

Evaluation of the impact of an online secondary school educational game *Asthma: 1, 2, 3...Breath!*

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Abstract : This full paper comprises five parts: (1) the problems associated with asthma in the province of Quebec and Canada; (2) the theoretical framework for the knowledge acquisition and attitude change enhanced by our online educational game, created by starting from the popular board game *Parchesi*, and intended for students in a senior secondary school health education program (15 and 17 years old); (3) the methodological approach, including the quasi-experimental research protocol, the target population, the variables being studied, the measurement instruments, the data analysis, and a description of the educational game; (4) the results of the pilot testing with regard to the game's design, user-friendliness, and pedagogical readability, and (5) the results of the pilot test of the measurement instruments (i.e., questionnaires) that assess the structuring of knowledge and attitude change.

Introduction

As part of a larger project financed by the Social Sciences and Humanities Research Council (SSHRC) from 2008-11, this study examined the impact of an online educational game on cognitive and affective learning. Starting from the popular board game *Parchesi*, an online game was created for a senior secondary school health education program for students between the ages of 15 and 17.

This full paper comprises five parts: (1) the problems associated with asthma in Quebec and Canada; (2) the theoretical framework for the knowledge acquisition and attitude change that the educational game can support; (3) the methodological framework including the quasi-experimental research protocol, the target population, the variables being studied, the measurement instruments, the data analysis, as well as a description of the educational game; (4) the pilot test of the game *Asthma: 1, 2, 3... Breath!* With the target population and the validation of the questionnaires regarding the structuring of knowledge and attitude change.

Health Education: The Problem of Asthma

Asthma is one of the more prevalent chronic diseases in Canada, affecting more than 10% of the population. The consequences of this disease are numerous and the human and socio-economic costs that result from this are enormous. Despite numerous efforts to develop practical guides based on available evidence, gaps still remain in our understanding of the evaluation and treatment of asthma.

Two pan-Canadian studies (Blais et al, 2001; Conseil du Médicament du Québec, 2003) involving

thousands of asthmatic people have shown that less than 50% achieve an adequate control of asthma, contrary to their own belief and that of health professionals that treat them, that their asthma is under control. The insufficient management of asthma is responsible for a high rate of emergency room visits or doctor appointments, hospitalizations and specialist consultations. These data show the importance of intervening with the Canadian population by proposing health education programs adapted to the needs of the population, and focussed as much on prevention as on therapy.

Some studies (Boulet et al., 2004; Lemièrè et al., 2004) have shown that with a better understanding of asthma and its optimal treatment, those suffering from this disease as well as their significant others can greatly improve their mastery and control over asthma. Improving the treatment of asthma is among the priorities of organizations such as Health Canada and the Quebec Medication Council. It is in this context that we conducted a study to assess the impact of an online game, *Asthma: 123...Breath!* on the knowledge acquisition and change in attitudes and behavior of senior secondary school students.

Impact of Digital Games as Tools for Health Education

Acquisition and integration of knowledge

Most studies examining these areas show that games have a positive impact on the way learners build mental schemas. Games can help the learner with cognitive skills such as problem solving, visualizing concepts, and establishing links (Aspinwall & Shaw, 2000; Gee, 2003; Kafai, 2001; Koirala & Goodwin, 2000; Meel, 2000; Steinman & Blastos, 2002). Therefore, games allow the learner to integrate new materials and new concepts in a more intuitive manner and also help the learner organize previously acquired information in a more comprehensive manner. These studies also provide evidence in support of variables such as integrating knowledge, developing skills such as accessing prior knowledge, facilitating the identification of key points in the content, helping the player understand differences and similarities in key points, and allowing the player to find conceptual links and analogies. These skills assist the learner in mentally structuring the knowledge they acquire.

However, no studies have addressed all of these variables as a set in an online educational game in health education. Therefore, our study examined all these variables and addressed the research objective of this study which was to measure the acquisition and integration of learning enhanced by an online educational game

Change in attitudes and behaviour

Numerous studies have shown that digital games can have a positive impact on changing attitudes and behaviours of players. Garris, Ahlers and Driskell (2002, p. 457) have described the affective learning developed through games: confidence, self-efficacy, attitudes, preferences and dispositions. Therefore, integrating of learning material within a game can also have an impact on changing attitudes or behaviours. According to Bijker, Van Buuren and Wynants (2006), attitudes reflect the influences of the social milieu on the individual and translate into automatic evaluations of situations. Bottino, et al. (2007) reported a change in behaviours and attitudes in players who participated in the games PappaLOTTO, Hexip, Studio 5, and Magic Bass compared to a control group; participation in the games resulted in a change in global attitudes towards various health-related themes.

Amaro and Viggiano (2006) examined some educational games on the topic of healthy nutrition. They found an increase in the weekly consumption of vegetables by students playing the game about a diet called Kalèdo, thereby demonstrating a behaviour change in young students. Brown et al. (1997) determined that a game to manage diabetes in young people aged 8-16 years showed a positive effect on their feeling of control in their ability to manage their diabetes, an increase in dialog with their parents, daily monitoring of their blood samples, and an improvement in their consumption of healthy foods.

Lennon and Combs (2007) noted that game players increased their confidence levels by playing a game dealing with dengue fever. Lieberman (2001), as well as Hostetter & Madison (2002) discussed the capacity of game players to become more open to their colleagues, or close personal friends and family members, regarding particular

health issues. Barab et al. (2005) assert that digital games help young people to become more autonomous and better understand relationships of cause and effect, particularly in areas that affect the decisions they must make.

Rassin, Gutman and Silner (2004), in an experiment with digital games for helping children prepare for a medical operation, demonstrated certain negative aspects of the game, including the violence that certain games develop in children or the physical inactivity of certain players. Baldaro et al. (2004) are cautious about the impacts of games on learning and attitude change. Others who have developed software (Kelly, 2005; Shreve, 2005; Virvou, Katsionis & Manos, 2005) concluded in their analysis of digital games that they are not particularly ludic (fun) nor educational.

Based on the above results, it is important to conduct research that assesses the impacts of games on the attitudes and behaviour of players. Therefore, the present study attempts also to respond to a second research objective: to measure the degree of attitude and behaviour change that occurs through playing an educational game about asthma.

Methodology

The methodological approach used in the research is based on a single group, pretest-posttest design, that allows us to measure if the game *Asthma : 1, 2, 3...Breath!* enhances learning by comparing prior knowledge and attitudes before the game with knowledge developed and attitudes modified after playing the game.

Research Questions and Hypotheses

The first question addressed in this study is : Does the game *Asthma: 1,2,3...Breath!* enhance the acquisition and integration of knowledge about asthma of senior secondary school students. We hypothesized that the more the educational game *Asthma : 1, 2, 3... Breath!* uses activities which require players to call upon prior knowledge, facilitate the identification of key points in the subject matter, support the understanding of differences and similarities in key points of the subject matter, and allow them to find conceptual links and analogies, the more players will be able to structure the information.

The second question addressed is: Does the game *Asthma: 1,2,3...Breath!* improve students' attitudes toward asthma and behaviour toward asthmatic persons? We hypothesized that the more the educational game *Asthma: 1, 2, 3...Breath!* provides activities involving role play and modelling, the more learners will demonstrate positive changes in attitudes toward asthma and positive preventive behaviours to support asthmatic persons.

The Target Population

In order to measure and analyze the numerous variables in this study, we selected a large sample of 160 students, but limited to several classes at the grade 10 and 11 levels because of how difficult it is to experiment in schools. The study is now underway, and the subjects are being informed that they are involved in this research study and are signing a consent form to confirm that they agree to participate in the experiment.

Concepts and Research Variables

In order to attain the research objectives, the main concepts were defined and operationalised with specific indicators that allowed us to devise research instruments in the form of statements.

To respond to the first objective of the study, "evaluating the type of learning enhanced by online educational games in terms of structured knowledge," five indicators were used: (1) the capacity to call upon prior knowledge, or establishing a link (sequential or chronological) between prior knowledge and information acquired during the learning process; (2) the capacity to locate key elements of the subject under study, as in identifying theoretical or declaratory knowledge of a given subject and to put it in logical order. This link corresponds to a

hypothetical relationship between several elements of the same contents; (3) an increased awareness of the differences and similarities between the various elements of the subject being studied, establishing a link based on the principle of contradiction. This link comes into play in the operations of distinction, selection, sorting and classification; (4) the capacity to establish links across concepts, as in developing a cause-and-effect link between two or more ideas or concepts. This can also work in the other direction, starting with the result and discovering and establishing the cause and (5) the capacity to establish an analogy or comparison between two additional pieces of information, either contradictory or complementary, in order to gain understanding. To verify whether these indicators had an impact on learning, 24 statements relating to the subject were defined. To respond to the second objective of the study, i.e., to measure the degree of change in attitudes and behaviour enhanced by an online educational game on asthma, we developed 24 statements about attitude change linked to three major categories of behaviour: (1) their predisposition to act based on their general perception of asthma as a chronic inflammatory bronchial disease, their own health, their vulnerability and that of their close friends and family, the gravity and danger if asthma is poorly controlled, controlling asthma by reducing the risk factors and eliminating the triggering factors in the environment; (2) the personal habits regarding health and the prevention of asthma, and (3) the perception of accessible and practical solutions in terms of personal benefits and obstacles to action.

Measurement Instruments and their Administration

Two measurement instruments were used at different points in this experiment. *Prior to the experiment*, a questionnaire asking about knowledge and attitudes regarding asthma was administered one week before playing the game. This was done to establish a baseline. *During the experiment* while students played the game, certain player actions were recorded in real time by the tracking system integrated into the game, namely, the duration of the game, the number of questions answered correctly, the number of questions answered incorrectly, the number of games completed in the class, and other variables. *After the experiment*, the pre-test questionnaire was re-administered during the week after the experiment in order to determine changes in knowledge, attitudes and behaviour as a result of playing the game. The order of the questions in the questionnaire was modified so that students could not rely on remembering their pre-test responses.

The quantitative data was organized using different descriptive analysis techniques (e.g., frequency, average, percentage). The results have been interpreted in order to draw conclusions about the impact of the *Asthma : 1, 2, 3... Breath!* game on the acquisition and integration of knowledge and changes in attitudes and behaviour

The Game – Asthma: 1,2,3...Breath!

As mentioned earlier, the online game (Figure 1) was created based on the generic Parcheesi board game. Designed by medical and asthma experts as well as specialists in online game design, *Asthma:1,2,3...Breath!* has the following cognitive objectives : (1) describe asthma and its symptoms; (2) differentiate among the various treatments for asthma and describe their effects; (3) identify the factors that trigger asthma in order to prevent it, and (4) identify the allergies that affect young people with asthma and describe ways to reduce their effects. In the affective domain, the objective is to sensitize young people to the problems caused by asthma and to make them more prevention-oriented towards persons with asthma in their environments.

To operationalize these objectives, 90 questions were inserted into the game, grouped into the following four content categories: (1) Prevention: predisposition, knowledge of the disease and its symptoms; (2) Control: absence or minimum symptoms during the day, no symptoms at night and in the morning, using the emergency pump less than four times per week, ability to perform normal activities and sports, test for normal pulmonary function, etc.; (3) Triggering factors: cold air, tobacco smoke, strong odors, air pollution, emotions and stress, etc.; and (4) Allergies : domestic animals, mites, pollen, dust, etc. Each category contains questions that measure indicators of knowledge as well as attitudes and behaviours. Two game modes are possible: single computer or network. By definition, the single computer game mode requires only one computer. This mode however, allows multiple people to play together, taking turns using the same keyboard. The network game mode is used when players are in different locations. They each use their own computer.



Figure 1. Game board for Asthma: 1,2,3... Breath!

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The game integrates feedback mechanisms by providing the following elements:

- for every learning activity, there is a feedback mechanism according to whether the question was answered correctly or incorrectly;
- for every player's move, the computer displays instructions or game rules;
- for every navigational error, the computer displays a message to correct or reorient the user.

Pilot Test with the Target Population

In order to ensure that the online educational game developed for the final experimental study is appropriate for the target audience, a pilot test was conducted with secondary school students. Our formative evaluation process used the Learner Verification and Revision (LVR) methodology (Komoski, 1979; 1984), which focuses on the user, is characterized by flexibility, and is well adapted to the context in which the product will be used (Nguyen et al., 2008). LVR involves expert testing to detect errors and problems, which are then corrected (Maddrell, 2008), and efficient validation of a prototype with a restricted sample of the target audience. This method, also known as an

educational trial, has been used for game development research (Kandaswamy et al., 1976; Stolovitch, 1982), and for other online GEGSs (Sauvé et al., 2002; Sauvé & Samson, 2004).

Two groups of secondary school students (Quebec level IV-55%; level V-45%), for a total of 40 students participated in the pilot test of the game. 55% were male and 45% were female. The students were all between the ages of 15 and 18 years. Among the 40 students, 50% were 15 or 16 years old and the other half were 17 or 18 years old. A brief report of the results is given below for the three areas examined: game design, user-friendliness and pedagogical readability.

Game Design. The results show a very high level of satisfaction with the game design. Students strongly agreed or agreed that the game design elements, namely the game board (94.9%), (98.3%), visible tokens (98.3%), player or team name display (95.8%), accessible game rules (97.3%), display of questions above the game board (94.9%), and selectable tokens and token movement (97.3%) were appropriate and supported the game's objectives. 93.8% of the students rated the overall game design as 8, 9 and 10 on a scale of 1-10. This confirms that the students appreciated the game design factors brought to their attention.

Pedagogical Readability. The results show a very high degree of pedagogical readability in the game. The participants strongly agreed or agreed that the vocabulary used in the questions (94.9%) and feedback (90.2%), the way pictures were displayed (89.4%), the video images and sound quality (90.8%), and the font size and color (95.8%) were among many characteristics of the game that were understandable and appropriate to the game's goals. 91.5% of participants students rated the overall pedagogical readability of the game as 8, 9 and 10. This confirms that the students appreciated the elements of the game's readability that were brought to their attention.

User-friendliness. The results show that *STIs: Stopping the Transmission* was seen as a very user-friendly game. The students strongly agreed or agreed that the instructions and help tips (89.7%) as well as the rules (95.8%) were easy to understand, that the graphics facilitated game play (94.9%), that the actions required did not require any advanced technological abilities (90.2%), and that, in general, playing the game was easy to understand (89.7%).

Finally, several comments from the students allowed us to revise some of the instructions and the general operation of the game.

Validation of the pre- and post-test measurement instruments for knowledge and attitudes

Since the pre- and post-test questionnaires for knowledge and attitudes were developed for the final experiment, we conducted a pilot test with our target audience to assure ourselves that the knowledge that was structured by playing the game and the attitudes that were to be modified were not already acquired by students prior to playing the game.

Forty respondents, the same group of students that participated in the pilot test, completed the questionnaires prior to playing the game. Their results are presented below according to five indicators of knowledge structuring and three indicators of change in attitudes.

The results in Table 1 show that the 25.5 to 48.3% of students more or less knew the content of the learning materials about the domain of asthma. The data also shows that only certain questions were answered correctly by all students. These questions will be replaced in the final version of the questionnaire.

Table 1: Variables indicating the structuring of knowledge before the final experiment with the game

Variables Studied	Correct response	Incorrect response
Prior knowledge	74 .5%	25 .5%
Key elements of the subject studied	56 .8%	43 .2%
Understanding of differences and similarities	70 .0%	30 .0%
The activities in the game allowed me to establish conceptual links	51 .7%	48 .3%
Establish analogies	56 .7%	43 .3%

results in Table 2 show that the students had different degrees of agreement and disagreement with regard to attitudes, and so we can retain these questions. However, some students neglected to answer all the questions. This problem will be eliminated when the questionnaire is placed online, as the system will prompt students to respond to each question.

Table 2: Variables indicating the attitude before the final experiment with the game

Attitude Scale	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	No response
4.4.1 The predisposition for action based on the individual's perception						
The general perception of asthma, chronic pulmonary disease	25.8%	32.9%	20.0%	11.7%	6.3%	3.3%
The perception of their own health	40.0%	30.0%	17.5%	0.8%	5.8%	5.8%
The perception of the individual regarding his and his peers' vulnerability to asthma.	19.2%	28.8%	25.0%	12.9%	8.8%	5.4%
The perception of the gravity and dangers represented by a poorly controlled asthma.	14.2%	44.2%	27.5%	8.3%	3.3%	2.5%
The perception of their control to reduce the risks and eliminate the environmental factors that trigger asthma.	55.0%	25.0%	10.0%	3.8%	2.5%	3.8%
<i>Mean</i>	30.8%	32.2%	21.2%	6.3%	5.3%	4.2%
4.4.2 The personal habits regarding their health and asthma prevention.						
<i>Mean</i>	55.0%	25.0%	10.0%	3.8%	2.5%	3.8%
4.4.3 The perception of accessible solutions and their application						
Concerning their personal improvements	35.6%	38.1%	16.3%	2.5%	4.4%	3.1%
Concerning their overcoming the obstacles to action	17.5%	28.5%	23.0%	11.5%	15.5%	4.0%
<i>Mean</i>	26.6%	33.3%	19.6%	7.0%	9.9%	3.6%

Conclusion

Asthma : 1, 2, 3... Breath! is an educational game developed by doctors collaborating with the project research team.

Regarding the ergonomics of the game, the results showed that students had a very high level of appreciation for the design, user-friendliness, and pedagogical readability of the game. The game board was seen as visually appealing, as were the various elements—tokens, rules, instructions, stopwatch, and questions. The game's instructions, rules and game play were reported as easy to understand. The content of the questions was interesting and questions used a vocabulary appropriate for students.

The experimental study is presently underway and will run from October to November, 2009. The study sample will be clearly described and the results with respect to knowledge will be described succinctly according to the five categories described earlier: (1) the capacity to call upon prior knowledge; (2) identification of key elements in the subject being studied; (3) increase in understanding of the differences and similarities between various elements of the subject studied, and (4) creation of conceptual links and (5) analogies.

The presentation of results with regard to change in attitudes and behaviour will be reported in the four content categories given earlier: (1) Prevention: predisposition, knowledge of the disease and its symptoms; (2) Control: absence or minimum symptoms during the day, no symptoms at night and in the morning, using the emergency pump less than four times per week, ability to perform normal activities and sports, test for normal pulmonary function, etc.; (3) Triggering factors: cold air, tobacco smoke, strong odors, air pollution, emotions and stress, etc., and (4) Allergies: domestic animals, mites, pollen, dust, etc.

Each category contains questions a measure of knowledge as well as attitudes and behaviours.

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