were bored. The results also show that most people did not experience extreme anxiety nor boredom states.

TABLE IV. EGAMEFLOW RESULTS

Factor	Mean	SD
Concentration	5.63	1.22
Goal Clarity	6.21	0.98
Feedback	6.14	1.12
Challenge	5.13	1.67
Autonomy	5.70	1.20
Immersion	5.40	1.42
Social Interaction	4.42	2.19
Knowledge Improvement	6.35	0.92

In addition to using the skill-challenge scale, the EGameFlow scale [8] was used to measure the flow of the participants playing the game. The EGameFlow is a scale designed to measure the flow of E-learning games through eight factors: Concentration (6 items), Goal Clarity (4 items), Feedback (5 items), Challenge (6 items), Autonomy (3 items), Immersion (7 items), Social Interaction (6 items) and Knowledge Improvement (5 items) [8]. Seven-point Likert-type scales were used to present all the items in the EGameFlow scale, with 1 and 7 representing the lowest and highest degree to which respondents agree with the items, respectively.

All scale factors scored above 4 (see Table IV), which indicates that the participants experienced flow. It also indicates that the participants who played the game, are satisfied with the eight factors that represent building a successful engaging E-learning game.

The game scored best in the feedback, knowledge improvement and goal clarity. This is due to the fact that all game goals are simple and are explained clearly throughout the game. Additionally, the participants received feedback on every action done in the form of text messages, as well as clear and immediate feedback on the answers provided to the questions. The results gathered from the pre- and post-test show that there is a significant increase in the knowledge of the player, which in turn agrees with the knowledge improvement being the highest score achieved by the game on the scale.

On the other hand, challenge and social interaction factors had the lowest scores. No social feature was provided by the game. Thus, items like "The game supports social interaction between players (chat, etc)" and "The game supports communities within the game", had the lowest scoring items on the scale. Similarly, items like "The game provides video or audio auxiliaries that help me overcome the challenges" and "The game provides different levels of challenges that tailor to different players" scored relatively low scores, due to the fact that the game does not offer different levels nor use multimedia to help players overcome challenges. Due to the simple nature of the task, the players are expected to play the game for a short duration. Hence, utilizing these features probably would not have had a significant impact on player performance.

Despite the previously mentioned points, the results show that players of the game experienced flow and were satisfied with all scale factors which strongly supports *H3*.

F. Discussion

Results show that the engagement level of the people using the website is low while the engagement level of the participants playing the game is high. As shown in Figure 7 and Figure 9, the percentage of participants who played the game and experienced flow (58.3%) is higher than that of the participants who have used the website (27.78%), thus supporting *H3*. Based on the previous, gamifiying the learning of traffic rules is an effective approach.

We believe that the main reason behind the difference between the scores of the participants playing the game and the participants using the website is the high engagement level the game provides. It has been observed that most of the participants who played the game seemed more involved with the game, and were greatly motivated to learn from their mistakes to get high scores, win medals and get their names

on the leader board. On the other hand, several participants who used the website seemed distracted, kept asking how many minutes were left just to finish the experiment and explicitly expressed their boredom. The poor engagement level of studying from the website was probably the main factor behind the participants' low scores.

IV. Conclusion

Our findings show that the *Rules on Wheels* game is a more effective method compared to using the Egyptian Ministry of Interior website for learning the traffic signs. Participants who played the game once, ended up with significantly higher scores in both the post-test and the gain compared to those who used the website. Participants who played the game twice, ended up with significantly higher scores in both the post-test and gain scores compared to those who played the game once. The analysis of flow performed in our research shows that the game had high levels of engagement, while the website did not. We believe that the engagement level is the main reason behind the game participants acquiring higher traffic law knowledge. Our findings back up the trend of using serious games as educational tools and answering this paper's main research question: Is the *Rules on Wheels* game an effective learning traffic signs tool?

In the future, we will be extending the game to include the entire traffic law rules and regulations and attempt to study the long term effect of playing the game regularly on participant driving performance.

References

[1] "Road Crash Statistics", Asirt.org, 2016. [Online]. Available: http://asirt.org/initiatives/informing-road-users/road-safety-facts/road-crash-statistics. [Accessed: 15- Mar- 2016].

[2] F. Bellotti, B. Kapralos, K. Lee, P. Moreno-Ger and R. Berta, "Assessment in and of Serious Games: An Overview", Advances in Human-Computer Interaction, vol. 2013, pp. 1-11, 2013.

[3] J. Lazar, J. Feng and H. Hochheiser, Research methods in human-computer interaction. Chichester, West Sussex, U.K.: Wiley, 2010.

[4] "Global status report on road safety 2013", World Health Organization, 2016. [Online]. Available: http://www.who.int/violence_injury_prevention/road_safety_status/2013/en/. [Accessed: 16- Mar- 2016].

[5] "Phaser - A fast, fun and free open source HTML5 game framework", Phaser.io, 2016. [Online]. Available: http://phaser.io. [Accessed: 22- Mar- 2016].

[6] "Ruby on Rails", Rubyonrails.org, 2016. [Online]. Available: http://rubyonrails.org. [Accessed: 22- Mar- 2016].

[7] J. PEARCE, M. AINLEY and S. HOWARD, "The ebb and flow of online learning", Computers in Human Behavior, vol. 21, no. 5, pp. 745-771, 2005.

[8] F. Fu, R. Su and S. Yu, "EGameFlow: A scale to measure learners enjoyment of e-learning games", Computers & Education, vol. 52, no. 1, pp. 101-112, 2009.

[9] Q. Li, R. Tay and R. Louis, "Designing Digital Games to Teach Road Safety: A Study of Graduate Students' Experiences", 2012.

[10] M. Zyda. "rom Visual Simulation to Virtual Reality to Games", 2005.

[11] "Play Driving School GT", GameSamurai.net, 2016. [Online]. Available: http://gamesamurai.net/381-Driving-School-GT.html. [Accessed: 15- Mar- 2016].

[12] Rodrigues, M. A. F., Macedo, D. V., Serpa, Y. R., and Serpa, Y. R. "Beyond Fun: An Interactive and Educational 3D Traffic Rules Game Controlled by Non-traditional Devices", 2015.

[13] "VRUM: Serious Games To Learn Traffic Rules", Seriousgamesmarket.blogspot.com.eg, 2012. [Online]. Available: http://seriousgamesmarket.blogspot.com.eg/2012/12/vrum-serious-games-to-learn-traffic.html. [Accessed: 15- Mar- 2016].

[14] "Dubai:Play by the traffic rules with an e-game", GulfNews, 2012. [Online]. Available: http://gulfnews.com/news/uae/crime/play-by-the-traffic-rules-with-an-e-game-1.1089753. [Accessed: 15- Mar- 2016].

[15] "Rules of the road: Mission impizzable", Animatedtrafficlaw.org, 2016. [Online]. Available: http://animatedtrafficlaw.org/atlc/games/. [Accessed: 15- Mar- 2016].

[16] "Driving Licence Test", Play.google.com, 2016. [Online]. Available: https://play.google.com/store/apps/details?id=com.damtechdesigns.drivinglicencetest.en. [Accessed: 06- Apr- 2016].

[17] "Traffic Signs & Rules", Play.google.com, 2016. [Online]. Available: https://play.google.com/store/apps/details?id=com.haty.trafficsigns. [Accessed: 06- Apr- 2016].

[18] "Mcity Test Facility — University of Michigan Mobility Transformation Center", Mtc.umich.edu, 2016. [Online]. Available: http://www.mtc.umich.edu/test-facility. [Accessed: 15- Mar- 2016].

[19] "Ministry of Interior Egypt Traffic Signs", Moiegypt.gov.eg, 2016. [Online]. Available: http://www.moiegypt.gov.eg/Arabic/Departments+Sites/Traffic/trafficSigns/denySigns/. [Accessed: 15- Mar- 2016].