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Designing and implementing a self-learning game with a problem-solving approach to improve students' personal health and healthy nutrition behavior

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Abstract

Objective This research is a quasi-experimental study conducted on male students from six elementary schools ranging from third to sixth grade in three regions of Shahrood city from March 2023 to February 2024. This study aimed to designing, implementing and evaluating a health-oriented self-learning game with a problem-solving approach in order to improve behavior in the field of personal health and healthy nutrition in elementary school students.

Results There was a significant difference between the knowledge ($p=0.01$), attitude ($p>0.001$) and behavior ($p=0.01$) in the control and intervention groups, after the intervention, while there was no significant difference between the two groups in these variables before the intervention. The utilization of health-oriented self-learning games proved to be effective in enhancing the knowledge, attitude, and behavior of elementary school students regarding personal health and healthy nutrition.

Clinical trial number Not applicable.

Keywords Attitude, Behavior, Education, Gamification, Health, Problem solving

Introduction

The advancement of technology and media has brought about shifts in communication and methods of delivering education. As a result, health education approaches should be adapted to align with these changes, ensuring that health information is effectively communicated [1]. Research indicates that health education is crucial during childhood as it lays the groundwork for lifelong health, productivity, and well-being. Educational interventions have been shown to enhance health-promoting behaviors in children [2]. The use of game-based learning methods as an interesting and innovative educational approach is increasing and developing, which can increase and improve students' motivation to learn better [2, 3]. Gamification involves employing games in non-game settings to captivate audiences, enhance engagement, and infuse enjoyment into routine tasks, resulting in motivational and cognitive advantages [4]. The integration of serious games and simulations in educational programs fosters

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heightened motivation, enjoyment, and enhanced performance for learners [5]. Gamification, which involves the use of game design elements and mechanisms, is a burgeoning field within the realm of health [6, 7]. It has garnered attention for its potential to enhance participation in health interventions and drive behavioral changes [8, 9]. By fostering increased user engagement, gamification can facilitate problem-solving and encourage specific behaviors within society [10]. Moreover, it has been proven to be effective for children in managing emotional stress, teaching new skills, and aiding in self-expression, relationship-building, and the articulation of experiences, thereby bridging their inner thoughts with the external world [11]. The game is effective for students' active learning, improving their basic health care knowledge and reducing their behavior problems [12, 13]. Additionally, the influence of peer groups is pivotal in acquiring practical training, life skills, and fostering societal health [14].

Today, children are confronted with a variety of new threats, including lifestyle factors. Improving health and well-being in childhood not only benefits individuals throughout their lives but also has positive effects for future generations [15–17]. It is important to note that most studies exploring healthy lifestyle behaviors for disease prevention have focused on middle-aged and older adults, and the results may not be directly applicable to young people, who have differing lifestyles and risk factor prevalence [18]. In schools, students are present in substantial numbers and for extended periods of time, providing schools with the significant potential to implement intensive, long-term health programs [19, 20].

Playful behavior and lack of attention are more prevalent among male students [21]. Boys are more prone to denying health issues compared to girls, and adolescent boys utilize health care services to a significantly lesser extent than adolescent girls [22]. Conversely, they are much more inclined than girls to participate in risky behaviors, possibly influenced by societal expectations for boys to exhibit stoicism and masculinity [23]. This research was conducted with the aim of designing, implementing and evaluating a health-oriented self-learning game with a problem-solving approach in order to improve behavior in the field of personal health and healthy nutrition in elementary school male students.

Method

Study design

This research is a quasi-experimental study on male students from six third to sixth grade elementary schools, three regions of Shahrood city, Semnan province in the northeast of Iran in March 2023 to February 2024.

Participants

In order to determine the sample size, based on Shirin's study, taking into account the confidence interval of 95% and the power of 90%, and taking into account the 10% probability of the samples dropping, according to the formula for calculating the sample size, 153 people were included in the study.

$$n = \frac{2\left(z_{1-\alpha} + z_{1-\beta}\right)^2 s_p^2\{1 + (m-1)\rho\}}{m\, d^2} \approx 140$$

$$= \frac{2 * (1.64 + 1.28)^2 * 0.1 * \{1 + 2 * 0.7\}}{3 * 0.01} \cong 137$$

Using a multi-stage random sampling method, Shahrood city was initially divided into 3 districts designated by the municipality. Six boys' elementary schools were then randomly selected, with two schools chosen from each district. Within each district, one school was allocated to the control group and one to the intervention group. Subsequently, one class from grades three to six was randomly selected in each school. To mitigate potential adverse effects, all students in a selected class were included in the study, leading to a larger sample size than originally anticipated. As a result, 92 students were assigned to the intervention group, while 99 students were placed in the control group. After applying inclusion and exclusion criteria, data from 80 students in the intervention group and 73 students in the control group were analyzed.

The inclusion criteria consisted of male students who had no plans to drop out or change schools within the current academic year, and whose parents had provided written consent for their participation in the study. Exclusion criteria involved failing to fill out the questionnaires, opting out of the intervention, and not engaging in the game.

Instrument and data collection

Since there were no appropriate standardized tools aligned with the research objectives, the researchers opted to create a questionnaire tailored to the study's aims and to assess its reliability and validity. This questionnaire consisted of two sections: the first encompassing demographic information (age, education level, parents' education level, parents' occupations), and the second intended to evaluate students' knowledge, attitudes, and behaviors pertaining to personal health and healthy nutrition. After designing the questionnaire by reading the articles and reliable sources, its validity and reliability were determined. To assess face validity, the questionnaire was piloted with 20 students meeting the study criteria (though not part of the primary sample),

wherein students evaluated knowledge and attitude-related queries, and parents assessed behavior-related ones. Participants were prompted after each item to provide feedback on aspects such as difficulty level, clarity of wording, relevance to questionnaire dimensions, and ambiguities. Subsequently, the questions were refined based on this feedback, with suggestions used to enhance question phrasing and clarity.

In order to determine the Content Validity Ratio (CVR) and Content Validity Index (CVI), the questionnaire was reviewed by 8 related experts (6 people from the field of health education and health promotion and 2 people from the field of nutrition). CVR values higher than 0.75 were accepted according to Lawshe's Table [24]. The minimum acceptable value for the CVI was considered to be 0.79 [25]. The questions that scored 0.7 to 0.79 were revised and evaluated again.

In order to evaluate the reliability, the questionnaire was completed by 20 students and their parents and reliability was checked using Cronbach's alpha test. Cronbach's alpha value for the questionnaire was 0.714.

Knowledge questions (8 questions) had three options, "Yes, I don't know and No" with a score of 0 and 1 and a score range of 0 to 8. Attitude questions (8 questions) were based on a 5-point Likert scale with the items "I completely agree, I agree, I have no opinion, I disagree, or I completely agree" with a score of 0 to 4 and it ranged from 0 to 32. The questions of these two parts were completed by the students. The behavior questions were by choosing one of the four options "always, sometimes, rarely or not at all" with scores from 0 to 3 and in the range of 0 to 48. The questions of this part were completed by the parents of the students.

Intervention program

In the design phase, the self-learning game was predicted and the scenario determined using poems that were in the form of questions in the field of personal health and healthy nutrition and in the form of playing cards. Then, questions were asked in this regard and the questions were examined and screened. Then, the questions were turned into poems, and a poem was composed and revised in the context of each of the desired answers with the help of experts.

According to the educational needs of the target group, one of the letters of the alphabet was designed individually and an image related to individual health issues with an arrangement not coordinated with the letter of the alphabet inserted on the card was designed. These cards featured animated visuals portraying positive attributes like joy and contentment, alongside negative traits symbolizing sadness, illustrating the impact of personal health choices on one's overall well-being. A total of 42 cards were meticulously crafted, covering educational themes on personal health, nutrition, predictions, and children's poems in concise verses. Each card was designed to encompass a single-word answer, serving as a clue to unlock the next question. To validate correct responses, a set of colorful geometric shapes were integrated, ensuring that the shape at the question's base matched the one atop the chosen card. Also, in order to create excitement and avoid the monotony and unattractiveness of the game compared to other games with non-health topics, luck was added to the game. Some of the letters of the alphabet were repeated twice, and in some of the cards, there was a positive poem to encourage and receive an additional card, or a poem with negative content and forbidding to receive a new card.

The game is played by arranging all the cards on the floor in a way that the alphabet letters are visible (face up). One player begins by picking up a card and announcing the one-word answer to the question on the card. They then take a card from the floor based on the first letter of their answer. If the answer is correct, they keep the card and proceed to the next question on its back. If the answer is incorrect, they return the card to the ground, forfeit their turn, and pass play to the next person.

The intervention was carried out using a game package within groups of four or five students. The game consisted of two stages, with a two-week break between each stage. Each session lasted at least 60 min, and the game was repeated with a new group of students. Initially, the researcher explained the game both theoretically and practically to the students. The students were then divided into groups and instructed to play the game. After two weeks of the first stage of the game, the second stage of the game was played in schools while reminding the rules of the game, and at the end of the game, a game package was given to the top players as a gift.

Before the educational intervention and one month after the intervention, the questionnaire was completed by the students and parents of the intervention and control groups, and in order to prevent educational deprivation, the students of the control group and their teachers were given game packages as gifts.

Statistical analysis

The data was analyzed by SPSS software version 16, and the confidence coefficient in all calculations was 95% and the significance level was $p < 0.05$. Mean and standard deviation were used to describe quantitative variables according to conditions, and frequency (percentage) report was used for qualitative variables. Descriptive statistics, independent or paired t-test were used in parametric or non-parametric mode. Chi-square test or Fisher's exact test was used to compare the qualitative factors between the studied groups. In the comparison

Table 1 Comparison of absolute and relative frequency distribution of the demographic characteristics of the studied community before the educational intervention

variable	control *N* (%)	Intervention *N* (%)	*P*-Value
educational grade			
Fourth	34(46.6)	29(36.2)	0.43
the fifth	24(32.9)	31(38.8)	
the sixth	15(20.5)	20(25)	
age			0.12
9 years	23(31.5)	11(13.8)	
10 years	17(23.3)	24(30)	
11 years	19(26)	23(28.8)	
12 years	13(17.8)	21(26.2)	
13 years	1(1.4)	1(1.2)	
father's education			0.17
elementary	9(12.5)	3(3.8)	
middle school - diploma	34(47.2)	39(50)	
Postgraduate diploma - bachelor's degree	20(27.8)	29(37.2)	
Master's degree - Ph.D	9(12.5)	7(9)	
mother's education			0.87
elementary	4(5.5)	3(3.8)	
middle school - diploma	39(53.4)	47(59.5)	
Postgraduate diploma - bachelor's degree	24(32.9)	24(30.4)	
Master's degree - Ph.D	6(8.2)	5(6.3)	
fathers' occupation			0.23
unemployed	1(1.4)	0	
employee	23(31.5)	37(46.3)	
freelance job	32(43.8)	32(40)	
worker	14(19.2)	9(11.3)	
retired	3(4.1)	2(2.5)	
mothers' occupation			0.43
housekeeper	50(68.5)	54(67.5)	
employee	14(19.2)	11(13.8)	
freelance job	9(12.3)	15(18.8)	

of the results between variables, regression models were used.

Results

The number of students who were followed up until the end of the study was 153 including 73 in the intervention group and 80 in the control group. The mean age of the students was 11 years, and the highest frequency was the fifth grade with 35.9%. The highest frequency of middle school and diploma education was that the students' fathers were 48.7% and their mothers were 56.6%, also the most frequent occupation of fathers was self-employed with 41.8% and their mothers were housewives with 68%. According to the results, there was no significant difference between the intervention and control groups in terms of demographic variables (Table 1).

Table 2 Comparison of the mean score of knowledge, attitude and behavior before and after educational intervention

Variable	control M ± SD	intervention M ± SD	*P*-Value*
Knowledge			
Before intervention	7.34 ± 0.92	7.49 ± 0.94	0.14
After the intervention	7.2 ± 1.02	7.55 ± 0.76	0.01
P-Value**	0.25	0.74	
attitude			
Before intervention	27.05 ± 3.18	27.64 ± 3.41	0.18
After the intervention	26.48 ± 3.3	28.77 ± 3.58	$p > 0.001$
P-Value**	0.06	0.00	
behavior			
Before intervention	35.48 ± 5.28	36.26 ± 5.51	0.3
After the intervention	34.2 ± 5.08	36.44 ± 4.6	0.01
P-Value**	0.05	0.99	

*Independent T-test. **Paired T-test

Table 3 Correlation between knowledge, attitude and behavior in intervention group after educational intervention

Variable	B coefficient	*P*-Value
Knowledge	0.4	$p > 0.001$
attitude	2.01	$p > 0.001$
behavior	1.74	0.02

According to the results, there was a significant difference between the knowledge ($p = 0.01$), attitude ($p > 0.001$) and behavior ($p = 0.01$) in the control and intervention groups, after the intervention, while there was no significant difference between the two groups in these variables before the intervention. Also, in the intervention group, a significant increase in attitude ($p > 0.001$) was observed after the educational intervention compared to before the intervention. Although this difference was not significant in knowledge and behavior. In the control group, there was no significant difference in knowledge, attitude and behavior before and after the intervention (Table 2).

The value of the coefficient (B) which shows the amount of the effect of training on each of the items "knowledge after intervention", "attitude after intervention" and "behavior after intervention" is 0.14, 2.01 and 1.74, respectively. In other words, our educational intervention has been able to significantly increase the knowledge ($p > 0.001$), attitude ($p > 0.001$) and behavior ($p = 0.02$) of students in the intervention group compared to the control group (Table 3).

Discussion

The current study aimed to create, implement, and assess a self-directed health-focused game using a problem-solving method to enhance understanding, attitude, and conduct related to personal health and healthy nutrition among students. As children are inclined to concentrate on games and entertainment, particularly the target

audience for this study, a game using physical cards was developed to encourage them to reduce their time spent in the online world, which was in line with Bochennek's [26] research.

By employing a self-learning approach, individuals are empowered to take the lead and promptly receive feedback on their progress through experimentation. The use of the problem-solving approach was in line with the research of Burgess [27]. The present study was in line with research that considered the problem-solving approach and had titles such as problem-based learning, case-based learning, game-based learning, and problem-solving approach [28–31].

The findings of the current study indicate that the average knowledge score in the intervention group saw a significant increase compared to the control group following the intervention. Studies have shown that knowledge improves after educational intervention, which is consistent with the present study [30, 32, 33].

The results showed that the attitude variable score in the intervention group increased significantly compared to the control group after the intervention. Gerber's study, which examined the impact of gamification on pharmacy students, showed that it created a positive attitude in students [34]. Veloo's study, examining students' progress in using team game competitions, showed that there was a significant difference in the attitude of the intervention group compared to the control group [35]. The present study was also in line with Khoshnoodifar's research on the effectiveness of gamification in increasing learning and attitude in health school students [36]. The attitude score in the control group decreased likely due to the impending start of school exams, leading to less focus on completing the questionnaire again. Despite this, efforts were made to emphasize students' attention, with the cooperation of relevant teachers. In contrast, the intervention group addressed this by engaging students in a game played in two stages.

The results showed that the mean performance score in the intervention group had a significant increase compared to the control group after the intervention. However, no significant increase was observed in the intervention group after the educational intervention compared to before it. The present study is consistent with Khalil's study, which examined the effect of a self-study package on knowledge and performance and showed that the intervention had a positive effect on performance [29]. In the present study, given that the performance-related questions were completed by the students' parents, it is possible that the external manifestation of intention to change or relative change in parental behavior was not evident. Therefore, it was difficult to observe a rapid effect in a short period of one month.

Limitations

Since the researchers of this study were male, conducting the study in girls' schools was problematic due to local cultural norms, so it was decided to conduct the study only in boys' schools. To ensure the effect of the educational intervention in sustainable behavior modification, there is a need for long-term follow-up, which was not possible in the present study. Due to the lack of a standard questionnaire appropriate for the present study, data collection was carried out using a researcher-made questionnaire, which could affect the validity of the results.

Conclusion

The utilization of health-oriented self-learning games proved to be effective in enhancing the knowledge, attitude, and behavior of elementary school students regarding personal health and healthy nutrition. Employing educational approaches that foster indirect learning among students, empower children to take action, and promote self-directed education are more successful in health education initiatives. It is suggested that self-learning gamification be used especially in health topics in students with long-term follow-up to determine the effect on people's behavior in the long term.

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Author contributions

Conceptualization: H J, H A N; Data curation: M H R, H A N, H J; Formal analysis: M A A; Methodology: H J, H A N, N SH; Project administration: M H R, H A N, H J; Writing–original draft: H A N, N SH; Writing–review & editing: all authors.

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Data availability

The datasets generated and analyzed during the current study are not publicly available because they contain raw data from study participants, and sharing these data requires participants' permission. But are available from the corresponding author on reasonable request.

Declarations

Ethical approval and consent to participate

Ethical approval was obtained from the Human Research Ethics Committee at the Sabzevar University of Medical Sciences (Code IR.MEDSAB.REC.1402.079). Given that the participants in the study were minors, after the objectives of the study and the manner in which the children would participate in the study were explained to the parents, written informed consent was obtained from their parents. The objectives of the parents' participation and the manner in which they would participate in the study were also explained to the parents. Then, written informed consent was obtained from them. Confidentiality and anonymity were ensured. All procedures performed in studies involving human participants were by the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration.

Consent for publication

Not applicable.

Competing interests
The authors declare no competing interests.

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