Mood and Learning Experience in Navigation-based Serious Games

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Abstract

Games are played for entertainment and stimulate a variety of moods during gameplay, including happiness. Serious or applied games are created and used to serve a purpose rather than pure entertainment. The relationship between mood and task efficiency has been investigated in psychology with contrasting results, also it appears there is a relationship between mood and learning. We have investigated players' mood and learning efficiency as a consequence of playing two serious games involving navigation in a virtual environment as the main action of gameplay, but with different learning objectives. The first game trained players on how to perform a religious ritual, while the second taught the route to a real world destination. The pre- and post-gameplay mood of 52 players have been considered. We found that both serious games helped the players developing a pleasant overall mood and significantly increased the self-reported happiness score in the post-questionnaire. We also found that players who felt happier spent more time learning, and in particular, women performed better when they were happier. Also, younger learners tended to obtain a higher learning performance score than other age categories.

Keywords: Mood, Gameplay, Serious game, Applied game, Navigation, Learning experience

Highlights

1. Navigation-based serious games induced positive overall mood in players.
2. There was a significant increase in self-reported happiness.
3. Happier players spent more time learning.
4. Happier women gained higher learning performance score after playing.
5. Younger players obtained higher learning performance score with serious gameplay.

1. Introduction

Serious or applied games are usually designed to fulfil target learning objectives or to design an engaging environment that provides skills development and behavioural transformations (Boyle, Connolly, & Hainey, 2011) for which they have been created. A considerable amount of interest has also been shown in the investigation of further outcomes of gameplay that can inform and improve society. For example, in order to win the game, students learned to code their own programs (Muratet, Torguet, Jessel, & Viallet, 2009), players tracked an object better after playing an action game (Green & Bavelier, 2006) and students improved prosocial behaviour despite playing computer games in which they had to kill some of the entities (Durkin & Barber, 2002).

Little work has been done to investigate the mood outcomes associated with playing serious games. Even before they start playing, gamers choose a video game genre or another to fit in with their current emotional state (Breuer & Bente, 2010), but it is not clear whether the initial mood is maintained or changed following serious gameplay.

In psychological research, Zillmann (1988), in his study on mood management, stated that people try to improve their mood through the activity they choose to do. Also, it has been shown that players demonstrate enjoyment in gaming when they improve the speed of play (Dye, Green, & Bavelier, 2009). However, in literature, a mood in gameplay has typically been investigated as a post-playing effect with contrasting results. Some studies have shown that playing video games improve players' mood (Burke et al., 2009; Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Klimmt, Schmid, & Orthmann, 2009) while others have proved it differently (Franceschini et al., 2013; Russell & Newton, 2008; Tazawa, Soukalo, Okada, & Takada, 1997).

A less researched topic is the effect of applied games on players' mood, which is an objective of the current study.

1.1. Mood and video games

In most video games, the game humour has shown to improve players' mood (Dormann & Biddle, 2009), and retain players' engagement until the end of gameplay. For example, when a player wins a game, s/he feels happy and tries to achieve the same or better performance in a next level (Jansz, 2005). In spite of the new challenges presented to players, levels in a game seem to preserve players' happiness and stimulate performances (Brox, Fernandez-Luque, & Tøllefsen, 2011). However, games can also be played for other reasons rather than obtaining a positive mood, for example, to relax or pass time.

Playing games does not always improve players' mood, and can induce negative emotions such as feeling tired and angry (Mitchell & Savill-Smith, 2004), which supports the concerns that some people have with regards to excessive video game playing, in particular among children (Boyle et al., 2011). In Japan, the cause of unexplained symptoms in 19 children was investigated and they found that excessive video game playing at home triggered tiredness (i.e. exhausted facial appearance) and other physical negative signs (Tazawa et al., 1997). Likewise, players who became addicted to online games playing developed mood disorders (Yee, 2006).

Understanding emotional outcomes of gaming also need to be considered in the context of gender differences. Previous studies have demonstrated that men feel happier than women when playing video games (Kirriemuir & McFarlane, 2004), regardless of the game genre (Cooper & Mackie, 1986). Given that in 2014, it has been shown that the number of women in the UK playing games has increased to 52% of the gaming audience, especially for online and social games (Stuart, 2014); we wonder whether women's perception of the game is now changing. As such, gender differences and mood outcomes after playing an applied game is a relationship that will also under enquiry.

1.2. Mood and learning experience

A learning experience is constructed through the knowledge encountered during learning (Kolb, 1984), however, the emotional state felt during the experience also influences the learning outcomes. That is, learners' mood has been shown as a major contributing factor during a learning experience (Opengart, 2005; Shuck, Albornoz, & Winberg, 2007), and determines learners' motivation to continue learning (Dirkx, 2001). Perry (2006), in his study on fear of learning new things in adults, describes that learners are demotivated if they experience a negative mood such as feeling uneasy before, during or after the task. As such, it seems to be important that people feel easy when they acquire new knowledge and that we hypothesise that a positive mood positively influences learning.

1.3. Mood and serious games

Serious games are games created to fulfil an objective rather than pure entertainment (Susi, Johannesson, & Backlund, 2007). Fernández-Aranda et al. (2012) reported that after playing PlayMancer, a video game therapy for emotional regulation, patients with mental disorders (i.e. impulse-related disorders) felt calmer and used the strategies from the game to deal with real world pressure. Players' emotions and behaviours have also been used as a method for evaluating gameplay in serious games and mapping a game style to players' characteristics (Nacke, Drachen, & Göbel, 2010). Franceschini et al. (2013) reported that after playing several hours of video games, children with dyslexia remarkably enhanced their reading skills; however, the game-based learning did not help them developing a better mood. As such, is not clear whether a serious game positively enhances players' mood after gameplay or not.

Sweetser & Wyeth (2005) have developed a model of enjoyment in games experience, named GameFlow that defines game enjoyment (or flow) as the optimal experience arising from good game design. GameFlow includes eight elements: concentration, challenge, skills, control, clear goals, feedback, immersion, and social interaction; but does not consider learning or mood and enjoyment as a feeling. Fu, Su, & Yu (2009) verified and improved the scale developed by Sweetser & Wyeth (2005) and validated it for e-learning games. In their work, they substituted questions related to skills, with questions related to knowledge improvement, but again they did not consider dimensions related to players' mood and enjoyment as an emotional state. In our work, we used Brief Mood Introspection Scale (BMIS) by Mayer (1988) (Mayer & Gaschke, 1988) that defines mood through adjectives describing the players' feelings rather than the game design characteristics. Furthermore, we considered mood as a direct experience (Mayer & Gaschke, 1988) gained through an immediate sense perception consequence of the experience of playing the serious games.

In a virtual environment, navigation task has been shown to be a constant and responsive measure of cognitive deficits in patients with mood disorders (Gould et al., 2007), therefore a navigation-based gameplay is a strong candidate for mood assessment in applied games. For Ruddle et al. (1999b), navigation refers to travel through a virtual environment while discovering information from different positions and orientations. This manifold information is then utilised to form spatial cognition of the environment (Chittaro & Ranon, 2009). In the current study, we defined navigation as same as Ruddle et al. (1999b), however, we emphasised the development of spatial ability from landmark and route knowledge. Also, we presented a navigation task in the environments which completely resembled real-life situations, looking for the real destination from the starting point. In addition, we considered memory recall from the walkthrough (i.e. learning performance) as an indication that learning has taken place, being learning the first step of creating a memory.

2. Aim of the Study

This study examines the relationship between mood and learning in serious games. The research questions are listed below:
i) Is it possible to influence participants' mood through playing a serious game?
ii) Does a positive mood during gameplay positively influence learning?
iii) Do men enjoy playing a serious game more than women?

We conducted two experiments involving two different navigation-based serious games. In the first experiment (Exp. 1), we created a 3D game representing the area around the Regent Court building of the University of Sheffield, UK, and the players were asked to learn a route from starting point to unknown destination (i.e. all players did not know the destination in the first place). The learning objectives (LO) for this game were as follows:
After playing the game,
LO 1: The player will be able to perform the route in the real world without mistakes.
LO 2: The player will be able to draw the route on paper and identify real world landmarks.

In the second experiment (Exp. 2), we created a game based on a 3D representation of the Mas'a, a place where pilgrims perform Sa'ie in Hajj (i.e. a ritual which pilgrims travel back and forth between Safa hill and Marwah hill) at Masjidil Haram, Makkah, Saudi Arabia. Players were asked to play this game to learn how to perform Sa'ie properly. The learning objectives were LO1 and LO2 as above; in addition,

the participants were asked to perform ritual actions while navigating the route. As such, the third objective as communicated to participants was:
After playing the game,
LO 3: The player will be able to determine and perform the correct ritual actions needed along the route.

Although the players did not obtain any badges, point or rewards for correct gameplay, both games presented several visually interesting 3D features that engaged them in the learning experience.

3. Data Collection Method

3.1. Questionnaire

All the questionnaire results were collected through an online questionnaire (i.e. Google Docs). The items measured through a questionnaire were as follows:

3.1.1. Background information
In both experiments, participants were asked to enter their age and gender. In Exp. 2, they also were asked whether they played video games and its frequency.

3.1.2. Spatial and navigational abilities
A spatial and navigational abilities test that developed by Hegarty et al. (2002) was administered. Of 27 questions, only eight questions were taken. We asked seven questions in both experiments, but we added one more question in Exp. 2.

Of eight questions, two were changed due to different scope of study, for example, 'I am very good at giving directions' was changed to 'I am very good at following a sequence of instructions', and 'I very easily get lost in an unfamiliar building' was changed to 'I very easily get lost in an unfamiliar area'. Another five questions were 'I do confuse right and left much', 'My "sense of direction'' is very good', 'I have a poor memory for where I left things', 'I can usually remember a new route after I have travelled it only once', and 'I try to remember details of the landscape (objects) when traveling in a new area'. The question we added in Exp.2. was 'I do not like to explore'. The score ranged from 1 to 5, where 1 was 'strongly disagree' and 5 was 'strongly agree'.

3.1.3. Mood
We used a reduced version of the BMIS (Mayer, 1988; Mayer & Gaschke, 1988) that asked participants to score whether they felt *'happy'*, *'tired'* or *'fed up'* before and after playing the game. As in the original questionnaire, the score of *'happy'* mood ranged from 1 to 4, where 1 was 'I definitely do not feel ...' and 4 was 'I definitely feel ...'. A similar pattern was used to enquire about their tiredness and frustration levels. Participants were also asked to score their *'overall mood'* before and after playing the game; the score ranged from 1 to 4, where 1 was *'very unpleasant'* and 4 was *'very pleasant'*.

3.1.4. Learning experience
After playing the game, participants were also asked to rate on a 5 point Likert Scale about their learning experience. They firstly were asked whether the applied game under consideration was *'interesting'*. In addition, to better understand the way the learning objectives were presented in the context of the specific game, we also asked in Exp. 1 whether they found the applied game was *'helpful'* in learning the ritual, and in Exp. 2 whether the signposts containing the road name were *'easy'* to find. The questions were designed by referencing the navigation questionnaire from Ruddle et al. (1999).

3.1.5. Comment
Finally, participants were also given a free text comment section.

The SPSS Statistics package was used to analyse the numerical results in addition to the qualitative analysis of the results.

3.2. Learning performance

Learning performance of participants was measured by considering the learning objectives in Section 2 and establishing criteria that indicated the new abilities were met.

3.2.1 Criterion 1: Perform route
To check LO1, participants were required to perform the route in the real world.

In Exp.1, the volunteers' route was tracked (Fig. 1) with a popular mobile app commonly used for tracking fitness activities (RunKeeper, https://runkeeper.com/). A score of one was given if they reached the destination by performing the exact same route, a score of 0.5 was given if they took a wrong path although they still reached the destination, and a score of zero was given if they did not reach the destination at all.

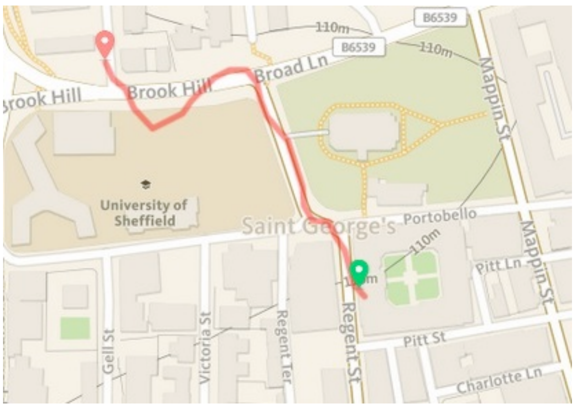

Fig. 1. A route recorded by RunKeeper

In Exp.2, we prepared a small indoor area to resemble the reference points in Mas'a, and we videoed participants' navigation during the ritual. Their navigation was scored considering whether they chose the correct starting (1 point) and end point for the ritual (1 point), and they completed the route by performing all seven rounds as prescribed (1 point maximum, 0.14 per each round). The maximum score for criterion 1 in Exp. 2 was three.

3.2.2 Criterion 2: Draw route and recognise landmarks

To test LO2, we asked participants to draw the route learnt on a paper and identify the landmarks.

In Exp. 1, we scored the route drawing (Fig. 2) based on five elements: the correct identification of the starting point (1 point) and destination (1 point), recurrence of cancelling lines (1 point for no hesitation, 0.5 for up to 3 amended errors, a score of zero for more than 3 errors), if they drew all five streets of the route (1 point for each street), if they drew exactly the route as taught without mistakes also they would be awarded 1 point, if they had one to three mistakes 0.5 and for four or more mistakes they would be awarded zero. The maximum score achievable in Exp. 1 was nine.

Fig. 2. Correct drawing by a participant in Exp. 1

In Exp.2, we scored the route drawing based on four elements: the start point (1 point), the end point (1 point), the correct labelling of start and end point (1 point), and route accuracy (1 point) that is they acknowledged the route had to be performed was seven times. The maximum score possible was four.

In both experiments, the participants were also asked to recall from memory and list as many as landmarks seen in the game as they could. The landmarks recalled were counted and one point was assigned for each one mentioned. The possible landmarks for Exp.1 were buildings located on both sides of the road, garden, car park etc., for a total of seven possible points. For Exp.2 the landmarks were the Safa hill (start point), Marwah hill (end point), Kaabah (black cuboid) etc., for a total of nine possible points.

3.2.3 Criterion 3: Perform the ritual actions

As mentioned in Section 3.2.1, after receiving consents, participants were video recorded while performing the route in the indoor area (Fig. 3). Their performance accuracy was scored based on two major elements: i) Compulsory Actions, these were six possible actions (6 points) (e.g. begin the ritual from Safa hill) and ii) Optional Actions. There were ten possible actions (10 points) (e.g. go over the hill of Safa). The maximum score for this criterion was sixteen.

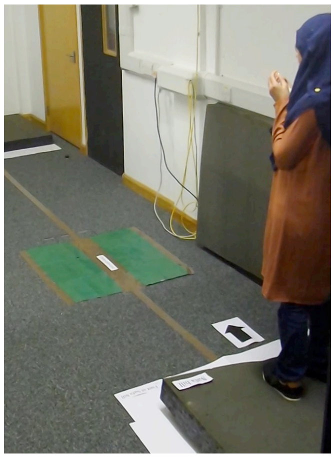

Fig. 3. A picture from video of real world performance

3.2.4 Learning performance score

In Exp. 1, the maximum score available across two criteria was 1 + 9 = 10 points. The maximum number of landmarks was 7; as such, each participant could be awarded a maximum of 17 for the learning performance.

In Exp. 2, considering the three criteria, the maximum score was 3 + 4 + 16 = 23. The maximum number of landmarks was 9; as such, each participant could be awarded a maximum of 32 points for the learning performance.

4. Experiment 1

4.1. Participants

Thirty-six participants were recruited through an email calling for volunteers for the experiment and word of mouth. An equal number of women and men were recruited (18 for each sex). The participants' average age was 29.9. A criterion for inclusion in the experiment was that they did not know the target location and they did not have any walking impediment.

4.2. Spatial and navigational abilities test

Participants were asked to score their spatial and navigational abilities with the Hegarty et al. (2002) test. The overall average score across all the questions test was 3.49/5, indicating that most participants felt they had average or above abilities. In particular, eight of them (22.22%) felt they were overall very good, twenty-one (58.33%) felt they were good, and seven (19.44%) reported having poor spatial abilities. Of the latter, six were women and one was a man.

4.3. The serious game of area around Regent Court

4.3.1. Route selection

A route where located in the University of Sheffield area was chosen based on route planning in Google Maps (Fig. 4). The distance and walking time from the starting point to the destination was 0.32 km and 4 minutes respectively. The starting point was 30 Regent St and its destination was Universal Computers, 1 St George's Cl. The destination according to navigation directions was located on the left side. The route had five streets that were counted from the street of starting point to the street of destination.

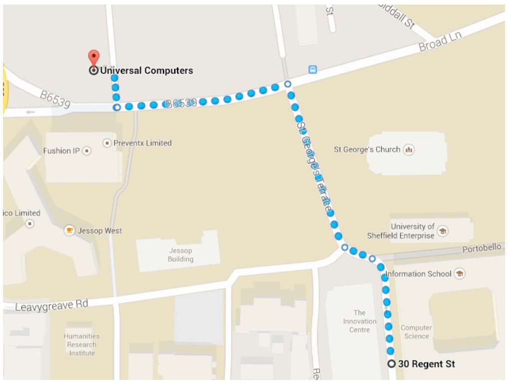

Fig. 4. Map view of the route used in Exp. 1

4.3.2. The serious game

The serious game of area around Regent Court (Fig. 5) was put together and animated using the game engine Unity. All buildings were created using the Match Photo technique in SketchUp Pro. All objects were exported as Kaydara (FBX) file into Unity where it was placed in the correct location in the game in a manner that replicated exactly the real world (Fig. 6). Landscape features, for example, trees, were imported from the Unity 3D library and other features, for example, a traffic light was taken from a free library.

Fig. 5. Representation of Regent Street in the game

Fig. 6. A photograph of Regent Street

A script was created to allow players to navigate in the environment, where they were asked to use four arrow keys on the keyboard. The UP key was used to go forward, the DOWN key to go backwards, and the RIGHT and LEFT keys were for right and left turn respectively. At all times, a white arrow located at foot level indicated the current direction of movement (Fig. 5).

A 13-in. Asus laptop (Intel® HD Graphics 1792MB) was connected to a 75-in. Samsung 3D TV was used together with the 3D active glasses to display the output from Unity application for game learning. A wireless keyboard and mouse were used to navigate in the game environment.

4.4. Procedure

Participants were asked to fill in their details, presented with an information sheet and experimental procedure, and asked to sign a consent form. They then answered background information and abilities test and filled the pre-learning questionnaire on mood. After answering pre-questionnaire, they learned to familiarise with a route and travel to a destination in the environment using assigned instructions.

In this experiment, only 10 minutes were given to complete the learning task, which was more than twice as long as the walking time needed to complete it. After 10 minutes, they were asked to stop the task, whether or not the task had been completed. On average, the players played for 3 minutes and 10 seconds, with the shortest session being 1 minute and 55 seconds.

After the learning task, the reduced version of BMIS questionnaire was administered again. Participants were also asked to answer the post-learning questionnaire as described in Section 3.1, including commenting on why they felt the game induced a specific mood if any. Prior to navigation in the real world, they were asked to do route drawing and landmarks recall. They were given a five pounds reward after completing the task.

4.5. Results

4.5.1. Mood before and after the learning task

The '*overall mood*' of participants before and after the learning task was analysed. Before the task, ten participants (27.78%) felt '*very pleasant*', nineteen (52.78%) felt '*pleasant*' and another seven (19.44%) felt '*unpleasant*'. The average '*overall mood*' was 3.08 (Table 1).

After performing the task, fourteen (38.89%) felt '*very pleasant*', twenty-one participants (58.33%) felt '*pleasant*' and one participant (2.78%) felt '*unpleasant*'. The average '*overall mood*' after the task was 3.36 (Table 1).

The mood differences between pre- and post-learning were compared using a Wilcoxon test as the data was not normally distributed and to check whether the mean ranks varies. The results of pre- and post-'*overall mood*' show that after learning, the applied game significantly improved participants' mood ($W = 19.5$, $p = .025$) (Table 1).

No significant difference was found for participants' '*tired*' or '*fed up*' score before and after playing the game. However, learning a route (i.e. familiarise and travel) in the applied game significantly increased participants' '*happy*' score ($W = 6$, $p = .005$) (Table 1). Of the 36, 11 participants (30.56%) felt happier after learning to travel in the game environment. Of those, 8 were men and 3 were women.

Table 1: Average of pre- and post-mood (Exp. 1)

Average	Pre	Post
Overall	3.08	3.36
Happy	3.17	3.47

The average time spent to complete the learning tasks was 3 minutes and 10 seconds, however, considering the participants who felt happier, five of them spent more than average in the game (up to 2 minutes).

4.5.2. 'Happy' mood and scored learning performance

The score obtained in the learning performance by the 36 participants was considered. The average score obtained was 11.17 over 17 points possible. Fourteen participants (38.89%) obtained a score below average and these were four males and ten females. Of these 14, seven participants (50%) gained below 8 and these were all females who also did not report an increase in happiness after playing the game.

Feeling happier after playing the game did not have a significant influence on the learning performance, however, the data showed some trends (Table 2). All participants performed well, but in particular, the score was higher if they felt happier, and this trend was respected across all the elements considered in the score.

Table 2: Learning performance score (Exp. 1)

	Mid-point score	Overall average	Participants with no mood difference	Happier participant average score
Learning performance score	8.5	11.17	10.82	11.95
Drawing the route element	4.5	7.14	6.98	7.5
Real-world navigation element	0.5	0.92	0.88	1
Landmark recall element	3.5	3.11	2.96	3.45

4.5.3. 'Happy' mood and self-reported learning experience

After the experiment, participants were enquired to comment about the gaming experience. In the questionnaire responses, all but two participants (34/36 – 94.44%) reported that found the game was *'interesting'* (the average score was 4.5/5) and 25 out of 36 participants (69.44%) found that it was *'easy'* to find a signpost in the environment (the average score was 3.78/5), despite some of them were not happier after playing the game.

In the free text comment section, no one made any comment with regards to their performance. All players with the increased *'happy'* score reported that they really liked the game, enjoyed learning and travelling in the environment because it felt real and easy to navigate. Those who did not report an increased *'happy'* score still commented that the learning experience was interesting and the world was easy to navigate, see Section 4.5.4. As such, we concluded that the game and the learning experience in itself were the cause of the participants' increased happiness.

4.5.4. Participants' comments

At the end of the experiment, participants were asked to comment on the experience in a free text box. The relevant comments are described below:

Comments about the experience

C1: "Game was the best to get involved."
C2: "It was easy to navigate which motivated me to finish the task."
C3: "I got familiar with the environment easily and it was easy to recall."
C4: "It was easy to remember the landmark."
C5: "It was easy to learn as it simulated necessary landmarks only (it reduced the information)."
C6: "I like the game because it was easy to navigate and recall (less information and simulated what was necessary only)."
C7: "Easy to navigate."
C8: "I like the game as it is easy to find the route and follow the direction."
C9: "I really like the game as it was real and amazing (immersed in the environment)."

Comments about the mood

C10: "It was an interesting environment and I felt so excited."
C11: "The game was really real and amazing. I felt excited doing the navigation task and I liked it much."

5. Experiment 2

5.1. Participants

Sixteen participants were recruited through an email calling for volunteers for the experiment and word of mouth, taking care to have an equal number of women and men (8 for each gender). The average age of the participants was 25.88. To participate in the experiment, a criterion was that they never performed the real ritual in their lifetime and they did not have any walking limitation.

Most participants were game players, in particular, ten participants in the sample (62.5%) played video games, while six (37.5%) did not play games. Two volunteers (12.5%) played every day, one (6.25%) played 5-6 times a week, one (6.25%) played 1-2 times a week, one (6.25%) stated s/he played every couple of months, and another five participants (31.25%) stated that they played less often.

5.2. Spatial and navigational abilities test

A spatial and navigational abilities test was administered. The overall average score across all the questions test was 3.61/5, demonstrating that most participants felt they had average or above abilities. In the sample, five participants (31.25%) felt they were overall very good, eight (50%) reported having good abilities and the remaining three (18.75%) felt they were poor.

5.3. The serious game of Mas'a

The method for developing the game of Mas'a (Fig. 7) was considerably similar as in Exp. 1. The building and its objects were created using SketchUp Pro and exported as FBX into Unity to replicate the real world (Fig. 8). A feature (i.e. hill) was taken from a free 3D object library on the web. User interface (UI) elements, for example, dialogue and pop-up boxes were added to allow players to control the game themselves and deliver some of the knowledge that the game designers wanted volunteers to learn. Several triggers were located in the environment to enable and disable the UI elements and facilitate gameplay, green lights indicated the next point (or target) players had to reach while moving across the environment.

Fig. 7. The serious game of Mas'a to learn Sa'ie and the features guiding the learning experience

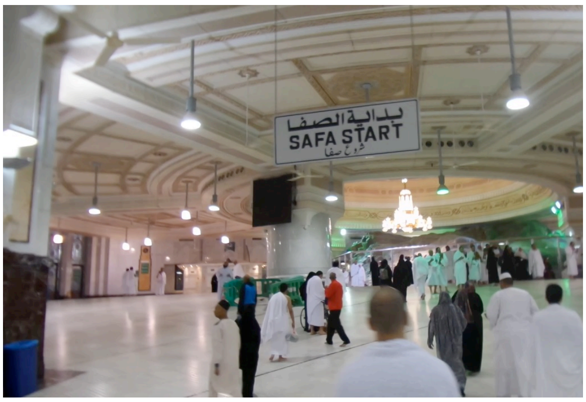

Fig. 8. Real world Mas'a in the Masjidil Haram

A script was created to allow players to navigate in the environment using the four arrow keys as same as in Exp. 1. They also were allowed to use WASD keys. W/S were used to go forward and backwards, while A/D were used to turn left and right. To look around in the environment, the players were asked to use a mouse. At all times, a blue arrow located at eye level (Fig. 7), indicated the next direction of movement.

The same equipment as in Exp. 1 was used to display the output and control the game-based learning

5.4. Procedure

Participants were asked to do the same pre-experiment formalities as in Exp. 1. They then answered background information and abilities test and filled the pre-learning questionnaire on mood. Following, they used the game to learn how to perform Sa'ie ritual.

No specific time limit was given for the learning the Sa'ie ritual, however, on average the players played for 12 minutes and 10 seconds, with the longest session being 17 minutes and 22 seconds, while the shortest session was 7 minutes and 13 seconds.

Following the experiment, they answered the post-study questionnaire including providing a text comment. Also, they were asked to do the route drawing and landmarks recall. Finally, they were asked to perform the similar route including carrying out all ritual actions at the indoor area. Participants were provided with some light refreshment after completing the task.

5.5. Results

5.5.1. Mood before and after the learning task

The *'overall mood'* of participants before and after the learning task was analysed. Before playing the game, the players' mood was mixed, five participants (31.25%) felt '*very pleasant*', six (37.5%) felt '*pleasant*', four (25%) felt '*unpleasant*', and one (6.25%) felt '*very unpleasant*', with an average '*overall mood'* of 2.94 (Table 3).

After the learning task, everyone, but two participants felt '*very pleasant*' or '*pleasant*'; in particular eight participants (50%) felt '*very pleasant'*, six (37.5%) felt '*pleasant'*, one (6.25%) felt '*unpleasant'* and one (6.25%) felt '*very unpleasant'* (these two volunteers did not change the score from pre-test), with an average '*overall mood'* of 3.31 (Table 3).

The mood differences between pre- and post-learning were compared using as the same test as in Exp. 1. The results of pre- and post- *'overall mood'* show that after learning with the applied game, players significantly improved their mood ($W = 0$, $p = .014$) (Table 3).

No significant difference was found for participants' '*tired*' or '*fed up*' scores before and after playing the game. However, learning Sa'ie ritual in the applied game significantly increased participants' '*happy*' score ($W = 0$, $p = .008$) (Table 3). Of the 16 participants, 7 people (43.75%) felt happier after learning Sa'ie from the game. Of those, 3 were men and 4 were women.

Table 3: Average of pre- and post-mood (Exp. 2)

Average	Pre	Post
Overall	2.94	3.31
Happy	2.94	3.38

The average time spent to complete the learning tasks was 12 minutes and 10 seconds, however, considering the participants who felt happier after the experience, five of them spent up to five minutes more than average in the game, suggesting that there was a relationship between time spent playing and the '*happy*' score.

5.5.2. 'Happy' mood and scored learning performance
Considering all 16 participants, the average score of learning performance was 21.55 over 32 possible points. Seven participants (43.75%) obtained a score below average and these were four males and three females.

Feeling happier after playing the game did not have a significant influence on the learning performance; however, the data shows some trends (Table 4). All participants performed well, but in particular, the score was higher if they felt happier. For this game, considering the individual elements of the score, the landmark recall did not respect the same trend as the overall learning performance.

Table 4: Learning performance score (Exp. 2)

	Mid-point score	Overall average	Participants with no mood difference	Happier participant average score
Learning performance score	16	21.55	20.75	22.57
Drawing the route element	2	2.84	2.64	3.10
Real-world navigation element	9.5	12.7	11.89	13.75
Landmark recall element	4.5	6	6.22	5.71

5.5.3. 'Happy' mood and self-reported learning experience
In the post-questionnaire, all 16 participants agreed that the learning material (game and content) presented was *'interesting'* (the average score was 4.88/5) and '*helpful'* (the average score was 4.75/5).

5.5.4. Participants' comments
After the experiment, the participants commented in writing on the experience and why their mood improved with gameplay. Also, the findings in Section 5.5.3 were reinforced by explanations provided in the comment section. However, no one made any comment with regards to their performance. The relevant comments are described as follows:

Comments about the experience
C1: "It was very fun to learn using the game, as it made me remembered more things than just learning by PowerPoint slide or normal lecture."
C2: "This game helped me to learn new knowledge about Sa'ie and strengthen my individual knowledge specifically."
C3: "I found the game of Sa'ie was very informative as it introduced an entertaining style to learn how to perform Sa'ie. Overall, it was a pleasant experience."

Comments about the mood
C4: "It set me free from study stress at that time."
C5: "The game was different and new. Learning (while moving) and playing together increased excitement."
C6: "As a gamer, I already felt excited before learning. I could not imagine learning religious things in the game. Super cool, and I really liked it."
C7: "I was so interested in religious things and curious to know how the Sa'ie game looked like. I felt being in real Masjidil Haram when playing the game. I felt satisfied after playing and learning from this game."
C8: "I like the idea of transformation Sa'ie learning into the game-based learning. I felt happy while playing and even after."
C9: "I was surprised at the beginning when seeing this game. I did not like to play video games. I felt happy after playing this game as learning something good from it, not just playing common video games."
C10: "I was so excited when playing this game. I moved in the environment where I had not seen before in real. This game was simple and not hard to play but informed the knowledge."

6. Findings of Combined Experiments

6.1. All participants

Considering all 52 subjects across the two experiments, they were gender balanced, their average age was 28.69, and the majority participants had good to very good spatial and navigational abilities (42/52 – 80.77%).

We tested whether the mean of gender, spatial and navigational abilities and mood had any relationship with learning performance mean using one-way ANOVA as the data was normally distributed, and we found no significance. However, there was a significant difference between age categories (F (2, 49) = 3.755, p = .030) (Table 5). A Tukey post hoc test indicated that learning performance score was significantly higher if participants were in 18-24 age category compared to age category of 25-34 (p = .040), suggesting that younger users achieved a higher learning performance score following serious gameplay.

Table 5: Learning performance score by age

Age category	Total participants	Learning performance average
18-24	12	18.16
25-34	34	13.44
35-44	6	12

Given only the 18/52 participants who indicated they felt happier after playing either of games, more male (11/18, 61%) reported an increased *'happy'* score as compared to females (7/18, 39%). This is in line with the finding in the literature that men enjoy playing games more than women.

6.2. Participants by gender

As the data was normally dispersed, we used a t-test to check a relationship between the mean of age, spatial and navigational abilities, and *'overall mood'*, and learning performance mean for both genders, but no significance was found. We checked the relationship between happiness and learning performance score for men and also found that there was no significance. However, when considering women, happier women had a significantly higher learning performance score as compared to those that have no mood improvement (t (24) = -2.618, p = 0.015) (Table 6).

Table 6: Learning performance score by gender and happiness

Gender	Overall average	Participants with no mood difference	Happier participant average score
Men	14.68	15.15	14.04
Women	14.04	12.10	19.29

Participants' self-scored spatial and navigational abilities were compared between genders using a t-test and we found that there was a significant difference, where men had higher abilities score than women (t (50) = 3.611, p = 0.001) (Table 7).

Table 7: Spatial and navigational abilities

Average score	Male average	Female average
3.53	3.81	3.24

7. Discussion

We have considered two serious games, one in which learners learned a religious ritual and the other one learned how to find a specific location in the real world. Playing both games involved navigation in a virtual environment as the main action to acquire the knowledge taught by the game. The games did not have a lot of traditional game features, such as scores, winner chart, splash screen or mood setting narrative to encourage the players to proceed with the gameplay.

It was found that it was possible to influence participants' mood through playing a serious game, and both serious games pleasantly enhanced the *'overall mood'* of players and improved their happiness at the end of the learning session. Considering both games, we only found that a positive mood during gameplay significantly influenced the learning performance score of women. However, in general, the data showed that the score tended to be higher if they felt happier. In addition, we found that younger players had a higher score of learning performance after learning from serious gameplay.

We did not find any significant relationship considering the participants' gender; however, more men reported to be happier as compared to women, in line with the literature. Besides, according to self-reported score, men obtained a significantly higher score in the spatial and navigational abilities test.

As both games involved navigation in a virtual environment that had several visually interesting features and provided experiential learning, we speculate this was one of the reasons why most players who felt happier, spent their time longer than average. This is supported by the participants' comments that found the learning experience was interesting and informative, and that helped them to understand the knowledge better in an exciting environment.

8. Conclusion

Serious games are different from video games for mere entertainment. As the focus is to achieve a given learning objective, they might have less rewarding features (such as points, badges, winner scores) compared to video games. Yet, serious games that involved navigation in an interesting and exciting environment (i.e. visual features and informative content) significantly induced a positive mood improvement in the players. In addition, happy players spent more time in the learning environment. Women that are happier after playing and younger players also tended to obtain a higher learning performance score. The findings, therefore, support the idea that serious games are a valid instruction method to be used by teachers to achieve the desired learning, while also improving the students' mood.

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