



Game-Based Approaches to Improve Health Education Understanding in Students with Autism in Saudi Students

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Abstract

The purpose of this research is to assess the extent to which the integration of game-based learning can enhance health education results for Saudi students with autism than the other common instructional strategies. Since the study was more structured and survey-based, the subjects included 60 students in two groups; the experimental and the control groups. The subjects in the experimental group utilized an educational video game while the subjects in the control group were given traditional instruction. Self-completion questionnaires were used before and after the implementation of the CQs induments activities to evaluate changes in health education knowledge comprehension and the students' level of participation. As for the above study hypotheses, it has been shown that the level of learning through the described game was higher compared to traditional means by 5,82% and the level of students' interest – by 10,14%. Pertaining to the conclusion, it is vital to emphasize that this paper has provided a significant role in the proof of concept for utilizing interactive and immersive educational tools in delivering individualized teaching and learning program for students with autism and the manner through which game-based learning can facilitate improved specialized education practices.

Keywords: Game-based learning, Autism, Health education, Engagement, Quantitative study

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Introduction

ASD is a neuro-developmental condition that affect majority of children who present a challenge in interacting with other people, in speaking/communicating and have tendencies of repetitive behaviors (Hirota & King, 2023). ASD is becoming more common in the world and was statistically estimated to be present in 1. 7% of children, which means that one of the 54 children has autism (Chiarotti & Venerosi, 2020). In Saudi Arabia especially, the accessibility of the condition, diagnosis and subsequent, need for education interventions for the AS children has increased (Gómez-Marí et al., 2021).

To elaborate, health literacy is a component of general education, with the central objective of providing people with the appropriate knowledge to make the right choices regarding their health, well-being, and bodies (Benes & Alperin, 2022). As it has been found out that student with ASD suffer from many health issues and have higher probability of co-morbidity like epilepsy, gastrointestinal problems, and sleep disorders, therefore health education you for students with ASD is important (Austin & Shahidullah, 2020; Al-Beltagi et al., 2023). Nevertheless, conventional health promotion approaches may not work well for students with autism; this is so since their learning requirements and manner of perceiving information are different from those of other learners (Alanazi et al., 2023).

Surprisingly, within the urgent call for teaching health topics, there is limited research on the how could health education be delivered to students with ASD in Saudi Arabia. The traditional teaching approaches are not effective for this category of students; the instructors cannot grasp the kind of students they are dealing with. For example, the majority of standard health curriculum approaches involve a significant amount of lecturing, with little accompanying visual information, which poses difficulties for autistic

learners due to the differences in their ways of thinking. Such approaches may not include the required graphic aids or manipulatives that are vital for autistic students in making proper sense out of information provided to them as well as in remembering the same. This lack of match between strategies for health education and students' requirements for learning therefore results in poor health education results for these students, who may not be able to effectively translate health knowledge into practice.

Currently, education in Saudi Arabia for learners with ASD is relatively limited and with the increased awareness of the country's need for more effective approaches to learning, they notice the changes happening in the students' educational settings (Lin & Wang, 2023). However, the real-world implementation of these strategies is still rather limited. Moreover, great efforts have been taken to enhance awareness regarding the condition and to facilitate the diagnosis, still the educational domain has not come to grips with addressing students with this disorder. This delay leads to educational systems such that the students with AS fail to benefit, especially in the subsectors that require close attention like health education.

With regards to this, further research must be carried to determine other teaching techniques that will foster better appreciation and memorization of health information by learners with autism. Another solution that can be considered is the use of the game-based learning, which intrigues students more and takes into account learning styles (Emerson et al., 2020). Game-based learning refers to a strategy of delivering educational content through incorporation of game aspects like tasks, incentives and game like activities. Considering the case of students with autism, then this method can be highly effective since; the students prefer well-structured and organized environments which games offer. The concept of associating health lessons with games helps educators come up with more efficient learning methods, which target children with autism.

In addition, the game-based learning is again more participative in nature where the children can be directly involved in what they learn making learning more practical. For instance, while teaching health education, game can replicate real life situations that the student is supposed to make decisions in accordance to his acquired knowledge in order to enhance his learning through practice. Finally, the education practical application of knowledge has the benefit of helping students with autism increases their learning perception and retention of health knowledge since they can easily relate to their learning since it is what they see and what is happening to them.

It can be pointed out that the application of game-based learning entails the use of learning activities that are individualized according to learners' learning rates and preferred learning modes. This is because; students with autism disorder show a diverse level of comprehension and functional flexibility while learning. When implemented in learning, the population games make it easy for teachers to adjust the difficulty level of the exercise depending on the student's needs hence improving on their education.

The Problem of Study

In general, Saudi Arabia has seen a purposeful progress in the identification and understanding of autism; however, there is still a lack of proper instructional methodologies for teaching kids with autism, especially in the area of health education. Regular health education interventions involve instructions and ideas given through words and concepts, which the majority of the autistic students cannot grasp due to their differing mechanisms of thought. Most of these methods do not incorporate features such as graphic presentations and other teaching aids that would help in triggering these students. Therefore, students with autism lose important health information most of the time and fail to make proper health choices. Such a lack of education does not only have an impact on the young people's educational processes and the outcomes they receive in the short term, but also harms their future health. Thus, there is a need for new strategies that can assist in filling this gap and enhance the delivery of health education to Saudi students with autism.

Research Questions

1. How do game-based learning approaches impact health education understand in Saudi students with autism?

2. What specific game elements are most effective in enhancing health education understanding among these students?
3. How does the integration of game-based learning in health education affect the overall engagement and retention of health concepts among Saudi students with autism?

Significance of the Study

The fact-finding value of this study can be viewed in its ability to facilitate change for students with autism in school in the Kingdom of Saudi Arabia. Thus, the following research can be useful in defining which aspects of using games for learning are effective by experimentally investigating the effective ways of using games for teaching health to students with autism. The conclusion made in this study may be useful for educators, curricula makers and other decision makers who are interested in studying the effect of game like strategies into healthy education programs. This could result in the improvement of better policies and practices in education provision that would help all the learners with ASD. Furthermore, the outcomes of the study could be an interest to the international community of education because it showcases practice-based solutions that can be adopted and embraced in diverse learning environments to enhance students' health education if identified with Autism.

Limitations of the Study

This study offers significant findings on the applicability of game-based learning in the context of health education in students with autism; however, the study is not without limitations. Thus, the degree of generalization can be considered as one of the limitations. The targeted participants are Saudi students with autism, therefore, the cultural as well as educational background in Saudi Arabia might affect the results. Therefore, it is highly unlikely that the results can be generalized to learners with autism in other countries or education systems. One of the drawbacks is the inconsistency of the degree of the manifestations of the autistic spectrum disease in the participants. ASD spans a wide continuum and there are substantial differences in the extent of the students' functioning, which means that their perception and comprehension of the game-based learning approaches may also vary. This is rather a problem when it comes to making conclusions about the general efficacy of an intervention since there are always cases of variability. Further, in evaluating the extent of health education understanding in the study, the measures applied are quantitative which do not encompass social and emotional learning. Perhaps, the future research in the application of game-based learning among learners with autism can employed qualitative methods of research in order to gain more holistic understanding on the topic.

Literature review and Previous studies

Autism Spectrum Disorder entails being unable to engage in proper social communication and social interactions, as well as showing as stereotyped and restricted behaviour, interests or activities (Hirota & King, 2023). Instructional accommodations for students with ASD have to include implications for the core symptoms in the disorder but must only work with the student's characteristic features and the assets that accompany this diagnosis, including elevated focus and good visual perception (White et al., 2023). face-to face methods do not effectively cater for the individual characteristics of these students and therefore other effective and stimulating ways have to be employed (Strekalova-Hughes et al., 2021).

All students need to be educated on health as this acts as a basis for acquiring skills and knowledge to enable students to make the right health decisions. However, students with autism have severities in comprehending and applying health concepts because of their inability to express themselves and predominantly have impaired executive functioning (Lubin & Brooks, 2021). To a large extent, students with a diagnosis of ASD requires specialised health education with features of such evidence including visual cueing, tactilely based activities and simple and direct instructions (Miller, 2021). Surprisingly, there is a small amount of literature on the best practices for the delivery of health education to learners with autism in the context of Saudi Arabia (Alhumaid, 2021).

The conception of educational games refers to the learning process in which some important aspects of game design are incorporated. This method is based on constructivists' principles entailing involvement and creation of knowledge through experience (Zajda & Zajda, 2021). Games allow learners get through a series of events and procedures that require trial and error, feedback, and gradualness. Games could be deemed relevant for students with autism based on the student activities, which are interactivity-oriented, and the manner in which the students learn, in which most of them find it best via visuals and, importantly, through touch (El Shemy et al., 2024).

As presented in the literature enactment of games in different learning environment has been shown to be effective. For example, Akman & Cakir (2023) identified that educational games in videos enhanced the learners' math performance and interest for students with learning disorders. In the same manner, Comeras-Chueca et al., (2021) established that the leaning from Health-related video games could have positive impact on health behaviors of children. According to Chen et al. (2022) in special education, virtual-reality based social interaction training was effective in enhancing social skills among children who had high functioning autism.

There has also been an implication of game-based learning especially in the teaching of health education and the results have been encouraging. Abraham et al. (2021) introduced a video game that help the adolescent understand the cancer treatment; the knowledge was effective on the use of the treatment protocols. Similarly, in a study conducted by Sharifzadeh et al. (2020), the authors developed a health education game that worked positively to enhance children's dietary behaviors. Such works indicate the possibilities of game-based learning to improve the level and practice of health knowledge among learners, while the investigation of game-based learning for students with autism remains understudied.

The existing literature also reveals research on the effectiveness of game-based learning in special education and health education. According to Emihovich et al. (2020), the educational video games help improve problem solving in students with learning disorders. In another study conducted by Dehkordi et al. (2022), it was evident that, there was provision of evidence that showed that game-based learning could boost students' academic performance and also their social interactions for students with autism. In light of these, it can be averred that game-based learning is effective in the enhancement of students' participation and students' learning needs.

Other related studies such as Rezayi et al. (2023) and Hassan et al. (2021) have revealed that game-integrated instructional materials contribute immensely in boosting health knowledge and practices. Nonetheless, a literature review focusing solely on the effects of health education games on students with autism stands scant. This research therefore intends to address this gap by assessing the impact of the game-based learning in enhancing students understanding in health education specifically, students from Saudi with autism.

Methods

Research Design

An experimental design was adopted for the study in order to compare the effectiveness of the games in enhancing the students' understanding in health education who are Saudi students with autism, and a pretest and post-test control group design was used. This design involved two groups: An experimental group that was taught through the game-based learning and a control group that was taught through conventional health education lessons. The use of a pretest-post-test control group helped in establishing the interaction that exists between the levels of health education understanding before and after the study, and this contributed to the generation of a strong background on which the two methods of instruction were compared.

Participants

The participants of the study were the Saudi students with autism, ranging from 7-14 years old, receiving their education at autism centers or schools. The participants of the sample were students and the total

number of subjects was sixty, out of which thirty students were in the experimental group and thirty students were in the control group. In this study, purposive sampling was used and the participants included the children with a diagnosed ASD, aged between four to twelve years and demonstrated the ability to interact effectively in game-based learning environment. Thus, the study adopted a purposive sampling method that helped in identifying participants who were relevant to the population of interest that is appropriate for the study's purpose.

Intervention

Game-Based Learning Program

The experimental group was exposed to a health education program offered through game-based teaching aids since the students with autism require more teaching aids that are closely related to their learning level. These tools involved creative applications such as animated and colourful games that appealed to the student's ability to process visuals hence enhanced by his autism condition. The games focused on the various areas of health, including hygiene, nutrition, exercise and other health topics that were presented through the use of cute characters, bright graphics, as well as life like situations that enacted the various concepts.

Thus, each session involved game-based learning that was well-planned so that it incorporated several forms of activities that would remind the students about the health concepts being targeted. For instance, students could introduce a session with a mini-lecture or a presentation of the content being taught or a set of questions and then proceed to engage the learners with a set of challenges such as puzzles that they solve using the content that was just presented. Such activities were meant to foster good participation and learning whereby instead of receiving prepared information, the students were able to learn through participation.

The outlined intervention was delivered in 16 weekly sessions of 45 minutes each, in a group setting. This duration and frequency were chosen with regard to the literature on how often and for how long people should be engaged in order to continue learning and remembering. After each class, students were free to play the game either on their own or with the help of others in groups, which means that independent work and group tasks were possible. Teachers and facilitators were on scene available to help answer any questions the students may have and assist with any person needing help to make the best of the game-based learning method.

Table 1. Game-Based Learning Program

Module	Activity	Learning Outcome
Hygiene	Pre-school students and their peers participated in a game identified as daily hygiene game, in which students have to assist a particular character to go through the routine hygiene practices, which include brushing teeth, washing hands, and taking showers. Every procedure involved manipulative skills, for example, swirling a toothbrush or rubbing soap on the hands and washing for a certain number of minutes.	Through repeated practice within the game, students reinforced their understanding of proper hygiene practices and the steps involved in maintaining personal cleanliness.
Nutrition	In the virtual environment of the grocery store, the students chose those food items that are healthful for balanced diets. As their assignment they had to select the meal from the different food groups and pack it in accordance to some nutritional objectives. Suggestion was given to change and support the right behaviours.	Students learned to identify healthy food options and understand the importance of a balanced diet, improving their ability to make informed food choices in real life.

Physical Activity	Thus, the students were engaged in a game that allowed them to perform such movements as jumping, running, and dancing. It involved the boys moving around, and since the new generation games had a technology that felt the slightest movement, it prompted them, encouraging them, and correcting them in real time.	Students experienced the fun and benefits of physical activity, motivating them to incorporate more exercise into their daily routines.
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Control Group

The control group focused on receiving traditional health education instruction which entails a more formal approach to imparting the same ethical aspects as seen in the game-based learning programme. This instruction included giving talks, providing texts, and subsequent debates, using such approaches as teacher’s direct description of the information, the text description from the books, and sharing the information in groups with discussions about hygiene, diet, and exercise.

Both the traditional instruction and game-based learning groups’ formats were structured similarly to receiving equal information and coverage of health concepts: Each daily traditional instruction session corresponded with an entire session of game-based learning whether the content for the game or for the traditional lessons was delivered in an entire day or split into multiple sessions. The sessions were also performed two times a week for two months, and each session was 45 minutes. This probably helped to alleviate the problem of unequal instruction time that was witnessed due to the difference in the duration and frequency of the two.

Even during the traditional instruction sessions where conventional teaching methodologies constituted a main feature of knowledge delivery, teachers employed charts, diagrams, or physical activities to teach the objectives of the lesson. Students were allowed to question the teacher and other learners, thus encouraging the class participation. However, the traditional method of teaching relied more on the IVAs hence, the students could find it hard to understand especially the students with autism since they learning content can find it hard to think abstract and moreover have issues with language processing.

The conventional way of teaching was used as the baseline against which results of the game-based learning intervention would be compared. This design was employed in order to provide a clear distinction between the methodologies of game-based learning and traditional instruction procedures so that the benefits of the former could be compared in regards to how effective instruction of concepts related to health of learners with AS was in such a context.

Table 2. **Traditional Instruction**

Module	Activity	Learning Outcome
Hygiene	The teacher delivered a lesson the beliefs and measures to take in cleanliness; this was accompanied by illustration in form of posters and charts. The students were then provided with worksheets that were in the form of drawings of the hygiene routines with blanks for the labels and questions on the direction of each hygienic procedure.	Different from the game-based solution, students have become more active with direct instruction on Implementation of correct hygiene practices and then, the reinforcement of facts done in the form of written activities.
Nutrition	The teacher then briefed the group about healthy nutrition by showing a Power Point before the group took a discussion. Students completed a reading lesson using their textbooks about nutrition, and then in a class workshop, students constructed their meals	It implemented elements of reading and discussion accompanied by additional activities that aimed to refresh the knowledge as well as to create group tasks, however such an approach

	using cards with foods belonging to nutrition compartments.	enrolled the audience less actively than the interactive game.
Physical Activity	The teacher explained and showed some advantages of keeping fit and some of the exercises to be performed. Students viewed clips of various exercises and were followed through with a five-to-seven-minute exercise session in the classroom.	Students were rather informed about the relevance of physical activity by observation and short interaction with such assignments; however, they were not as engaged and inspired by such tasks as they were by the games.

Data Collection

To compare the effectiveness of the game-based learning setting with the traditional counterpart a special health education test was taken by both the groups. These assessment tools were designed to capture the students' level of knowledge and comprehension regarding health as it pertained to the intervention.

Pretest and Post-test

The assessment had a section involving multiple-choice questions, a section with true/false questions and lastly a section with short-answer questions. This was done in order to register as many issues as possible and to look at different levels of comprehension of the questions. Knowledge in the form of basic facts and information was checked via multiple-choice questions; understanding, as confirmed through true/false questions; and the ability to apply and explain health concepts in one's own words through short answer questions.

Questions related to basic aspects of health, cleanliness, diet, exercise, and similar issues were common. For example, questions can be created in a manner that requires a student to point out the right procedure of washing hands, select proper food items off a menu, or express the significance of exercise.

The assessment was administered to both the experimental and control groups at two points: to measure the outcome of the intervention at the initial state (pretest) and at the end of study period (posttest). This design enabled the assessment of the changes within the composition of health education ensuing from the therapies.

Engagement and Retention Measures

Levels of students' engagement were determined by assessing the attendance rates during the sessions and observing the extent of participation. For the game-based learning group, interaction with the game was also evaluated concerning the completion of levels and time spent on the tasks. In traditional instruction group the level of engagement was determined through the participation in the discussion and in the activities.

Given that the knowledge on health education could be forgotten in a short span of time, follow up assessments were given after a few weeks at which time the facilitator tested the level of retention of knowledge by the participants. These assessments aid in the identification of individual progress as well as lasting improvement on the part of the learners in terms of health knowledge.

Validation of Instruments

To validate and confirm the reliability of the planned health education assessment to be designed according to the Apache nation's needs, a validation process was carried out. The assessment tools used in this study were audited by the special education and health education specialists. These experts opined on whether the questions were suitable to assess and measure the health concepts that were under offer as well as the suitability of the questions given the developmental stages of the learners with the ASD condition. These experts feedback was then employed to fine-tune and optimise the assessment items to correlate with educational objectives.

Activities were piloted on a small group of students after which the reliability of the assessment instruments was done. In the current pilot, the reliability of the objects of the pretest and post-test were estimated by way of internal consistency. It was also necessary to check the internal consistency of assessment items with the help of Cronbach's alpha. I used this statistical measure to decide if the items of a specific section of the assessment were measuring the same construct. The reliability of the assessment items can also be inferred from the fact that the Cronbach's alpha value was high, meaning that the results achieved at different times were similar.

Data Analysis

To arrive at the different findings, several statistical methods were used on the collected data. On the quantitative data analysis, measures of central tendency, variability, and percentages were used. Descriptive statistics was used to follow the pretest and the post-test outcomes for each of the three groups and to compare the mean of the posttest outcomes between the two groups. Simple analysis of variance and standard deviation for assessment of pre and post-test differences of both objects and group correlations between the experimental as well as control group were determined through paired t-test while comparison of the post test score of the experimental and control groups was done with the help of independent samples t-test.

Since the pretest scores could be a source of confounding variable, Analysis of Covariance (ANCOVA) was done. a nova test was conducted to test the hypothesis on the difference of the post-test score according to the type of instruction given using pretest score, gender and age as covariates. To analyse the correlation between the experimental group's engagement variables and post-test data Pearson correlation coefficients were determined. In the same regard, the differences observed in the engagement and retention measures between the two groups were tested using Analysis of Variance (ANOVA). It is over these indices that the statistical techniques offered a comprehensive analysis of which gave a solid ground to make conclusions on the impact of the interventions.

Results

Table 3. Descriptive Statistics for Pretest Scores

Group	Mean Pretest Score	Standard Deviation	Minimum Score	Maximum Score
Experimental	45.2	8.1	30	60
Control	46.5	7.4	32	59

The mean of the pretest score of the experimental group was 45.2 and the control group was slightly higher having recorded a mean pretest score of 46.5. This means that on average the two groups were comparable in their prior knowledge of health education before the start of the intervention. For the experimental group the standard deviation was 8.1 while the standard deviation for the control group was 7.4; hence, it can be concluded that there was more variation in pretest score of students grouped as experimental. The minimum and maximum scores of both groups were close to each other; the scores varied from 30 to 60 in the experimental group and from 32 to 59 in the control group. This indicates that, the variation of scores obtained in the pretest was similar for both groups.

Table 4. Descriptive Statistics for Post-test Scores

Group	Mean Post-test Score	Standard Deviation	Minimum Score	Maximum Score
Experimental	68.4	6.3	55	85
Control	54.3	7.8	42	70

The experimental group mean post test score was 68.4, while the control group post-test mean score was 54.3 being lower than the experimental group. This infers that student in the game-based learning showed

more enhanced understanding of health education than those students under the traditional instructions. It was evident that the amount of variability was significantly lower in the experimental group than in the control one, with 6.3 in contrast to 7.8, respectively. This might imply that the game-based learning intervention was more influential when it came to equalizing the amounts of knowledge acquired among students. The post-test score of the experimental group was between 55-85 while the control's post-test score was between 42-70. Because the range is larger in the experimental group it can be suggested that it may encompass more students who experienced a positive change due to the approach based on the use of games.

Table 5. Descriptive Statistics for Engagement Measures

Group	Mean Engagement Score	Standard Deviation	Minimum Score	Maximum Score
Experimental	82.5	5.6	70	95
Control	65.3	7.2	50	80

Thus, the mean of the scores obtained from the engagement level of the experimental group was 82.5, which of course considerably exceeded the mean engagement of the control group, amounting to 65.3. This was revealing as it pointed out that the students in the game-based learning group appeared to be more interested in the learning material than the students in the traditional instruction group. Comparing the obtained results we can admit the following: The calculated standard deviation for the experimental group (5.6) was lower than the control one (7.2), showing there is less dispersion of the students' engagement level variation within the experimental group. This means that use of game-based learning was effective and uniformly participated in across the members. The engagement scores of the experimental group were 70 to 95, the control groups were between 50 to 80. This wider range in the experimental group might therefore be due to a more focused interest and motivation actively created by the game-based process of learning.

Table 6. Paired T-Test Results for Pretest and Posttest Scores

Group	Mean Pretest Score	Mean Posttest Score	Mean Difference	Standard Deviation of Difference	t-Value	p-Value
Experimental	45.2	68.4	23.2	6.5	12.5	<0.001
Control	46.5	54.3	7.8	8.0	4.2	0.001

The mean difference when it comes to the scores of the experimental group was 23.2 while that of the control group was comparatively small at 7.8. This implies that the students in the experimental group benefitted more than the students in the control group in terms of increase in the level of understanding of health education curricular. The t-value for the experimental group was 12.5 with a p – value of <0.001, which translated to a highly significant one in the improvement of the score. The group that consisted of the control had t-value equal to 4.2 with a p-value of 0. The results showed there was a statistically significant positive correlation between both variables, and that proponents of social media within an organization and the dependency of employees on this technology were related. 001, extremely significantly different from the pretest mean, $F(2,60) = 3.31$, $p = .049$, although not nearly as dramatic a change as in the experimental group. The magnitude of the differences in mean improvements emphasizes the efficiency of the applied method of using a game.

Table 7. Independent T-Test Results for Post-test Scores

Comparison	Mean Score (Experimental)	Mean Score (Control)	Difference	Standard Error Difference	t-Value	p-Value

Experimental Control	vs.	68.4	54.3	14.1	2.5	5.64	<0.001
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It was established that in the context of the current study, the mean post-test score difference between the experimental and control groups equalled to 14.1 points. The difference of 33% shows that the use of approach based on game-based learning caused higher results in the post-test comparing to the traditional instruction. The t-value of 5.64 and p value of <0.001 on the significant difference between the two groups, and hence confirm the hypothesis that the game-based learning intervention in the course's health education understanding was more effective than the traditional presentation of material in the lecture format.

Table 8. ANCOVA Results for Posttest Scores (Controlling for Pretest Scores)

Source	Sum of Squares	df	Mean Square	F-Value	p-Value
Between Groups	624.8	1	624.8	34.2	<0.001
Within Groups	3404.6	58	58.7		
Total	4029.4	59			

The F-value of 34.2 is statistically significant with a $p < 0.001$. Here, the global index signifies the effect of the type of instruction on post-test scores when pretest scores have been accounted for. This result has supported that post-test scores of the experimental and control groups are statistically significantly different and as such, the intervention has influenced the scores and not the initial differences.

Table 9. Multiple Regression Analysis Results

Predictor	Coefficient	Standard Error	t-Value	p-Value
Game-Based Learning (Experimental)	15.3	2.3	6.65	<0.001
Pretest Score	0.75	0.12	6.25	<0.001
Constant	10.5	3.8	2.76	0.008

The coefficient for the game-based learning variable comes out to be 15.3, and the p-value that was tested was <0.001. It can therefore be concluded that, according to the post-test mean scores and pretest scores as covariate, students who received game-based learning post-test mean scores were significantly higher than student who received traditional instruction post-test mean scores. The coefficient with the pretest score is 0.75 having the p-value of <0.001. Therefore, it is possible to conclude, basing on the optimal value of criterion, that the idea, according to which higher pretest scores mean higher post-test scores, is accurate, so the initial level of knowledge affects the result of the post-test.

Table 10. Pearson Correlation Coefficient for Engagement and Post-test Scores

Variable	Mean Engagement Score	Mean Post-test Score	Correlation Coefficient	p-Value
Engagement and Post-test Scores	82.5	68.4	0.68	<0.001

The results indicated a moderate level of relationship between the variables through a Pearson correlation coefficient of 0.68 implies indication of positive relationship between the level of engagement and post-test scores among the students. This implies that the post-test results were also affected by the level of engagement with the game-based learning materials giving a nod to the use of game-based approach in increasing engagement and performance.

Table 11. One-Way ANOVA for Post-test Scores by Instruction Type

Source	Sum of Squares	df	Mean Square	F-Value	p-Value
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Between Groups	2453.6	1	2453.6	27.4	<0.001
Within Groups	5281.2	58	91.4		
Total	7734.8	59			

The F-value of 27.4 <0.001 in other words, the p-value for this z-score of 4 is less than 0.001. There is a significant difference between the post-test scores of the gamified learning group and that of the traditional instructional group in the study. Thus, the findings of this study imply that the type of instruction influenced the comprehension on health education among students with the group that undertook game-based learning outcompeting others.

Table 12. Two-Way ANOVA for Post-test Scores by Instruction Type and Engagement Level

Source	Sum of Squares	df	Mean Square	F-Value	p-Value
Instruction Type	1634.4	1	1634.4	18.2	<0.001
Engagement Level	1234.8	2	617.4	7.0	0.002
Interaction	342.7	2	171.4	1.9	0.156
Within Groups	4397.9	54	81.5		
Total	7609.8	59			

The F-value of 18.2, accompanied by a p-value of <0.001 proves that there was a noticeable difference in post-test scores depending by the method of instructional used, which is in agreement with the results of using one-way ANOVA; it states that game-based learning method was significantly more effective than the traditional training. The value of 7.0 by the game method confirmed the statically significant difference of the post-test scores based on the level of post-test scores and instruction type interact This implies that the effects of instruction type on post-test scores were not moderated by clients' level of engagement.

Table 13. One-Way ANOVA for Engagement Scores by Instruction Type

Source	Sum of Squares	df	Mean Square	F-Value	p-Value
Between Groups	1025.6	1	1025.6	24.0	<0.001
Within Groups	2424.4	58	41.8		
Total	3450.0	59			

The F-value of 24. [Read text] while there was no statistically significant difference ranging from 0 with a p-value of <0.001 means the inference about the average engagement scores of the game-based learning and traditional instruction groups is statistically significant, that is, the two groups differ significantly from each other. Thus, it may be inferred that the learners in the game-based learning condition were more interested in the learning activities than their counterparts in the traditional instruction condition.

Discussion

The two works' findings also corroborate the subject's general interaction between game-based learning and traditional teaching to support the educational research trend. Gaming as a form of learning has become a phenomenal in teaching and learning practices because of its potential to transform learners' behaviour, level of participation, and achievement. Video games have been described as a learning mode that cannot be experienced in the classroom by Fromm et al. (2021). Games enhance powerful learning spaces that immerse students in problem-solving and critical thinking hence transforming the way students learn. Such an approach is extremely effective in managing the students' focus and interest, which are essentials for enhanced learning.

Plass et al. (2020) also expand on this line of reasoning to emphasize that game-based learning also employs techniques, such as providing feedback immediately after an attempt, which must be repeated multiple

times in order to internalize what has been learned. These features assist in developing an environment that makes students happy in that they learn through play rather than having stern and dull classes. These findings are supported by the current study because the game-based learning group improved a lot regarding performance and comprehension in different content areas as noted in this research.

Worth to note is that students with ASD continue to face issues concerning learning disposition most especially to specific contents in their classes owing to their deficient understanding of techniques that are traditionally used in class. According to the research, such groups of students should be taught in special conditions to satisfy their needs (Juniarni et al., 2024). Game-based learning provides such a learning environment due to its context of structured, yet sufficiently free and self-arranged learning activities that can be tailored to individual requirements.

Dahl, Schroeder, and Skaarhaug (2021) note that game-based learning is more effective for students with ASD to because it involves both the visual and the auditory senses which will pique their interest. The element of play that is inherent in games calls for a continuous practice and hence can be very essential for students with AS because most of them require frequent reinforcement to be able to understand new concepts. This corresponds with the literature review of this study, that demonstrated that students with autism benefited in health education following the implementation of the game-based approach.

This was supported by Rezayi et al. (2023) who implemented game-based interventions and had a massive impact on correcting cognitive and social skills of learners with autism. Their study also revealed that due to the feature of games that involve interactivity, they assist in enhancing various key learning skills including the aspects of problem solving as well as social interaction a area that most student with autism face challenges. Likewise, in their study of the effectiveness of the digital games as learning interventions for students with autism, Gillespie-Lynch et al. (2023) claimed that digital games can define learning environments that are most appropriate to students with autism. Their study emphasized on the fact that these kinds of games are useful due to their structured environment which offers objectives and feedback which are easily understood as are useful in the improvement of students' learning characteristics and performances.

Supporting Structured and Engaging Learning Environments

These aspects relate well with students with autism because they include well-structured learning developed through game forms that are more structured, presented in a way that children with autism can easily understand and are readily motivated to engage in. Schnitzler et al. (2021) have explained that these students' needs can often remain unmet with conventional approaches and this triggers disengagement and poor academic performance. Introducing elements of gaming, corporation could facilitate a learning process more effectively as it addresses better to students with different rates of studying.

Similar to Wang & Xing's (2022) study, the learning utilization that is supported by this research show that children with ASD can be engaged by digital games in a way that provides a forum for learning. According to their study, they have found that game-based learning can be adapted to have picture prompt, schedule, and repetition that is needed for students with autism. With the ability to adapt to the needs of learners, game-based learning also makes it easy to capture students' attention and at the same time assist in revision of some concepts that would otherwise be quite hard to address using conventional methods.

General Benefits of Game-Based Learning and Focus on Health Education

As prior studies have provided basic evidence of the advantages of using games in learning, which includes increasing the interest in students, as well as benefits in the cognitive and social areas, few research focused about the application of using game-based learning in health education for students with autism such as the present study. Overall learners' performance in content area suffers in numerous ways as per evidence by research works that advocate for the use of game-based learning, learning through games and other related processes (Shi et al., 2022; Pellas & Mystakidis, 2020). Yet, the prospective research on the effects of the game-based learning in health education for students with autism is scarce.

o a certain extent, this research fills this gap by presenting the fact that engaging students diagnosed with autism in game-based content can enhance the efficacy of health education. Health education must be a central focus of students with autism because they are exposed to big problems concerning the understanding of health and personal hygiene (Simonyan & Harutyunyan, 2022). According to the outcomes of this study, the scholarly work proves the benefits game-based strategies could have in this special educational context. This contribution is important as the use of game-based learning has previously been explored for more common academic subjects and even fundamental cognitive ability training and this is a fundamental area that impacts the students' lives.

Previous Research Focus and Study's Contribution

Prior research has mainly focused on the positive outcomes of game-based learning in any form in general education or learning and effects on cognitive and social aspects. For example, evidence from studies has shown that, game-based learning improves on aspects such as problem solving and memory as well as other social skills including teamwork and communication as revealed by Chou et al. in 2023. Through these studies, the general framework on how this approach to learning can enhance different domains of learners' development has been described.

However, more specific focus is paid to understanding the impact of game-based learning for health education of students with the autism spectrum. Zhang et al. (2024) also indicated that there is an urgent need for studies in this area suggesting that with generally finding game-based learning as effective in general education positive impact on health-related education outcomes has not been discovered. This study fills this gap by confirming the proposition that the use of computer games improves the understanding of health curriculum concepts and students' concentration among learners with autism. Through giving an emphasis to the health education lesson, the study demonstrates that game-based learning can target concrete areas of the educational curricula dealing with the practical aspects of individual's life and bodily functions.

Health literacy is even more crucial in students with AS they can face with multiple difficulties having to do with communication and interaction, and sensory issues affecting their ability to understand and manage their health (Strömberg et al., 2022). Hence, health education has a critical role of assisting these students in addressing their own health issues and institutionalise health enhancing habits. An approach with extensive potential is game-based learning for providing this education in a more accessible from and attractive for students with autism spectrum disorder.

Due to its emphasis on continence and healthy living, the study shows that Game based learning might be applied to redress individual difficulties of learners with autism. According to Tsikinas & Xinogalos (2020), it is revealed that game-based learning leads to the formation of well-organized learning environment which meet the requirements of learners with autism. Therefore, the present study further builds upon these outcomes by showing that game-based learning also has positive effects on enhancing students' understanding of health education, arguably a particularly important domain in the lives of these children.

Recommendations

From the results of this study, it is clear that the method of learning through the use of games enhances the learning of health among the Saudi students with autism. Analysing the results of the games' application, the improvement in the students' knowledge of the health-related concepts and their interest were identified to be greater compared to more conventional forms of instructions. The findings are consistent with research findings relating to game-based learning proposing applicability of game-based learning in deep learning and motivation to solve the problems.

First, the study fulfils a significant research absence in the current educational scholarship, as it targets the education in health, as seen from the perspective of students with autism, an unfortunately under investigated aspect in prior research. In this way, the research proves that the approach based on the principles of gamification is appropriate and facilitate the enhancement of overall understanding of the health education among students with ASD, and thus back up the proposition for the necessity of a focused

and individualized education support for the students with autism. This is especially noble because there are always times that these students struggle in comprehending traditional lessons being taught in classrooms. Moreover, the findings also lay emphasis on implication for educational practice and policy. Incorporation of game-based learning into curricula of health education is a possible way of enhancing educational performance as well as students with autism. The paper is useful for educators and curriculum developers to demonstrate the positive effect of providing interactive teaching aids to solve some problems in education.

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