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PRELIMINARY ANALYSIS OF GAMIFIED EXTENDED REALITY EXPOSURE THERAPY APPLICATION FOR SPIDER PHOBIA (ARACHNOPHOBIA)

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Abstract. *Extended Reality (XR) is one of the technologies currently gaining popularity due to the metaverse. Previous research revealed that XR technology, such as Virtual Reality (VR) and Augmented Reality (AR), could be applied to exposure therapy for Spider Phobia (Arachnophobia). In this research, the SephiaXR application is made based on XR with the gamification approach. SephiaXR has two different XR modes: AR Mode, which implements AR technology, and VR Mode, which implements AR, in which Cardboard-based VR adds. Ten respondents with a computer science background were involved in testing the application's usability in both modes. The results show that the application's usability level is quite good in both modes (Mean > 3.40). Furthermore, when a comparison is made between the two modes, the results show no significant difference in usability between AR Mode and VR Mode ($p > 0.05$).*
Keywords: Metaverse, Extended reality, Spider phobia, Arachnophobia, Augmented reality, Virtual reality, Usability questionnaire, Extended reality game questionnaire

1. **Introduction.** Extended Reality (XR) is a term for immersive technology that covers the entire technology of the reality-virtuality continuum [1]. This term relates to technologies that are Virtual Reality (VR), Mixed Reality (MR), and Augmented Reality (AR) [1,2]. Previous research revealed that XR technology had been widely applied in manSy fields [21], including entertainment, education, training, to exposure therapy [3-7]. Exposure therapy itself is one of the treatments to overcome mental illnesses such as specific phobias [8]. Specific phobia is one of the most common mental illnesses with a prevalence of 3%-15% over a lifetime [4]. One example of a specific phobia is Spider Phobia (Arachnophobia), which is a phobia of animals such as spiders [8-10]. Previously, there was an application of game elements (gamification) that could be used as a two-way medium for exposure therapy in spider phobia [11,12]. Applying gamification can make the experience more varied, motivating and funny [11,13-16].

Previous research on the application of gamification in spider phobia has been carried out by Wrzesien et al. by using a projector to visualize a digital object as a spider [17]. Wrzesien et al. also applied the quantitative variance of the spider's digital object in several scenarios or interventions [17]. On the other hand, Corbett-Davies et al. implemented AR by using Kinect to visualize digital spider objects [18]. Corbett-Davies et al. visualized a digital spider object on a table and presented it to the user using a TV monitor [18]. Furthermore, research conducted by Zimmer et al. used AR technology for

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exposure therapy by giving a task to watch a digital spider object placed close to the user [4]. Zimmer et al. also applied several level stages where there are differences in time and distance variances [4]. On the other hand, de Witte et al. also conducted a similar study using the commercial application PHOBOS AR app to visualize various visual variants of spider objects [8]. De Witte et al. applied the visual differences of spiders at each level, the higher the level, the more realistic the spiders used [8]. Meanwhile, Kurscheidt et al. used a mixed reality approach using HoloLens and some Arduino hardware to generate haptic feedback [19]. Haptic feedback is applied to the user's hand, when a digital spider object appears on the user's hand, there will be haptic feedback on the user's hand. Furthermore, in VR technology, Musalek and Vasek used HTC Vive to perform exposure therapy on spider phobia [13]. Musalek and Vasek made an application that asks the user to be able to survive in a virtual environment where there is a spider [13].

Furthermore, previous research also revealed that the application of XR technology with gamification elements has a good level of usability and engagement [17,20]. We proposed an extended reality-based exposure therapy application with a gamification approach (The Gamified XR Exposure Therapy) with implementation application named SephiaXR. In Gamified XR Exposure Therapy (GXRET), we tried to design and implement different approaches for implementation of XR through low-cost mixed reality and gamification. On the other hand, it also involves several respondents comprehensively to evaluate and analyze the usability level of the application. In evaluation, we designed the usability measurement that was modified from previous research.

The structure of this study includes the following. 1) Introduction tells the research background and related work related to this research. 2) The Gamified XR Exposure Therapy explains the proposed method using exposure therapy for spider phobia based on XR with a gamification approach. 3) Methodology explains how the experiment for evaluation is carried out in detail. 4) Results describe the evaluation results and provide analysis through a statistical approach. 5) The conclusion summarizes all the research that has been done.

2. **The Gamified Extended Reality Exposure Therapy (GXRET).**

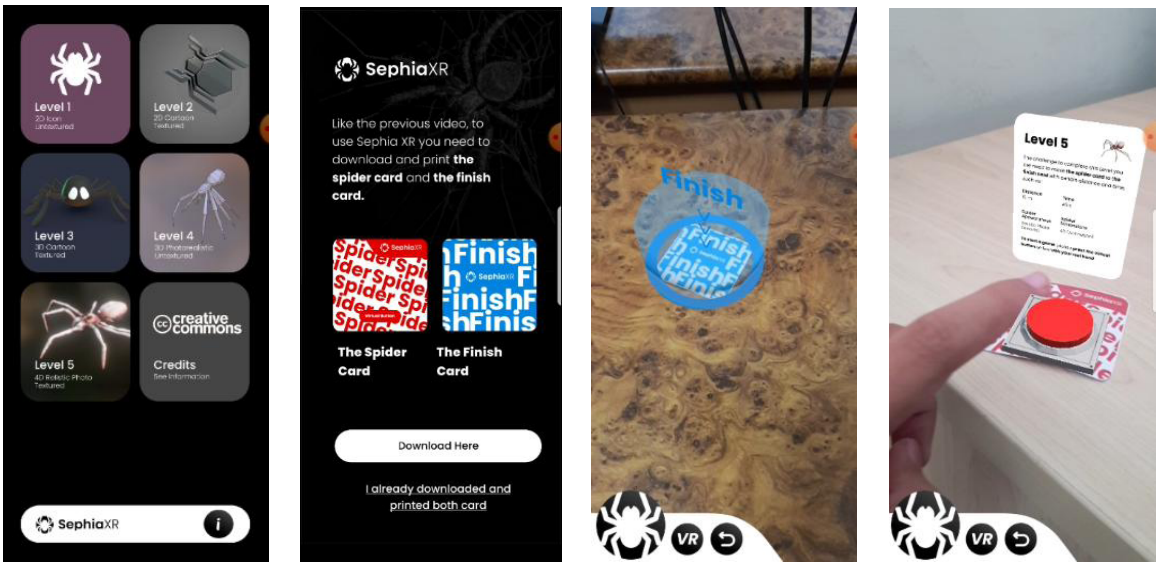
There will be three main types of features consisting of the addition of XR using low-cost AR and VR (The Proposed XR), then, the proposed exposure therapy using image target (The Spider Card and The Finish Card), and the proposed gamification using the concept of level based on time and distance that must be completed by the user. Furthermore, we designed a new measurement for evaluating the usability within GXRET called XR Game Usability Questionnaire (XR-GUQ).

2.1. **The proposed extended reality.**

In this study, an application prototype for spider phobia therapy named SephiaXR was made. SephiaXR application was based on XR with image target. Image target is a type of AR from Vuforia that can render digital objects on top of an image (marker). SephiaXR adopts XR technology which is divided into two modes. The first mode (See Figure 2(a)) is image target-based AR technology (AR Mode). The second mode (See Figure 2(b)) is the same as the first mode with the addition of using a VR Headset (VR Mode). So, image target-based AR is rendered on a mobile-based VR headset. This combines AR and VR, which is like mixed reality mode.

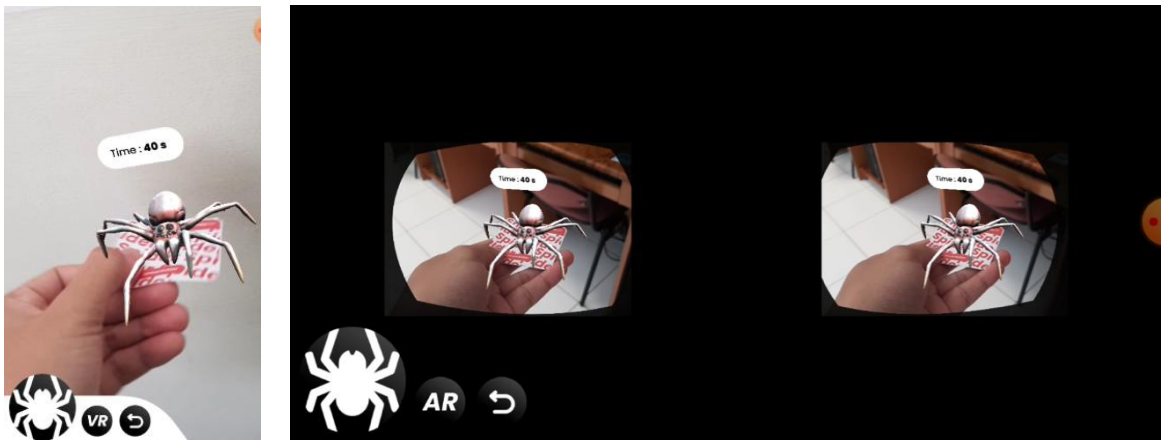
2.2. **The proposed exposure therapy.**

The SephiaXR (See Figure 1) application adopts AR based on image target using markers (See Figures 1(c), 1(d), and 2(a)). Markers for the digital rendering of objects come in two types (See Figure 1(b)). The first marker is 'The Spider Card' in this marker, and the application will render a digital object in the form of a spider (See Figures 1(d), and 2(a)). On the other hand, the second marker is 'The Finish Card' which will render a finish line object (See Figure 1(c)).



(a) (b) (c) (d)

FIGURE 1. The application of SephiaXR: (a) The main menu that displays levels; (b) visual display of The Spider Card and The Finish Card markers; (c) digital objects display on The Finish Card marker; (d) digital display of virtual button and The Explanation objects on The Spider Card marker



(a) (b)

FIGURE 2. The application of SephiaXR: (a) Display application in Augmented Reality Mode (AR Mode); (b) application display in Virtual Reality Mode (VR Mode)

In this application, an exposure therapy model is created that applies gamification. The exposure therapy is in the form of 'The Challenge' which the user must complete. As for 'The Challenge' (See Figure 1(d)), the user will be asked to move the spider object on The Spider Card to the finish line object on The Finish Card within a certain time. The 'The Challenge' is divided into several levels.

2.3. **The proposed gamification.** In this application, the concept of gamification is applied which is divided into five levels (See Figure 1(a)). What distinguishes each level is the time span and the type of spider. The higher the level, the less time is given, the farther the distance between The Spider Card and The Finish Card and the more realistic the spider object is rendered on The Spider Card marker. As for the beginning of the

game at a level, the user will be given 'The Explanation' which explains 'The Challenge' at a level (See Figure 1). The Explanation contains information on what the user must do, the maximum distance between The Spider Card and The Finish Card, and the type of spider rendered on the marker.

In completing The Challenge at a level, the user can click the virtual button that has been placed on The Spider Card marker. After the virtual button is clicked, the time will start running backward according to the time at that level. The user is asked to move The Spider Card from the starting point to the finish point within a certain distance. The distance between The Spider Card and The Finish Card in each level varies, the higher the level, the farther it is. Suppose the user can move the spider (The Spider Card) from the starting point to the endpoint where the location of The Finish Card is on time. Then the user successfully completes the level and can continue to the next level. However, if the user cannot complete it within that time span, the user has failed to complete The Challenge at that level and has not been able to proceed to a higher level.

3. **Methodology.**

3.1. **Study design.** The developed application has two AR and VR modes, as well as game elements in it (Gamification), the proposed XR-GUQ, is a modification of the Five Human Factors and the 'Paldokangsan3' Usability Test [6,11]. In order to justify the measurement (XR-GUQ), we use statistical approach such as Pearson Correlations and Cronbach's Alpha to make sure this evaluation is valid and reliable. Previous research revealed that the Five Human Factors were used to measure usability for VR and AR applications. While the Usability Test 'Paldokangsan3' is used for measurements that are for serious games or applications with game elements in them.

Furthermore, this study will involve respondents to perform several procedures on AR Mode and VR Mode on the application. After that, we compare the usability level between AR Mode and VR Mode to see if there is a significant difference in the usability level between the two modes. Based on the analysis carried out, the following hypothesis is obtained:

- H0: VR Mode does not have a better usability level than AR Mode
- H1: VR Mode has a better usability level than AR Mode

3.2. **Participants and procedure.** This research involved 10 respondents with undergraduate computer science backgrounds at BINUS University for preliminary studies. Meanwhile, the respondents had previous experience in using AR and VR applications. The respondents were asked to use the SephiaXR application and perform procedures in the context of the experiment. Two experiments were carried out to compare the usability level of the two modes in the application. In the first experiment, the respondents were asked to complete 'The Challenge' at each level in AR Mode. Respondents were asked to answer questions right after the experiment was done. Then, in the second experiment, the respondents were asked to complete 'The Challenge' at each level in VR Mode. After that, the respondent was asked to answer the same question as the previous question.

3.3. **Extended Reality Game Usability Questionnaire (XR-GUQ).** In measuring usability to evaluate applications, respondents will fill out each question on the XR-GUQ using a 5-Likert scale (1: Very Bad, 2: Bad, 3: Neutral, 4: Good, 5: Very Good). The interpretation on XR-GUQ is interpreted as follows: 1.00-1.79 indicates the usability is very bad, 1.80-2.59 means the usability within the application is bad, 2.60-3.39 shows the app has neutral usability (not bad or not good), 3.40-4.19 indicates good usability within app, 4.20-5.00 means the application has very good usability.

XR-GUQ consists of 10 question items and five variables, namely Easiness, Learnability, Challenges, Efficiency, and Satisfaction (See Table 1). Each variable consists of questions

Table 1. Questionnaire

Extended Reality Game Usability Questionnaire (XR-GUQ)		
Variable	Item	Questions
Easiness	EAS1	Was the game within the application to control as you want?
	EAS2	Could you see the feedback for your action within the application?
Learnability	LRN1	Was it easy to understand how to control the game within the application?
	LRN2	Could you remember easily to control the game within the application?
Challenges	CHG1	Did you think you would like to the game do better next time?
	CHG2	Did you feel to continue to play the game for the next level?
Efficiency	EFF1	Was the game within the application helpful for your normal memorization ability?
	EFF2	Has it got easier to control the game as you repeat the game within the application?
Satisfaction	SAT1	Was the game within the application good enough to play next time?
	SAT2	Was the game within the application interesting to play?

that are modifications of previous research (See Table 1). The variables are as follows. 1) Easiness describes how easy it is for users to control games on the XR application. 2) Learnability describes how quickly the user learns to control the XR application. 3) Challenges measure how challenged the user is to play the XR game application again. 4) Efficiency describes how fast the user is in remembering and mastering how the application works. 5) Satisfaction describes the level of how interested and satisfied the user is in playing games on the XR application.

4. **Results.** In this section, descriptive statistics are presented to see the value of the validity and reliability of the use of XR-GUQ (See Table 2). In Table 2, the results of the validity measurement using the product moment (Pearson correlation) show that the valid values for all items are valid ($r > 0.428$). This indicates that each question on the XR-GUQ is valid to be used in usability measurement. Reliability (Cronbach's Alpha) analysis was also carried out for each variable in the XR-GUQ (See Table 2). The results in Table 2 show that each variable used is reliable (> 0.60). This shows that each variable in the XR-GUQ has a good or reliable level of consistency.

In Table 2, overall, each question item on the XR-GUQ indicates that the usability of the proposed exposure therapy through the SephiaXR application is good (Mean > 3.39). Other results reveal that the application has good usability in the aspects of Easiness, Efficiency, and Satisfaction (Mean > 3.39). This indicates that our proposed exposure therapy is easy to control well by the user, the proposed exposure therapy process is easy to remember and mastered well, and has a level of satisfaction with good interest. On the other hand, in terms of Learnability and Challenges, the results indicate very good results (Mean > 4.19). The Learnability aspect indicates that the application is fast and easy to understand, which is very good for users. While the Challenges aspect indicates that the application is very exciting and challenging for users very well.

In Table 3, a statistical test analysis is carried out to see if there is a significant difference in usability when users use AR Mode and VR Mode. Of all the variables in the XR-GUQ, the data used had a normal data distribution ($p > 0.05$) after being tested using Shapiro-Wilk. Because the data is normal, a comparison test was conducted using Paired T-Test on all XR-GUQ variables. The Easiness variable indicates that there is no significant

TABLE 2. The result of descriptive statistics

Descriptive statistics									
	Variable					Item			
	N	Mean	Std	α		N	Mean	Std	r
Easiness	40	3.63	0.952	0.786	EAS1	20	3.40	0.995	0.912
					EAS2	20	3.85	0.875	0.885
Learnability	40	4.25	0.809	0.792	LRN1	20	4.10	0.912	0.927
					LRN2	20	4.40	0.681	0.864
Challenges	40	4.25	0.809	0.805	CHG1	20	4.45	0.605	0.514
					CHG2	20	4.05	0.945	0.836
Efficiency	40	4.08	0.829	0.786	EFF1	20	3.85	0.745	0.809
					EFF2	20	4.30	0.865	0.862
Satisfaction	40	3.90	1.081	0.777	SAT1	20	3.95	0.999	0.803
					SAT2	20	3.85	1.182	0.864

Notes. r: Pearson correlation, α: Cronbach's alpha, Std: Standard deviation, N: Count of raw data from respondents, Mean: The average score

TABLE 3. The result of test statistics result

Test statistics						
		Easiness	Learnability	Challenges	Efficiency	Satisfaction
		AR Mode -VR Mode	AR Mode -VR Mode	AR Mode -VR Mode	AR Mode -VR Mode	AR Mode -VR Mode
Shapiro-Wilk	z	0.626	0.863	1.144	0.24	0.795
	w	0.907	0.895	0.878	0.924	0.898
	sig.	0.266	0.194	0.126	0.405	0.213
T-Test	df	9	9	9	9	9
	t	−1.964	1.616	0.48	0.557	−1.309
	p	0.081	0.14	0.642	0.591	0.223

Notes. z = z-score, w = test statistic (Shapiro-Wilk), sig. = df = degrees of freedom, t = t-value p = interpretation

difference in how easy it is for users to control the game between AR Mode and VR Mode ($p > 0.081$). Furthermore, there is no significant difference in terms of how quickly the user learns to control the application (Learnability) with a p-value > 0.14. Meanwhile, the Challenges aspect indicates that there is no significant difference regarding how challenged the user is to play the application again ($p > 0.642$). Regarding efficiency or how fast the user is in remembering and mastering how the application works, it also indicates that there is no significant difference with a p-value > 0.591. Finally, from the Satisfaction aspect, there is no significant difference in Mode ($p > 0.223$) in the level of how interested and satisfied users are in playing games in both AR Mode and VR Mode. Overall indicates that VR Mode is not better than AR Mode. It means that there is no difference in usability between AR Mode and VR Mode in all aspects.

5. **Conclusion.** Despite the limitation of respondents in this study, the inference is that exposure therapy for Spider Phobia (Arachnophobia) can be carried out using an XR application with a gamification approach. This is because, judging from the evaluation results, all items in each aspect have good level terms of usability. In terms of the application of XR technology to applications, there is also no significant difference in usability. This indicates that the exposure therapy can be applied through AR technology (AR Mode) or rdboard-based VR Mode. Supported by the gamification aspect of exposure

therapy, we can see that the application has an excellent level of how challenged the user is to play. In future research, further evaluation will be carried out regarding the application of XR to AR Mode and VR Mode to see if there are differences in presence and immersiveness to engagement. Then, an XR exposure therapy application will be carried out involving respondents with spider phobia to see if there is an effect or correlation in reducing the phobia.

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