

ORIGINAL ARTICLE

DIABESCAPE: An innovative educational project on diabetes[☆]

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KEYWORDS

Diabetes mellitus;
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Abstract

Introduction: The aim of this study was to assess the effectiveness of a gamification-based educational intervention to improve knowledge about diabetes, targeting GCSE-level vocational training students who will work in the field of social/health care.

Materials and methods: This was a quasi-experimental study aimed at further education students in Auxiliary Nursing Care and Care of People in a Situation of Dependency at the educational centres in the Autonomous Region of Navarra. After assessing the students' prior knowledge, a random draw was carried out to determine which classes would form part of the control group and which the intervention group. In the traditional programme, a one-and-a-half-hour session was held and in the innovation programme, they had an Escape Room with a brief explanation lasting a total of two hours. In both educational programmes, they completed a pre-test and then a post-test one week after the interventions to assess the degree of knowledge acquisition, in addition to a satisfaction questionnaire. The project ran from October 2019 to February 2020.

Results: 302 students took part (162 from the intervention group and 140 from the control group) with a mean age of 18.4 years; 87.4% were female; and 52.7% were studying in vocational training in Care for People in a Situation of Dependency. The post-test knowledge score was 32.70 (SD 10.637) in the control group and 38.07 (SD 11.421) in the intervention group ($p=0.000$). Meanwhile the level of satisfaction was 8.19 (SD 1.594) in the control group and 8.60 (SD 1.163) in the intervention group ($p=0.020$).

Conclusions: Gamified education enhances knowledge acquisition with respect to the traditional methodology and improves student satisfaction. Further studies are needed to verify the effectiveness of these innovative educational methods in the medium and long term.

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PALABRAS CLAVEDiabetes mellitus;
Educación;
Innovación**DIABESCAPE: un proyecto educativo innovador sobre diabetes****Resumen**

Introducción: El objetivo de este estudio es evaluar la efectividad de una intervención educativa basada en gamificación para mejorar los conocimientos sobre diabetes, dirigida a estudiantes de ciclos de grado medio que trabajarán en el ámbito socio-sanitario.

Materiales y métodos: Se trata de un estudio cuasi experimental dirigido a estudiantes de grado medio en Cuidados Auxiliares de Enfermería y Atención a Personas en Situación de Dependencia de los centros educativos de la Comunidad Foral de Navarra. Tras evaluar los conocimientos previos del alumnado, se realizó un sorteo aleatorio para determinar qué aulas formarían parte del grupo control y cuáles del grupo intervención. En el programa tradicional se realizó una sesión de 1 hora y media de duración y en el programa de innovación se llevó a cabo un Escape-Room y una breve explicación de 2 horas de duración total. En ambos programas educativos cumplimentaron un pretest y un postest una semana después de las intervenciones para valorar el grado de adquisición de conocimientos, al mismo tiempo que el cuestionario de satisfacción. El proyecto se desarrolló de octubre de 2019 a febrero de 2020.

Resultados: Participaron 302 estudiantes (162 del grupo de intervención y 140 del grupo control) con una edad media de 18,4 años. El 87,4% eran mujeres y el 52,7% estudiaba el grado medio de Atención a Personas en Situación de Dependencia. La puntuación en el postest de conocimientos fue de 32,70 (DS 10,637) en el grupo control y de 38,07 (DS 11,421) en el grupo intervención ($p = 0,000$). Mientras que la satisfacción fue de 8,19 (DS 1,594) en el grupo control y de 8,60 (DS 1,163) en el grupo intervención ($p = 0,020$).

Conclusiones: La educación gamificada favorece una mayor adquisición de conocimientos respecto a la metodología tradicional y mejora la satisfacción del alumnado. Se deben realizar más estudios para comprobar la eficacia de estas metodologías educativas innovadoras a medio y largo plazo.

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Introduction**Epidemiology**

According to data from the World Health Organization, in 2014, 8.5% of adults had diabetes.¹

The 2017 Encuesta Nacional de Salud [Spanish National Health Survey] determined that 7.8% of Spanish people had diabetes mellitus,² while the Di@betes study found that the prevalence of people with type 2 diabetes mellitus in Spain was 13.8% (6% undiagnosed).³

Diabetes is one of the most prevalent chronic diseases around the world, and its prevalence is gradually increasing. This is very concerning, as the disease has a major impact on patient quality of life. It is also associated with significant expenses, including hospital care, outpatient care and medication costs.¹

Options for professional training intervention

The goal of professional training is to increase professional knowledge and skills to introduce students to the world of work.

Both auxiliary nursing care technician (técnico en cuidados auxiliares de enfermería, TCAE) vocational programmes and vocational programmes in care for dependent persons (atención a personas en situación de dependencia, APSD)

teach students to take a holistic approach to people while caring for whatever health conditions they may have. They also teach students to promote humanisation of healthcare in patients using health education techniques and achieve effective communication with the people for whom they care.

In addition, they should encourage patients to adopt self-care attitudes and habits and participate in associations and support groups. They are responsible for being involved, to the extent they are able, in forming and promoting healthy eating habits.⁴

Given their roles and the large number of people who suffer from diabetes, TCAE and APSD graduates are thought to have many opportunities to intervene in this population.

Educational innovation

There is mounting interest in changing traditional educational methods in the interest of acquiring knowledge, skills and attitudes with greater efficiency. Gamification represents a notable concept in the field of educational innovation.^{5–7}

Gamification is defined as a way of using the principles of gaming — i.e., challenges, feedback and interactivity — in uncommon contexts.⁸

Various studies have confirmed that, after 15–20 min, students' attention wanes if they do not interact or actively

take part in classes. Similarly, educational neuroscience studies have found that students need motivation and rewards to optimise their attention.⁹ This means that this type of methodology has proven more appealing for students, since it allows them to interact and experience classes while reaping continuous rewards.

They may also acquire more knowledge, develop more skills and improve their teamwork abilities.¹⁰⁻¹³ The use of gaming in an educational context is highly motivating for students: at its core, it is fun. Students learn by gaming.

Notable among the advantages of using gaming in educational contexts is that students are leaders of their own learning; mistakes are allowed (without judgement); feedback is provided in real time; it promotes the development of teamwork abilities; it enhances students' imagination and creativity; and, most importantly, it is enjoyable, motivating and stimulating.

The escape room as an educational tool

Among the new gamification-based methodologies, the escape room is one of the tools that has been gaining the most popularity in recent years.

An escape room is a live-action game in which a team of players (two to six participants) must find clues, solve puzzles and perform tasks in one or more rooms.

This involves multidisciplinary collaboration with team members with the goal of escaping the room before time is up (normally, in 50–60 min). The content of the game encourages players to think creatively and critically about the topic in question.^{14,15}

This activity comprises the natural drivers of learning: gaming, exploration of the environment and interactions among peers.¹⁶ It also boasts every advantage in promoting knowledge and skills acquisition, since it consists of experiential learning in a highly motivating context.

This educational proposal has many benefits for students in terms of motivation to learn, social skills (communication, active listening and empathy) and improvement of teamwork (cooperation, problem-solving, time management, perseverance, creativity, etc.), which are key skills for future vocational nurses.

As these are novel methodologies applied in an educational setting, their efficacy must be confirmed with scientific studies.

Objective

To assess the effectiveness of a gamification-based educational intervention to improve knowledge on diabetes, targeting students in vocational training programmes who will work in health and social care.

Methods

This was a quasi-experimental study aimed at students in professional training in TCAE and APSD vocational programmes in the Autonomous Region of Navarra.

The project was conducted in the classrooms of the corresponding educational centres between October 2019 and February 2020.

The classrooms that would form part of the intervention group, in which the gamification-based educational intervention was carried out, and the classrooms that would serve as a control group, in which a traditional educational offering in the form of a lecture was held, were determined randomly.

Participant recruitment

All educational centres with TCAE and APSD programmes were sent a leaflet describing the study to be conducted, inviting them to take part and explaining the objective of the project and the importance of their participation.

Once the centres had signed up, they were contacted by telephone to schedule a date and time to carry out the education programme.

Inclusion criteria

The sole inclusion criterion was the desire of the centres to voluntarily participate in the educational programme, for which they signed up by filling in a participation form created with Google® Forms.

Exclusion criteria

Classrooms with more than 25 students were excluded from the intervention group as it was not possible to carry out the innovative programme with that many students.

Description of the intervention

Assessment of baseline knowledge

A diabetes knowledge questionnaire was prepared and distributed among students in TCAE and APSD vocational programmes. The purpose of this questionnaire was to assess their baseline knowledge in order to determine their training needs at the start of the project. It was prepared and administered through Google® Forms.

Responses were collected from 66.6% of the centres that provide such training in Navarra; this enabled us to adjust the design of the educational intervention to their training needs.

Educational programmes

The content covered in both groups consisted of: definition, classification and diagnosis of diabetes; normal blood glucose values, hyperglycaemia and hypoglycaemia; treatment (diet, exercise and medication), techniques for administering insulin and measuring blood glucose; and the role of social healthcare/healthcare professionals in the care of people with diabetes.

Traditional diabetes educational programme (control group): nature of the session

The educational programme for the control group consisted of a one-and-a-half-hour session. The first half was essentially theoretical; the second half consisted of a workshop in which students learned to perform capillary blood glucose measurements and inject insulin and glucagon.

Educational innovation programme (intervention group): nature of the session

With the intervention group, a two-hour session was held consisting of a gamification-based educational intervention. An escape room was used that included all the content covered in the traditional programme, but in a more fun, experiential way.

After the students were informed of what an escape room is and the rules to be followed, they were introduced into the game narrative. The session concluded with a short presentation covering the lessons learned, suitable clarifications and the evaluation.

With the help of a narrative based on the death of Dr Z, the participants solved eight riddles requiring them to perform tasks ranging from solving puzzles to measuring capillary blood glucose to determine the doctor's cause of death.

Evaluation

In the absence of up-to-date validated questionnaires to measure diabetes knowledge, the Escala de Conocimientos sobre la Diabetes [Diabetes Knowledge Scale] (ECODI) was adapted¹⁷ by selecting 15 questions on an *ad hoc* basis in relation to the knowledge requirements of the study population. Information was gathered through quantitative methods using the following instruments:

- Questionnaire to determine the baseline knowledge of students of auxiliary nursing care and care for dependent persons.
- Questionnaire on the diabetes knowledge of participating students following the intervention.
- Participant satisfaction questionnaire.

After the educational interventions, the participants completed a questionnaire on their overall satisfaction with the intervention in which they were given an opportunity to assess the knowledge acquired, the content covered, the methodology, the duration and their overall satisfaction on a scale of 0–10.

In addition, the questionnaires were repeated in order to assess the knowledge acquired on a scale of 0–40 points. The nurse who taught the subject oversaw their completion the week after the intervention by means of a Google[®] form.

The differences found compared to baseline were calculated, and the changes detected following participation in the innovative intervention compared to the control group were evaluated.

Statistical analysis

The data were analysed with the statistical software programme Statistical Package for the Social Sciences (SPSS[®]), ver. 25.

In the descriptive statistics, means and standard deviation were calculated for quantitative variables, while frequencies were calculated for qualitative variables. A bivariate analysis was performed with independent data taking into account the control group and intervention group, as well as the study's two time points, pre-test and post-test. The chi-squared test was used to compare qualitative variables, while Student's *t*-test was used to compare quantitative variables. The differences between the two groups, as well as at the study's two time points, were evaluated using Student's *t*-test for independent samples (for quantitative variables) and the chi-squared test (for categorical variables). Statistical significance was considered to be $p < 0.05$.

Results

The final sample consisted of 302 students belonging to nine of the 11 existing centres distributed throughout the Autonomous Region of Navarra (162 in the intervention group and 140 in the control group). In this autonomous region, there are 396 students in the TCAE and APSD vocational programmes altogether. A total of six sessions using traditional methodology and eight innovative sessions were conducted. One session with a control group was scheduled but ultimately could not be held as it was not possible to set a date with the corresponding educational centre.

Women comprised 87.4% of the study population. TCAE students accounted for 47.3%. Most participants (81.8%) were first-year TCAE or APSD students (Table 1).

In the sociodemographic variables analysed, significant differences were found between the control group and the intervention group in terms of training programme and programme year (Table 1).

At the start of the study, a knowledge questionnaire (pre-test) was administered. Its analysis indicated that the group was homogeneous in terms of knowledge, as we only found statistically significant differences between groups in answers to question no. 3 and question no. 7. The intervention group included more people who knew the puncture sites for measuring blood glucose than the control group (51.9% versus 35.7%). However, the control group was more knowledgeable about age of onset in type 1 diabetes (50% versus 35.8%) (Table 2).

The total scores on the questionnaire were 22.58 (SD: 8.663) for the control group (traditional lecture) and 23.33 (SD: 9.336) for the intervention group (DIABESCAPE). The differences in scores between the two groups were not statistically significant.

Following participation in the educational programme, knowledge improved in both groups (Tables 3 and 4). The intervention group showed statistically significant improvements on 11 of the 15 questionnaire items, while the control group showed such improvements on six of them.

In addition, the mean overall score on the questionnaire increased by more than 15 points in the intervention group

Table 1 Sociodemographic characteristics of participants.

	Control group No. (%)	Intervention group No. (%)	p value
<i>Gender</i>			0.239
Male	21 (15)	17 (10.5)	
Female	119 (85)	145 (89.5)	
<i>Training programme</i>			0.000
TCAE	91 (65)	52 (32.1)	
APSD	49 (35)	110 (67.9)	
<i>Year</i>			0.011
First	106 (75.7)	141 (87.0)	
Second	34 (24.3)	21 (13.00)	
<i>Age (mean and standard deviation)</i>	18.32 (SD: 4.987)	18.48 (SD: 5.594)	0.307

APSD: vocational programmes in care for dependent persons; SD: standard deviation; TCAE: auxiliary nursing care technician [técnico en cuidados auxiliares de enfermería].

Table 2 Knowledge before the educational intervention.

	Intervention group (DIABESCAPE) Baseline n = 162	Control group Baseline n = 140	p value
	No. (%)	No. (%)	
1. What is diabetes?	97 (59.5)	81 (57.5)	0.722
2. What is insulin?	109 (67.3)	96 (68.6)	0.811
3. Puncture sites for blood glucose measurements	84 (51.9)	50 (35.7)	0.005
4. Insulin injection sites	105 (64.8)	87 (62.1)	0.630
5. Symptoms for the diagnosis of diabetes	47 (29)	53 (37.9)	0.103
6. Types of diabetes	42 (25.9)	38 (27.1)	0.811
7. Age of onset in type 1 diabetes	58 (35.8)	70 (50)	0.013
8. Normal blood glucose levels	69 (42.5)	56 (40)	0.648
9. Type 2 diabetes treatment	27 (8.9)	13 (9.3)	0.059
10. Food group to manage in people with diabetes	44 (27.2)	42 (30)	0.586
11. Insulin injection technique	53 (32.7)	51 (36.4)	0.573
12. Causes of hyperglycaemia and hypoglycaemia			
12.1. Insulin	53 (32.7)	33 (23.6)	0.079
12.2. Physical exercise	106 (65.4)	76 (54.3)	0.059
12.3. Food	111 (68.5)	97 (69.3)	0.886
12.4. Disease or infection	35 (21.6)	22 (15.3)	0.192
13. Carbohydrate-rich foods			
13.1. Milk	73 (45.1)	62 (42.3)	0.892
13.2. Mandarin oranges	30 (18.5)	21 (15)	0.416
13.3. Pasta	89 (54.9)	69 (49.3)	0.327
13.4. Grains	92 (56.8)	73 (52.1)	0.419
14. Definition of hypoglycaemia	60 (37)	45 (32.1)	0.373
15. What to do if a diabetic loses consciousness	28 (17.3)	14 (10)	0.068

and by more than 10 points in the control group; to 38.07 points (SD: 11.421) in the intervention group and 32.70 points (SD: 10.337) in the control group.

At the end of the intervention, a post-test was conducted, revealing statistically significant differences on six questionnaire items. This was because there was a larger percentage of people in the intervention group (compared to the control group) who were familiar with types of diabetes, normal blood glucose levels, food groups that should be managed in diabetics, the insulin injection technique,

what hypoglycaemia is and what to do if a diabetic loses consciousness.

The overall score on the diabetes knowledge questionnaire in the intervention group was significantly higher than in the control group: 38.07 (SD: 11.421) versus 32.70 (SD: 10.637) ($p=0.000$) (Table 5).

Finally, the degree of satisfaction of the participants in the educational innovation programme was greater than the degree of satisfaction of the participants in the control group in terms of methodology ($p=0.002$), overall eval-

Table 3 Intervention group pre/post knowledge.

	Intervention group Pre-test Baseline n = 1624 No. (%)	Intervention group Post-test Baseline n = 152 No. (%)	p value
1. What is diabetes?	97 (59.5)	96 (63.2)	0.550
2. What is insulin?	109 (67.3)	117 (77)	0.056
3. Puncture sites for blood glucose measurements	84 (51.9)	68 (44.7)	0.207
4. Insulin injection sites	105 (64.8)	131 (86.2)	0.000
5. Symptoms for the diagnosis of diabetes	47 (29)	75 (49.3)	0.000
6. Types of diabetes	42 (25.9)	109 (71.7)	0.000
7. Age of onset in type 1 diabetes	58 (35.8)	83 (54.6)	0.001
8. Normal blood glucose levels	69 (42.5)	130 (85.5)	0.000
9. Type 2 diabetes treatment	27 (8.9)	46 (30.3)	0.004
10. Food group to manage in people with diabetes	44 (27.2)	116 (76.3)	0.000
11. Insulin injection technique	53 (32.7)	99 (65.1)	0.000
12. Causes of hyperglycaemia and hypoglycaemia			
12.1. Insulin	53 (32.7)	52 (34.2)	0.779
12.2. Physical exercise	106 (65.4)	117 (77)	0.024
12.3. Food	111 (68.5)	118 (77.6)	0.069
12.4. Disease or infection	35 (21.6)	51 (33.6)	0.018
13. Carbohydrate-rich foods			
13.1. Milk	73 (45.1)	93 (61.2)	0.004
13.2. Mandarin oranges	30 (18.5)	49 (32.2)	0.005
13.3. Pasta	89 (54.9)	100 (65.8)	0.051
13.4. Grains	92 (56.8)	85 (55.9)	0.877
14. Definition of hypoglycaemia	60 (37)	112 (73.7)	0.000
15. What to do if a diabetic loses consciousness	28 (17.3)	98 (64.5)	0.000
Score	23.33 (SD: 9.336)	38.07 (SD: 11.421)	0.002

SD: standard deviation.

uation ($p=0.002$) and general satisfaction ($p=0.020$). All aspects were rated very highly, since all means exceeded 7.80; the assessment of the methodology used in the intervention group, the escape room, was outstanding, with a mean of 8.95 out of 10 points.

When the results after the lecture and the escape room were compared, the following could be seen (Table 6).

Discussion

A gamified educational intervention achieved a significant improvement in diabetes knowledge among the students in TCAE and APSD programmes. Furthermore, it must be stressed that the degree of satisfaction with the escape room was very high.

It is no coincidence that degree of motivation was correlated with improvement in knowledge acquired, since students need intrinsic motivation to learn. When students want to learn new things for the sake of learning, they pay attention; this is a necessary factor in knowledge creation. Learners cannot be instructed if they are not motivated.⁹

An escape room requires instructors to spend a great deal of time planning and designing the intervention compared to a lecture. It also requires around 15 min of prior preparation directly beforehand. On top of that, several sets of games should be created, since it is done with groups of three to five students, and classrooms usually have 20–28

students. Given the normal dimensions of classrooms, an escape room with more than five groups — i.e., in classes of more than 25 students — is complicated. However, it is an investment; once created, it can be used in subsequent years and improved over time.

Educational experiences with escape rooms at other centres aimed at students from different years and subjects have corroborated the effectiveness of this methodology in terms of knowledge and motivation.^{11,18–20}

It should be borne in mind that, in an intervention such as the one implemented in this study, participants are also working on other very important skills for their training, such as collaboration, hard work, perseverance, dealing with challenges, teamwork and communication skills.²⁰

Ultimately, the gamified educational intervention carried out with students in professional training achieved improvements in their diabetes knowledge that will have repercussions for the people with whom they work in future.

Nevertheless, the study has several limitations. First, its main limitation was its small sample size. We were unable to enrol a higher number of participants as the study was based in the Autonomous Region of Navarra and participation was offered to all professional training centres in the region.

Moreover, the post-test was conducted online, one week after the end of the intervention. To ensure that the improvements achieved with the programme are enduring, participant knowledge would have to be re-evaluated after a longer period of time.

Table 4 Control group pre/post knowledge.

	Control group PRE Baseline n = 140 No. (%)	Control group POST Baseline n = 105 No. (%)	p value
1. What is diabetes?	81 (57.5)	64 (61)	0.626
2. What is insulin?	96 (68.6)	76 (72.45)	0.519
3. Puncture sites for blood glucose measurements	50 (35.7)	34 (32.4)	0.586
4. Insulin injection sites	87 (62.1)	90 (85.7)	0.000
5. Symptoms for the diagnosis of diabetes	53 (37.9)	59 (56.2)	0.040
6. Types of diabetes	38 (27.1)	54 (51.4)	0.000
7. Age of onset in type 1 diabetes	70 (50)	56 (53.3)	0.605
8. Normal blood glucose levels	56 (40)	78 (74.3)	0.000
9. Type 2 diabetes treatment	13 (9.3)	24 (22.9)	0.030
10. Food group to manage in people with diabetes	42 (30)	56 (53.3)	0.000
11. Insulin injection technique	51 (36.4)	50 (47.6)	0.078
12. Causes of hyperglycaemia and hypoglycaemia			
12.1. Insulin	33 (23.6)	29 (27.6)	0.471
12.2. Physical exercise	76 (54.3)	75 (71.4)	0.006
12.3. Food	97 (69.3)	76 (72.4)	0.599
12.4. Disease or infection	22 (15.3)	29 (27.6)	0.023
13. Carbohydrate-rich foods			
13.1. Milk	62 (42.3)	63 (60)	0.015
13.2. Mandarin oranges	21 (15)	30 (28.6)	0.010
13.3. Pasta	69 (49.3)	68 (64.8)	0.016
13.4. Grains	73 (52.1)	52 (49.5)	0.685
14. Definition of hypoglycaemia	45 (32.1)	62 (59)	0.000
15. What to do if a diabetic loses consciousness	14 (10)	49 (46.7)	0.000
Total score	22.58 (SD: 8.663)	32.70 (SD: 10.337)	0.028

SD: standard deviation.

Table 5 Knowledge after the educational intervention.

	Intervention group (DIABESCAPE) Baseline n = 152 No. (%)	Control group Baseline n = 105 No. (%)	p value
1. What is diabetes?	96 (63.2)	64 (61)	0.720
2. What is insulin?	117 (77)	76 (72.45)	0.403
3. Puncture sites for blood glucose measurements	68 (44.7)	34 (32.4)	0.052
4. Insulin injection sites	131 (86.2)	90 (85.7)	0.915
5. Symptoms for the diagnosis of diabetes	75 (49.3)	59 (56.2)	0.280
6. Types of diabetes	109 (71.7)	54 (51.4)	0.010
7. Age of onset in type 1 diabetes	83 (54.6)	56 (53.3)	0.841
8. Normal blood glucose levels	130 (85.5)	78 (74.3)	0.024
9. Type 2 diabetes treatment	46 (30.3)	24 (22.9)	0.190
10. Food group to manage in people with diabetes	116 (76.3)	56 (53.3)	0.000
11. Insulin injection technique	99 (65.1)	50 (47.6)	0.005
12. Causes of hyperglycaemia and hypoglycaemia			
12.1. Insulin	52 (34.2)	29 (27.6)	0.264
12.2. Physical exercise	117 (77)	75 (71.4)	0.315
12.3. Food	118 (77.6)	76 (72.4)	0.336
12.4. Disease or infection	51 (33.6)	29 (27.6)	0.313
13. Carbohydrate-rich foods			
13.1. Milk	93 (61.2)	63 (60)	0.848
13.2. Mandarin oranges	49 (32.2)	30 (28.6)	0.531
13.3. Pasta	100 (65.8)	68 (64.8)	0.865
13.4. Grains	85 (55.9)	52 (49.5)	0.312
14. Definition of hypoglycaemia	112 (73.7)	62 (59)	0.014
15. What to do if a diabetic loses consciousness	98 (64.5)	49 (46.7)	0.005

Table 6 Comparison of satisfaction and knowledge between the traditional intervention and the innovative educational intervention.

	Control group	Intervention group	p value
<i>Test score</i>	32.70 (SD: 10.637)	38.07 (SD: 11.421)	0.000
<i>Satisfaction</i>			
Duration	8.04 (SD: 1.921)	8.80 (SD: 1.480)	0.000
Knowledge acquired	8.17 (SD: 1.649)	7.86 (SD: 1.527)	0.123
Content covered	8.39 (SD: 1.644)	8.62 (SD: 1.342)	0.224
Methodology used	8.24 (SD: 1.924)	8.95 (SD: 1.495)	0.002
Overall evaluation	8.11 (SD: 1.799)	8.72 (SD: 1.289)	0.002
<i>Total</i>	8.19 (SD: 1.594)	8.60 (SD: 1.163)	0.020

SD: standard deviation.

In addition, the duration of the programme was different in the two groups. The innovative educational programme was two hours long, whereas the traditional educational programme was an hour and a half.

Another limitation was that the samples were not homogeneous. Students were randomly assigned; their programmes and years were not taken into account. Also, as groups with more than 25 students per class were excluded from the intervention group only, the groups were not strictly comparable.

Due to limitations on human resources and time, the tests could not be encoded; therefore, learning was measured on a general level.

On the other hand, the study had multiple strengths. First, it had a quasi-experimental design conducted by a single person, which rendered the groups more comparable. Second, the study was rooted in highly practical education for the students' future work, since they will meet many patients with diabetes, it being a highly prevalent disease. Finally, its gaming focus motivated students and improved their learning.

In summary, despite the study's limitations, it can be concluded that this intervention achieved improvements in diabetes knowledge among the participating students, was very highly rated and contributes another experience to support the use of innovative methodologies in the classroom.

Conclusions

- Students learned more with the innovative methodology compared to the traditional methodology, and they perceived their knowledge acquisition to be lower.
- Active methodologies promote knowledge acquisition in their learning process.
- The students were more satisfied after the innovative educational intervention than after the traditional educational intervention.
- Further studies must be conducted to confirm the efficacy of these innovative educational methods.
- Students' middle- and long-term knowledge must be evaluated to determine which of the two methods yields better consolidation of acquired knowledge.

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Conflicts of interest

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