Can We Predict the Best Gamification Elements for a User Based on Their Personal Attributes?

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Abstract. Different studies have reported on the various effects of gamification on learners in the online learning course. Thus, it may be valuable to build a learner model that can be used to adapt gamification elements to learners' attributes (e.g. personality). To do this, it is important to understand the relationship between gamification and the learner's personality. A few empirical studies have tried to understand this relationship, but they were based on self-report questionnaires obtained from learners at the end of the study. Using this approach may bias the results because they ignore the learners who dropped out in the middle of the experiment. In the work presented here, we report on a series of studies, each using different gamification elements and each using dropping out as a proxy for motivation. Furthermore, we measured the learners' knowledge gain and satisfaction. The results show that gamification affects learners with different personality dimensions in different ways. Some personality dimensions gain significant benefits from some forms of gamification, while other personality dimensions do not. This variation in the results shows that it can be useful to use personality (ideally with other factors) as a basis for adapting gamification elements. The results can also be used to build a prediction model to match the most beneficial gamification elements to different personality dimensions.

Keywords: Gamification · Motivation · Online learning · Personality · Dropout · Survival

1 Introduction

Previous research has shown that gamification, which is the use of game elements in non-game contexts, can enhance the motivation and engagement of some learners in an online learning environment [18]. However, some learners become annoyed with gamification elements and others are distracted by them [4]. Considering these variations, we suggest building a model that could be used to adapt gamification elements based on the learners' personality profile [20]. The objective is to be able to utilise the gamification elements that would be most beneficial to a specific learner and avoid the negative effects from others.

To build this model, we needed to understand the relationship between gamification elements and the learners' dimensions. A few studies have attempted to address this relationship; however, their results may not be reliable because these studies were

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based on self-report questionnaires that were completed after a gamified course was finished. Moreover, they either forced the completion of the course, which misses the main aim of gamification, or the analysis excluded the learners who dropped out part way through the experiment [8,29]. Thus, in our research, we aim to utilise a more objective approach to measure the effect of different combinations of gamification elements on learners' with different personality profiles.

Within this paper, we aimed to answer the following main research question:

Do learners with different personality dimensions respond differently to different gamification elements?

To answer this question, we conducted three different studies with different gamification elements, but we used the same overall method. In these three studies, we used different measurements. Learners' dropout rate is measured and used as a proxy for learners' motivation. We hypothesised that learners who are more motivated by gamification elements will use the gamified version longer. We also measured the learners' knowledge gain and satisfaction at the end of the experiment.

In these studies, we hypothesised that personality dimensions will respond differently toward different gamification elements.

Our results supported our hypotheses for the variations in the effects of gamification elements. Some learners (e.g. highly extroverted ones) obtain significant benefits (at least, in terms of time spent on the course), whereas others (e.g. highly conscientious ones) obtain little benefit from gamification. The results from the three studies must be combined to build a model that can predict the best gamification elements to provide for each personality dimension.

In this paper, we discuss the method that was used to understand the relationship between gamification and personality type. This method requires a special kind of analysis (survival analysis), which will be discussed in the following sections.

2 Background

Online learning is growing rapidly due to its potential benefits, such as flexibility in terms of time and location. Learners can subscribe to any course from any place at any time without incurring the cost of travel time and accommodation [2]. However, one major drawback of online courses is the lack of engagement and motivation that comes from real world classes. Many learners drop out from online courses after just a few weeks after enrolling [30]. Therefore, studies have evaluated techniques that can be used to enhance learner motivation and engagement. Changing the learning content into a video game is one strategy that has been implemented to motivate learners [16]. However, using video games and other kinds of games, such as serious games and game-based learning, may distract learners causing them to engage more with playing the game rather than learning the curriculum. Furthermore, different research studies have argued that the main purpose of a game is to entertain learners, whilst the main purpose of online courses is to teach learners [14].

Moreover, changing the learning content to make it more game-like requires extra time and cost for teachers and developers. Consequently, different research studies have suggested using gamification as a technique to enhance the motivation and the engagement of online learners [7, 13, 34].

2.1 Gamification

The term 'gamification' is defined in different ways based on the area of concern. For example, in the field of marketing, gamification is defined as the integration of game elements into a state or community to change the users' behaviour and engage them [5]. However, all gamification definitions can be integrated into a single definition: the use of game elements (e.g. points and badges) in a non-game context (e.g. learning or business).

Studies have identified the positive impact of gamification on enhancing online learners' motivation [12, 14]. These studies have shown that if gamification elements are designed well, they will enhance the learners' motivation, engagement and satisfaction [24]. Gamification elements provide instant and quick feedback that will motivate and engage learners to do more. Furthermore, in the gamified system, some learners may feel that they are in a game so they are less likely to fear failure [15]. Even in the worst case, learners might not feel depressed or anxious, and they will have sufficient feedback about their progress [14, 21].

Some studies have identified the relationship between self-determination theory and gamification. For example, Wilson et al. [42] mapped gamification to learners' intrinsic motivation, finding that gamification can satisfy the three elements of intrinsic motivation. For example, presenting points and badges allows learners to receive quick feedback about their progress, giving them the feeling that they can do the task. However, Martí-Parreño et al. [31] believed that gamification can only be linked to extrinsic motivation. The authors [31] use examples of gamified sports applications to justify their claims. They argue that users will not participate in any exercises if they do not have the ability and tendency to complete it [31]. Wilson et al. [42] noted that gamification elements can be considered either intrinsic or extrinsic motivators based on the learners' interest and on their need for the content.

From another point of view, Hamzah et al. [24] pointed out that gamification elements can be annoying and boring, especially if they are not integrated well. Some learning gamified applications add different elements without any relationship between the elements and the learners' behaviour during the learning process [35].

Martí-Parreño et al. argued that learners' perceptions of gamification elements differ [31]. For example, some learners are properly motivated by gamification elements, while others may be distracted. These learners spend their time collecting points and competing with their friends in the leaderboard, while other learners dislike gamification elements because they find them tedious [29].

To overcome the variations in the users' perceptions of gamification, we argue that a learner model should be developed that can be used to adapt the gamification elements to the learners' different attributes. For example, the learners' mood and affective state may be used as a basis for this adaptation. However, these attributes are dynamic and

difficult to detect. In contrast, personality is usually argued to be a stable attribute, and reliable psychological instruments can be used to assess it [3]. Thus, we will focus on personality in the rest of this paper.

2.2 Personality

Personality is a set of characteristics that determine how individuals interact with the outside world [25]. Different models have been developed to describe personality. In this research study, we used the Big Five model (sometimes referred to as the Five-Factor model), which has been widely used in similar research. The Big Five model is used to describe and classify personality into the following five categories or dimensions: conscientiousness (individuals who are careful, hardworking, responsible and organised), extroversion (individuals who are social, active and energetic), agreeableness (individuals who are helpful, friendly and kind), neurotic tendencies (individuals who are anxious, depressed, angry and insecure) and openness to experience (individuals who are imaginative, curious and open-minded) [25]. Table 1 summarises the five dimensions of the Big Five model [23].

Different tools have been developed to measure the Big Five model, such as the Neo-Five Factor Inventory (NEO-FFI) and the Big Five Inventory (BFI). These tools provide reliable measurements on the five personality dimensions. However, the length of these tools (usually more than 100 questions) make it difficult to apply them. Consequently, different shorter versions of these tools have been developed that vary in length. For example, some tools used a smaller version of the NEO-FFI that consists of 10 questions. However, these smaller versions mostly suffer from several reliability issues [36]. Therefore, we used a more accurate and reliable personality test that is neither too long nor too short. We utilised a special version of the BFI that is designed for children that consists of 46 questions. This tool is free and available in different languages [10].

Table 1. A summary of the big five personality traits (adapted from [41])

Personality	Characteristics
Conscientiousness	Leadership skills, the capability to make long-term plans and often an organised support network
Extroversion	Has good social skills and numerous friendships, often participating in team sports and having club memberships
Agreeableness	Forgiving attitude and a belief in cooperation
Neuroticism	Low self-esteem and irrational and perfectionistic beliefs
Openness to experiences	Interested in different hobbies and knowledgeable about foreign cuisine

2.3 Adaptivity in Gamification

Adapting the gamification elements based on the learners' personality dimensions requires one to investigate how different personality dimensions are influenced by the gamification elements. Theoretical works have suggested different gamification elements for different personality dimensions based on the attributes associated with each type of personality [34,36]. For example, highly conscientious learners are described as hard-workers, and they may only need gamification elements to provide them with instant and quick feedback, which will motivate them. Highly extroverted learners enjoy gamification elements, especially the social elements. They like to interact and compete with others.

In terms of practical and empirical research, a few studies have addressed the relationship between gamification elements and personality dimensions. For example, Codish and Ravid [8] focused on one dimension of personality (extroversion). Another study [9] included all the Big Five personality dimensions. These two studies, along with other similar work [29,38], examined the effects of the gamification elements on learners with different types of personality dimensions; the results showed that learners with different personality dimensions prefer different gamification elements. Table 2 summarises the findings from the related research studies that have examined the effect of gamification on different personality dimensions.

The methods used in the previous related research studies were based on self-report questionnaires that asked learners about their preferred elements. However, using this type of approach may provide unreliable results [20]. These studies only analysed the results from learners who completed the study, which may cause bias in the results; this conflicts with the main aim of gamification. Further, these studies did not include data on the learners who dropped out in the middle of the experiment. It is important to identify the reasons why the learners dropped out. For example, is the dropout rate the result of the gamification elements? Thus, the current study takes a more objective approach, which will be explained in the next section.

3 Method

This research aims to build a learner model that can be used to adapt gamification to individual learner's personality dimensions. To accomplish this, three stages must be completed. First, we need to understand the relationship between gamification and personality dimensions. Second, we use the obtained understanding to build the adaptive model. Finally, the proposed adaptive model must be evaluated to examine if it is beneficial for learners (Fig. 1). In this paper, we focus on the first stage.

To build a strong understanding of the relationship between gamification and personality dimensions, we conducted three different studies at different times with different participants. In each study, we used different gamification elements and we measured the learners' motivation, knowledge gain and satisfaction.

3.1 Setup

We built an online learning website for a course that teaches learners how to use Microsoft Excel. The course consists of 15 lessons, beginning with simple topics, such

Table 2. A summary of related research studies that present how different personality dimensions benefit from gamification elements

Personality	Points	Badges	Leaderboard	Social elements	Avatars	No gamification elements
High conscientious	[33,38]					[9,37]
Low conscientious	[20,22]	[20,22]	[20,22]	[22]		
High extrovert	[20,22,33,38]	[8,20,22,37]	[20,22,28,29,33,37,38]	[22,37,38]		
Low extroversion		[9]	[8,29]			
High agreeableness	[20,33,38]	[9,20]	[20,28,33,38]	[38]		
Low agreeableness						[20,22]
High neuroticism	[20,29,37]	[20]	[20]			[22]
Low neuroticism	[22]	[22]	[22,28]	[22]	[33]	
High openness	[20,22,33,38]	[20,22]	[20,22]	[22]	[37]	
Low openness	[20,22]	[20,22]	[20,22,28,33]	[22]	[8,33]	

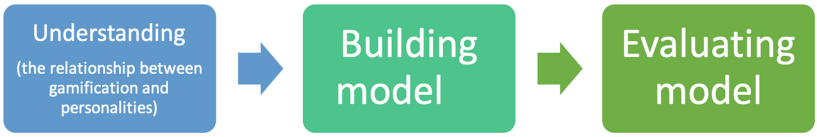

Fig. 1. The process required to build model

as 'What is Excel?' and 'How can tables can be created in Excel?' The course then moves onto more advanced topics, such as mathematical and logical operations. Each lesson was followed by a short test to provide learners with feedback and to inform them about their progress.

Two versions of the course were designed. One version had integrated gamification elements and the other version did not. We used a variety of gamification elements in the design of each study. For example, in the first study, we used the most common gamification elements, points, badges and a leaderboard, as argued by [29]. Points could be obtained each time a learner gave a correct answer on the lesson test. By collecting five points, a learner earned a badge. The number of collected badges could change the learner's position on the leaderboard.

In the second study, we aimed to increase the cost of the gamification elements. Thus, we added some social gamification elements that allowed the learners to interact with others, and to chat.

Finally, in the third study, we used another gamification element: avatars. However, it is important to identify the way that an avatar is presented to the learner. For example, a learner can build his/her own avatar to present himself/herself while experiencing the system. Thus, avatars will be presented differently to the learners based on their choices [39].

To prevent this, in this study, we decided to use the avatar as a form of guidance for the learners. The avatar is presented in the same way for all learners every few minutes carrying a regular motivational phrases, such as 'You are doing great. Carry on!', are also presented. Thus, in the third study, we used points, badges, a leaderboard, an avatar and motivational phrases.

3.2 Participants

We asked 600 high school learners from Saudi Arabia (almost 200 learners in each of the three studies) ranging in age from 16 to18 years to participate in our studies.

Before conducting the studies, we obtained approval from the schools, the learners' parents and the learners, and we specified that all collected data would be anonymous and securely stored. The learners were made aware that they were free to drop out of the studies at any time.

3.3 Procedure

After establishing these agreements, we conducted our studies with a between-subjects design. At the schools, we asked the learners to register on our website by completing three forms: 1) one that obtained their demographic information (e.g. age, gender), 2) a pre-test consisting of eight questions related to the course to measure the learners' prior knowledge level and 3) a BFI to measure the learners' personality dimensions.

Unlike other studies that classified personality dimensions into high and low, we classified each dimension of a learner's personality into three classes: high, average or low. We believe that classifying personality dimensions into two classes at the mid-point is not sensible, as argued by [27].

These three classes were determined (for each personality dimension) by taking the mean (μ) and standard deviation (σ). Then, we classified the learners who scored lower than $\mu - \sigma$ as low. Learners between $\mu - \sigma$ and $\mu + \sigma$ as average and learners above $\mu + \sigma$ as high, for that personality dimension.

Afterwards, we divided the learners equally into two groups, balanced according to their age, gender, personality profile and prior knowledge level. One group used the gamified version of the website, and the other group used an identical version of the website without any gamification elements.

The learners were free to dropout at any time, and we used this variable as a proxy for motivation and engagement. We hypothesised that the learners who were more motivated would use the system for a longer period of time [22].

When all the learners in both versions either had completed the course or stopped using it, we asked them to complete a post-test that had the same structure as the pre-test. We calculated learners' knowledge gain using the following formula:

Learners' knowledge gain = Learners' post-test − Learners' pre-test

We also asked the learners to complete an e-learner satisfaction tool [40]. Figure 2 shows the flow of the studies.

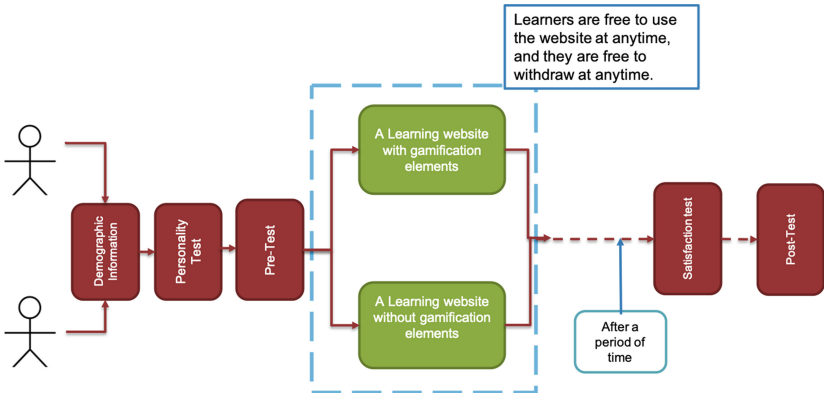

Fig. 2. The flow of our studies.

4 Results

In this paper, we provide an overview of three experimental studies that aimed to understand the influence of different combination of gamification on online learners' personality dimensions. We measured the influence of gamification elements by using three different measurements, such as: learners' motivation, knowledge gain and satisfaction.

As the space allotted in this paper does not permit us to report all the results, we will summarise the most interesting findings in below:

4.1 Motivation

Unlike other related research studies that used self-report questionnaires to measure the effect of gamification on motivation, we used a more objective approach by measuring the dropout rate and using it as a proxy for motivation. Because we used a different approach, we needed to apply a special analysis known as survival analysis.

One way to perform a survival analysis is to use the Kaplan-Meier estimator, which visualises the dropout rate of the two groups [11]. Figures 3 and 4 show an example of Kaplan-Meier estimator after it is applied on the high and low extrovert learners in the second experiment, respectively.

The Kaplan-Meier estimator can provide an understanding of which version is better, but it does not present the degree of difference between the dropout rate for the two groups. Furthermore, as Mills (2010) [32] pointed out, the Kaplan-Meier estimator may provide unreliable results if it is applied with continuous data. Thus, we used a different kind of survival analysis, the Cox Proportional Hazards Model, which evaluates the effect of specific factors in a particular event (e.g. death, dropout). This factor is called the hazard rate (HR). The model analyses the relationship between the hazard function and the predictors by assuming a nonlinear relationship between them [11]. We used the Cox model to examine whether there were any significant differences between the dropout rate of the two groups. Thus, we identified the extent of the dropout rate difference between the two groups. Table 3 shows the results obtained using the Cox model.

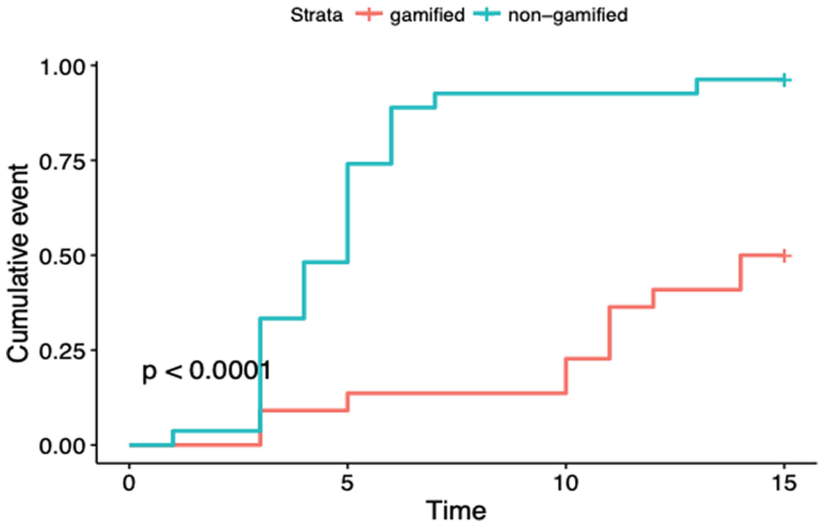

Fig. 3. The Kaplan-Meier estimator for the highly extrovert learners in the second experiment.

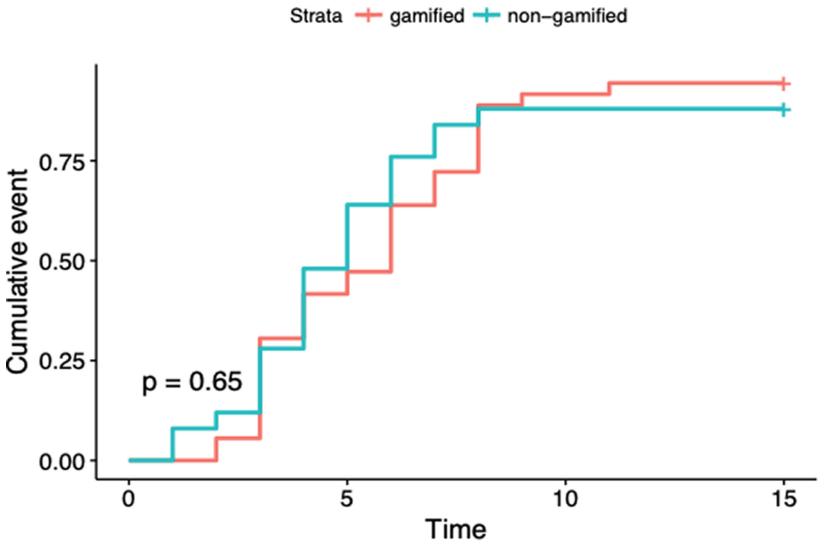

Fig. 4. The Kaplan-Meier estimator for the low extrovert learners in the second experiment.

The results show that most of the learners were more motivated in the gamified version. This can be clearly seen from the sign of the *coef*. The positive value shows that the dropout rate is higher in the second version (the non-gamified version). While, the value of the HR shows the difference in the dropout rate between the two groups.

From the table, it can be noticed that the dropout rate varies between the different personality dimensions. Some personality dimensions, such as highly extroverted learners, gain a significant benefit from the points, badges and leaderboard. This benefit is increased when the social elements are added. While other personality dimensions, such as highly conscientiousness learners, gained a slight benefit from the gamification elements. The dropout rate was almost the same between the two versions in the three studies. However, we did notice that highly neurotic learners were demotivated by some of the gamification elements, such as the avatars.

4.2 Satisfaction

Following the results from the effect of gamification elements on learners' motivation, we compared the satisfaction of the learners in the two versions. Our results support what is suggested from [6] as there is a good correlation between learners' motivation and satisfaction. Most of the learners were motivated because of the gamification elements, and they were also more satisfied. Table 4 shows an example of the learners' satisfaction results from the second study.

4.3 Knowledge Gain

As we are measuring the effect of gamification on the learning environment, it is obvious that we should measure learners' knowledge gain. In the studies, we aimed to measure learners' short-term gain by asking them to fill in a post-test directly after finishing the study. In addition, we aimed at measuring learners' long-term knowledge gain by asking them to fill in another post-test four weeks after finishing the study. However, for different reasons related to the schools and the participants, we were unable to measure learners' long-term knowledge gain.

Regarding learners' short-term knowledge gain, the results were different from those obtained for learners' motivation and satisfaction. Some of the learners were

Table 3. The results from Cox model in the three studies

Independent variables	Experiment (1)			Experiment (2)			Experiment (3)		
	P-value	Coef	HR	P-value	Coef	HR	P-value	Coef	HR
Overall learners	<0.00001	0.66	1.9	<0.00001	0.63	1.8	0.4	−0.13	0.87
High conscientious	0.05	0.48	1.6	0.06	0.2	1.8	0.6	−0.23	0.79
Low conscientious	0.01	0.84	2.3	0.04	0.6	1.9	0.1	0.62	1.8
High extraversion	0.01	1.0	2.7	<0.00001	1.9	7.0	0.9	−0.03	0.96
Low extraversion	0.3	−0.4	0.6	0.6	0.15	1.1	0.02	−1.04	0.35
High agreeableness	0.001	1.4	4.2	0.1	0.89	2.4	0.4	−0.73	0.48
Low agreeableness	0.5	0.25	1.3	0.1	0.43	1.5	0.9	0.03	0.96
High neuroticism	0.01	0.92	2.5	0.7	0.1	1.1	0.04	−0.67	0.5
Low neuroticism	0.3	0.43	1.5	<0.00001	1.4	4.2	0.2	−0.58	0.56
High openness	0.01	1.2	3.5	0.02	0.6	1.9	0.5	0.27	1.31
Low openness	0.02	0.99	2.7	<0.00001	1.4	4.2	0.06	−0.97	0.37

highly motivated by the gamified version. However, their knowledge gain in the gamified version was worse than in the non-gamified version. For example, highly extroverted learners enjoyed and were motivated by the gamification elements, especially the social elements. However, we found that their knowledge gain in the gamified version was lower. This was not expected, as we had hypothesised that improving learners' motivation would improve their knowledge gain. However, this was not the case. Instead, gamification might be a distraction for learners from concentrating on the course. Table 5 shows an example of the learners' knowledge gain in the gamified and non-gamified versions in the second experiment.

Overall, our results showed a variation in the responses of different personality dimensions towards gamification.

The results from our three studies indicate that gamification had a positive effect on most of the learners. However, this positive result varied across different types of personality dimensions. Some learners, such as the highly conscientious ones, only experienced a slight positive effect from the use of points, badges and the leaderboard. In contrast, low conscientious learners benefitted the most from these gamification elements.

5 Discussion

In this paper, we discuss a series of studies that were conducted to understand the effect of different gamification elements on learners' personality dimensions. We asked about 600 learners to participate in our studies (almost 200 learners in each of the three studies). After registration, we divided the learners into two groups, in which they were balanced in terms of their age, gender, prior knowledge level and personality profile. Then, we asked the learners to use the online learning website at any time and any place they wished; they were also free to drop out at any time. After, we compared the dropout rate in both groups, and we used that data as a proxy for motivation. Furthermore, we measured the learners' knowledge gain and satisfaction.

The results from the studies showed a variation in the response of different personality dimensions towards gamification. Furthermore, the learners' motivation, knowledge gain and satisfaction were different under the same gamification element. For example, highly extroverted learners were found to be very motivated by and satisfied with the gamification elements, especially the social elements. However, their knowledge gain was lower in the gamified version. Thus, we tried to trace the behaviour of the highly extroverted learners when they were interacting with the gamification elements. We found that these learners were using the social gamification elements, and they were talking about topics that were not related to the course. Moreover, some highly extroverted learners used the social elements to compete with their friends by asking them about the number of collected points and badges. Consequently, we can suggest that the presence of the social gamification elements may distract highly extroverted learners from concentrating on the course content. Thus, we can conclude that social elements are very important to highly extroverted learners, since they are motivated by and satisfied with these elements. However, the presence of these elements must be controlled. In the case of the existing social elements, learners should be supervised by the administrator or the teacher. Thus, for example, if the social elements start to distract highly

Table 4. An example of the summary of the results of the satisfaction for the personality dimensions in the second experiment

Personality	Total number of learners	Satisfaction in the gamified version			Satisfaction gain in the non-gamified			Benefit from gamification
		N	μ	Sd	N	μ	Sd	
Overall learners	194	97	6.62	0.311	97	6.17	0.3	0.45
High conscientious	37	23	6.6	0.8	14	6.4	0.78	0.2
Low conscientious	33	18	6.4	0.78	15	6.07	0.73	0.33
High extrovert	47	23	6.64	0.58	24	6.1	0.49	0.54
Low extroversion	40	24	6.54	0.58	16	6.1	0.76	0.44
High agreeableness	54	26	6.64	1.3	28	6.4	1.1	0.24
Low agreeableness	50	28	6.32	0.8	22	6.28	0.87	0.04
High neuroticism	48	26	5.7	0.83	22	6.3	0.87	−0.6
Low neuroticism	40	26	6.3	0.78	14	6.3	0.75	0
High openness	40	21	6.5	0.78	19	6.3	0.83	0.2
Low openness	37	23	6.27	0.88	14	6.3	0.8	−0.03

extroverted learners, the teacher must redirect the topics to be related to the course. Another suggestion is to make the social elements be a reward for highly extroverted learners. Thus, learners can begin the course with a basic level with no social elements and then work harder to move onto the next level that has the social elements.

Another issue in our studies is the presence of the avatar. We chose to present the same avatar to all learners in the same way. The same avatar will be presented to the learners every couple of minutes, along with some motivational phrases. Choosing to present the avatar in this way may be the reason why some of the learners were demotivated. Most learners prefer to choose their own avatar to best represent themselves, their personality, their hobbies and their preferences, as argued by [39]. However, we designed our study using the same avatar for all learners in the same way to avoid introducing any new effect that may bias the results.

The use of the between-subjects design is another issue related to the design of our studies. Designing an experiment in this way is effective and prevents the impact of any learning effect, as argued by [1]. However, this type of study design requires a large number of participants. Furthermore, there is a significant chance of having noise in the results. Thus, when building our model based on the obtained results, there is a risk that it would be based on noisy data.

The previous results indicate that it is worthwhile to adapt gamification elements, and personality can be a good predictor for learners' behaviour in a gamified system. However, the issues presented above make the process of building an adaptive model based on our results more challenging. For that reason, we suggest building the adaptive model based on the obtained results from our studies and the related studies in the literature [8,9,29,38]. We will also include suggestions from theory that explain the

Table 5. An example of the summary of the results of the knowledge gain for the personality dimensions in the second experiment.

Personality	Total number of learners	Knowledge gain in the gamified version			Knowledge gain in the non-gasified			Benefit from gamification
		N	μ	Sd	N	μ	Sd	
Overall learners	194	97	1.39	2.14	97	1.97	1.91	−0.58
High conscientious	37	23	2.12	1.5	14	2.6	1.7	−0.48
Low conscientious	33	18	2.51	0.45	15	2.16	1.86	0.35
High extrovert	47	23	1	2.1	24	2.04	1.45	−1.04
Low extroversion	40	24	2.04	1.9	16	1.73	1.65	0.31
High agreeableness	54	26	1.81	2.1	28	2.4	1.61	−0.59
Low agreeableness	50	28	2.01	2.39	22	2.23	1.14	−0.22
High neuroticism	48	26	1.42	1.8	22	1.78	2.01	−0.36
Low neuroticism	40	26	1.61	1.9	14	2.5	1.28	−0.89
High openness	40	21	1	2.4	19	2.37	1.5	−1.37
Low openness	37	23	1.27	1.53	14	1.64	10.94	−0.37

best gamification elements based on the characteristics of each personality dimension. Using this approach, we can have a set of predictions on how to match a combination of multiple gamification elements to the learners' personality profile.

For example, as suggested from our results, learners who are highly conscientious did not gain any significant benefit from the gamification elements. These learners are usually described as being hardworking, and they always do their job. They do not need any techniques to motivate them. Thus, we suggested avoiding using any gamification elements for these learners.

In our studies, the highly neurotic learners did not benefit from the gamification elements. Integrating avatars and motivational phrases was found to have a negative effect. Moreover, highly neurotic learners are usually described as being emotionally unstable, and they are usually more anxious and sadder than other personality dimensions [26]. Thus, it may be risky to integrate gamification elements into an online learning venue for these learners because they may find them tedious and childish. We suggest avoiding any gamification elements for this kind of personality dimension when building our model.

In contrast, the highly extroverted learners were shown to gain the most significant benefit from the different gamification elements. From our studies, these learners were motivated by points, badges, leaderboard and the social elements. This result confirmed what was suggested by [38]. Furthermore, highly extroverted learners are usually active and full of energy [26]. They also prefer to talk and interact with others. Thus, in building our model, we suggest providing different gamification elements. At the same time, the presence of these elements must be controlled. The suggested adaptive model must

track the learners' behaviour; if there is any risk that the gamification elements might distract learners, the system must dynamically update the presence of the gamification elements, either by blocking the existing gamification elements or adding a new gamification element.

After predicting how to match a combination of the gamification elements to the learners' personality dimensions, we will build the model based on these predictions. Then, the proposed adaptive model will be evaluated to assess its effectiveness. One way to evaluate the model is by using the match/mismatch approach [19]. To accomplish that, we divided the participants into two groups: one group was asked to use an adaptive version of the learning website that matched their personality dimensions. The other group was asked to use the same online learning system but with gamification elements that did not match their personality. The main objective was to examine if there was a variation in the response of the learners in the matched and the mismatched groups.

The proposed adaptive model can be considered to be an effective technique to improve learners' motivation, knowledge gain and satisfaction. However, the model must be evaluated with other groups of learners, as we believe that the effectiveness of the obtained model might be restricted to the target learners who are aged 16–18 years old. Further, the model may not consider learners with special needs; for example, learners with colour-blindness or dyslexia. In addition, most of the studies that focused on the effect of gamification, including ours, ran on a short-term basis only. However, we believe that the effect of gamification may be reduced over time. Thus, learners may become bored after a period of time from using the adaptive gamified system. In that case, we suggest that it may be better to make the system half-adapted. Thus, the adaptive model provides the initiative's adaptive gamification elements. Then, the learners have the freedom to change the gamification elements if they get bored. This also allows us to understand how users' preferences change and which attributes, other than personality, can affect learners' behaviour. This understanding can be used for optimising the adaptive gamified system to improve users' experience.

6 Conclusion

Recently, gamification has been used to improve users' motivation and engagement [7]. However, some studies have shown that gamification has a varied effect on users. For example, some users are motivated by these elements for a short period of time, but they then become bored and demotivated [17]. Other users enjoy these elements, but become overwhelmed by them [23]. For example, some users may distract themselves by collecting points and badges rather than concentrating on the task. Furthermore, [29] pointed out that some users may dislike the presence of the gamification elements because they find them to be tedious, while other users describe these gamification elements as a waste of time. For this variation in the response of users, we suggest building a model that can be used to match learners with different personality dimensions with the most beneficial combination of multiple gamification elements. However, accomplishing that required going through several stages. First, it is important to understand the relationship between the gamification elements and the personality dimensions. Then, this understanding can be used to build and evaluate the proposed model.

In this paper, we focused on the first stage that aimed to understand the influence of the gamification elements on personality dimensions. While a few studies [8,9,29,38] have tried to understand the relationship between gamification elements and personality dimensions, they were based on self-report questionnaires obtained from learners who completed the study. However, using that approach may bias the results because the participants are forced to complete the entire study. Furthermore, these studies ignored the users who dropped out in the middle of the study without examining the reason for dropping out, which could be due to the gamification elements.

To address these limitations, we decided to examine the relationship between the gamification elements and the personality dimensions. We applied a more objective approach by using different measurements to understand the influence of the gamification elements on different personality dimensions. We used the dropout rate as a proxy for motivation. We also measured the learners' knowledge gain and satisfaction.

We conducted a series of studies with 600 learners. In each of these studies, we assigned learners (balanced by age, gender, prior knowledge level and personality type) into two groups: one group used a website integrated with gamification elements and the other group used a website that was not integrated with gamification elements. We used different gamification elements in each study. In the first study, we used points, badges and a leaderboard. In the second study, we added social gamification elements, such as chat. In the third study, we used points, badges, the leaderboard, avatars and motivational phrases. The learners were free to dropout at any time, and we used their dropout rate as a proxy for motivation. After ensuring that all the learners had either dropped out or completed the course, we measured the learners' knowledge gain and satisfaction.

The results from the three studies did not show a significant negative effect from gamification (except for the effect of the avatars on the highly neurotic learners). However, we did observe positive effects, which varied among the different personality dimensions. Some personality dimensions, such as the highly extroverted learners, benefitted significantly from the gamification elements, such as the social elements. Others, such as the highly conscientious learners, experienced less extensive benefits from gamification. The motivation of the highly conscientious learners was almost the same in the gamified and non-gamified versions. Furthermore, the highly neurotic learners did not obtain any significant benefit from the gamification elements, such as points, badges or the leaderboard. These learners had a negative effect from some of the gamification elements, such as avatars.

This variation in the effects of gamification shows that a learner's personality can be considered to be a good predictor of their behaviour in gamified online courses. However, we need to consider other factors, such as learners' friendships, moods and physical contexts, which may influence their behaviours. For example, happy conscientious learners may prefer to use gamification elements, but when these learners are angry or sad, they may dislike using those elements.

Furthermore, we could not apply all the gamification elements in the design of our studies. Our studies used a between-subjects design, which is considered to be an effective way to design this type of study. However, the results from this kind of study may provide noisy data. Consequently, in the next stage of this process, we combined the

results obtained from our studies with suggestions from theoretical work and data from related empirical studies to generate a prediction. The prediction was used to build an adaptive model. This model matched each combination of multiple gamification elements to the learners' personality profile. The chosen gamification elements must be those that are most beneficial to the learners. Thus, the chosen gamification elements must improve the learners' motivation, knowledge gain and satisfaction. It is also important to note that the proposed adaptive model must be built dynamically because it must track the users' behaviour. Then, the model must be able to update the presence of the gamification elements based on the learners' behaviour (either by blocking the existing gamification elements or integrating new ones). The proposed adaptive model must be then evaluated to assess its effectiveness, and to ensure that it can provide learners with the best experience when using a gamified system. In addition, the model must be evaluated with other group of learners, such as younger or older learners. Further, it may better to assess the effective of the adaptive gamification elements on learners in the long-term. This understanding can help to improve users' experience.

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