Personalized Gamification in E-Learning with a Focus on Learners' Motivation and Personality

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ABSTRACT

Background: This study sought to develop a personalized gamified e-learning system based on students' motivation and personality, and evaluate its efficacy with regard to their performance in mathematics.

Methods: In this pretest-posttest experimental study, the participants included 117 students already familiar with e-learning systems. They took a mathematics course in January-February 2020, and were randomly assigned to five groups: Personalized Gamification (PG) based on motivation and personality (n=23), PG based on personality (n=23), PG based on motivation (n=23), non-personalized gamification (n=23), and control (n=25). Then the students' scores and the time they spent on the learning management system (LMS) were compared before and after the personalization procedure. The collected data were analyzed using SPSS version 26. In this regard, independent-samples t-test was used to compare the mean scores at P<0.05 significance level.

Results: The personalized game-based learning system tailored to learners' motivation and personality did significantly improve their scores and promoted their engagement in LMS, as compared to the pre-personalization phase (P<0.05). Moreover, the students' mean scores increased compared to the non-personalized gamification (P<0.008). Furthermore, a comparison between the control and experimental groups indicated that factoring in both motivation and personality resulted in an improvement in both student grades and the time spent on LMS. However, when considering personality or motivation alone, the scores improved with no significant increase in user time on LMS (P>0.916 in both cases).

Conclusion: PG has a significant positive effect on students' scores compared to the non-gamified system, and it leads to a significant improvement in the learning time spent on LMS, compared to non-personalized gamified systems.

Keywords: E-learning, Gamification, Motivation, Personality

Introduction

Personalized e-learning systems are a new generation of e-learning systems providing personalized content for each individual based on their needs. Learners will have a personal learning experience tailored to their characteristics and can acquire knowledge using their own individual methods (1). In a personalized learning environment, educational content is compatible with learners' individual needs and learning styles (2). Taking into account the individual characteristics could positively affect students' performance and increase their understanding and knowledge in the learning process (3). Customizing content or environment based on individuals' personal traits in e-learning systems is documented to have improved learners' performance on an online learning system. Characteristics such as learning style (4), cognitive style (5), personality (6), memory (7), age (8), and gender (9) have been examined for learner modeling. In addition, motivational traits such as motivation (10), self-efficacy (11), goals (12), expectations (13), and learning preferences (14) have also been used to model learners. However, these traits have not been sufficiently factored into the personalization of e-learning systems.

Moreover, many researchers have examined the effect of game-based approaches on non-game applications to create learning incentives and motivate learners. However, no study has simultaneously considered personality traits and motivation as two fundamental characteristics of each person for personalization purposes.

While personalization and gamification approaches have been separately addressed in previous studies, using gamification to create a personalized e-learning environment consistent with students' personality and motivation has not been studied thoroughly. A study in this area can be beneficial in view of the positive effects of learners' personal traits on their performance in e-learning environments, and the possibility of reinforcing these effects by means of gamification as a personalization method.

Motivation is a core characteristic of each learner and can be defined as a measure of continuous effort towards reaching a goal (15). Being a key factor of success, it serves as a critical component of learning process (16). Motivated learning is a prerequisite for the processing of learning content and acceptable long-term performance, and results in the arousal of pleasant feelings and greater interest in learning (10). In other words, motivation is a major driving force making learners strive and overcome the learning challenges. Furthermore, motivation is not an internal and fixed element; it may improve over time, especially when teaching strategies and a suitable learning environment are provided for learners (17).

Personality comprises an amalgam of human characteristics, and entails generally consistent behavioral, cognitive, and emotional patterns, which determine an individual's differences. In spite of all the environmental, biological, and personal developments in an individual's life, the personality traits in adulthood rarely change (18). This affects the learners' preference for learning content, and specifies the elements of a learning approach such as data collection, communication with teacher and other learners, study behavior, activity, and learner performance (19).

Some well-known models such as Digman's model (20) and Myers-Briggs' personality test model (MBTI) (21) have been proposed to describe learner characteristics. These two models can cover the learners' behavioral characteristics and are recommended to be used in online learning (22).

In this study, a new personalized gamified e-learning system was designed using Moodle for the International Mathematics Competition (IMC) course. A total of 117 participants took this course, wherein the content delivery mechanism was based on gamification, and the game elements were provided for learners in accordance with their motivation and personality.

This paper consists of three sections: In the first section, the design method is described.

Then, the results of the implemented system are presented, and finally, the findings are discussed.

Methods
Study Design
The present pretest-posttest experimental study was conducted on a control group (with no intervention) and four experimental groups:

1- Personalized Gamification based on learners' motivation and personality

2- Non-personalized gamified system

3- Personalized Gamification based on learners' personality

4- Personalized Gamification based on learners' motivation

Inclusion Criteria
The participants were selected based on their age and familiarity with the e-learning system. These two criteria were highly critical in this research, given that learners should have sufficient knowledge of the system to follow the games and be mature enough to contribute to the course and provide content in the form of a game. Mathematics was selected since it allows the provision of a variety of content in the form of games. Accordingly, students with no previous experience in e-learning systems and those aged below 15 or over 17, as well as students taking other courses but mathematics were excluded. The researchers collected the data based on the system log as well as self-reported questionnaires. The system log is an accurate way to follow the user's activities on the system.

Sample Size and Randomization
To determine the sample size and ensure that the test has a power of 80% and a significance level of α=0.05, the effect size was calculated based on a possible 10% improvement in student's performance after personalization, while the deviation in student's grades in the e-learning system was 0.28 for more than 1000 students.

Under such conditions, the sample size was estimated to be over 115 participants. Almost 140 students were invited to participate in this study, and 23 persons were excluded due to their unwillingness to participate or invalid data.

The number of students in each group was also selected with a margin of error of 10% and the confidence level of 90%, and with the likely sample proportion of 10%. According to the calculations, the number of samples in each group should be at least 21 persons.

As for randomization, all participants were first listed in numerical order from 1 to 117. Then four sets of 23 random numbers were generated using simple randomization between 1 and 117 with the software and assigned to four experimental groups. The remained numbers were assigned into the control group.

Ethical Consideration
The research protocol was explained to all participants, and they were aware of the study procedures and objectives. Then they voluntarily participated in this research. They were ensured that the collected data were not used for purposes other than the research.

The research was confirmed by the Ethics Committee of the Islamic Azad University.

Setting
The research population encompassed 117 high school students from the Tehran math home online school, who attended this class during February 2020 to January 2020.

Data Collection
To collect the data on the students' motivation and personality, the participants were asked to fill in two personality and motivation questionnaires; hence, the required data was collected before the course.

Different questionnaires have been presented in previous studies to measure learners' motivation (23-27), one of which is the Academic Motivation Scale (AMS) with 28 items scored based on a seven-point Likert scale. This questionnaire was developed in two sections to be used either in high schools or universities (27). The questionnaire addresses

different aspects of internal motivation (to do a work only for its own sake and to gain a sense of satisfaction and happiness by being involved in that work), external motivation (a set of behaviors to do a work not for its own sake but to achieve a result) and amotivation (lack of intrinsic and external motivation, which may arouse reluctance or demotivation in individuals). Seven main sub-scales of AMS are as follows (28):

-Intrinsic motivation to know and learn (IM-KL)

-Intrinsic motivation for achievement and accomplishment (IM-AC)

-Intrinsic motivation to experience stimulation and engagement (IM-EE)

-Extrinsic motivation by rewards and constraints (EM-RC)

-Introjected regulation (self-regulation) (IR-SR)

-Internalization of extrinsic motives (IEM)

-Amotivation (failure to connect consequences and actions)

The validity and reliability of the AMS test have been previously established (29).

In this paper, regarding the use of personality for gamification purposes, Digman's five-factor model was selected to better fit with the game typology model. In Digman's five-factor model, individual personality differences are determined regarding five dimensions: neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness.

The learner's personality can be explicitly extracted by the NEO Five-Factor Inventory (NEO-FFI). This questionnaire has 60 items (12 items per domain). It was initially developed for adult men and women without overt psychopathology; however, it was documented to be valid for children as well. The revised version is also presented in (30).

In this paper, gamification as a personalization tool was used for the intervention, and it refers to the use of game elements for non-game purposes such as learning. There are eight game elements for gamification. In this study, the following eight elements were developed and added to the

learning environment: "Points,» "Level," "Prize," "Badge," "Content," "Leaderboard," "Road map," and "Feedback."

For each group, the intervention process was performed during the last six weeks of the study using the data extracted from these two questionnaires. In other words, the data collected during the pre-gamification phase was used to add appropriate game elements to their web page on LMS, as explained in more detail in the next section.

To evaluate their performance, two variables 'time spent on LMS by learners' and 'learners' scores' were traced to see the effectiveness of the gamified personalization.

The course lasted two months, and in the first two weeks, the scores and the time spent on LMS for each learner were considered as a representative of their performance in the non-personalized system. Then in the next six weeks, after the personalization phase, the time spent on LMS and their scores were measured once more.

For the variable 'scores', six quizzes were taken from students, and the mean score of the first two quizzes was considered the initial score, and the mean score of the last four quizzes was considered as the final score.

The variables were extracted from the database of the LMS system and, since they were not manipulated, they were considered as the outcome data.

Intervention

The intervention groups received gamified personalized content on their LMS webpage according to their group's specifications. Personalization consists of providing personalized content or designing a personal environment based on each learners' personal characteristics and needs on an e-learning system. Motivation and personality are two essential traits of each learner, based on which personalization can be performed. In this paper, these two characteristics were used to present gamified content in the form of intervention for the experimental groups.

After determining the learner's game type, the elements fitting his/her types of

motivation and personality can be selected. Few models have been proposed to detect the game typology, among which the "BrainHex" model was selected in this study because it provides a comprehensive model compared to other models (31). According to this model, there are seven types of players:

1. Seekers: They are curious and want to experience unforgettable moments in the game environment. "Content" is suitable to satisfy their curiosity. With a low level of seeker type to make the learner more interested, a "roadmap" is depicted to motivate them to follow the subsequent activities.

2. Survivors: It is a state in which a person is placed in a frightening situation and seeks a pleasant feeling by overcoming the challenges. Accordingly, the "roadmap" element is intended to create a challenge for individuals with a high level of the "survivor" type. If this feature is at a low level, due to the lack of interest of these individuals in the sense of fear or great challenge, the "prize" element will be selected.

3. Daredevils: For this group of players, the style of the play is the same as the thrill of chasing, taking risks, and generally playing on the edge. In this group, according to their interest in excitement, a "roadmap" is displayed to stimulate the learner's sense of overcoming a challenge. If this feature is at a low level, due to the lack of interest of these individuals in excitement and risk-taking, the fundamental game element of "points" are shown to the learner to enjoy the experience of playing with little excitement.

4. Masterminds: They enjoy solving puzzles, designing strategies, and focusing on effective decisions. Accordingly, the "content" such as puzzles is suitable for these individuals, and a "roadmap" is shown to those with a low level of this type to make them aware of the course progress.

5. Conquerors: Some players are not satisfied with an easy win and want to challenge themselves. The elements "badge" and "leaderboard," which require victory in more difficult challenges, are appropriate for such individuals, and those with low levels of

this trait receive a "roadmap" to observe their progress independent from others.

6. Socializers: Communication is the primary source of enjoyment for players in this category, they like to talk to others and help them. There is a "leaderboard " for those with a high level of this trait. This is because they can communicate with progressive students and become motivated to make more efforts. Individuals with a low level of this type receive a "roadmap" to observe their progress independent from others.

7. Achievers: This group of individuals are explicitly goal-oriented and motivated in long-term achievements. For individuals with high level of this trait, the element of "prize" is placed as it can respond to their primary incentive. In individuals with moderate levels of this trait, the elements "score" and "roadmap" are placed so that they can be more independent of the goals set in the system and be more motivated based on their performance. For medium levels of each player type, feedback is received from learners to provide appropriate content based on their opinons.

Regarding the type of motivation in each student, their game typology was selected, and the appropriate game elements were added to their web page.

The relationship between motivational type and game typologies were investigated to obtain each person's appropriate game elements:

1. (IM-KL) is directly corerelated with a person's desire to discover new concepts. It is more associated with the "Seeker" style because, in this type of game, the player is interested in discovering new angles due to an internal incentive for knowing and understanding.

2. (IM-AC) means engaging in an activity with the internal motivation to gain pleasure and satisfaction while completing a new activity or creating something new. It is mainly similar to the style of "Achiever" because the priority in both types is the achievement of goals.

3. (IM-EE): It refers to the cases where a

person engages in a new activity to experience new emotions and sensory pleasures. "Mastermind" and "Daredevil" game styles are mostly related to this type of motivation since those with mastermind game types feel happy to solve challenges, and daredevils enjoy excitement when experiencing new emotions.

4. (EM-RC): It refers to the cases where a person engages in an activity due to externally predetermined goals. This type of character is more similar to the "Achiever" since both groups try to achieve the predetermined goals to feel satisfaction in the game process.

5. (IR-SR): It refers to the cases where a person internalizes the incentives and reasons for performing an activity. Individuals with this type of motivation are more similar to the "Conquerors" because they want to achieve the goals, create internal challenges, and overcome their challenges.

6. (IEM): It refers to the cases where external motivations become so valuable to an individuals that he/she internalizes them as if they were his own choice. They are mainly associated with both game types of "Achiever" and "Mastermind" because the intellectual challenges engaging individuals to achieve their goals are most attractive to these types.

By recognizing the learners' personality dimensions, their game type can also be specified, and consequently, the appropriate game elements can be selected in their profile web page on LMS. This trait is identified based on the big five model. The relationship between these personality traits and different game typologies are as follows:

1. Neuroticism: Those with a high level of neuroticism experience anxiety, tiredness, fear, anger, frustration, jealousy, guilt, depression, and loneliness more than other individuals (32). These features are closely associated with the "Survivor" player type as they seek to play on the edge and experience intense excitement and fear.

2. Extroversion: Extraverts tend to express their feeling in energetic external behaviors associated with conversation.

High extraversion directly affects the type of "Socializer" game type because they both enjoy communicating with others and sharing their ideas.

3. Openness to experience: This trait includes various dimensions such as active imagination, aesthetic sensitivity, and attention to inner feelings, preference for diversity and curiosity, and intellectualism. The trait is related to the "Seeker" and "Mastermind" game styles. In these game types, the player is interested in gaining new experiences and exploring the game world. Furthermore, masterminds try to challenge their intelligence and creativity to solve puzzles to achieve a sense of enjoyment from the game. Both features are evident in those with high levels of openness.

4. Conscientiousness: It refers to the desire to do a good job and accept commitments seriously. This

feature is more noticed in those with the "Achiever" game type because they are goal-oriented, accurate, and hard-working.

5. Agreeableness: This personality trait corresponds to traits such as kindness, compassion, and cooperation. Individuals preferring social games have better agreeableness because they enjoy more trust and communication with others and a sense of empathy. In contrast, those with low levels of agreeableness are more similar to the "Conqueror" game type because they exhibit more selfish behaviors and lack of empathy, and they enjoy defeating the impossible enemies to reach victory and beating other players in the game environment. Accordingly, those with low levels of agreeableness are associated with the "conquerors" type, and high agreeableness is associated with the "socializer" player type.

According to what mentioned, the appropriate game elements for each motivation and personality trait are represented in Table 1. This table summarizes the intervention method adopted in this study. According to individuals' personality traits and motivation and their intervention group, the appropriate game elements are added to the LMS web

Table 1. Game elements based on motivation and personality type

Game elements	Intrinsic motivation to know and learn (IM-KL)			Intrinsic motivation towards achievement and accomplishment (IM-AC)			Intrinsic motivation to experience stimulation and engagement (IM-EE)			Extrinsic motivation through rewards, constraints (EM-RC)			Introjected regulation (self-regulation) (IR-SR)			Internalization of extrinsic motives (IEM)		
	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Point							✓			✓			✓					✓
Level		✓																
Prize					✓					✓				✓				
Badge													✓					
Content	✓						✓							✓				
Leader board													✓					
Roadmap			✓			✓	✓		✓			✓			✓			✓
Feedback					✓			✓			✓			✓			✓	

Game elements	Neuroticism			Extraversion			Openness			Agreeableness			Conscientious		
	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Point											✓				✓
Level					✓	✓					✓				
Prize			✓										✓		
Badge											✓				
Content															
Leader board				✓				✓		✓					
Roadmap	✓							✓	✓	✓					✓
Feedback		✓						✓			✓			✓	

page for each learner.

Statistical Method

In this study, SPSS software version 26 was used to analyze the data. Descriptive statistics, including mean and standard deviation, were used to describe the data in both control and experimental groups.

The experimental groups were compared with the control group using the independent samples T-test. The significance level was set to be $P<0.05$ for the outcome variables, including scores and LMS-time. This test was selected to measure the effectiveness of the system by comparing the means of these two variables in the research groups and detect whether there was a significant difference between the behaviors of these groups.

Results

A gamified personalized e-learning system was developed based on personality and motivation. As shown in Figure 1, each learner's scores of motivation and personality dimensions were determined by the NEO-FFI and AMS tests, respectively. Then the game elements were selected for each user and added to their system. The learning environment was designed using Moodle, and the LMS was designed based on the same software as
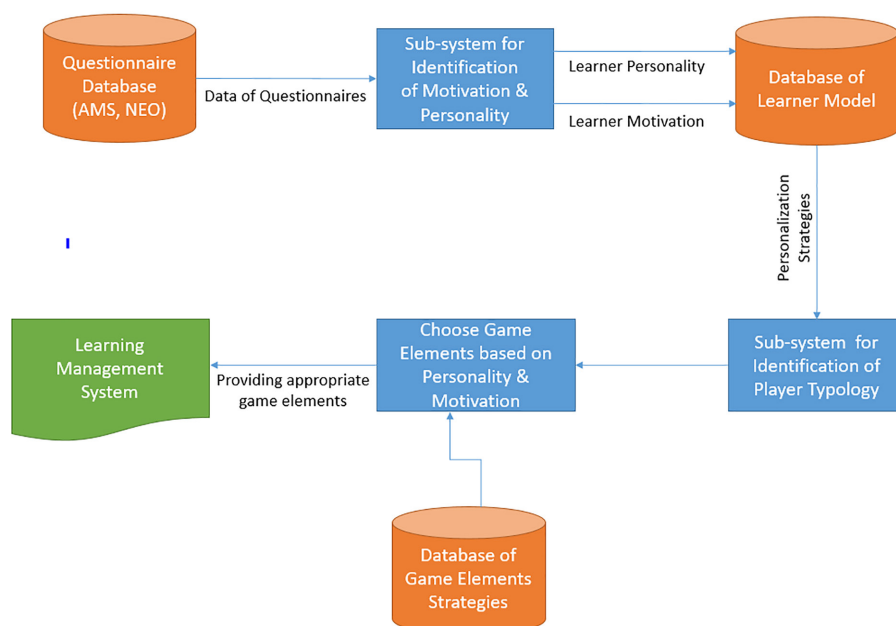
Figure 1. Implementation of the designed system

well. The course content consisted of visual, audio, and text files, and all students were provided with homework and quizzes as well as some troubleshooting classes. Moreover, each student had its specific game elements. The course was held in eight sessions and consisted of 50 course content, including video, text, and audio files. Table 2 presents the participants' demographic specification.

Table 3 represents the statistical description of the test variables before and after the personalization phase. As shown in Table 3, on average, the LMS-time and the learners' scores increased in all groups, compared to the pre-personalization phase. Moreover, t-test was used to compare the mean scores of the test variables in each group before and

after the personalization phase to detect if the improvements were significant. Hypotheses with $P<0.05$ are normally accepted, and hypotheses with $P>0.05$ are rejected. As shown in Table 3, there is a significant difference between the initial and final scores in all groups, except the control group. Accordingly, the hypothesis indicating that the mean scores improved after the personalization phase was accepted. In Group 1, there is a significant increase in the average usage of the system, while this trend is not noticed for the other groups.

Table 4 presents the comparison of the control group with the intervention groups. As it can be noticed, before personalization, there is no significant difference between these five

Table 2. The students' demographic characteristics

Variable	Control Group (n=25)	Gamified personalization system based on motivation and personality of the learner (n=23)	Non-personalized gamified system (n=23)	Gamified personalization system based on the personality of the learner (n=23)	Gamified personalization system based on the motivation of the learner (n=23)
Numbre of Male students	12	9	10	11	13
Numbre of Male students	13	14	13	12	10

Table 3. Statistical behavior of test variables and comparison of mean scores before and after personalization phase

Test Variables		Group 1	Group 2	Group 3	Group 4	Control group
LMS-time before personalization	Mean	40.5	39.04	32.88	37	28.66
	Std.	32.25	29.67	21.17	44.17	25.47
LMS-time after personalization	Mean	82.48	49.91	41.12	42.58	43.16
	Std.	40.29	16.83	25.62	43.59	27.45
Grades before personalization	Mean	50.8	50.37	51.22	53.64	48.88
	Std.	21.12	22.07	15.49	33.06	11.92
Grades after personalization	Mean	64.95	63.44	64.85	56.15	60.77
	Std.	12.5	14.77	13.19	16.83	9.29
LMS-time	T-value	3.995	1.28	0.76	1.03	0.427
	P value	0.001	0.213	0.469	0.33	0.675
Grades	T-value	2.91	2.6	1.741	2.405	0.298
	P value	0.008	0.016	0.12	0.043	0.77

Table 4. Comparing the mean scores of test variables between experimental groups and control group

Test Variables		Group 1	Group 2	Group 3	Group 4
LMS-time before personalization	T-value	0.278	0.166	0.318	0.61
	P value	0.783	0.87	0.753	0.548
LMS-time after personalization	T-value	2.97	0.581	0.108	0.073
	P value	0.005	0.566	0.916	0.942
Grades before personalization	T-value	0.32	0.046	0.89	0.315
	P value	0.975	0.964	0.93	0.756
Grades after personalization	T-value	3.28	2.81	2.65	2.26
	P value	0.003	0.008	0.016	0.033

groups regarding the students' scores and their time on LMS. However, after personalization, the experimental groups revealed a significant difference with the control group in terms of scores. In terms of their time on LMS, only group 1 showed a remarkable increase, while the difference of system usage for the other groups was negligible.

In general, the findings show that gamified personalization has a significant positive effect on improving students' grades, compared to the non-gamified system. It leads to a significant improvement in students' time on LMS (Group 1).

Discussion

In this article, for the first time, a gamified personalized e-learning system based on the learners' personality and motivation was designed. While different personality traits have been vastly utilized in personalized e-learning systems (1-7), personality traits (21, 22) and motivation (9-11) have been

already investigated to ameliorate students' performance in e-learning environment by using personalization. However, the combination of learners' motivation and personality traits has never been examined in this context. In this paper these two variables were considered simultaneously to develop a personalized e-learning system. Moreover, gamification has been also dealt with in different studies (8, 10, 19); however, the personalized gamification has been rarely investigated. Accordingly, a novel gamified e-learning system was proposed in this study, and its effectiveness in improving students'' performance was examined. The findings show that gamification in e-learning systems can improve students' performance. This improvement can be more remarkable if it contains the personalization of gamified elements based on the student model. Using both motivation and personality traits has led to students' better performance, while using either motivation or personality

traits increased students' scores without significantly affecting the time they spend on LMS. In other words, these criteria contribute to the better modelling of students in designing a personalized gamified e-learning system.

The novel proposed design procedure in this paper consists of detecting learners' personality traits and motivation level to select appropriate game elements. To this end, the player type of learners was determined based on the BrainHex model using their motivation and personality traits.

With using their player type, the game elements corresponding to each player type were selected and added to each learner's page on LMS. The system's architecture was implemented, and the presented personalized strategies were finally evaluated. To evaluate the effect of personalization and gamification, students were divided into four experimental groups and one control group, and their academic performance was assessed based on two critical factors, namely students' scores and their time on LMS.

The findings indicated that the average LMS time and the mean scores increased in the experimental groups compared to the control group. The finding of this research suggest that the use of personality traits and motivation simultaneously for personalization of gamified e-learning systems significantly increases the mean scores and time spent on LMS among students.

Collecting data from students is a remarkable obstacle in such research. In this research, the initial and final data were collected from the LMS database, which was highly time-consuming. Possible substitute solutions are suggested to be adopted in future research.

To conclude, the research findings provide strategies to provide gamified content based on learners' attribute in further relevant research for a better student modeling in gamified personalized e-learning systems.

Ethical Considerations

All procedures in this study were in accordance with the ethical standards of the institutional and national research committee and the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The participants voluntarily agreed to participate in this research and were aware of the nature of this study and the confidentiality of their information and submitted their informed consent form to be involved in this study.

The research was also approved by the Ethics Committee of the Islamic Azad University.

Authors' Contributions

All authors wrote and critically revised the article and approved the final submitted version.

Conflict of Interest

The authors declare that they have no conflict of interest.

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