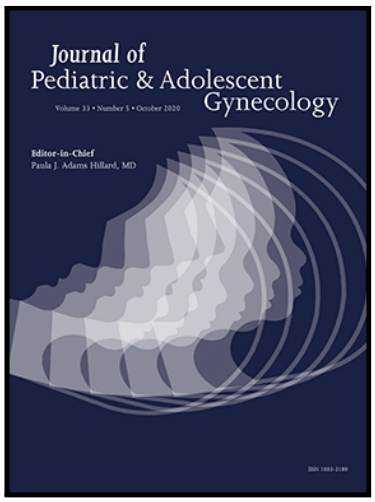

Improving pubertal health education for adolescent girls through a gamified learning approach

Sana Nazmi , Atefeh Omrani , Fereshteh Bahmanesh , Hossein-Ali Nikbakht , Manoosh Mehrabi , Romina Hamzehpour

PII: S1083-3188(25)00003-8
DOI: https://doi.org/10.1016/j.jpag.2025.01.003
Reference: PEDADO 3151

To appear in: *Journal of Pediatric and Adolescent Gynecology*

Received date: 4 October 2024
Revised date: 30 November 2024
Accepted date: 4 January 2025

Please cite this article as: Sana Nazmi , Atefeh Omrani , Fereshteh Bahmanesh , Hossein-Ali Nikbakht , Manoosh Mehrabi , Romina Hamzehpour , Improving pubertal health education for adolescent girls through a gamified learning approach, *Journal of Pediatric and Adolescent Gynecology* (2025), doi: https://doi.org/10.1016/j.jpag.2025.01.003

Improving pubertal health education for adolescent girls through a gamified learning approach

Sana Nazmi[1], Atefeh Omrani[2], Fereshteh Bahmanesh[3*], Hossein-Ali Nikbakht[4], Manoosh Mehrabi[5], Romina Hamzehpour[6]

[1]Student Research Committee, Babol University of Medical Sciences, Babol, I.R. Iran Email: sananazmi98@gmail.com ORCID: 0000-0002-7005-2717

[2] Lecturer and Researcher in Health and Social Care and Public Health, Faculty of Education and Society, Department of Health and Social Care, University of Sunderland in London, London, United Kingdom ati.omrani@sunderland.ac.uk

[3]* (correspondence) Social Determinants of Health Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, I.R.Iran.

Email : f.behmanesh2015@gmail.com ORCID : 0000-0001-5837-4265

Tel: 009832199594

[4] Social Determinants of Health Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, I.R. Iran & Population, Family and Spiritual Health Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, I.R. Iran

ep.nikbakht@gmail.com ORCID: 0000-0002-8556-431X

[5] Department of e-Learning in Medical Sciences, Virtual School, Center of Excellence for e-Learning in Medical Sciences, Shiraz University of Medical Sciences, Shiraz, Iran mehrabi.manoosh@gmail.com 0000-0002-2024-9415

[6] Clinical Research Development Unit of Shahid Yahyanezhad Hospital, Babol University of Medical Sciences, Babol, I.R. Iran rominahamzehpour@gmail.com

0000-0003-2544-687X

Word count of the abstract: 250

Word count of the main text: 2818

Acknowledgment

The authors would like to thank the Deputy of Research and Technology of Babol University of Medical Sciences for financially supporting the project.

Authors' contributions

F.B. & S.N. Conceptualization, Methodology, Software, HA.N. Validity tests, Data curation, Writing- Original draft preparation. S.N. & F.B. Visualization, Investigation. F.B. Supervision. S.N. Software Validation. F.B., S.N., A.O., R.H., M.M., & HA.N. Writing- Reviewing and Editing.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Financial support

This work was supported by Babol University of Medical Sciences. Grant number: 724134467

Conflicts of interest

There are no conflicts of interest.

Abstract

Background: Adolescence is a crucial phase in a person's life. The purpose of this study was to evaluate the efficacy of gamification in the education of teenage females on pubertal health.

Methods: This clinical trial, conducted on 90 adolescent girls in XXX, XXX, during the 2023-2024 year, used a multistage cluster sampling method to assign participants randomly to intervention and control groups. The intervention group received weekly puberty health education over four weeks through a gamification platform. Data collection involved a socio-demographic questionnaire as well as puberty awareness and practice assessments, completed by both groups before the intervention, immediately, and one month after study.

Findings:The average puberty awareness and practice scores of the students in the intervention group significantly increased significantly, immediately and four-week after the intervention compared to the

control group (P<0.001). The standardized effect sizes for awareness and practice were 0.74 and 0.25, respectively. In the intervention group, puberty awareness siginificanlty increased by 5.28 (95% CI:4.51 to 6.06) and 5.06 points (95%CI:4.31to 5.82) when comparing the two time periods before and immediately after, and before and four weeks after the intervention, respectively. Similarly, the puberty practice score significanly increased by 6.82 (95% CI:4.24 to 9.40) and 8.73 points (95% CI:5.94 to 11.51) in the same time comparisons (P<0.001).

Conclusion: This study demonstrated the effectiveness of using gamification in puberty health education on increasing puberty awareness and practice among adolescent girls. This innovative educational approach can enhance puberty health education programs, leading to better health outcomes for adolescent girls.

Keyword: Adolescents, Gamification, Puberty ،Health promotion

Introduction

Adolescence and puberty are critical periods for establishing healthy patterns in adulthood. It is an opportunity to implement necessary interventions that can guide individuals toward better health in the future [1,2]. Meeting the educational needs of girls during puberty and addressing these needs is a critical public health issue in society [3,4].

Studies show that 47.9% of adolescents have not received education or information about puberty, and 39.9% of them experience confusion and distress regarding their physical changes during the early stages of puberty [5,6]. Without prior education and preparation regarding the physiological changes of puberty, girls may experience anxiety, fear, and despair during this age, leaving many of their questions unanswered[7].Frequently, families lack the required abilities to educate their adolescents about puberty [3,6]. Puberty health education promotes healthier behaviors and helps adolescents understand the connection between increased awareness, improved practices, and the positive impact on overall health [8]. Addressing common challenges during girls' puberty is crucial for ensuring the health of future generations [3,6], as these girls may become the mothers of tomorrow's society. To achieve significant success and meet the educational goals set by the education system, it is essential to enhance and advance global educational practices [9].

In XXXian schools today, lectures are the primary method used for health education [10]. In this approach, the students remaining passive. Conversely, contemporary teaching methods emphasize active student involvement in their own learning [11]. One such modern technique is gamification [9]. Gamification is an innovative technology that can be employed as a strategy for e-learning. Gamification involves incorporating game mechanics, techniques, and elements into

educational and non-game settings to motivate and engage participants in reaching specific learning, professional, and health objectives. It is also utilized in health education to enhance engagement and effectiveness [12]. Various studies support the effectiveness of gamification in health education [13-15]. Innovative gamification platforms have the potential to offer valuable, engaging, cost-effective, and enjoyable learning experiences [16-18]. Gamification creates an environment where participants not only absorb educational content but also cultivate the motivation to persist and apply what they have learned, all while enjoying the learning experience [19]. A study found that this approach had a more positive impact on students' sexual health outcomes and comprehension compared to traditional educational methods [20]. Another study highlighted the effectiveness of this method in lowering anxiety levels among adolescents [21]. However, a different study found no significant difference in practice improvement between the intervention and control groups and gamification did not enhance educational outcomes and might even have a negative impact on motivation, satisfaction, and empowerment [22]. Given the contradictory findings of previous studies, the present research was conducted to evaluate the efficacy of gamification in the education of teenage females on pubertal health.

Methods

Setting

This clinical trial study was approved by the Ethics Committee of XXX University of Medical Sciences and the XXX Department of Education (IR.MUXXX.REC.1402.026). Additionally, approval was obtained from the XXXian Registry of Clinical Trials on July 30, 2023 (IRCT20180218038783N4). The research setting consisted of middle schools for girls in the city

of XXX. The protocol article of this study has been accepted for publication in the Journal of Education and Health Promotion.

Sampling

The sample size was calculated considering all the study objectives, with the largest sample size being considered. Based on previous studies [14] and considering the comparison of means and the difference in standard deviations (effect size of 0.88), with a 95% confidence level and study power, the required number of participants per group was determined to be 35 using GPower software version 3, assuming a two-tailed hypothesis. Accounting for a 25% dropout rate, the final sample size was set at 90 participants (45 in each group).

The samples were selected using a multistage sampling method. The city of XXX is divided into two regions based on municipal divisions. In the first stage, three schools from each region were randomly selected from the list of schools. These schools were then randomly assigned to either the control or intervention group. Subsequently, within each school, students who met the inclusion criteria were randomly selected.

Inclusion and exclusion criteria

Students were included in the study if they consented to participate, had parental approval, were approved by school authorities, were 12 to 13 years old and in seventh grade, had experienced at least three menstrual cycles, had access to a mobile phone or laptop for gamification in the intervention group, and obtaining average and undesirable scores from the knowledge and practice questionnaire. Students were excluded from the study if they left more than 10% of the questions on the questionnaire unanswered [23] or if they were reluctant to participate in the study.

Implementation

The main researcher visited the selected schools, introduced themselves to the authorities, and explained the study's objectives. School officials collaborated to obtain written consent from parents. Students received questionnaires in sealed envelopes along with the consent form and were instructed to present them to their parents. Of the 338 students who completed the awareness and practice questionnaires, 189 were excluded for not meeting the inclusion criteria. From the 149 eligible students, 90 were randomly selected through a simple lottery sampling method. (Figure 1). Separate schools were chosen for the gamification and control groups to prevent information transfer between them. The study process was explained over the phone to parents of daughters assigned to the game intervention group after random allocation.

To design the game elements for the study, a platform developed by Danosh Company was purchased and used. The project was written in Python. The game management panel can be accessed through the website https://app.dgamify.ir. Based on the gamification components and the puberty health educational content detailed in Table (1), challenges were created. During the platform design, at least three elements - points, leaderboards, and badges - were utilized. Students earned one point for studying each section, and a ranking table showed their standings relative to others. Each training topic featured at least two challenges. The platform's challenges included three formats: multiple-choice questions, descriptive questions, and key point reviews. For instance, a multiple-choice question might ask, "Which minerals are essential for teenagers? a) calcium and iron b) magnesium and sodium c) sodium and potassium d) magnesium and potassium." A descriptive question could be, "List the four stages of the menstrual cycle." In key point reviews, students earned points by accessing links that provided relevant information, such as "Iron deficiency anemia in teenagers leads to concentration issues and fatigue." Each

challenge had a point value based on its difficulty. Completing challenges allowed students to progress to the next level of gamification.

Content was delivered to students via links once a week over a four-week period. Students could access the links and review the educational materials at their convenience using a computer or mobile phone. Students earned points for completing each section, and a leaderboard displayed their rankings relative to other users. All applicable national regulations concerning virtual environments were strictly followed in this educational approach. The content delivered through gamification over the four weeks is outlined in Table 1.

During the first week, using the designed gamification educational platform, content on the age of onset of puberty signs and anatomy of the reproductive system was provided. In the second week, information on physical signs of puberty, menstruation, and hygiene was covered. In the third week, the focus was on proper nutrition during puberty and psychological signs of puberty. In the fourth week, content on customs, traditions, beliefs, and religious rulings related to puberty was uploaded to the platform for the students. After reviewing the content and completing the challenges, students earned points for that week and could continue the game in the following week. If the weekly stages were not completed, students could not access the subsequent stages in future weeks. Throughout all stages, students could compare their scores with their peers. Additionally, the top three students with the highest scores across the four weeks of intervention were awarded prizes by the researcher. The students were informed about the rewards before the study began to encourage their participation.

Before the intervention, immediately after, and again one month later, both the intervention and control groups completed the puberty awareness and practice questionnaires. During the

intervention, the control group did not receive any educational content. After the study, to ensure ethical standards, the intervention materials were shared with the control group.

Instruments

The data collection tools included a socio-demographic questionnaire and a puberty health awareness and practice questionnaire. Socio-demographic questionnaire collected details including age, parents' age, parents' education, parents' occupation, residence, number of family members, birth order, prior knowledge of puberty, sources of puberty information, and preferred sources for obtaining puberty information.

The puberty health awareness and practice questionnaire, developed by the researchers, measures adolescent girls' awareness and practice regarding personal puberty health (e.g., balanced diet, good hygiene, seeking emotional support). It consists of 34 items divided into two sections: the first section includes 12 multiple-choice questions on awareness, with scores of 1 for correct answers and 0 for incorrect ones. The second section comprises 20 practice-related questions measured using a four-point Likert scale (from "never" to "always"), with each item rated between 1 and 4. Higher scores indicate better awareness and practice. The validity and reliability of the questionnaire have been confirmed by experts in the field, with Cronbach's alpha reported above 0.70 [24].

Data Analysis

Descriptive statistics included measures of central tendency (mean) and dispersion (standard deviation), as well as frequencies and percentages. Data normality was assessed using the Kolmogorov-Smirnov test. The Chi-square test analyzed qualitative demographic variables; Fisher's exact test was used when Chi-square conditions were unmet. Independent t-tests compared mean age, puberty awareness, and practices between the two groups. To evaluate

changes in awareness and practice scores post-intervention, while controlling for baseline values, analysis of covariance (ANCOVA) was employed. All analyses were performed using SPSS version 25, with significance set at $p<0.05$.

Results

There were no statistically significant differences between the two groups in variables such as age, father's education, father's occupation, mother's occupation, parents' age, place of residence, birth order, source of information, and preferred source of information. However, there was a difference in the variable of mother's education (Table 2). The preferred sources of puberty health information for students, with the majority (65%) favoring their mothers as the primary source.

Table 3 presents the mean puberty awareness and practice of students at three intervals: before, immediately after, and four weeks after the study in both the intervention and control groups. There was no statistically significant difference in puberty awareness and practice between the intervention and control groups prior to the intervention. However, immediately after the study, the intervention group experienced a five-point increase in puberty awareness and a six-point improvement in practice, both statistically significant compared to the control group. Four weeks post-intervention, the intervention group again demonstrated significant enhancements in both awareness and practice compared to the control group. The Standardized Mean Difference (SMD) indicates that these increases are also clinically significant (Table 3).

Table 4 compares the mean awareness and practice scores of students in the intervention and control groups at three time points: before vs. immediately after, before vs. four weeks later, and immediately after vs. four weeks later. In the intervention group, awareness scores significantly increased by about five points from pre-intervention to immediately post-intervention and from

pre-intervention to four weeks later. However, there was no significant change in awareness from immediately after to four weeks later, indicating that the gamification intervention had similar effects in the short and long term. In the control group, awareness scores showed no statistically significant differences across the time periods. In the intervention group, the puberty practice variable showed a statistically significant increase of about seven points from the pre-intervention to the immediate post-intervention period, and a nine-point increase from pre-intervention to four weeks later. However, the two-point increase from immediately post-intervention to four weeks later was not statistically significant. In contrast, the control group experienced a statistically significant decrease of roughly four points from pre-intervention to immediate post-intervention and about five points from immediate post-intervention to four weeks later (Table 4).

An ANCOVA test was conducted to assess the difference in puberty awareness and practice scores between the intervention and control groups, considering baseline values and the mean mother's education. The results showed significant differences between the two groups after controlling for these factors ($p < 0.001$). The baseline differences did not compromise the results' validity. The observed power indicated that the sample size was adequate for meaningful findings, with effect sizes of 0.74 for awareness and 0.25 for practice, highlighting a greater impact of the intervention on awareness compared to practice.

Discussion

This study assessed the efficacy of gamification in the education of teenage females on pubertal health in XXX City, XXX, specifically evaluating changes in puberty awareness and practice. Results indicated that both awareness and practice significantly improved in the intervention

group compared to the control group, both immediately and four weeks post-intervention. Effect sizes across three time periods supported these findings.

In contrast to traditional lecture-based teaching, which may slow cognitive development and be less effective for practical knowledge and behavior change, gamification fosters active engagement [25]. Teacher-centered methods, such as lectures, often result in early forgetting among learners. In contrast, gamification, with its learner-centered approach, boosts motivation and enhances learning outcomes [24].

Studies on educational packages for puberty education have demonstrated improvements in various student outcomes [24,26]. The increasing use of gamification to tackle complex learning issues highlights its effectiveness in bridging existing gaps. A key reason for gamification's success in educational programs is its ability to foster intrinsic motivation among learners [16-18]. Intrinsic motivation is often considered the most powerful driver of behavior. In education, it, along with self-awareness, is viewed as a key indicator of successful learning. Research by Xi and Hamari (2019) suggests that gamification can significantly enhance users' intrinsic needs satisfaction [27].

Several studies have highlighted the impact of gamification on education. For instance, Haruna et al. (2018) demonstrated that using gamification for teaching puberty health positively affected students' understanding of sexual health [14]. Ezezika et al. (2018) found that gamification improved adolescents' knowledge, attitudes, and behaviors regarding nutrition Ezezika [28]. Kim et al. (2022) showed that gamification helped students enhance their problem-solving skills [19]. Peña et al. (2021) reported the effectiveness of gamification in controlling obesity among students [29], and Sandrone et al. (2021) also observed significant benefits of gamification in educational

settings [30]. Otero-Agra (2019) [31] and Timpel et al. (2018) [32] supported these findings, aligning with the results of the current study. Additionally, Mohammad Alizadeh (2014) demonstrated that computer-based education positively impacted girls' puberty awareness and practice [24].

Some studies indicate that gamification may negatively impact learning. Hanus et al. (2015) reported that students in a gamified group experienced decreased intrinsic motivation during the post-intervention period, which led to lower final exam scores. Their findings suggested that leaderboards, badges, and competitive elements did not enhance educational outcomes and could harm motivation, satisfaction, and empowerment. This decline in intrinsic motivation likely contributed to poorer exam performance [22]. The discrepancy between the results of the present study and those of Hanus et al. (2015) may be due to cultural differences between the research samples or differences in the interaction styles of educators [16,27].

Kwon and Özpolat (2021) conducted a study titled "The Dark Side of Narrow Gamification", which focused on the negative effects of gamification assessment on student perception and content knowledge. Their findings indicated that gamification significantly reduced students' knowledge of the taught content. They highlighted that over time; gamification might decrease learners' motivation and engagement. Since students are accustomed to traditional learning methods and approach tasks similarly in each lesson, the new gamification method might diminish or even harm their test performance. However, they suggested further research to evaluate the impact of gamification on learning [33]. In addition, the study's focus on higher education students may limit its applicability to adolescents. Younger learners may have different cognitive and motivational responses to gamification, potentially affecting how well these findings translate to adolescent education [14,20,24].

In line with the results of the current study, while other researchers argue that gamification techniques engage participants, encourage problem-solving, and stimulate creative thinking through game design principles in learning environments [30-32,34], the contradictions observed in various studies suggest that further, long-term research is essential to fully understand gamification's effectiveness in learning. Given the critical role that puberty health education plays in adolescent well-being, it is crucial to adopt modern teaching methods that can better address the needs of young learners. Gamification offers several advantages over traditional educational approaches. It can transform the learning experience by incorporating elements of play, competition, and rewards, which help to maintain students' interest and motivation. This increased engagement can lead to a deeper understanding of puberty health issues and more effective application of knowledge in real-life situations.

In light of these benefits, it is recommended to integrate gamification and similar innovative teaching methods into puberty health education programs. Such approaches can make learning more enjoyable and impactful, ultimately supporting better health outcomes for adolescents. A strength of this study is its focus on an age group that is ideally suited for learning about puberty health, combined with the use of a highly engaging educational method [29,31,32]. A notable limitation was the substantial time and cost involved in acquiring the platform and developing gamification challenges. Additionally, the study found a decrease in puberty practice among the control group post-intervention, potentially due to the self-reported nature of the questionnaire, which may be affected by students' differing health conditions throughout their menstrual cycles. Future research should investigate similar studies across various regions and countries, addressing puberty health for both girls and boys. Expanding studies to include larger sample sizes and diverse educational contexts would also be advantageous.

Conclusion

Gamification in puberty health education significantly enhances awareness and practices among adolescent girls by incorporating engaging, interactive game-like elements. This effectiveness underscores its potential as a valuable tool for improving puberty health education.

Conflicts of interest

There are no conflicts of interest.

References

1. Draper CE, Micklesfield LK, Kahn K, et al. Application of Intervention Mapping to develop a community-based health promotion pre-pregnancy intervention for adolescent girls in rural South Africa: Project Ntshembo (Hope). *BMC Public Health*. 2014;14 Suppl 2(Suppl 2):S5. doi:10.1186/1471-2458-14-s2-s5
2. Dorn LD, Hostinar CE, Susman EJ, Pervanidou P. Conceptualizing Puberty as a Window of Opportunity for Impacting Health and Well-Being Across the Life Span. *J Res Adolesc*. Mar 2019;29(1):155-176. doi:10.1111/jora.12431
3. Ziapour A, Sharma M, NeJhaddadgar N, Mardi A, Tavafian SS. Educational needs assessment among 10-14-year-old girls about puberty adolescent health of Ardebil. *Arch Public Health*. 2020;78:5. doi:10.1186/s13690-019-0388-3
4. George N, Johnson AR, Lobo A, Pousiya S, Agrawal T. Health problems and health seeking behavior among school-going adolescents in a rural area in South Karnataka. *JIACAM*. 2018;14(2)
5. Cohen GL, Prinstein MJ. Peer contagion of aggression and health risk behavior among adolescent males: an experimental investigation of effects on public conduct and private attitudes. *Child Dev*. Jul-Aug 2006;77(4):967-83. doi:10.1111/j.1467-8624.2006.00913.x
6. Ziapour A, Sharma M, NeJhaddadgar N, Mardi A, Tavafian SS. Study of Adolescents' Puberty, Adolescence Training Program: The Application of Intervention Mapping Approach. *Int Q Community Health Educ*. Oct 2021;42(1):5-14. doi:10.1177/0272684x20956485
7. Li AD, Bellis EK, Girling JE, et al. Unmet Needs and Experiences of Adolescent Girls with Heavy Menstrual Bleeding and Dysmenorrhea: A Qualitative Study. *J Pediatr Adolesc Gynecol*. Jun 2020;33(3):278-284. doi:10.1016/j.jpag.2019.11.007
8. Jarrahi R, Golmakani N, Mazlom SR, Forouzanfar H. The effect of menstrual health education in peer group on menstrual health behaviors in adolescents: A randomized clinical trial study. *Journal of Torbat Heydarieh university of medical sciences*. 2020;
9. Sadovets O, Martynyuk O, Orlovska O, Lysak H, Korol S, Zembytska M. Gamification in the informal learning space of higher education (in the context of the digital transformation of education). *Postmodern Openings*. 2022;13(1):330-350.
10. Rad EF, Keshavarz Z, Simbar M, Nasiri M, Mehraliyan H. The impact of a school-based intervention using the PBSEIM model on health promoting behaviors and self-care in adolescent females. *Advances in Nursing & Midwifery*. 2017;27(1):15-19.
11. Nazarpour S, Arabi Z, Simbar M, Keshavarz Z, Baghestani AR. A comparison between the skills-based education with a lecture-based education on female adolescents' knowledge, attitude and practice about health in puberty: A randomized trail study. *Adv Nurs Midwifery*. 2020;29:15-23.
12. Werbach K, Hunter D. *The gamification toolkit: dynamics, mechanics, and components for the win*. University of Pennsylvania Press; 2015.
13. van Gaalen AE, Brouwer J, Schönrock-Adema J, Bouwkamp-Timmer T, Jaarsma ADC, Georgiadis JR. Gamification of health professions education: a systematic review. *Advances in Health Sciences Education*. 2021;26(2):683-711.
14. Haruna H, Hu X, Chu SKW, Mellecker RR, Gabriel G, Ndekao PS. Improving sexual health education programs for adolescent students through game-based learning and gamification. *International journal of environmental research and public health*. 2018;15(9):2027.
15. Kostenius C, Hallberg J, Lindqvist A-K. Gamification of health education: Schoolchildren's participation in the development of a serious game to promote health and learning. *Health Education*. 2018;118(4):354-368.
16. Gentry SV, Gauthier A, L'Estrade Ehrstrom B, et al. Serious Gaming and Gamification Education in Health Professions: Systematic Review. *J Med Internet Res*. 2019/03/28 2019;21(3):e12994. doi:10.2196/12994

17. Felszeghy S, Pasonen-Seppänen S, Koskela A, et al. Using online game-based platforms to improve student performance and engagement in histology teaching. *BMC Medical Education*. 2019/07/22 2019;19(1):273. doi:10.1186/s12909-019-1701-0
18. McCoy L, Lewis JH, Dalton D. Gamification and Multimedia for Medical Education: A Landscape Review. *Journal of Osteopathic Medicine*. 2016;116(1):22-34. doi:doi:10.7556/jaoa.2016.003
19. Kim H, Kim B. Effects of Situation-Based Flipped Learning and Gamification as Combined Methodologies in Psychiatric Nursing Education: A Quasi-Experimental Study. MDPI; 2022:644.
20. Zarshenas L, Saranjam E, Mehrabi M, Setoodeh G. Microlearning and gamification in anxiety management among girl adolescents in Iran: An interventional study. *P J M H S* 2020;Vol. 14
21. Rondon S, Sassi FC, Furquim de Andrade CR. Computer game-based and traditional learning method: a comparison regarding students' knowledge retention. *BMC Medical Education*. 2013/02/25 2013;13(1):30. doi:10.1186/1472-6920-13-30
22. Hanus MD, Fox J. Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. *Computers & education*. 2015;80:152-161.
23. Nulty DD. The adequacy of response rates to online and paper surveys: what can be done? *Assessment & evaluation in higher education*. 2008;33(3):301-314.
24. Mohammad Alizadeh Charandabi Sakineh MM, Rahmani Azad, Seidi Simin, Safari Elnaz, Mahini Minoo, Saghi Sima. The effect of software on knowledge and performance of teenage girls toward puberty hygiene: a randomized controlled trial. *Iranian journal of medical education*. 2014;
25. Kay R, MacDonald T, DiGiuseppe M. A comparison of lecture-based, active, and flipped classroom teaching approaches in higher education. *J Comput High Educ*. 2019;31(3):449-471.
26. Hosseininasab D AM, Faizollahzadeh H. . The Effect of Computer Assisted Instruction and

Demonstration on Learning Vital Signs Measurement in Nursing Students. *Iranian Journal of Medical*

Education. 2007;7: 23-30. [Persian]
27. Xi N, Hamari J. Does gamification satisfy needs? A study on the relationship between gamification features and intrinsic need satisfaction. *International Journal of Information Management*. 2019;46:210-221.
28. Ezezika O, Oh J, Edeagu N, Boyo W. Gamification of nutrition: A preliminary study on the impact of gamification on nutrition knowledge, attitude, and behaviour of adolescents in Nigeria. *Nutr Health*. Sep 2018;24(3):137-144. doi:10.1177/0260106018782211
29. Peña S, Carranza M, Cuadrado C, et al. Effectiveness of a gamification strategy to prevent childhood obesity in schools: A cluster controlled trial. *Obesity (Silver Spring)*. Nov 2021;29(11):1825-1834. doi:10.1002/oby.23165
30. Sandrone S, Carlson C. Gamification and game-based education in neurology and neuroscience: applications, challenges, and opportunities. *Brain Disorders*. 2021;1:100008.
31. Otero-Agra M, Barcala-Furelos R, Besada-Saavedra I, Peixoto-Pino L, Martínez-Isasi S, Rodríguez-Núñez A. Let the kids play: gamification as a CPR training methodology in secondary school students. A quasi-experimental manikin simulation study. *Emerg Med J*. Nov 2019;36(11):653-659. doi:10.1136/emermed-2018-208108
32. Timpel P, Cesena FHY, da Silva Costa C, et al. Efficacy of gamification-based smartphone application for weight loss in overweight and obese adolescents: study protocol for a phase II randomized controlled trial. *Ther Adv Endocrinol Metab*. Jun 2018;9(6):167-176. doi:10.1177/2042018818770938
33. Kwon HY, Özpolat K. The dark side of narrow gamification: Negative impact of assessment gamification on student perceptions and content knowledge. *INFORMS Transactions on Education*. 2021;21(2):67-81.
34. Strickland MC. A Hermeneutic Phenomenological Study of Teacher Perceptions of the Effects Movement Strategies Have On Student Learning. 2022;

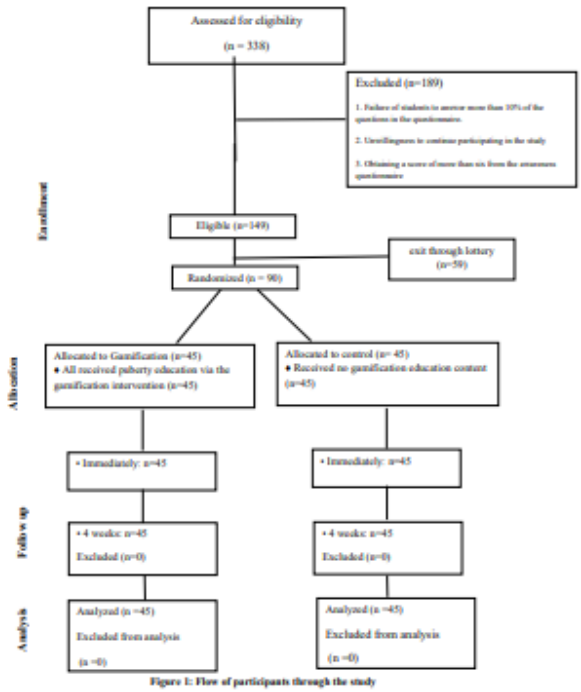

Figure 1: Flow of participants through the study

Table 1: Topics Covered for Adolescent Puberty Education During the Training Sessions

Session	Topics Covered	Gamification Stages
1	* Age of Onset of Puberty Signs *Anatomy of the Reproductive System	* Introduction of the issue, age of onset of puberty signs, anatomy of the reproductive system *Presentation of challenges related to the provided content for students, and earning points for completing this stage.
2	* Physical Signs of Puberty * Menstruation and Hygiene	* Introduction of the issue, physical signs of puberty, menstruation, and hygiene *Presentation of challenges related to the provided content for students, and earning points for completing this stage.
3	* Proper Nutrition During Puberty *Psychological Signs of Puberty	*Introduction of the issue, proper nutrition during puberty, and psychological signs of puberty *Presentation of challenges related to the provided content for students, and earning points for completing this stage.
4	* Customs, Traditions, and Beliefs Related to Puberty	*Introduction of the issue, customs, traditions, and beliefs related to puberty, and religious rulings

	* Religious Rulings Related to Puberty	concerning puberty *Presentation of challenges related to the provided content for students, and earning points for completing this stage.

Table 2: Socio-demographic characteristics of the research participants by group (prior to the intervention)

Variable name	Variable subgroup	Total (Number)	Groups		p-value
			Intervention Number (%) Mean ± SD	Control Number (%) Mean ± SD	
Age*(year)	12	42	17(40.5)	25(59.5)	0.091
	13	48	28(58.3)	20(41.7)	
Father's education*	Lower than diploma	39	25(64.1)	14(35.9)	0.052
	Diploma	41	17(41.5)	24(58.5)	
	University	10	3(30.0)	7(70.0)	
Mother's education*	Lower than diploma	27	20(74.1)	7(25.9)	<0.001
	Diploma	39	22(56.4)	17(43.6)	
	University	24	3(12.5)	21(87.5)	
Father's job**	Unemployed	7	6(85.7)	1(14.3)	0.110
	Employed	83	39(47.0)	44(53.0)	
Mother's job*	Housewife	50	30(60.0)	20(40.0)	0.056
	Employed	40	15(37.5)	25(62.5)	
Only child or not*	1	56	26(46.4)	30(53.6)	0.515
	≥2	34	19(55.9)	15(44.1)	
Source of information*	No answer	18	11(61.1)	7(38.9)	0.253
	Mother	42	17(40.5)	25(59.5)	
	Non-mother	30	17(56.7)	13(43.3)	
Level of	Insufficient	6	3(50.0)	3(50.0)	0.889

information**	Average information	51	24(47.1)	27(52.9)	
	Enough	33	18(54.5)	15(45.5)	
Preferred source of information*	Mother	65	33(50.8)	32(49.2)	1.000
	Non-mother	25	12(48.0)	13(52.0)	
Parents' age* (Year)**	Father	90	42.76 ± 6.37	41.67±5.05	0.372
	Mother	90	37.73±4.65	37.31±4.66	0.669

*Chi-square

**Fisher's exact test

***Independent Samples T Test

Table 3: An independent examination of the mean and mean difference in puberty awareness and practice between the intervention and control groups across the three time periods assessed in the study.

Variable name			**Before Mean (SD)**	**Immediately Mean (SD)**	**Four weeks later Mean (SD)**
Awareness	**Groups**	**Intervention**	5.11±1.31	10.40±1.60	10.18±1.52
		Control	5.22±0.95	4.96±1.36	4.56±1.25
	Mean difference (CI%95)		-0.11(-0.59 to 0.37)	5.44(4.82 to 6.06)	5.62(5.03 to 6.20)
	Standard Mean difference (CI%95)		-0.09(-0.51 to 0.31)	3.66(2.97 to 4.33)	4.02(3.29 to 4.74)
	P-value		0.648	<0.001	<0.001
Practice	**Groups**	**Intervention**	55.89±7.32	62.71±7.10	64.62±6.74
		Control	57.56±6.34	56.33±8.30	52.91±8.50
	Mean difference (CI%95)		-1.66(-4.53 to 1.20)	6.37(3.14 to 9.61)	11.71(8.49 to 14.92)

	Standard Mean difference (CI%95)	-0.24(-0.65 to -0.17)	0.82(0.39 to 1.25)	-4.039(-4.75 to -3.31)
	P-value	0.252	<0.001	<0.001

Independent Samples T Test

Table 4: Examining the difference in average scores for puberty awareness and practice across three time periods in the intervention and control groups.

Variable	Groups	Time period	Mean difference (CI% 95)	p-value Pairwise comparisons	p-value Total
Awareness	Intervention	Immediately- Before	5.28(4.51 to 6.06)	<0.001	<0.001
		Four weeks later- Before	5.06(4.31 to 5.82)	<0.001	
		Four weeks later- Immediately	-0.22(-0.68 to 0.24)	0.566	
	Control	Immediately- Before	-0.26(-0.68 to 0.24)	0.324	0.002
		Four weeks later- Before	-0.66(-1.10 to -0.22)	0.001	
		Four weeks later- Immediately	-0.40(-0.79 to -0.01)	0.043	
Practice	Intervention	Immediately- Before	6.82(4.24 to 9.40)	<0.001	<0.001
		Four weeks later- Before	8.73(5.94 to 11.51)	<0.001	
		Four weeks later- Immediately	1.91(-0.56 to 4.38)	0.173	
	Control	Immediately- Before	-1.22(-3.29 to 0.85)	0.388	<0.001
		Four weeks later- Before	-4.64(-6.78 to -2.50)	<0.001	
		Four weeks later- Immediately	-3.42(-5.17 to -1.67)	<0.001	

Repeated Measures ANOVA