Gastronot: a pilot project for promoting healthy eating habits using mixed-method study design [version 2; peer review: 1 approved with reservations, 1 not approved]

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Abstract

Background: Eating habits are formed from childhood and develop into adulthood. Unhealthy eating habits will persist into adulthood and can lead to various diseases. Healthy eating and behaviour should be taught using engaging tools. The study aims to pilot nutrition education using the game-based learning approach, implementing a specially designed learning board game entitled "Gastronot".

Methods: A mixed-method study was used in two stages. The first stage was an FGD with 14 informants and in-depth interviews with six informants to develop the game. The second stage was the game's development, and a pre and post-test were conducted on 88 children to evaluate the game—the study was conducted from August 2019 to July 2020.

Results: Results showed almost half the children (49%) never heard about Balanced Nutrition Diet Pyramid. There was a significant difference between respondents’ knowledge before and after playing the game with a p-value of 0.021. The game was able to engage participants in the active learning process.

Conclusions: We concluded that the game-based learning utilizing the Gastronot board game demonstrated good results as a method for teaching primary school students about food and healthy eating habits.

Keywords
Healthy eating habits, Children, Gamification, Game-Based Learning, Education.
Introduction

Malnutrition in children is a serious public health problem that can affect child growth and development, leading to a variety of disorders and even death. Malnutrition is common in developing countries, including Indonesia. Malnutrition is not only a deficiency, excess, or nutritional imbalance resulting from inadequate nutrient intake, it also arise from excessive intake. Indonesia is currently experiencing a double burden of malnutrition, that is, an increase in cases of overweight/obesity, and still having unresolved undernutrition problems. UNICEF stated that A fifth (20 percent) of primary school children are overweight and obesity doubled among adults. However, about one in three children under five years old experience stunting, and one in ten children experience wasting. Wasting defined as low weight-for-height which indicates recent and severe weight loss. Stunting defined as low height-for-age as a result of chronic or recurrent undernutrition. Micronutrient insufficiency is also on the rise in Indonesia. Malnutrition in children, especially throughout their growing stage, cannot be isolated from children's eating habits, according to empirical data collected in the field and in academia. Numerous studies have been carried out to establish why children are prone to developing bad eating habits. For instance, children who suffer from overnutrition risk noncommunicable diseases (NCD), including obesity, hypertension, type 2 diabetes, and cardiovascular diseases. Therefore, modifying a child's eating habits into healthier ones can lower the risk of developing a diet-related illness in the following years into adulthood.

In order to combat malnutrition, the Indonesian government has undertaken communication, information, and education programs centered balanced nutrition. It was visualised with Tumpeng Gizi Seimbang or Balanced Nutrition Diet Pyramid and Isi Piringku or My filled Plate. The method used is direct delivery, such as social marketing, competitions, and the appointment of ambassadors for a balanced nutrition diet. In addition, there was indirect delivery, such as training and teaching in various health institutions and schools, workshops, and role play. The media used are electronic, printed, online, and audio media. However, these efforts are still ineffective in increasing public knowledge about balanced nutrition. In Indonesia, the prevention of malnutrition problems has been centered on the policy, with adults or parents as the primary target. Since the messages are aimed at children, it is required to use a particular or distinct intervention method on children in order to encourage them to eat healthier. An approach engaged in delivering messages is using the gamification method or game-based learning approach.

Game-Based Learning is part of a serious game developed to bring participants engaging and immersive learning experiences to meet expected learning goals. Game-based Learning enhances participants' cognitive and affective aspects to achieve expected learning goals used in different areas. Game-Based Learning designs learning activities that gradually introduce learning concepts to increase participants' knowledge. A well-designed game can engage and motivate participants by satisfying the participants' basic psychological needs. Games also offer challenges that match the player's current abilities. For example, the independence of in-game decision-making reflects autonomy in real life so that the game creates a space that motivates participants to make behavioural changes.

A systematic review regarding game-based Learning and gamification to improve diet and nutritional habits concluded that gamification positively influenced dietary behaviour and nutritional knowledge. Some research conducted on elementary school students shows that the game-based learning approach in nutrition education increases nutrition knowledge, improves eating and drinking habits, and has a positive attitude towards gaming. As well, serious games can improve eating habits by enhancing nutrition knowledge and attitudes, according to other studies. Games can also increase children's courage to explore new healthy foods and reduce eating unhealthy snacks. Game-Based Learning is a new approach that can improve children's knowledge about nutrition and induce healthier eating habits.

To the best of our knowledge, there is a scarcity of game-based approaches for raising children's awareness of good eating habits in Indonesia. This paper will describe the program to deliver the campaign of balanced nutrition using a game-based learning approach. We proposed a pilot project to explore how an interactive (game-based) learning and gamification program can be designed, optimised, and implemented.
Methods
The study comprised of two parts using a mixed-method study design. The first step was a qualitative one based on individual interviews and a focus group discussion. The second part was the development of the board game based on the findings from the first part. The informants chosen for the in depth interviews were the one who involve and concern in providing good nutrition for children.

In the first part, in-depth interviews were conducted with six informants which were two health officers responsible for the nutrition programs to understand government targets and available programs, a nutritionist specialist, and a healthy food practitioners for information regarding ideal healthy food. We also interviewed two mothers to understand the nutrition knowledge and skills needed to make nutritious food. In-depth interviews were conducted in the informants’ workplaces or homes. Time used for interviews ranged from 30 minutes to 2.5 hours. The instruments used were an in-depth interview guide for the topics related with each informant as mentioned above. We use notes and a tape recorder to record data.

To develop the game, we conducted a Focus Group Discussion (FGD) attended by 14 people. They were involved in nutrition programs from the Health Office Bandung and the Office of Bandung City. Also attended a Public health expert, Health promotion expert, Family Health and Nutrition expert, two Game designer, a representative from Nutritionist Association and from Nutrition Specialist association, an organic farmer, organic farm community representatives, and two community representatives (housewives). The FGD lasted for three hours. All participants for the interview and FGD gave their written consent prior to the FGD.

The instruments used in the FGD and interviewed were unstructured interview guides developed in the discussion as needed. Unstructured interviews were chosen because they provide an opportunity to get the best in-depth data compared to other interviewing techniques. Informed consent was obtained from all individual participants included in the study. Data were recorded by notes and with a tape recorder. We tested the validity of the data and its analysis to establish its credibility. We used triangulation and assessing its transferability, dependability, and confirmability.

The focus group discussion and in-depth interview recording results were transcribed ad verbatim (precisely as spoken): the thematic analysis method used to identify and analyse’s themes. The study constructs the themes from the data collected. They were objectively and systematically computed to produce descriptive descriptions of the text content. Thematic analysis was chosen because the central theme was already known (nutrition campaign). This analysis is used to summarise many details into concepts, models, or a more general picture. The guideline in data management is inductive study served to search for themes, patterns, and categories for the source analysis in the data.

The second stage was developing the game using information from the analysis. Authors engaged professional game developers to assist with the development of the game. The process from the idea to the board game development took around three months. Finally, the board game was tested on 88 children aged 10-13 years old through gameplay sessions using a convenience sampling method through a voluntary approach. Before the activities, consent was given by parents verbally.

To evaluate the ability of the board game to deliver the messages, we conducted pre and post-test to the children. Knowledge of balanced nutrition was measured using a questionnaire of 10 questions. A questionnaire of 10 questions was used to assess attitude variables, while five questions were used to assess behavioural variables. With a cut point as follows, if the score is >80% means excellent; 60-80% is sufficient, and insufficient is less than 60%. Software STATA MP 16 from Stata Corp used for data analysis to determine differences in respondents’ knowledge, behaviour, and attitudes about balanced nutrition before and after gameplay sessions. Meanwhile, to find out the differences in knowledge, attitudes, and behaviour between the groups involved in gameplay, the Independent T-Test and Mann Whitney test was used as alternatives with an error rate of 5%. The study was conducted from August 2019 until June 2020.

This study has obtained ethical approval No. 389/Komite Etik FK/VIII/2019 from the Health Research Ethics Committee of Faculty of Medicine Universitas Islam Bandung.

Results
The findings are organized around the themes identified by the research focus group discussion, which are based on elements that have a significant impact on the nutrition campaign. Much of this is reported in the present tense, as that was the way it was articulated. In order of presentation, the themes were challenged to deliver the campaign, environment and provide fun and exciting messages. The themes are further described below.

Informants from the FGD are in the table below.
Emerging themes
We found three emerging themes that were Nutrition Campaign Challenges, Environment, and Campaign messages.

Nutrition Campaign Challenges
According to the data, the Indonesian government has already supported certain programmes aimed at improving children's nutritional status. For example, at the National level, the Nutrition Campaign of Piramida Gizi Seimbang or Balanced Nutrition Diet Pyramid and a guidance campaign of si Piringku or My Filled Plate have been implemented since 2014. Beas Bereum (Bekal Anak Sekolah Bergizi, Enak, dan Murah or Nutritious, Tasty, and Affordable School Lunch Box) was the regional campaign by the Health Office Bandung City. All programs are utilising Puskesmas (Health Centre) and schools. The primary objectives were to convey the campaign's content, focusing on the four pillars of the Balanced Diet Pyramid (food types and recommended portions, hygiene, and the advantages of regular exercise) and the food composition of My Filled Plate. Each school and the District Health Centers have already begun implementing the campaign through lectures and other activities. However, the program still struggles in delivering the content in the best way possible and requires continuous improvement in its method and delivery media.

Environment
We recognised that the biggest challenge lies in school-age children. They rarely eat breakfast. It could be since their family's lack of resources or time to feed them and skipping breakfast affected their school performance. The school environment also promotes unhealthy foods, such as selling ultra-processed foods and sugar-sweetened beverages in school cafeterias, convenience stores, and street stalls outside schools. It was found that controlling the external food environment was very difficult.

Campaign Messages
In these themes, some sub-themes emerge, such as the knowledge of nutrition that needs to be delivered. There was the concept of My Filled Plate, the proportion of food to fill each plate at every meal, the concept of eating various foods, and the idea of the recommended number of meals per day. It should also incorporate the concept of nutritional deficiencies and overload. It should include an understanding of the division of nutrients into carbohydrates, protein, fat, vitamins, and minerals. Also noteworthy was the concept of the number of calories needed by the body to meet the recommended calorie requirements (not far above or less than the required, ideal calorie).

The second stage was the development of Gastronot using the game-based approach. Gastronot, a board game created by the author, is based on the same concept. This game-based approach used Balanced Diet Journal, Balanced Nutrition Pyramid, and My Filled Plate as the main message and content. Players' main goal is to collect foods and arrange them to fulfill the nutritional needs based on the suggested composition and proportion in the above messages.

To accommodate the prioritised contents of knowledge, the two main messages of the program are translated into the game scoring mechanic. Using the Balanced Nutrition Journal as the primary reference, the game scoring mechanics will consist of several components: - Balanced Nutrition Pyramid presented as a part of the whole scoring system. In addition, each Food Ingredients Card will contain several Nutrition components (based on the data by Health Office), and players can gain scores by collecting these components within the appropriate suggested amount. Five types of nutrition to be collected during the game are Carbohydrates, Protein, Fat, vitamins & minerals, and Water. The actual values of nutrition on each food ingredient are scaled and modified accordingly for gameplay purposes but still represent the good and correct information.

Below is the tool used in the board game and the reward system (see Figures 1-3).

My Filled Plate is translated as the second part of the scoring system. Collected foods are to be arranged in 3 lines representing the three main meals during a day. Based on the My Filled Plate campaign information, players can get more scores by setting the cards in correct compositions. The game focused on ensuring that each meal consists of various types of food (Staple Food - Side - Vegetables - Fruits). The scoring system/mechanic will be presented on the player boards to remind the players of their main goals and objectives constantly.

We also want to make sure that the participants are aware of the many types of dietary ingredients. For that purpose, players can get additional scores at the end of the game by collecting as many unique food ingredients as possible (more variety of foods = more scores assets of the board game). In two elementary schools, 88 children participated in a gameplay trial.
For the analysis, two data sets were excluded since they were not complete. The children were accompanied by their teachers, who were also involved in the gameplay sessions. Informed consent was given by the parents or guardians of the children before the intervention. Table 1 lists the characteristics of the participants in the focus group discussion. Table 2 shows respondent’s characteristics and Table 3 shows the results of the pre- and post-test results.

The result from the pre and post-test can be seen in Table 3.
Table 3 above shows that the average score of respondents' knowledge about balanced nutrition before playing was 37.94, then increased to 41.13 after. Based on the Wilcoxon test, the z-value is \(-2.302\), and the p-value is 0.021. There is a significant difference between respondents' knowledge before and after playing the game.

On the attitude variable, the average score of respondents about balanced nutrition before the game session was 79.94, then decreased to 79.30 after playing the game. However, there is no significant difference between respondents' attitudes before and after the gameplay session.

In the behavioural variable, the average score of respondents before playing the games was 72.33. It decreases to 70.47 after the game. Based on the Wilcoxon test, the z-value is \(-0.825\), and the p-value is 0.410. There was no significant difference between the behaviour of respondents before and after the gameplay session.
Behaviours that can last for life are usually gained during the childhood period. Knowledge delivery was the first and foremost step in bringing the children toward a balanced diet and healthy eating habits. Therefore, education about nutrition is essential to improve the quality of life and health for the children to have better adulthood. Whenever nutritional education and information are given to children, they can build their awareness in choosing healthy food. This study engages game-based learning/gamification design to ensure that participants learn essential information with motivation and engagement. This factor is significant in Learning.

The main goal of our study was to develop the board game to deliver the contents of the campaign, mainly focusing on four pillars of a Balanced Nutrition Diet such as food types and suggested portions, hygiene, and the benefits of regular exercises. It also incorporated the food composition of My Filled Plate. The understanding needs to be appropriately delivered to children since children should consume the proper quantity and a variety of food for an adequate, healthy, and balanced diet. Based on the theme from the FGD, the game content focus aligned with an ongoing campaign that incorporated the national program Balanced Nutrition Diet Pyramid and a guidance campaign of My Filled Plate.

We chose Gastronot as the game’s name since we were inspired by the daring character of space exploration. It combined the word Astronaut (or Astronot in Bahasa Indonesia) with Gastronomy. The name is also served as a reminder.
for children to be more adventurous in choosing food ingredients. As in several studies, children tend to choose only one of two types of food. The board game Gastronot aims to show that food comes in wide varieties.

The findings revealed that there has been a significant rise in participants' awareness of information on the Balanced Nutrition Diet, particularly about a complete meal proportion (i.e., the Fill My Plate campaign). A statistically significant difference between respondents' knowledge before and after playing the game was found. The findings were similar to some studies that found that students tend to have better post-intervention scores after education about nutrition.\textsuperscript{14,18,32}

The game-based learning session was engaging for the participants. According to the data analysis of the post-questionnaire, it had a positive impact on the level of awareness regarding balanced nutrition knowledge. As per our observations, the majority of the children were engaged and participated in the game throughout the session. They could reiterate the information from the game during the debriefing session. The game-based learning approach in this study strengthened the findings from other studies that concluded that game-based Learning and gamification effectively improve nutrition knowledge.\textsuperscript{14,28,33}

Although not statistically significant, we observed a decline in attitude and practice score following the gameplay sessions. It could be because the children were still unfamiliar with the game-based approach. This finding contradicts the prior study on the nutrition game.\textsuperscript{33,34} In this study, some children were not acquainted with a quantitative measurement tool (using questionnaires) and were confused about filling it out. To them, it was more like an exam and they were striving to find the right answer rather than filling it out based on their knowledge.

The author saw that schools are vital to education about nutrition, which correlates with some studies.\textsuperscript{17,22} However, education methods through traditional ways that only provide information should be limited. Instead, active participation in nutrition education becomes very important to teach an exciting and effective method of knowledge transfer. Using game-based learning methods to deliver the information will help children acquire healthy eating habits and, ideally, improve their quality of life.

**Conclusions**

The game-based learning approach with the Gastronot board game showed promising results in promoting sustainable diet and healthy eating habits among elementary school children. Most children showed engagement and participated in the game for the whole session. They could reiterate the information from the game during the debriefing session, and results showed a significant increase in participants' awareness of the information about the Balanced Nutrition Diet. Our findings from implementing the game-based learning approach to promote a healthy diet shed some light on how we can incorporate games (and gamification) to motivate an effective learning process and public participation to overcome some public health issues.

**Data availability**

**Underlying data**


This project contains the following underlying data:

- Balanced Nutrition Diet Pyramid Raw Data.xlsx (This dataset contains the following: Characteristic of respondents, knowledge, attitude and behaviour)

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

**Acknowledgement**

The author acknowledged the support from Ms, Slivana Paath, Mr. M. Rianto Utama, Hivos South East Asia, Ludenara Foundation, House the House Studio and Bandung District Health Office.
References

Open Peer Review

Current Peer Review Status: ✗ ❓

Version 2

Reviewer Report 23 June 2023

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Tom Baranowski

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The comments raised in the peer review report for the Version 1 have not been addressed. In addition to this, the authors must severely temper their claims in regard to the outcome in the Abstract, Discussion and Conclusion. The game demonstrated changes in knowledge but not attitudes or behavior. Post-test differences, even in the desired directions, do not support a claim of change when insignificant. Not significant is not significant. The Discussion should address how the game might be modified to attain change in attitude or behavior. This is particularly important since the literature indicates that changes in knowledge are not related to changes in attitude or behavior.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Version 1

Reviewer Report 22 June 2022

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Introduction:

The definition of malnutrition as "Malnutrition is a deficiency, excess, or nutritional imbalance resulting from inadequate nutrient intake." should be revisited - malnutrition does not only result from inadequate nutrient intake, it also arises from excessive intake.

After the sentence "Indonesia is currently experiencing a double burden of malnutrition, that is, an increase in cases of overweight/obesity, and still having unresolved undernutrition problems.", the author did not provide any narrative on overnutrition after claiming an increase in the double burden of malnutrition.

Methods:

The age group of the participants in the FGD should be indicated.

In the paragraph, "To develop the game, we conducted a Focus Group Discussion (FGD) attended by 14 people. They were involved in nutrition programs from the Health Office Bandung and the Office of Bandung City. Also attended Public health expert, Health promotion expert, Family Health and Nutrition expert, Game designer, Nutritionist Association, Nutrition Specialist association, organic farmer, organic farm community representatives, and community representatives (housewives). The FGD lasted for three hours. All participants for the interview and FGD gave their written consent."

1. Who were the participants for the FGD?
2. What commonality do the participants have together?
3. Who were the participants for the interview?
4. Clearly indicate if the 10 different people listed were for FGD (but they ought not) or interview.
5. Why was the interview conducted?
6. The aim or the scope of the interview needs to be indicated.

Informed assent is given on behalf of children and not consent.

For the cut off point; the term good and sufficient denotes almost the same. Kindly consider >80% to be excellent; 60-89% good/sufficient and <60% insufficient.

In the sentence, "Meanwhile, to find out the differences in knowledge, attitudes, and behaviour between the groups involved in gameplay,":

1. Nothing until now indicated that you are assessing attitudes and behaviour.
2. What were the tools and how were they assessed?
Results:

With only a glimpse of the aims of the FGD, it may be difficult to appreciate the emerging themes.

Discussion:

The sentence, "In our study, the campaign to improve nutrition was implemented in various schools using lectures and other activities initiated by each school and District Health Centers." is confusing. Was there any form of lecture for the students? This was not indicated in the methodology.

Is the work clearly and accurately presented and does it cite the current literature? 
Yes

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
No

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Nutrition Education, Maternal and Child Nutrition

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 08 Feb 2023

Titik Respati

Dear Dr. Leshi,

Thank you so much for the valuable input, I will revise them accordingly.

Regards,
Author Response 06 Jun 2023

Titik Respati

Introduction:

The definition of malnutrition has already been revised
A narrative on overnutrition was added.

Methods:

The age group of the participants in the FGD is already stated in Table 1.

All explanations regarding informants for the interviews are in the method section, paragraph two

The cut-off point is revised to >80% to be excellent, 60-89% good/sufficient, and <60% insufficient.

The method for assessing knowledge, attitudes, and behavior is stated in paragraph 7 of this section.

Discussion:

The sentence, "In our study, the campaign to improve nutrition was implemented in various schools using lectures and other activities initiated by each school and District Health Center." is deleted.

Thank you for your valuable review.

Competing Interests: None
Tom Baranowski
Department of Pediatrics, USDA/ARS Children's Nutrition Research Center, Baylor College of Medicine, Houston, Texas, USA

This article is a report of the development and preliminary evaluation of a nutrition education board game to promote healthy eating among Indonesian children. Ordinarily, this would be two papers: 1) focus groups/interviews and 2) design and preliminary pilot testing/feasibility study of implementing the game. The manuscript lacks an enormous amount of detail as indicated by the questions I have raised for the authors. The measures appear to have been ad hoc, rather than standardized or validated.

The authors need to provide more detail on their methods of conducting the focus groups and interviews, and of analyzing this qualitative data. How were triangulation, transferability, dependability, and confirmability assessed?

Why did the authors elect to study 10-13 yo?

How were they recruited? Of whom/what are they representative?

What were the inclusionary/exclusionary criteria?

In the evaluation part of the study, what measures of knowledge, attitude and practice were used? Are there validity coefficients associated with each?

Why didn't the authors ever conduct focus groups and/or interviews with the targeted age group to find out their knowledge, attitudes and preferences, and how they might respond to different intervention elements? How were the cutpoints determined?

Why wasn't there a control group? Any pre-post differences could have been influenced by the other components of the national nutrition program?

It would help for the authors to add a table that lists in one column each of the specific concepts that were attempted to be communicated and in a second column list the methods/procedures in the game designed to achieve that communication. It would help if this table also clearly specified what each of the constructs for knowledge entailed.

It is not clear where students were supposed to obtain the information to answer the questions raised in the game?

A game usually has rules and a player can win or lose, usually with an opportunity to play the game to do better if s/he fails on early tries. In what way(s) is Gastronot a game?

How many sessions was the game played between pre and post over what time?

The Figures are not self-evident and should be explained.

This preliminary evaluation of the game should be a pilot/feasibility study, as indicated by the authors' use of the word "pilot" in the title. A pilot/feasibility study answers questions of Can
children be recruited? Will they play the game? Do they like it? What problems occurred that need correction?

What did the authors learn from the focus groups and early interviews?

The authors make an overly positive spin on what was learned/achieved in the study. There was a very small increase in knowledge, but that did not translate into a change in attitude or behavior. This is unfortunate but should be stated realistically. In contrast to the apparent positive findings cited by the authors in other nutrition education studies, at least one review found limited evidence of success from nutrition games, mostly just small knowledge increases, which usually did not convert to behavior change. See T Baranowski et al. Games for Health Journal. 2019;8(3):153-176.

If the intervention was conducted in schools, then this is a cluster analysis. The authors must account for school/cluster in their analysis of change from pre to post. A high intraclass correlation could vitiate the power assumed in the current analysis.

Did the authors conduct interviews with the children at post to assess their evaluation of the game? Why not?

References

Is the work clearly and accurately presented and does it cite the current literature?
No

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
No

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
No

Are the conclusions drawn adequately supported by the results?
No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: games for health in general and for diet change in particular
I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

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