


Article

Educating Adults with a Location-Based Augmented Reality Game: A Content Analysis Approach

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Abstract: With the exception of Pokémon Go, relatively little is known about other Mobile Augmented Reality (MAR) games, and the attitudes of middle-aged and elderly adults towards them are hitherto poorly examined. The aim of this research is to examine the opinions of young, middle-aged, and elderly adults about the location-based MAR game Ingress. The responses to questions related to Ingress were collected from 24 adult players aged 20–60 from Greece and subsequently were analyzed by means of content analysis, both qualitatively and quantitatively, using the Jaccard index of similarity. Our findings showed that opinions of young people (20–35) agree more with those of elderly adults (>52) than with those of the intermediate age group of 36–51. It was also revealed that knowledge of geography facilitates the ability to play the game better, the game’s scenario is very interesting to adults, and the feeling of playing locally in a global game is also appreciated by all age groups. Along with these findings, with this research, it was shown that (a) content analysis is a valuable method for exploring opinions and attitudes of adult users towards MAR games and (b) Jaccard indices can be used to quantitatively explore themes emerging from content analysis.



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Keywords: mobile augmented reality (MAR); augmented reality; adult education; MAR games; content analysis; Jaccard index; Ingress; augmented reality in education

1. Introduction

Innovations using mobile technologies have expanded into all market categories over the past few years [1,2], and augmented reality (AR) applications for mobile devices have dynamically entered the consumer market [3]. In addition, innovations have converged from devices used for personal tasks (e.g., a mobile phone can be used to make phone calls and to serve as a digital assistant) to devices that can be used for a broad range of tasks [4].

AR is the name of a media type in which digital knowledge is realistically incorporated into the physical world, merges the physical and virtual worlds together, and offers opportunities for different sectors, including those that make entertaining and engaging games [5]. Unlike virtual reality, AR is not cut off from reality, but, according to Craig [6], it is a “medium in which digital information is superimposed on the physical world that is interactive in time and in both spatial and temporal registration with the physical world”.

In the past five years, research interest in AR has increased, with researchers focusing on user adoption behaviour [7], marketing potential [8], and user requirements [8,9]. In general, these studies suggest that new and diverse factors drive consumer behaviour (e.g., wearability and perceived increase), so that user behaviour cannot be explained by single hypotheses, since different factors drive different patterns of usage.

Previous studies on Computer-Mediated Environments (CME) have shown that flow, quality of service, and satisfaction have direct or indirect effects on the intention to continue use. People play games to experience the sense of flow [10], and this aspect has a strong effect on the willingness of a consumer to play a mobile game. As a consequence, this study examined flow-related variables first.

Probably, the most extensively studied Mobile Augmented Reality (MAR) game is Pokémon Go. Schade et al. [11] evaluated the influence of playing Pokémon Go on the physical activity of students and found that the amount of distance travelled by university students did not increase. Madrigal-Pana et al. [12] examined the perception of videogames and the use of Pokémon Go in Costa Rica and identified positive and negative perceptions of videogames mediated by age and level of education and that attitudes towards videogame playing depended on age and gender. Ma et al. [13] analysed the relationship between the use of Pokémon Go and the physical activity of players and how the relationship varies between players with different levels of physical activity. Finco et al. [14] studied how Pokémon Go allows people to walk in various urban places, encouraging users to be more involved and connect with other users, and discovered that it is one of the first mobile-based game plays that can promote a healthy lifestyle with a new way of communicating while transforming sedentary habits, with a wide potential for health education.

However, this game is mainly intended for young people and, as a matter of fact, most of the research carried out in AR in education has focused on how younger generations perceive and evaluate such applications, but there is a marked deficit in scientific research concerning the use of AR by adult learners.

As is well documented, adult learning differs from that of minors in five key respects, according to Courau [15], which can be summarized briefly as follows: (i) adult learning is encouraged when instruction is specifically linked to the everyday life of an adult; (ii) if it is not followed by complete comprehension, adult learning becomes difficult; (iii) recognition of the aims of the educational project is significant for an adult learner; (iv) adult learners are directly interested in the instruction and the objects of learning, that is, they learn actively; and (v) adults learn more easily if they think they contribute towards a good cause or within the context of a community of learners. However, apart from the above, it should be noted that adults have a wide variety of learning types and thus, while minors engage in an educational process because they owe it to the state or their parents, adults learn and/or participate in an educational program for different reasons also (i.e., to use the knowledge and skills they will acquire either in their career or in their social advancement, to improve their financial situation, etc.). For instance, environment-focused learning theories [16] place great emphasis on the environment, from which the stimuli that contribute to the learning process come, as well as human contacts and interactions between the person and the environment, eventually contributing to the transformation of learning into action. In addition, according to the theory of “personal creation” [17], adult learning is not decided by external processes, but the learner is the creator of his own learning and information.

Although the mobile gaming industry is rapidly growing and competitive and since previous studies have already focused on Pokémon Go [12–14,18], other location-based AR mobile games deserve investigation as well. Previous research in applications of MAR games has identified both positive and negative factors affecting user experience [19,20] and if the game is played by children, several positive experiences have been examined, such as enthusiasm, enjoyment, and arousal of curiosity [21].

Pokémon Go, however, is not a game that would attract adult users’ interest for very long and, certainly, is not the only Location-Based MAR game available; the game “Ingress” is probably the most relevant to adult users.

Moore [22] observed that players of Ingress sought to assert and protect territories within physical environments by generating control fields, since players who use public landmarks as “portals” hack and protect these landmarks in order to gain control of specific areas. Ingress, like other types of urban mobile gaming, allows players to interact with both their mobile device and the urban environment at the same time.

Sdravopoulou et al. [23] examined young, middle-aged, and elderly adults’ opinions about the location-based MAR game Ingress by applying John Keller’s ARCS learning motivation model (Attention, Relevance, Confidence, and Satisfaction). In that research, the efficacy of educating adults in this game was assessed quantitatively, on the basis of a quantitative approach (questions allowing only Likert-type answers).

This study focused on evaluating the location-based AR game Ingress to identify what players enjoy about the game, what they dislike, and what changes they would suggest being made to it. To explore these attitudes and experiences towards this game, it is necessary to use open questions, and thus the problem is how to analyze the participants' responses to the open questions. The standard method adopted in educational research in such cases is only "qualitative", consisting in discussing opinions and ideas expressed by the learners qualitatively, most commonly by using excerpts from the participants' responses [24]. This method, however, is not very informative when we have responses recorded from many participants. In such cases, we need a method for analyzing the content of their responses, which should also be (preferably) quantitative. It is at this point that this research suggests the use of two hitherto unexplored avenues for analyzing such qualitative data: "content analysis" in conjunction with the use of a statistical method based on the Jaccard index.

One of the key features of adult learning is that adults need to connect learning with previous experiences and also need to express their own opinions about what they learn. Considering this, and in view of the deficit in the literature related to how adults learn to play location-based MAR games, this research tackles the following questions: (i) What are the adults' main attitudes and opinions about Ingress? (ii) How do these opinions depend on user age? (iii) Can the Jaccard index be useful to quantitatively analyse the responses to open questions by more than one person?

2. Materials and Methods

The location-based MAR game Ingress was selected for this research project. It is a multi-player online augmented reality game [25–27] that was developed and published in 2014 by Niantic, a Google spinoff company (the same company that created Pokémon Go), which announced that it had more than 7 million players in 2015. As a basis for overlaying game elements to real-world places, the game uses Google Maps.

There are two factions in Ingress ("Enlightened" vs. "Resistance") that players need to choose from which to identify with themselves. The main objective of the game is to take control of "portals" that are mapped to different locations in the real world, such as landmarks, public places, parks, or local businesses [28]. By putting a mark (called a "resonator") at a portal, users mark the portal based on their team membership, and in this way, the portal is captured by the user (on behalf of her team) and the portal changes colour to either green for the faction of "Enlightened" or blue for the faction of the "Resistance". If players come across portals already run by the opposite team, by using in-game weapons such as "burstlers" or "ultra-strikes", they can disable the influence of the opposing faction. By deploying "fields" connecting three portals into a triangle, players aim to take control of as many portals as possible and control a geographical area as large as possible. These game control activities can occur at different scales; "microfielding" is the term for the activity of connecting portals that are highly concentrated in a small local region, while a large-scale activity that can span several states or even countries is called a "megafield". Many participants and tight coordination are needed for the larger fielding efforts and are referred to as "field operations" ("field ops"). Eventually, the main objective of the game is to conquer as many portals as possible on behalf of a faction and to impose control over a large field.

To achieve the aim and objectives of the project, qualitative research methods [24,29] were applied for data collection in order to assess the educational activity (person-to-person training in the game by the principal author of this research) that was carried out centered on Ingress. The survey questionnaire was composed of open questions and was developed specifically for this work. The questions were the following:

- Q₁ How much does knowing the geography of the area facilitate your ability to play the game better?
- Q₂ What is your opinion about the scenario of the game?
- Q₃ How does playing locally in a global game makes you feel?

- Q₄ How do you evaluate the idle phases during the game (intervals of repetitions or dullness)?
- Q₅ What changes would you make to the game?

These questions allowed for the understanding of how the experience of playing Ingress fits into players’ lives. The open questions focused on experience and mood and on how players evaluate the game. These questions were phrased in a neutral manner to allow both positive and negative experiences to be shared. In the present case, interviews were appropriate as a qualitative method [24], and the data obtained from the qualitative research were examined in detail by means of the method of “content analysis” [30]. The participants’ responses were analysed following methods of content analysis, which is “a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use” [30]. Content analysis as a method necessitates the use of advanced techniques and is independent of the researcher’s personal authority [30].

The survey involved 24 users in Greece aged 20 to 60 years old. The participants (friends and relatives who were interested and willing to participate) were chosen on the basis of four characteristics: (a) they used an Android smartphone, (b) they understood-written and spoken English, (c) they could understand the game directions (either written or orally), and (d) they were not familiar with Ingress at all. Of the participants, 20.8% were graduates of secondary education, 8.4% were university students, 33.3% were university graduates, 33.3% held a master’s degree, and 4.2% held a doctoral degree.

The participants were trained to learn the basics of Ingress for two hours. Six steps are usually used in content analyses to describe the procedure:

- (i) Unitizing: the process of systematically separating text segments that are relevant to the main focus of the study.
- (ii) Sampling: by restricting observations to a manageable subset of units that is statistically or conceptually representative of the set of all possible units, sampling helps the analyst to save time or other resources.
- (iii) Coding: the process of converting information into code; the process of defining or classifying recording units according to the categories of the chosen analytical constructs. In this phase, main themes and subthemes are identified within the responses.
- (iv) Data reduction: This step meets the needs of analysts, who need efficient representations of large amounts of data.
- (v) Inferring conclusions: In content analysis, this stage employs an understanding of how the variable accounts of coded data relate to the phenomena the researcher is interested in learning about.
- (vi) Narrating: the researchers make their findings understandable to others by narrating the responses to content analysts’ questions.

The 24 participants of this research were evenly distributed among age groups: three age groups were defined with 8 persons in each group and at 15-year intervals: 20–35, 36–51, and 52–67. The means and standard deviations per age group are given in Table 1.

Table 1. Age groups with the number of participants per group, mean age, and standard deviation.

Ages	Participants	Mean Age	Standard Deviation
20–35	8	28.6	5.55
36–51	8	45.9	4.94
52+	8	56.6	1.92

Content analysis was performed on the users’ responses both qualitatively (to identify characteristic sentences expressing attitudes and opinions) and quantitatively. For the quantitative assessment of similarities between responses for each question and subtheme, the Jaccard similarity index J_{ij} was calculated pairwise for every pair i, j of participants [31]:

$$J_{ij} = \frac{M_{11}}{M_{01} + M_{10} + M_{11}} \tag{1}$$

where M_{11} denotes the number of agreements between respondents on a subtheme (“yes–yes”), M_{01} is the number of disagreements where the respondent i responded “no” and the respondent j responded “yes”, and M_{10} is the number of times with the reverse responses. Although originating from ecology [32], the index has found applications in many domains [33–38].

After the creation of the 24×24 matrix of Jaccard indices for all 24 participants of this research showing agreement or disagreement among participants for each subtheme, the mean Jaccard index by pairs of participants i, j for all n raters can be calculated using the following formula:

$$\hat{J}_{ij} = \frac{2}{n(n-1)} \left[\sum_{i=1}^n \sum_{j=1}^n J_{ij} \right] \quad (2)$$

Consequently, the inter-age group Jaccard index $J_{u,v}$ for age groups u, v (with $u = 1, 2$, and 3 and $v = 1, 2$, and 3) is calculated, and hence, the sum of the values of the similarity indices for all subthemes of each question and for all participants, by age group, is represented by:

$$J_{u,v} = \sum_{u,v} (J_{ij})_{u,v} \quad (3)$$

For all age groups (three in this case), the mean Jaccard similarity index for each question and age group, taking into account all subthemes and among all participants by age group is:

$$\hat{J}_{u,v} = \frac{\sum_{u,v} (J_{ij})_{u,v}}{\hat{J}_{ij}} \quad (4)$$

A Chi-square test was performed to test the significance of the entries of the resulting matrices for each and all questions.

3. Results

The results concern the fields examined: the role of geography in playing the game better, the scenario of the game, the feeling of playing locally in a global game, the role of the idle phases, and the suggestions for improvement of the game.

3.1. Knowledge of Geography Facilitates the Game

When asked if the knowledge of the geography of the participants’ area helped them to play the game better, the vast majority of participants answered in the affirmative for reasons such as that in an unknown area they would face additional difficulty and that they saved time, enjoyed it more, and felt safe.

The thematic “knowing the geography facilitates you to play the game better” was found to be related to 13 subthemes, as follows: it is decidedly a game based on geography, it gives motivation to continue playing, unknown areas are associated with more difficulty, knowledge of the area helps to gain time, the game has suspense, there are texts with information about the local area, the game can be enjoyable, it gives a sense of safety, requires concentration, can be indifferent, is based on walking, experiential knowledge of geography helps the user play it better, and it motivates the user to know other areas (Figure 1). Percentages correspond to the number of mentions in the participants’ responses related to the main thematic “knowing geography facilitates the game”.

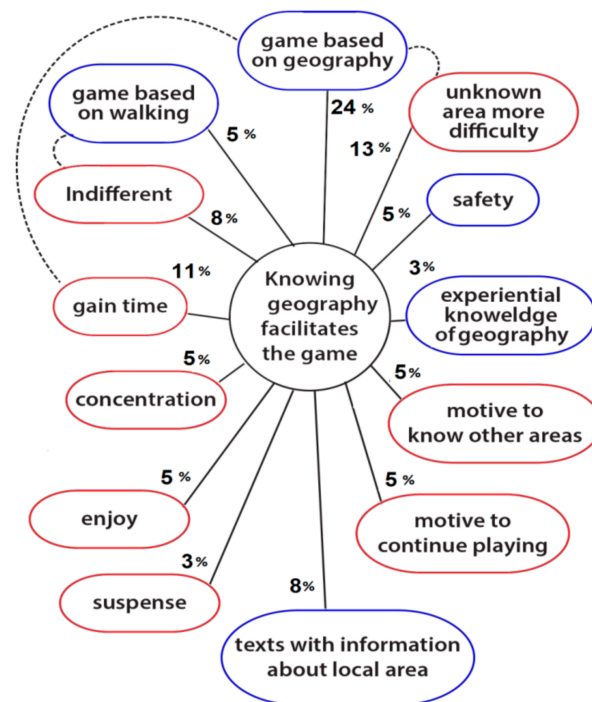


Figure 1. Subthemes resulting from the content analysis of the responses to question 1. Percentages correspond to the number of mentions related to the main thematic “knowing geography facilitates the game”. Some subthemes were mentioned more than once by the participants, who also mentioned the subthemes that are connected with dotted lines. Subthemes in red relate to the user, while those in blue relate to the game.

As many as twelve subthemes were evaluated positively and one negatively, and 50% of the adult learners agreed that Ingress is a game based on geography and that by knowing the area they save time. The mean similarity of responses between the participants was calculated with the Jaccard similarity index, which was 0.11 for this question. Quoting two characteristic responses:

“It is not possible to play Ingress if you do not know the geography of the area that plays it very well. It is a geographical game combined with augmented reality. This is because either you will play (so it presupposes knowing where you are going without wasting time), or you will be looking to find the portals (so you are not playing but you are looking for and learning the area)”.

“The fact that I am unfamiliar with the area discourages me so much that I want to play it less than once or twice a month. I do not like searching areas, either with Ingress or without it. If I were in the city where I was born and raised, I would play it every day. That is, for a game like Ingress, knowing the area you are playing in is a determining factor that can function either very positively or very negatively”.

Analyzing the subthemes, it was revealed that the subtheme “game based on geography” was highlighted more by the 36–51 age group (with a percentage of 67%), followed by the 20–35 age group (with a percentage of 22%) and the >52 age group (with a percentage of 9%). Interestingly, those who expressed the opinion that knowledge of the area’s geography did not help them play the game any better mentioned as a reason that Ingress is based on movement, and therefore, it is unavoidable to move into unknown areas.

3.2. Scenario of the Game

Opinions varied regarding the Ingress scenario. The content analysis showed that the central thematic (“scenario of the game”) was related to 12 subthemes (see Figure 2, in

which the percentages correspond to the number of mentions related to the main thematic “knowing geography facilitates the game”). The content analysis also indicated that it is fascinating to be part of a group, the scenario gives suspense to the user while they may also appear indifferent, relates to an interesting discussion about the evolution of humanity, allows the identification with one of the groups and for communication among team members, is addressed to all ages, the game’s oral instructions give more information about it, it is challenging, reminiscent of fairy tales or conspiracy theories, and that it is interesting as it refers to CERN.

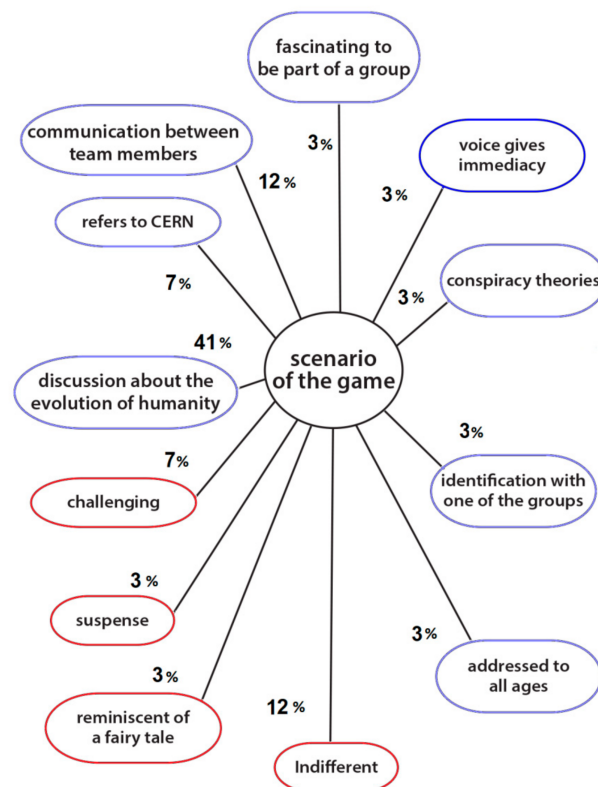


Figure 2. Subthemes with percentages of mentions related to the main thematic “scenario of the game” (question 2). Subthemes in red relate to the user, those in blue relate to society, and those in dark blue relate to the game.

As many as 41% of the answers indicated that the scenario of the game interestingly reflects part of the discussion about the evolution of humanity, while equal percentages (10.3%) followed the opinions that the game allows communication between the team members as well as the opinion that it is indifferent.

Among the opinions expressed, the following two were perhaps most characteristic:

“It’s perfect. First of all, it has an interesting scenario, while I expected it to be monotonous. You are member of a team and you are called to defend your team’s interests, you make friends and allies; you are not alone. Each area is marked either by your own team or by the opponents and you need help to advance the game. You do not know what will happen next and you also have a purpose for which you are fighting for; a mission”.

“I liked the script. It also has to do with conversations. I hear so much about technology; to what extent have new technologies changed our lives and since the human species is evolving, such or a similar evolution is inevitable. And on this issue there are various views, theories”.

In fact, the subtheme “discussion about the evolution of humanity” concentrated as many as 58% of the mentions of the 36–51 age group, followed by the 20–35 age group, with 25%,

and finally the >52 age group, with 17%. The mean similarity of the responses between the participants was calculated with the Jaccard similarity index, which was 0.212.

3.3. Feeling of Playing Locally in a Global Game

When asked about how participants feel about playing locally in a world game, feelings of excitement, insecurity, and caution were reported. It was also pointed out that the game was relevant to most of them, and indeed, for some participants, it was the only game they knew in which it is possible to play from one's own country on a global scale.

Specifically, the content analysis of the responses to question 3 showed that the thematic "the feeling of playing locally in a global game" was related to six subthemes (Figure 3): excitement, current, game played worldwide, hesitation, insecurity, and has advantages and disadvantages.

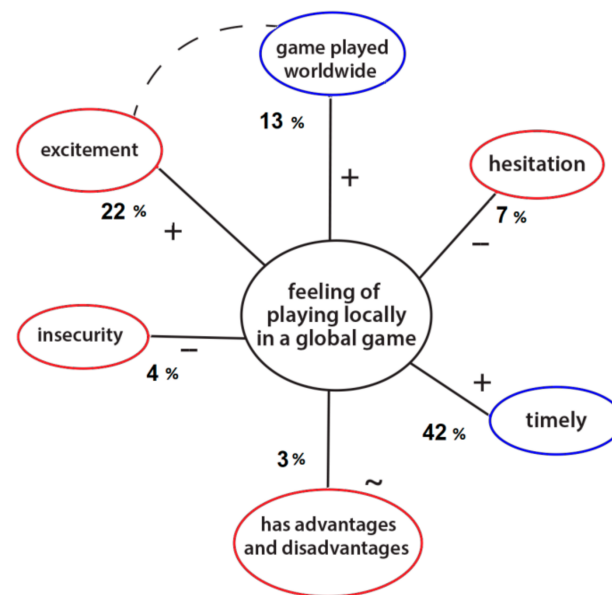


Figure 3. Subthemes with percentages of mentions related to the main thematic "feeling of playing locally in a global game" (question 3). Two subthemes were mentioned more than once (with dotted lines). Subthemes in red relate to the user, and those in blue to the game. The signs +, −, and ~ represent the learners' disposition towards the subtheme to which these signs relate (positive, negative, and neutral disposition, respectively).

Two indicative responses were:

"This side of the game is also relevant. We now live in a globalized society, whether we realize it or not. Some of us (realize it) to a higher degree. As for me, it is a daily experience to meet people from different countries, because I am doing my master's degree in England and in my department my fellow students are from 11 different countries".

"It is good to be accustomed to thinking locally but also through a global context. Because we are used to thinking only locally and without being part of a broader plan and of course without a specific ideology. On the other hand, for me personally, I felt it was very binding that in order to be able to play the game, I had to choose one of the two warring factions".

Of the six subthemes, three were evaluated positively, two negatively, and one neutrally. The mean similarity of the responses between the participants was calculated with the Jaccard similarity index, which was 0.279. The subtheme "timely" concentrated 42% of the mentions. Next was "excitement", with 22% of mentions; therefore, these two subthemes accounted for over 50% of mentions. The subtheme "timely" was focused more in

the 20–35 age group, with a percentage of 46%, then the >52 age group, with a percentage of 31%, and finally the 36–51 age group, with a percentage of 23%.

3.4. Idle Phases

Initial descriptive statistics showed that 83.33% of the players rated Ingress as extremely interesting, without boring phases between activities, as one activity follows another with specific goals that the player is required to accomplish. Special mention was made of the fields that the map shows as well as the fact that the portals are in real places in the area, such as shops and cultural heritage sites. As for the participants who stated that it has boring intervals, the causes pointed out included the need to walk in order to play the game, long distances between portals, exposure to weather conditions, and the slow transition from one level to another. In particular, the responses to question 4 can be summarised as follows. The thematic “idle phases” were related to eight subthemes (Figure 4): they may be due to large distances between portals, they are seldom experienced because the game has clear goals at every level, the map of the area provided by the software is helpful, activities run smoothly, it is easy to exit and reenter the game at any time the user wishes, running between levels is relative slow, the software’s oral instructions are helpful, and the weather conditions affect the play. Of these eight subthemes, five were evaluated positively, two negatively, and one both positively and negatively (the weather conditions), and in 1/3 of the cases, the same players mentioned at least two subthemes. All the positive subthemes (clear goals at every level, real map of the area, smoothly running of activities, easy exit and reenter and weather) were mentioned more than once. The subtheme “real map of the area” was mentioned in 31% of the mentions. This was followed by the smooth running of activities, with 24% of mentions; therefore, these two subthemes accounted for over 50% of mentions. The subtheme “real map” was equally emphasized by the 20–35 and >52 age groups, with a percentage of 36%, and less by the 36–51 age group, with a percentage of 28%. From the qualitative analysis of the content, two players characteristically responded: “If it was even a little boring, I would tell you right away and I would not bother a second time. But I liked it that such a real and challenging game has been created, so I tend to deal with it” and “It is boring to walk from one place to another, especially when they are somewhat distanced. Just that. Because otherwise it is a very convincing game”. The mean similarity of the responses between the participants was calculated with the Jaccard similarity index, which was 0.17.

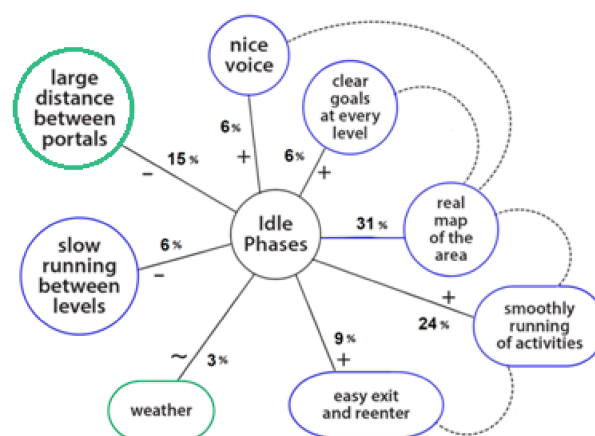


Figure 4. Subthemes (with percentages of mentions) related to the main thematic “idle phases”, as derived from the content analysis of the responses to question 4. The subthemes “clear goals at every level”, “real map of the area”, “smoothly running of activities”, “easy exit and reenter”, and “weather” were mentioned more than once by the participants, who also mentioned the subthemes that are connected with dotted links. Subthemes in blue relate to the game, and those in green relate to the environment. The signs +, −, and ~ represent the learners’ disposition towards the subtheme to which these signs relate (positive, negative, and neutral disposition, respectively).

3.5. Suggested Changes to the Game

When asked about the changes proposed to the game by the participants, some of the opinions expressed were that they would add shapes, turn the sound louder, make colours more lively, and insert more informative texts. However, most participants answered that they would not make any substantial changes to the game.

The thematic “changes to the game” was related to nine subthemes, as follows (Figure 5): more shapes, more intense colors, more texts, louder sounds, not personalized shapes, logo for each group, more portals, fewer symbols, and, expectedly, some responded that no changes would be necessary (32%).

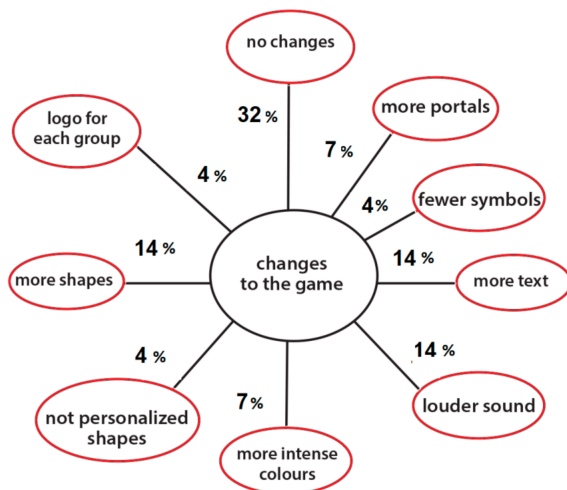


Figure 5. Subthemes with percentages of mentions related to the main thematic “changes to the game” (question 5). Subthemes in red relate to the user.

Some characteristic answers were:

“No changes to it. First of all, it’s a game and so it’s expected to have shapes, and colors and music. And because it is an augmented reality game, the relationship with the natural environment is very welcome. An augmented reality game can not be deprived from shapes and sounds, because it would not be a game after all, and on the other hand, it cannot be full of such, because it would not be “augmented” reality but “virtual” reality instead”.

“Yes, much more informative texts about streets, squares, parks, that is, this street is called ... and a few words about the name of the street, below this square is called a square... a few words about the name of the square and then it should be full of various information. As for the colors, I would make them a little more intense, they look very neutral to me”.

The subtheme “no changes” was equally mentioned by the 20–35 and 36–51 age groups (with percentages of 44%), followed by the >52 age group (with a percentage of 12%). The mean similarity of the responses between the participants was calculated with the Jaccard index at 0.17.

From the values of inter-age group indices of similarity $J_{u,v}$, and as concerns question 1 about whether the knowledge of the geography of their area helped the users in the game, the 36–51 age group completely agreed with the >52 age group that it is a game fundamentally based on geography, as well as that playing it in an unknown area is a source of extra difficulty.

With respect to question 2 about the game scenario, the 36–51 age group agreed more with the >52 group, mainly in the view that it interestingly reflects some of the current debate on the evolution of humanity.

As regards question 3, which deals with how the adult learners felt when they played locally in a worldwide game, a higher agreement was observed between the 20–35 and >52 age groups, primarily in that Ingress is a timely game, and then with balanced feelings of both excitement and insecurity.

In question 4 on whether there are idle phases in the game, the 20–35 and >52 age groups agreed more that the game does not present idle phases for reasons such as that it has a built-in real map, a smooth flow of activities, and it is easy to exit and reenter.

Finally, as relates to question 5 (on whether the users suggested any changes to the game), the highest agreement was observed between the 20–35 and >52 age groups that they would not make any change to the game.

Hence, for most questions, higher agreements were observed between the 20–35 and >52 age groups (Figure 6). This was somewhat unexpected; for most questions, the lowest agreement was between the 20–35 and 36–51 age groups, meaning that the game was perceived differently by people aged 35 or more.

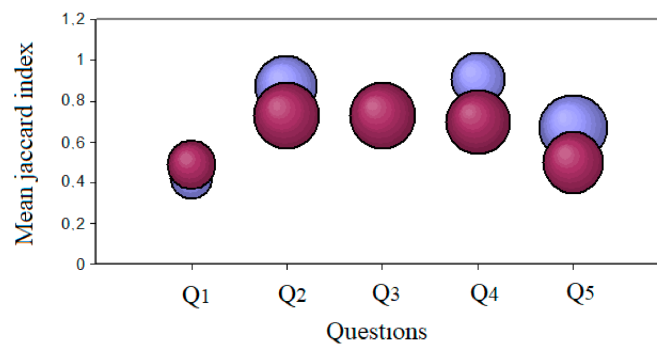


Figure 6. Values of the mean Jaccard index (with their standard deviations) per question, for the comparisons between the 20–35 and 36–51 age groups (purple balls) and 20–35 and >52 age groups (blue balls): the 20–35 and >52 age groups had higher means of agreement than the 20–35 and 36–51 age groups for all questions except for question 1.

The matrices of the Jaccard similarities in responses for all subthemes for all the age groups per question are given in Table 2, and the levels of confidence following the test for statistical significance are given in Table 3.

Table 2. Sums of Jaccard similarity indices $J_{u,v}$ (for ages u and v) per question Q_k for all responses, all subthemes, and all three age groups, per question.

	Question 1			Question 2			Question 3			Question 4			Question 5		
	Age groups			Age groups			Age groups			Age groups			Age groups		
Age groups	20–35	36–51	52+	20–35	36–51	52+	20–35	36–51	52+	20–35	36–51	52+	20–35	36–51	52+
20–35	5.7	8.5	6.7	17.3	15.3	13.0	6.0	15.3	15.8	6.5	20.8	5.5	2.8	13.4	11.1
36–51		2.0	5.0		4.0	8.0		11.0	21.0		6.8	5.7		5.3	10.5
52+			1.8			1.0			5.7			2.0			4.5

Table 3. Level of significance of the values of $J_{u,v}$ for each question.

Question	Interval Level of Significance α
Q1	90% < α < 95%
Q2	99% < α < 99.5%
Q3	97.5% < α < 99%
Q4	95% < α < 97.5%
Q5	$A > 99.9\%$

4. Discussion

Our study revealed that adult learners in three different stages of adulthood focus on different issues, which are ideally revealed through content analysis (“subthemes”). The theory and practice of adult education have revealed that their responses are, in most cases, more complicated in meanings and attitudes than those of young people. This is reflected by the fact that their personal experiences and professional expertise often intermingle with the way they judge anything new they learn [39]. For this reason, content analysis may be more appropriate to discover what they think about the subject they learn.

Open ended questions, in contrast to questions that are in closed form, are usually studied by content analysis, which is a research technique for the objective, systematic, and quantitative description of the manifest content of the communication [40]. Another issue with open-ended questions is the role of missing data (either non-valid responses or skipped questions) in inferring results from them since the amount of missing data is usually higher for open-ended questions. This problem is specific to self-administered questionnaires because there is no other interviewer to check for improper responses and/or any omitted items [41]. In addition, since some respondents answer in broad terms, the researcher may have to focus on particular answers, especially when it comes to attitudinal questions, because there is no interviewer to probe and inspire respondents to provide more detailed responses [41].

Content analysis is more complex and complicated than quantitative analysis [42], and it has no clear rules for data analysis, as each investigation is unique and the outcomes are determined by the investigator’s talents, insights, observational abilities, and style [43]. One of the challenges of content analysis is that it is very flexible, and there is no one-size-fits-all approach. Researchers must determine which combinations are most suitable for their specific problems [44], which makes the research process both difficult and fascinating. This research process has received little attention in the literature of Information and Communication Technologies (ICTs) in education. Backman and Kyngäs [45] described the beginning of the categorization process as chaotic since researchers have many apparently unconnected pieces of knowledge to cope with and classify. Another issue is that the content of the narrative is seldom linear, and transcribed interview paragraphs can include elements from multiple categories [43,46]. Reporting and presenting the study’s findings can be difficult as well since the findings are the product of a multi-phase process. Some aspects of this process can be described in great detail, but others, such as the researcher’s own behavior and insights, may be difficult to express [45].

However, our study nevertheless has some limitations. One is the small number of game players, and another is that it is possible that some of the findings of this study might be biased by particular geographical settings (i.e., different cities and cityscapes within the same city) or by the participants’ particular demographics, and thus further research under different conditions and participants might be needed. In addition, with alternative classifications of the three age categories, different results might be derived. This particular classification into three categories did, however, reveal some similarities and differences between age groups. Some responses to multi-parametric questions, however, may present rather unexpected results. This was the case with the fifth question in this study, to which as many as 32% of the participants responded that they would not make any changes to the game.

However, content analysis, as a research methodology, is shown to offer new perspectives, improving a researcher’s comprehension or advising realistic behaviour, and it is thus an appropriate method for analyzing data, particularly those derived from research in adult education [33].

In this paper, content analysis was ideally combined with the Jaccard similarity index because it was applied to record agreements and disagreements between subthemes, and in this way, it allowed us to analyse qualitative data (i.e., the subthemes) quantitatively. Furthermore, the combination of content analysis and the Jaccard similarity index can be used in similar studies also (i.e., for analyzing texts relating to user interface and

qualitative software evaluation). Until now, quantitative content analysis was used either by measuring the frequencies of words in a text or qualitatively only (exploring meanings and semantics).

As regards the game itself, the subtheme “knowledge of geography facilitates playing the game better” seemed to occupy a central position among the opinions expressed in answering question 1. Ingress, like other types of urban mobile gaming, allows players to interact with both their mobile device and the urban environment at the same time. Pervasive games have historically been used to investigate such activities as an extension of the gaming world into everyday spaces [47,48]. By contrast, urban play has been debated as a natural part of daily life, with parallels drawn between historically situated urban mobility activities [49]. In the case of urban mobile games such as Ingress, play is influenced by socio-cultural circumstances prevailing in an area, while at the same time, the play generates a new, unique perception of urban environments [38] that is based on one of AR’s most characteristic feelings, the “immersion”. According to Gong et al. [50], location-based mobile games are gradually turning “serious” ordinary spaces into playful spaces, thereby blurring the lines between play and everyday life. The use of mobile devices and the physical movement of players in space has increased the importance of the social construction of space. In addition, the game reveals new information about people’s mobility habits [51–53].

From the responses to the question concerning the scenario of Ingress, it was noted that the subtheme highlighting the fact that the game convincingly relates to the evolution of humanity accounted for 41% of the respondents, and this points to a much-discussed and timely issue regarding socialization through MAR (Mobile Augmented Reality) games. It is widely recognized [54–56] that location-based AR is more suitable for building scenarios and promoting collaboration. Moreover, naturalistic approaches applied to location-based MAR are suitable for designing multidisciplinary applications, can be used for training, and have the potential to be designed so as to account for locality and context [57].

When participants were asked how they felt while playing locally in a global game, 22% of them expressed enthusiasm that the game is adapted to our daily lives, which mostly follows the ubiquitous “glocalization” patterns of contemporary life. However, because of the real-world nature of Ingress, Windleharth [58] stated that the “Ingress Communities of Practice” (CoPs) face unique challenges, such as risks to physical safety in order to achieve the game goals, “spying” (with attempts to gather information from in-game and out-of-game systems) while monitoring real-world locations and behaviors and risking real-world identity exposure, along with a range of other issues (such concerns were also mentioned by some 11% of the respondents in our study). The Ingress CoPs have developed specific practices to solve problems that blur the line between digital and real-world gaming, encouraging players to self-police and change their actions to suit group norms [58]. The vast majority of responses were that the game is very interesting, that its activities flow smoothly, and that there are clear goals at every level. Those players who stated that Ingress has idle phases mentioned the need to walk long distances between portals, the fact that the levels proceed slowly, and the weather factor (which may impose restrictions to play).

Previous studies [59–61] have shown that younger adults (18–35 years) are more familiar with videogames than older adults (67 years and older). However, Madrigal-Pana et al. [12] agreed that game exposure and practice, rather than age, could be to blame for any negative attitudes towards games. Indeed, new research shows that once older adults grasp and play videogames, their negative attitudes gradually fade away [62,63]. This coincides with the findings of our research with Ingress, in which a positive attitude to Ingress was revealed, even by adult users of the >52 age group. This backs up the idea that, at least in part, questions about such games stem from a lack of experience with the medium. This is also supported by research by Przybylski [64], which found a connection between negative attitudes towards video games and generational issues.

5. Conclusions

This study reveals that, so long as the scenario of an MAR may appeal to adult users, the game can very well be approached and played by adults of various ages and educational backgrounds. Location-based MAR games offer the additional advantage to adult users that they combine physical activity with the excitement offered by AR technology.

Particularly as concerns the game Ingress, we can conclude that regarding the playing of Ingress by adult users who play it for the first time, those over 36 years old focused on the fact that it is primarily a geographical game and its scenario reflects interesting discussions about the evolution of humanity. Next, whether the game is boring and how they feel playing locally in a worldwide game and with respect to any changes they would suggest, the highest agreement among participants' views was observed between the 20–35 and >52 age groups, who commented that the game does not have idle phases, that it combines excitement with insecurity, about playing in their country within a game of planetary proportions, and that they would not suggest any notable change in the game's design or settings.

In addition, methodologically, it was shown that content analysis presents the researcher with several advantages: texts derived from interviews and/or answers to open questions of educational research can be analyzed both qualitatively and quantitatively with Jaccard indices. The method proposed here shows how, after the themes were identified from within the typical content analysis methods, the subthemes may subsequently be analyzed by means of Jaccard indices in order to derive assessments of agreement of the participants' responses.

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