ORIGINAL RESEARCH

Influence of an innovative game on nutrition education for nursing students

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ABSTRACT

Background and objective: The growing global burden of individuals with malnutrition shows no signs of decreasing. Schools are an important arena for health promotion. This study is to develop and to test the innovative game with Good Food cards designed to enable students to acquire knowledge in healthy eating and other influence on their eating behaviors as well as nursing role in dietary education.
Methods: *Design:* A mixed method design was used to evaluate the effectiveness of the game. We conducted pretest-posttest quasi-equivalent groups with cluster sampling design and recruited 109 students at two sites of health center. The game intervention was implemented in two to four 20- to 30-minute sessions for 55 junior nursing students. *Method:* Univariate analysis of covariance (ANCOVA) was performed to compare knowledge change between the two groups. Additionally, a focus group was performed to collect data from students. Audio-recorded, transcribed verbatim and thematically analyzed were conducted by researchers. Correlation analysis was used to was used to explore factors related to the concept and behavior intention.
Results: The knowledge on healthy diet was significantly higher in the experimental group compared to the control group. Effective learning experiences and intention to change eating behaviors were also perceived by participants.
Conclusions: The Good Food cards and game mechanism matched the learning objectives of the dietary education. Gaming is a valid learning strategy not just a fun activity. During nursing practicum period, students who are familiar with healthy diet concept perceived the help to facilitate therapeutic relationship building with clients and more willingness to change eating habits. More research is needed to test other children, students, or adult population with this card. Also, factors related to concept and behavior change from playing with this card can be investigated to strengthen students' competence and focusing more strongly on how best to influence students' healthy dietary behavior.

Key Words: Innovation, Game, Dietary education, Nursing students, Quasi-experimental study

1. INTRODUCTION

Dietary imbalance is common in many developed countries. Currently, nearly one in three (1.9 billion) adults worldwide are overweight or obese.[1] Poor eating is a leading cause of chronic illness. In 2018, the WHO passed a resolution to reduce salt intake by 30% and to halt the rise in diabetes and obesity in adults and children in the global population by 2025.[2] Poor health literacy can lead to unhealthy eating habits.[3] The Community Nursing Practicum at college or university is designed to equip nursing students with the knowledge needed to promote health in their clients or community. Therefore, one of the challenges for students enrolled in the practicum is to acquire knowledge needed to educate the public in the principles of a healthy diet and to

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motivate the public to adopt healthy eating behaviors.

Games have proven effective in using realistic simulations to achieve various learning goals in diverse populations, from community members to domain experts, and at all ages, from childhood to adulthood. A review of 43 studies found that gamification of health-related education through use of games can promote healthy eating in children, e.g., by reducing picky eating behavior and by improving nutritional knowledge and attitudes.[4] Integrating game attributes in a cognitive training task can also improve working memory and performance.[5] Therefore, the aims of this study were to design and evaluate the efficacy of a game for diet-related education and for encouraging healthy eating behavior in nursing students.

2. Background

2.1 Healthy diet concept

No single food item provides all nutrients. Although the quantity of food consumed varies widely among individuals, a balanced diet is characterized by consumption of a wide variety of foods that are nutrient-rich but relatively low in calories.[2] However, 88% of countries are burdened by high rates of malnutrition,[6] including undernutrition, micronutrient deficiency, obesity, and diet-related diseases (i.e., type II diabetes, cardiovascular diseases, and certain cancer types). Some countries have established recommendations for caloric intake to address issues of overweight and obesity. For example, the UK government recommends a cap of 2,500 kcal/day for males and 2,000 kcal/day for females and has recently recommended increased fiber intake for adults.[7]

Diet, which is the single most important contributor to malnutrition, depends on many factors, including personal preferences, culture, education, income, and national availability of foods. To improve nutrition and food consumption patterns and to decrease the incidence of diet-related diseases, more than 100 countries worldwide have developed dietary guidelines to foster healthy eating habits that prevent disease in the general population. In Taiwan, dietary guidelines implemented by the Health Promotion Administration call for increased consumption of items in six food groups: whole grains, beans/fish/eggs/meat, vegetables, fruit, oil/nuts, and dairy.[8]

2.2 Current status of healthy diet knowledge

The Taiwan Nutrition and Health Survey concluded that consumption of saturated fat, cholesterol, and calories in the general population of Taiwan was excessively high, but consumption of dairy products and vegetables was insufficient.[7] The survey also revealed that most people aged 13-44 years lacked knowledge in using the "traffic light" system of categorizing foods by nutritional profile for weight control. Younger people were most likely to be familiar with the traffic light system because it is currently taught in most of elementary schools. In contrast, only 1.7% of people older than 75 years were familiar with the system. Additionally, 80% of adults aged 19-64 years had an inadequate daily nutritional intake and did not consistently include the six food groups recommended in the Daily Diet Guide of Taiwan.[9]

Schools which provide an infrastructure for health promotion program delivery are an important arena for health promotion.[10] Health literacy can cause unhealthy eating habits.[3] A study in Norway found that food and health education have relevance to students' daily life, but have little to no effect on healthy food choices among 31 7th to 10th grade students.[11] This study claims to strengthen teachers' competence on food choices. Additionally, fully 100% of Taiwan nursing students study health education in Community Health Nursing course before taking national registered nurse examination. Thus, we hypothesized that innovates teaching material can promote students' competence on dietary education and eating behavior change.

2.3 Game-based learning

Educational use of games is an innovative teaching-learning strategy that is grounded on constructivism and is mainly driven by educational goals. In a game, learning occurs simultaneously with self-evaluation of behaviors or decisions based on the feedback provided by the game environment.[12] Gamification of a learning objective increases learning efficiency by making the learning process both entertaining and challenging. Game elements that contribute to the effectiveness of a game include competition, interaction, and feedback.

In Lu et al.,[13] for example, nursing students experienced a learning loop that enabled them to develop superior skills in empathy and develop insight into the learning content. In the past decade, educational use of games in various formats (board game, computer game, training simulation) has rapidly increased in diverse domains, including education/training and health promotion/ healthcare.[14]

In the education/training domain, for example, researchers have demonstrated the effectiveness of games in motivating learners and in reinforcing learning through increased engagement with the learning content,[15] both of which contribute to improved learning outcomes (i.e., increased empathy; improved skills in communicating, problem-solving, critical thinking, and collaborating; improved ability to apply these skills in novel situations; deeper and longer lasting understanding of content; behavioral changes to prevent illness

or injury)[13, 16–18] That is, games are gaining acceptance as an alternative strategy for student-centered teaching and learning. Cognitive outcomes observed in experiments in games indicate that the joy of successfully completing a series of tasks in a game contributes to memory encoding, which is consistent with the Gagne cognitive learning theory.[19]

In the health promotion/healthcare domain, a systematic meta-analysis of 34 clinical experimental randomized studies supported the use of games for promoting health behavioral change in children younger than 18 years.[20] Effect size was large in studies in which the age of the participants was low, the number of games played was fewer, the duration of the games playing was short, but the quality of the study was low.

In another study, an intervention performed in hemodialysis patients combined education via a game and education via a standard paper-based nutrition manual. The authors reported that, compared to the nutrition manual, the game obtained superior outcomes in terms of prevalence rate of hyperphosphatemia and ability to recognize phosphorous-rich foods.[9] In Mitchell et al.,[21] a game improved awareness and knowledge of influenza in nursing students and increased their intention to receive an influenza vaccination.

When applying the gamification concept in learning, the task of educators is to integrate game mechanics or elements in a series of learning processes to engage students and to motivate them to apply the increasing knowledge they acquire as they play the game. Game mechanics is a vital component of gamification, not only because it can make a non-game context pleasurable, but also because it can be designed according to the interests of the players, which increases engagement. Examples of gamification in learning include awarding points or badges for achieving a learning objective, using leaderboards to encourage competition or cooperation, and integrating a narrative or a journey experience to maintain motivation.[22]

For an effective learning environment, a game requires well-designed game mechanics, i.e., goals, rules, procedures, scaffolding, paths to goals, and feedback.[23] Scaffolding is support given to students according to their needs, which can help students meet and/or achieve learning goals. Other elements of an effective game include clear criteria for success or failure, freedom of choice, a sense of challenge and achievement, and the potential to induce a flow state or immersive state in the player.[24]

Studies also indicate the critical role of the educator in the practical application of a game. In a study of Dimitriadou et al, for example, a survey of 41 educators in postsecondary institutions across the United States revealed that the main challenges of using games were designing and administering games and changing negative or dismissive attitudes about games.[25] The authors suggested strategies that educators should apply when implementing games, including developing trust among users, establishing a technology team, ensuring academic objectivity, devising clear directives for usability and effective attitudinal strategies, and incorporating diverse ideas in the curricula.

However, research in the effectiveness of games for educating students in dietary health and balance is limited. Additionally, to the best of our knowledge, no games have been designed specifically for increasing knowledge of dietary health in practicing healthcare professionals. Finally, few studies have discussed the perceived value of games for preparing nursing students for clinical practice.

Therefore, this study addressed this gap by designing a game that matched game objectives with learning objectives and engaged students in knowledge construction. We hypothesis the game designed in this study would not only improve the health literacy of the students enrolled in the community practicum, but also motivate them to improve their eating habits. Additionally, acquiring knowledge of healthy dietary practices would enable the participants to provide public education in healthy diet concepts and healthy food choices.

3. METHODS

3.1 Design and participants

A mixed method design was used to evaluate the effectiveness of the game in achieving the learning objectives in the students. To facilitate engagement and to control for outcome differences, students who randomly arranged to nearby health centers to complete nursing practicum were recruited and these centers have similarity characteristic for comparing the intervention effect. These health centers provide the same health services for citizens in Tainan city. There is no any significant way in terms of settings and students other than the game intervention between two groups.

The knowledge survey was voluntarily completed by 109 participants (55 in the experimental group and 54 in the control group). Eighty eight percentage of participants were female with mean aged of 18.15 and 18.93. Qualitative data were collected in a group interview of seven students in the experimental group. Potential participants were recruited from fourth- and fifth-year students enrolled in a single nursing school in Southern Taiwan.

3.2 The board cards

This study designed a table board game for the purposes of increasing knowledge of healthy foods and encouraging adoption of a healthy diet. The first author developed a "Good Food Cards" system that included three categories of cards: food cards, dinner plate cards, and function cards. Each card was printed on both sides. On the front of each card was a photograph of a food item, and its name and a suggested serving size (by weight) appeared underneath the photograph. The upper right corner of the card showed the calories for the suggested serving size. The upper left corner showed a substitute food item and the number of servings that yielded the same number of calories. The back of the card showed the category of the food groups and the color of light in the food traffic light system.

The Good Food cards could be used in three different games: a sorting game, a matching game, and a combination game. Although the three games had different objectives, they all required ability to classify a food item into one of the six food groups and into one of the three traffic light categories. For example, the matching game, which was like the card game "Slapjack", required the players to match a food card with a traffic light category.

3.3 Intervention protocol

The first session of the intervention performed in the experimental group comprised a 1-hour lecture on the six food groups and the dietary traffic light system followed by explanation/demonstration of the three card games. The objective of one card game, for example, was to be the first player to "plan" a 650-kcal meal by selecting food cards from each of the six food groups. This card game included a scoreboard that depicted the food choices of each player and the contribution of the food choices to a healthy diet.

For the following 3 weeks, groups of 4-6 students in the experimental group played the card games for two to four sessions and 20 minutes per session. During the same period, the control group completed the standard community health practicum without the Good Food board game.

During the card games, the researcher played the role of leader and judge, e.g., the researcher determined the winner by calculating the number of calories and confirming that all six food groups were represented. The researcher also prompted students to interact with each other during the game based on the gamification concept and experiential learning theory. Such as having player to select favor foods as one's breakfast. After the game, the researcher prompted students to discuss their food choices in the game and to reflect on their eating habits. Later on can have players to arrange lunch box and so on.

3.4 Ethical considerations

The study was approved by the Institutional Review Board. Before enrollment, all participants received a leaflet explaining the details of the study. Additionally, all participants gave informed consent to participate in the study before completing the survey or engaging in activities related to the game.

3.5 Instruments

After a comprehensive literature review, the authors developed a questionnaire for assessing the effects of the intervention in the four dimensions: healthy diet knowledge, benefit of the game, attributes of the board cards and game, elements of the game, and flow experience. An open-ended question on the questionnaire was also added to collect their thought about the game intervention.

Healthy diet knowledge: The 12-item self-administrate questionnaire involve knowledge about six food groups and traffic light diet. The KR-20 alpha was 0.473 in 147 participants. The top 27% of the highest score is the high group, and the bottom 27% is the low group. The independent t test shows the top 27% of the highest score group and the low score group have significant differences (p = .01 .0000), showing the items' discrimination.

The 3-item attributes of the game consist declaration of gameplay, readable content of card, and card interface design in terms of color, size and texture.

The 3-item benefits of the game involve 'helping to build nursing relationship through game play', 'knowing a balanced diet through game play', 'trying to change the diet habit through game play'. The Cronbach's alpha is .81 with 50 college students.

Elements of game: A modification of the 10-item instrument developed in Hou was used to survey the experiences and views of the participants regarding cognitive elements of the game (instant feedback, contextualization, cooperation, full immersion, scaffold clue) and game elements (freedom to choose, unpredictability, scarcity, ownership, accomplishment).[13] Cronbach's alpha is .87 and .85 respectively and the total Cronbach's alpha is .91 in this study with 55 junior college students.

Flow experience: Flow experience was assessed using the 12-item instrument developed by Kiili[26] and translated into Chinese by Hou and Li.[27] The Cronbach alpha was 0.90 in this study of 55 junior college nursing students.

3.6 Data collection and analysis

Data for all variables were collected via a self-administered questionnaire between August, 2020, and April 2021. The Statistical Package for Social Sciences for Windows 20.0 was used to analyze data. The paired t-test statistical method was used to check the flow related experience and elements of games during the community practicum (duration, 3 weeks). Univariate analysis of covariance (ANCOVA) was performed to compare knowledge change between the two groups. Correlation analysis was used to identify related variables for concept and intention change on healthy diet among experimental group.

Additionally, seven students in one of the experimental groups were recruited by their willingness to solicit their learning experiences and suggestions for future improvements with open-ended questions in a focus group interview. Transcripts of the interviews were analyzed by qualitative content analysis.[28]

4. Results

4.1 Demographic characteristics

The mean age of the 109 participants was 18.93 years (SD, .539; range, 18-21 years). Table 1 indicates that more than half (n = 57, 52.3%) of the students had experience in conducting dietary education for clients. Most (n = 37, 67.2%) of students had dietary education specifically related to diabetes. However, less than half of the students (n = 20, 35%) had teaching experience specifically related to food substitutes for the same food group. The experimental group and the control group did not significantly differ in age (t = 0.367, p = .714), dietary education (t = 0.671, p = .504), healthy diet knowledge (t = 0.28, p = .78).

Table 1. Characteristics of participants (n = 109)

Variables	C (n = 54) (Mean, SD), n (%)	E (n = 55) (Mean, SD), n (%)	t or χ^2	p value
Age	18.93 ± 0.53	18.15 ± 0.36	0.36	.714
Gender				
Male	6 (11.11)	4 (7.27)	.482	.488
Female	48 (88.88)	51 (92.73)		
Dietary education				
Yes	24	28	.67	.504
No	30	27		

4.2 Effect of intervention on healthy diet knowledge of students and other effects

Healthy diet knowledge and perception of game elements such as experiencing sense of control, unpredictability, ownership, and accomplishment during playing the game, increased significantly (t = 3.43; t = 2.7, p < .01) in the experimental group (n = 55). The control group showed no significant (t = 0.32, p > .05) change in healthy diet knowledge.

Healthy diet knowledge was compared between the experimental group and the control group before and after the intervention (see Table 2). Before performing ANCOVA, the interactive effects of covariates and groups on the predictions of healthy diet knowledge were evaluated. The analysis revealed significant interacting effects among group (F = .22, p = .638), which was consistent with the assumption of homogenous regression coefficients. Compared to the control group, the experimental group had a significantly higher adjusted mean post-test score for healthy diet knowledge. That is, the "Good Food" activities increased healthy diet knowledge in the experimental group.

Table 2. Post-test comparison of the two groups by ANCOVA

Variables	C (n = 54) (Mean ± SD)	E (n = 55) (Mean ± SD)	F	p value	Eta^2	power
HDK	9.58 ± 0.197	10.33 ± 0.195	7.2	.008	.064	.758

Notes. HDK: healthy diet knowledge; C: control group; E: experimental group.

On posttest, scores for the 12-item survey of 'Flow Experience' remained above mean score of 47. After playing the game on first time and third time, the score in flow experience remains higher and did not significantly differ between the first and last times the participants played the game (see Table 3). However, three of them kept the highest score, such as item16 'it was no effort to keep my mind on game events' (4.09 ± 0.8); #14 'I was not worried about my performance during playing' (4.09 ± 0.69); #5 'My attention was focused entirely on playing the game.' (4.07 ± .071).

Table 3. Other benefits or effects (n = 55)

Variables	Last time Score Range	First time (Mean ± SD)	Last time (Mean ± SD)	*T*	*p* value
Flow	33-59 (12 item)	47.02 ± 6.78	47.04 ± 7.24	0.018	.98
Flow antecedent	29-50 (10 item)	40.20 ± 4.83	39.89 ± 5.52	-0.627	.534
Game element (Fun)	20-50 (5-item)	37.73 ± 5.77	39.52 ± 6.85	2.705	.009
Cognition element	26-50 (5-item)	39.07 ± 4.81	38.91 ± 6.04	-0.276	.78
Relationship	2-5		3.81 ± 0.91		
Food Awareness	3-5		4.17 ± 0.72		
Willing to change	1-5		3.77 ± 1.06		

Flow antecedent tended to decrease after the participants played the game several times. Especially in #2 'Spontaneous use of game operations', #11 'The description of the game is clear and easy to obtain', and #1 'I was challenged, but I believed my skills would allow me to meet the challenge.' have lower mean scores 3.73 ± .917, 3.88 ± .789, and 3.9 ± .881 respectively.

Game-related elements of the game were investigated through paired t test. Participants perceived significantly increase in game element between the first time and the last time. Especially two items 'Free to choose answer' and 'Sense of accomplishment' have above 8 points out of 10.

Benefit of the board game in terms of three aspects includes 95.8% participants who perceived moderate level of help (3 points or more in Likert scale) to establish relationship with client through the board game, 100% increase healthy food awareness, 87.5% were willing to change diet habit into healthy style. Moreover, 81.2% participants rated with 4 points or more in knowing healthy eat, 64.6% rated the willingness to change eating behavior in the future with 4 points or more. Nine students (16.4%) plan to change diet habit in half year and 31 (56.4%) plan to change in one month,10 (18.2%) already had habit and 5 (9.1%) want to keep in the future.

From qualitative data, thirty-three students with responses of cognitive gain, such as interesting to know, expanding diet or food knowledge, inspiring thinking, and discussion for correct answer.

4.3 Factors related to Healthy Diet concept and intention development

Since there is no factor significantly correlated with scale of Healthy Diet Knowledge (r = .037 .132, p = .163 .947), we used one item of 'knowing how to eat healthy through the gameplay' to explore the correlation with characters of game designs and perception of gameplay. We found there was a positive correlation between knowing healthy eat and willingness to change eating (r = .61, p < .001), building relationship with client (r = .696, p < .001), perceived game element (r = .322, p = .026), perceived cognition element (r = .49, p < .001), having flow experience (r = .453, p = .001), perceived flow antecedence (r = .462, p = .001), gameplay explanation (r = .579, p < .001), card interface (r = .345, p = .015), card readability (r = .538, p < .001), but not the times of playing (r = .169, p = .126).

4.4 Reflections of participants

Some participants proposed that the game would be more realistic if it included options for consumption of unhealthy foods and more challenging tasks. Most participants reported that they found the game enjoyable and that it increased their healthy diet knowledge and their awareness of their eating habits. Additionally, most participants agreed that the game increased their confidence in making dietary recommendations to clients. The reflections of the participants could be divided four main themes: Exciting, Deep learning, Food awareness in terms of calories and balance, and Teaching confidence.

Exciting: 'There are plenty ways to play. It's exciting and improve concentration. Since I look forward to winning, it's necessary to be more mindful. You will have a sense of accomplishment when you win.'

Deep learning: 'The cognitive load is not high. I get automatically to remember the content of healthy diet through matching food group.'

Food Awareness in terms of calories and balance: 'Find out that I only eat yellow and red foods which arouse me to understand that I like to eat foods with higher calories.' 'It has driven students to eat healthy and motivate students to change their diets.'

Teaching confidence: 'Willingly and confidently teach people about balanced diet.' 'I can better apply a balanced diet and traffic light diet to tell people the variety and portion of each meal. Also, I speak more eloquently while I facing client.' 'I can analyze people's diet and offer individualized instruction for them. I can also judge my own diet healthy or unhealthy and point out whether the boxed meal is healthy.'

5. Discussion

5.1 Nursing practicum development and refinement

In the practicum setting, students were encouraged to provide not just physical assessments for patients, but also dietary assessments and recommendations for patients. Practicum setting was a critical factor in the design of the curriculum and the game, including the overall duration and opportunity to have practice for new concept acquired. The design of the curriculum differed from that in Wu et al.,[18] in which the 14 participants played a web-based game before playing a 2-hour board game with food cards. Our findings indicated the health service center practicum setting provide chances for students transfer knowledge of healthy diet and deeper learning effect. Contrary with the finding in a meta-analysis on effective of games for promoting health among child and adolescent, that the health behavior change was negatively associated with the duration of each session of the game.[20] Probably, participants in our study play the game as their free time during practicum, totally three to fourth times. Instructor provides consults or mentoring function for students.

As advised by Mayer and Johnson, the game designed in our study included components essential for an effective game, including goals, rules, procedures, and path leading to goals.[23] By playing the game, the participants learned new skills, reflected on their eating habits, and experienced cognitive conflict that motivated them acquire new healthy diet knowledge and to make positive changes in their dietary habits. The focus group interview results also substantiated the report by Volejnikova-Wenger et al. that the engagement of a player and knowledge transfer in a game are important components inherent in a game.[15] The flow experience or engagement of a player in game is essential factor in the efficiency of knowledge transfer.

This finding concurs with the theoretical underpinnings of the experimental learning theory proposed by, which learners play and reflect on the card play, then form new knowledge. Finally, apply the new knowledge to examine their diet or eating behaviors.[29] Similar to the findings of Lu et al.,[13] the continuous double-loop learning happens among participants via the game elements of competition, interaction, and answer checking.[30] Participants who play cards have chance to reflect on their assumption or knowledge and correct their choices in each play, which further facilitates motivation and develops confidence to conduct health education for clients. Thereby, the goal of the healthy diet education lesson is achievable within a creative game-based learning environment.

5.2 Factors related to healthy diet knowledge

There is positive correlation among knowledge gain and game design elements and flow experience. Based on the references of Ferro, this game designed has considered the elements and mechanics of game and experienced flow as well as learning by students.[31] We have connected with players' need and created meaningful experiences for them. Thus, the Good Food game has met the aim of this study in terms of knowledge acquirement. Other effectiveness also indicates in confidence building and intention to change.

Individual's perceptions of the task as challenge, achievement and interest were most important for flow experience. Participants' flow antecedent tends to decrease and have indicated to add more challenge task on the game. To sustain intrinsic and extrinsic motivations for game play is relevant for the effective gamification.[32] Amabile even claimed that a considerable degree of intrinsic motivation such as interesting, enjoyable, and challenging have firstly met and satisfy participants' psychological needs for autonomy, curiosity, competence, and relatedness, then extrinsic motivation can further promote intrinsic motivation.[33] Adding more intrinsic motivation which comprises of game mechanics such as trade, reveal, celebrate, and ensure rules that are relevant to the intrinsic motivation elements so that the user's aspirations to continue playing the game are recommended for optimizing players motivation for gaming in further study.

6. Conclusion and limitations

The objectives of the game with Good Food board cards developed in this study matched the learning objectives of the dietary education for nursing students. While playing the game, participants reported healthy food knowledge acquisition and experienced intention to change dietary habits. Additionally, some students perceive the help to facilitate therapeutic relationship building with clients while in nursing practicum period. These findings were correlated with the game designs, including the food card interface and gameplay.

Despite their many advantages, however, a game should be applied as a teaching/learning aid rather than as a standalone tool or replacement for standard teaching materials and methods. For the public health, we recommend that nursing instructors address healthy diet concept using game and offer students chances to reflect on the dietary habits.

Further research is needed to test other children, students, or adult population with this card. The 12-item Healthy Diet Knowledge is needed further test with large sample. Also, attributors related to concept and behavior change from playing with this card can be investigated to strengthen students' competence and focusing more strongly on how best to influence students' healthy dietary behavior.

Conflicts of Interest Disclosure

The authors declare that there is no conflict of interest.

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