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More than mere games: a review of card and board games for medical education

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Abstract

During recent years, attempts have been made to complement more classical concepts of medical teaching by introducing card and board games on medical topics. These teaching tools cover every age and education group, and many different medical topics. In this article we have reviewed all card and board games for medical education purpose listed in NCBI PubMed database and Internet game databases ($n=29$). It summarizes games that might be useful to medical teaching staff. To categorize these games, a new schema for medical games categorization, based on the game mechanism and theories on experiential learning circles, is proposed and discussed. Additionally we have a view on card and board games with medical topics for entertainment ($n=22$).

Background

Games for medical teaching

In an unconstrained setting, games may simulate processes of decision-making and can enrich teaching strategies. Therefore games are increasingly used as supplemental teaching tools in medical education (Averdon & Sutton-Smith 1971; Karlin 1987; Henry 1997). Traditional lectures do often not reflect the levels of complexity of practical applications or real-life situations. By contrast, games are simplified models of complex systems that clarify difficult issues by presenting them as plain game processes. In addition, they have the potential to motivate students and include an element of competition and surprise (Livingston & Stoll 1973; Gershon & Handelman 1974; Zeedyk et al. 2001). Structured and rule-guided, they provide enjoyable physical or mental training, including narrative and simulative aspects. Games are based on skill, strategy and chance. Combination of these attributes result in diverse subtypes. Card and board games—defined by the game layout—improve communicative skills and promote active learning through interaction with other players (Neame & Powis 1981; Richardson & Birge 1995). While other areas of expertise (i.e. like military education) have used games for centuries, the first games for medical under- and postgraduate education were developed during the seventies of the 20th century only. Beside medical doctors' training, today card and board games are commonly used in the training of nurses (Cessario 1987; Sparber 1990; Wildman & Reeves 1996; Baldor et al. 2001).

Aims

In this review we discuss the pros and cons of various game concepts in medical and health education. To this end we present and analyse the differences in game conception and game playing of all medical games listed in the in NCBI

Practice points

- Both card games and board games on medical topics are widely used for medical teaching of both undergraduate and postgraduate students.
- Common general game categorizations are not always suitable for medical games. We propose a novel categorization system for medical card and board games.
- Beside obvious game criteria (i.e. number of players, target group, game setup) the game mechanism and complexity of learning processes can be used to categorize medical games.
- Evaluations of medical teaching games with larger groups of students are still at want. With these, important aspects such as the appeal of playing and replaying should also be covered.

PubMed database, of medical games for free download on the internet, of all commercial games dealing with medical issues listed in international game databases (Luding¹, BoardGameGeek², Spotlightongames³) as well as of all commercial games about medical topics listed in the German Game Archive.

Computer games are not subject of this review as well as games used for diagnostic (i.e. in psychological tests) or therapeutic purposes, advertisement giveaways and games dealing solely with growing up, ageing, dental disease and nutrition (Corbin & Nelson 1980; Menks 1983; Celano 1990; Neistadt et al. 1993; Bartfay & Bantfay 1994; Vergheze et al. 2003). Computer games use differing game mechanisms, they wield much more data in order to simulate complex situations, and e-learning is a concept worthy to be discussed on its own. Role-playing games (games of collaborative storytelling, during which the player assumes of a fictional character) are

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only discussed when they also match the term of card or board games.

Method

Aspects of medical game categorization

Various games for teaching medical topics have been published within the past decades. As these games differ in topic, mechanism, evaluation and replaying motivation, it is important to categorize games to allow comparison. Categorization might also help medical teachers to choose the appropriate game for teaching, and might support medical game developers. There is no international standard for categorizing games about medical topics, and categorization systems for non-medical games often either apply criteria that are too general or they concentrate on their special subject.

We developed a categorization concept for medical games based on two main criteria: the game mechanism and the complexity of the underlying concept of learning by experience.

The game mechanism as a categorization criterion

To describe the games' main mechanisms, all reviewed games were categorized based on the game categorizing system of the University of Marburg, Germany (German Game Archive, GGA), where research on card and board games is conducted on a scientific basis (Table 1).

The complexity of experiential learning cycles as a categorization criterion

On the ten-step-scale of experientiality provided by Gibbons & Hopkins (1980), game-playing is described as an analytic learning process (step three and four of the scale). Therefore, games may be analysed and categorized according to other learning processes. To describe the complexity of a game as a didactical process, we have applied the theories of experiential learning cycles to medical games: Learning cycles describe the process of learning as a sequence of steps that form a circle of repeating actions (Figure 1a).

Games may be seen as experiential learning cycles in that they repeat learning stages in each game turn or every game played. The simplest experiential learning process in a "game" might be: experience (single-stage-model) followed by experience and so on. Throwing a coin is a model for single-stage games because the anticipation of the result of the next throw depends on experience alone. In a two stage-model game (based on Bacon (1987)), experience is followed by reflection. Typical two stage-games are simple

quiz games: a question has to be answered, the answer is evaluated, and the next question follows. As this kind of learning process reflects an exam-like situation, many games intended for learning are based on this concept. More refined quiz games follow a three-stage model (based on the theory of experience by Dewey (1934)) and comprise experience, followed by reflection, followed by a new plan for the next cycle. Quiz games that let you choose the categories of answers or allow bidding processes are typical three-stage-models. A four-stage model (based on Kolb (1984)) includes experience, followed by reflection, followed by an abstraction of the issue and then by planning the next step of experience.

A two-dimensional matrix can be created by these two categories game mechanism and experiential learning cycle, that permit the developer to categorize his game, and the teacher to find games with the attributes needed to support his lesson (Figure 1b).

Further information should be added including the *topic* of the game, the *game setup* (board or card game), the *target group* (medical postgraduates, medical undergraduates, nurses, laypersons, adults, youngsters, children), the *condition of victory* (competitive vs. cooperative), *knowledge transfer* (the mechanism is or is not transferring the issue), *evaluation* (has benefit for teaching been evaluated?) and *availability/source* (free internet download, PubMed/scientific journals, semi-commercial, commercial).

Results

The right game to choose...A medical game review

Following the matrix proposed above, this review starts with two stage dice & luck games and continues to four-stage dexterity games. Additional information as mentioned above can be found in Table 2.

(I) Dice and Luck

Dice and luck games are often 2-stage games, as the result of the players action does not necessarily depend on abstraction and a new plan for the next turn, but on the result of a random event (i.e. throwing a dice).

A game that demonstrates the potential of board games to reach people in difficult social and environmental settings is "AIDS Challenge" (two stage) from Malawi. The game is a typical snake-and-ladder-game with 100 cards making wrong and correct statements about HIV and AIDS. Playing the game repeatedly during four weeks increased the knowledge of

Table 1. The game mechanism as a categorization criterion. The modified game categorization system of the German Game Archiv (Deutsches Spiele-Archiv, University of Marburg). Independently of the games' topics, all kind of card and board games fit to one of the categories, depending on the main mechanism of the game.

Category	Code	Subcategories included
Dice and Luck	I	dice games, start-goal-games, search and catch games
Outlay games	II	symbol layout games, letter layout games, lottery games, figure layout games, picture layout games
Thinking games	III	strategic games, tactical games, combination games, memory games, solitary games
Quiz/Communication games	IV	question & answer games, quiz games, fortune-telling games, creativity games
Role-play games and simulations	V	economy games, criminal games, adventure games, conflict games
Dexterity games	VI	dexterity games, action games, reaction games, sport games

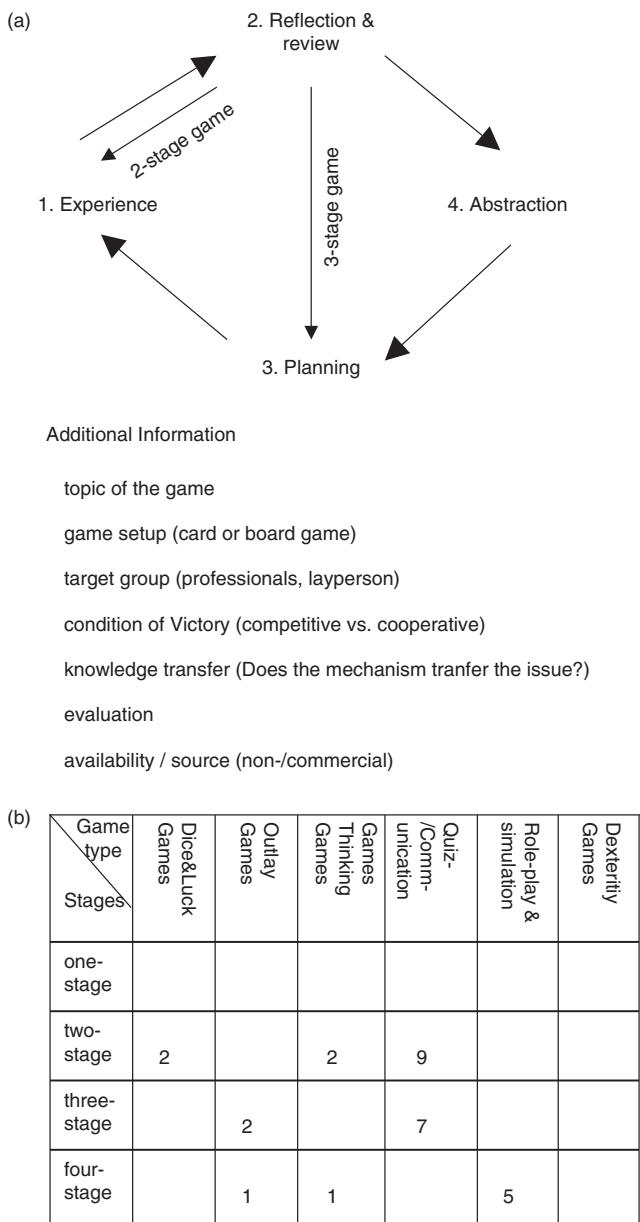


Figure 1. (a) The complexity of experiential learning cycles as a categorization criterion. Very simple games consist just of one step: repeated experiences (one-stage game). More complexity is gained when a game concept includes reflection and review of the experience (two-stage game). As a result of this reflection, an active planning step can enrich a game concept (three-stage game). If the players are guided by the game mechanism to a point of view where they can see the abstract background of the game's mechanism, an even higher level of experiential learning is reached (four-stage game). Additional information as listed above should be given to support teachers and game developers in choosing an optimal concept for their game. (b) Two-dimensional matrix of medical game categorization. Stages of experiential learning and game mechanism forming a matrix to categorize all games ($n=29$).

players' significantly and also influenced the behaviour in the families of the playing children (Dodd 1995). "The Downward Spiral" (two stage) is a board game developed to support the prevention of drug abuse. In a comparative study, a group of college students played the game, a second group watched an educational video about drug abuse and a control group did neither. Afterwards, a questionnaire about addiction was answered. Both, however but game playing more so than video watching, increased the students' intentions to limit alcohol consumption compared to students who served as controls (Czuchry et al. 1999).

(II) Outlay games

Outlay games are characterized by the task to identify and put together parts of a greater pattern or picture in a correct order.

Two "B-/T-lymphocyte self-tolerance games" (three-stage) were designed to help facilitate students' understanding of immunology. Cards represent different aspects of the immune system, which can be laid out on game boards. Evaluation of the game showed an increment of knowledge for 95% of 120 students in before-and-after play tests, and even the students' grades improved significantly (Eckert et al 2004). Because both games include the stage of planning, they are quite strategic and pictorial.

An uncommon but effective way to teach immunology to adolescents and young adults is "A tradingcard game about host defence". Each player has a layout board displaying liver, lung, intestine and blood with a number of points that can be reduced by attacks. Each turn, players can either play a defensive card to defend their organs or play a pathogen to attack organs of another player. Pathogen cards display different viral, bacterial, fungal and parasitic infections or cancer cells, which sometimes need a modifier card to be played (like smoking for lung cancer). Loss of organ points can be avoided or reduced by answering questions about the pathogens. Defensive cards display medications, vaccinations or surgical treatment. The game is a four-stage game, as it incites to think and talk about all the possible result of the recent turn, to abstract the objective and to react optimally to the opponent's move. The game was tested with pupils and first-year medical students and caused a significant increase in test scores, from 39% to 58% correct answers in 8th graders, from 47% to 59% among 10th graders, and from 80% to 88% among the medical students (Steinman & Blastos 2002).

(III) Thinking games

An early game of an emergency patient's examination and management (*Emergency Game*, two stage) was designed as a card game for third-year medical students. The player has to select and document a decision-making pathway to deal with a given hypothetical emergency patient. The result is compared with an expert's decision-making pathway for this case at the end of the game (Saunders & Wallis 1981). Here not each game turn, but the whole game offers a two stage learning process: The player compiles a decision-making pathway which is then evaluated. With a new game, former decisions can be reconsidered. Remarkably, the mechanism of the game, namely to create sequence of action and reaction, already conveys an important aspect of the issue.

Table 2. The right game to choose . . . Overview on games for medical education ($n=29$). All games have been categorized by our proposed categorisation system. Additional information: setup (B = board, C = Card game); Target group (L = layperson, N = Nurses, S = undergraduates, P = postgraduates), Condition of Victory (comp = competitive, coop = cooperative), Knowledge transfer (yes = game mechanism already transfers the topic, no = game mechanism and topic are independent), Evaluation (yes = published, no = not performed or not published).

Game	Category	Setup	Target group	Condition of Victory	Knowledge transfer	Evaluation	Source
AIDS Challenge	I/2	B	L	Comp	No	Yes	Dodd
Downward Spiral	I/2	B	L	Comp	No	Yes	Czuchry et al.
B-Lymphocyte self-tolerance game	II/3	C	S	Comp	No	Yes	Eckert et al.
T-Lymphocyte self-tolerance game	II/3	C	S	Comp	No	Yes	Eckert et al.
Tradingcard game about host defence	II/4	C	L	Comp	No	Yes	Steinmann, Blastos
Emergency Patient Game	III/2	C	S	Comp	Yes	No	Saunders, Wallis
Gro	III/4	B	L	Comp	No	No	Interformic Games
Lactation Game	IV/2	B	S	Comp	No	Yes	Elder, Gregory
MediCumLaude	IV/2	B	S	Comp	No	No	MPL, Urban&Schwarzenberg
Neonatology Emergency Trivia Game	IV/2	C	N	Comp	No	Yes	Gordon, Brown
PhysiCumLaude	IV/2	B	S	Comp	No	No	MPL, Urban&Schwarzenberg
Sexual Dysfunction Trivia Game	IV/2	C	S	Comp	No	Yes	Skinner
Stryer Biochemistry Game	IV/2	B	S	Comp	No	No	Spectrum Verlag
T- an B-Cell ontogeny game	IV/2	B	S	Comp	No	No	Girardi et al.
Trivia Psychotica	IV/2	C	S	Comp	No	No	Kelly
Who wants to be a Physician?	IV/2	C	S	Comp	No	Yes	Moy et al.
Board game for health education teaching	IV/3	B	P	Comp/Coop	No	No	Robertson, Tannahill
Ecstasia	IV/3	B	L	Comp/Coop	No	No	Ravensburger Spieleverlag
Non-Trivial Pursuit of Physiology	IV/3	B	S	Comp	No	No	Zakaryan et al.
Pediatric Board Game	IV/3	B	S	Comp	No	Yes	Ogershok, Cattrell
Puerperal Women Game	IV/3	B	L	Comp/Coop	No	Yes	Fonseca et al. (2000, 2002)
Smile	IV/3	B	S	Comp	No	Yes	Udin, Kuster
Survivor Game	IV/3	C	S	Comp/Coop	No	No	Howard et al.
Clinical Pharmacology Game	V/3	B	S	Comp	No	No	Tomlinson
Black Death	V/4	B	L	Comp	No	No	Blacksbrugs Tactical Research Center
Body War + AIDS Expansion	V/4	B	L	Comp	No	No	B.T. Games
Coma – Uma Guerra Biológica	V/4	B	L	Comp	No	No	Game Office
DRG	V/4	C	L	Comp	No	No	Themenspielverlag Meppen
The Oncology Game	V/4	B	S	Comp/Coop	Yes	Yes	Fukuchi et al.

(IV) Quiz-/Communication games

As described above, quiz games are often two stage learning processes: experience and reflection. Quiz games are quite common in educational game play because they are easy to invent and are capable to simulate test situations.

The “Neonatal Emergency Trivia Game” (two stage) was designed to be played by nurses of neonatology wards. It contains 101 expert and peer reviewed test questions covering pathophysiology, resuscitation and medication to prepare players for emergency situations. Test-retest-reliability was reviewed by pre-post knowledge testing of twelve nurses with encouraging results, studies with a larger group were planned but have not been published to date (Gordon & Brown 1995). A good example for a quiz game leading carefully towards an often-untouched topic is the “Lactation Game” (two stage), which was introduced to provide knowledge about breastfeeding to residents (Elder & Gregory 1996). Questions about breast-feeding are asked during the game, and all who attended in a first phase of testing gave positive feedback. A quite similar game titled “Trivia-psychotica” (two stage) has been described for the schooling of nurses working with patients with psychiatric disorders (Kelly 1995). “Who wants to be a Physician?” (two stage) is a spin-off from a TV quiz show. Developed for first-year medical students, it consists of multiple-choice questions (MCQ) about pulmonary physiology and pathophysiology. The authors describe improvement of

the students’ learning process and of their ability to understand and retain information (Moy et al. 2000). “The Sexual Dysfunction Trivia Game”, (two stage) was designed to educate staff nurses about sexual dysfunction and prevent the emergence of taboos (Skinner 2000). Pre- and post-play tests of knowledge were performed, and showed an increment of knowledge about the subject, but no evaluation of larger groups has been published. The “Pediatric Board Game” (two stage), another quiz game for third-year medical students and for residents, transfers paediatric knowledge. 400 Questions in four degrees of difficulty are included. In a first evaluation, 37 medical students and 12 residents took part in a 5-point Likert scale evaluation, who voted high scores for the game in all 10 survey questions (Ogershok & Cottrell 2004). We also found three commercial games for medical teaching: “MediCumLaude” (MLP, Urban&Schwarzenberg, two stage) and “PhysiCumLaude” (MLP, Urban&Schwarzenberg, two stage) are typical quiz games. The player moves along the board and has to answer original multiple-choice questions of German medical exams for second and fifth-year students, respectively. The “Stryer Biochemie Spiel” (“Stryer-Biochemistry-Game”, Spektrum Akademischer Verlag, 1994) (two stage) is a similar commercial quiz board game with 1000 questions about medical biochemistry.

The latest two stage game in this category is the “T- and B-cell ontogeny game” (two stage), a board game for six players and one trainer. Pawns are moved on a game board depending

on a dice throw, and questions from different categories must be answered to win the game (Girardi et al. 2006).

The "Survivor Game" (three-stage) is a computer supported quiz game with 108 MCQ about respiratory physiology in Medical Board Examination format. Teams of players compete in front of an audience. Questions have to be answered by the teams and the interacting audience. In case of wrong answers, a team member leaves the team and joins the auditorium, until a last "survivor" wins (Howard et al. 2002). This quiz game differs from quiz games mentioned above in two ways: first, it involves a plan for the next turn, namely the decision which team member has to leave the team. Second, by playing in teams and involving the audience, a cooperative component is included in the game mechanism. Recently, a modified version called "Non-Trivial Pursuit of Physiology" (three-stage) was presented (Zakaryan et al. 2005).

The game "Smile" (three-stage) is about special problems of handling children and disabled people in dental care and creates situations that might be encountered by students during their clinical course. 42 test students were divided into three groups: one for standard teaching ($n=13$), one for game play ($n=10$), and one ($n=19$) without special teaching. However, no difference concerning their attitude towards children's special needs could be found afterwards (Udin & Kuster 1985).

Another drug prevention game for up to 24 players is the semi-professional "Ecstasia" (Förderverein Gesundheitsförderung Saarbrücken, Ravensburger Spieleverlag, three-stage). As they move figures on a board, the players have to answer questions, discuss issues and manage action tasks. The game is used in all secondary schools in Luxembourg, but its impact has not yet been evaluated.

Puerperal women in a rooming-in unit in São Paulo can learn much about breastfeeding and newborn care through a board game (*Puerperal Women Game*, three-stage). The game is coordinated by a nurse, mothers are divided in two groups, one asking questions, the other answering. Through structured interviews, the knowledge about the topic was evaluated, showing an increase in correctly answered pre post-game questions from 17% to almost 78% (Fonseca et al. 2000, 2002).

The communicative "Board game for Health Education Teaching" (three-stage) features a spinning arrow in the centre of a circle with 16 questions. Postgraduate students have to concisely state their opinion about a variety of issues of teaching in health education, resulting in a short group discussion. Although this game has a minimalist equipment, the induction of discussion, reflection and abstraction makes it a complex teaching tool (Robertson & Rannahill 1986).

(V) Role-play and simulation games

Games which simulate clinical situations (simulations) or include collaborative storytelling and fictional characters (role-play games) often reach a high level of communication and complexity. An early game of this kind is described as a card and board game to reinforce learning of elementary clinical pharmacology. Medical students roll the dice and move patient characters on a game board. When a "patient" arrives at a disease field, the player has to offer the right medication from his cards hand to liberate the patient. Students enjoyed

playing this game and used it to learn drug names and therapeutic principles, but no further evaluation has been performed (Tomlinson 1979) (three-stage).

A combination of a board and computer game is "The Oncology Game" (four-stage). Designed for third-year medical students, it is conceived to point out the importance of interdisciplinary treatment of oncology patients. Two teams of students have to treat cancer patients by sending them to different clinical departments on a playing board; the movement is limited by dicing and answering questions. A computer holds the data of all patients, and the players choose elements and sequence of therapy (radiology, medical oncology or surgery). When a patient arrives at a clinic, the computer provides feedback for the players' decision and gives hints for further treatment. The evaluation of the game revealed a significant increase in the number of questions correctly answered after each game. The students themselves also felt that their knowledge about oncology improved during game-play (Fukuchi et al. 2000).

The "DRG – Die riesen Gemeinheit" ("DRG – The Huge Meanness", Themenspielverlag Meppen 2004, 2005, 4-stage) is a semi-professional economy card game explaining the system of diagnose related groups to pre- and postgraduates. Players take the role of residents (DRG – Neurology, DRG – Internal Medicine), they are dealt patient-cards they must encode in the DRG-system to earn money depending on main and auxiliary diagnoses. An alternative version of the game (DRG – Neurology 2006) has been created for the use by layperson.

Comparing complex immune reactions with war-like acts is common in illustrative games. The Italian "Body war" (B. T. Games, 1986, 4 stage game), in its second edition supplemented by an "AIDS-Expansion", simulates the struggle between T/B-cells and viruses, bacteria and tumour cells on a hexagonal grid. Moving rules and dice regulate the war-like scenario between immune system and invaders. "Coma – Uma Guerra Biológica" (Game Office, Stage 4) from Brazil has a similar concept, played on the scheme of a human body. Also working with a tactical war simulation concept, "Gro" (Interformic Games, Stage 4) simulates the growth of bacteria colonies. Every player cultures a strain of bacteria in a Petri dish which all players share trying not to be overgrown by the other populations.

"Black Death" (Blacksburg Tactical Research Centre, 1993, Stage 4) is a tactical simulation of the spreading of a disease all over Europe. It is in fact a unique simulation of the plague's expansion during the mediaeval times: the player assumes the role of a disease, possessing a "virulence factor" and a "mortality factor" that influence both disease spread and killing efficacy. That player wins who first accumulates 30 Million victims by moving counters on a map of Europe.

Dexterity games

No dexterity board or card games for medical education have been published yet.

Recreational games dealing chiefly with medical topics

Some board and card games deal explicitly with medical issues but have been invented for recreational use only. Although they do not transfer medical knowledge, they shall be mentioned here briefly (Table 3) for two reasons: Firstly,

Table 3. Games dealing mainly with medical topics for recreation ($n=22$) listed in the international Internet game databases of Luding¹, BoardGameGeek² and Spotlightongames³. With comments and author's non-binding recommendations on players age: c = children, y = youngster 12 years or above, a = adolescent 16 years or above.

Game	Publisher	Comment	Age of Players
Anno Domini -Health & Nutrition	Fata MorganaAbacus	Creating a timeline from cards with events on the front and dates on the reverse, medical history is assembled in front of the player's eyes.	y
Ben Casey MD	MB	Following the plot of a TV drama, player have to assign symptoms to heal simulated patients	y
Doctor, Doctor!	Ideal	A game of deduction. Player Collect symptoms and try to find out the correct fun-diagnosis.	c
Doktor Igel	HABA	Very young players have to help a hedgehog doctor to cure a robin and an mouse	c
DRG Neurologie 2006	Themenspiele Vlg. Meppen	Economy simulation for layperson; alternative Version of the teaching tool simulation the DRG system.	a
Dynamite Nurse	Hobby Japan	Fantasy card game where nurses cure strange sicknesses	y
Dynamite Nurse 2	Hobby Japan	Part II of the card game, subtitle: Bloody Temple	y
Ebola Monkey Hunt	Placebo Press	Brings the player in the tricky situation to catch Ebola-virus infected monkeys escaped in a lab without being shot by the other players.	y
The flying doctor game Infection	Coral Indust. PTY LTD. Inc. Earwig Ent. enterprises	Dice-Game dedicated to the flying doctor service in Australia Players have to get rid of their infectious diseases by visiting different health institutions and avoiding new infections transmitted by other players.	c y
Intern	Avalon Hill	Simulates an internship in a hospital	a
Operation	Hasbro/MB	Surgical operations performed on a plastic patient	c
Operation: Shrek Edition	Hasbro/MB	Surgical operations performed on a plastic patient	c
Operation Brain Surgery	Hasbro/MB	Surgical operations performed on a plastic patient	c
Medical Monopoly	Professional Games	Monopoly clone with a trivia element	y
Pain doctors	Dreamsville Publishing	Game of black humour. Every player as a surgeon has to cause as much pain as possible to a patient	a
Plague and Pestilence	Hillary's Toy Box	Makes every player a leader of a medieval town who has to take care for his townsfolk while being threatened by the plague.	y
Quacksalbe	Feuer & Flamme	Each player is curing patients as a specialised doctor with acupuncture, drugs, blood letting or electric shocks	y
Snit's revenge	TSR	Strategy game in which one play plays the attacking disease while the other is defending the invaded patient	y
Therapy	MB	Travelling around the game board on a couch, players try to heal their psychosis with the help of other players by answering questions and assess the character of the other players.	y
Virus & Co	Zoch	Being doctor and patient in one person, players try to infect each other with viruses (cards) and heal themselves with medication	y
What's up, Doc?	MB	Patients race through a hospital to be the first in the doctors office	y

they express the game authors' perspective on medicine, secondly, they may influence the laypersons' concept of disease and medicine.

Conclusions

Games and Categories: Conclusions from the review

The games for medical education ($n=29$) analysed in this article cover various topics. They are often models of the immune system ($n=8$), depicting a state of infection or cancer as a strategic or tactical struggle for domination of the immune system over invading microorganisms or malignant cells. Other topics covered repeatedly are psychology ($n=4$) and physiology ($n=3$). Five games especially catch the eye because they stand for aspects that set card and board game apart from other teaching tools: The "AIDS Challenge" from Malawi demonstrates that even board games can sufficiently support medical education in environments where no computer game or high-tech teaching tool can be used.

The "Tradingcard game" simulates the battle-like situation of invader and host by an action-reaction mechanism. Using the concept of a trading card game ensures a high grade of replay-motivation (Steinman & Blastos 2002). The "Survivor" game depicts the extraordinary interactivity of board games, allowing to combine cooperative and competitive elements, teamwork and guidance by a tutor (Howard et al. 2002). The "Oncology Game" includes real-life situations of loosing time, wrong assessments, long distances and waiting time in oncology patients' treatment (Fukuchi et al. 2000). In the "Black Death" game the movement of the disease all over Europe transfers major problems of damming up a spreading disease. These games transfer knowledge about the game issue to the player by the game mechanism, already.

Facing such interesting and diverse games for teaching, it becomes obvious that many criteria usually used for game categorization do not fit medical games. The medical topics are spread too wide or are too specialized to use for game categorization. Additionally, a game categorization based on the games' topics could differ in national and cultural settings.

The target group of a game can often be changed easily by adapting tasks and questions to other target groups, and the replay-motivation of a game depends on other underlying factors. Therefore these aspects are not suitable for a medical game categorization.

The game mechanism and the game's level of complexity are both independent of a game's topic, cultural background, target group, and other factors like game setup, the condition of victory, the kind of knowledge transferred and replay motivation related to it. The complexity of learning cycles included in the game concept can give a good hint at the replay motivation and the target group of a game. The game mechanism is relevant criterion to decide if a game suits in the actual teaching concept.

Evaluation: fun not included

The evaluation of medical games is fundamental as it is not a matter of course that a good game in itself yields good learning results, i.e. the pre-post playing evaluation of the "Smile" game shows no difference between players and control group (Udin & Kuster 1985). It may be expected that some of the non-evaluated games would also yield insignificant results. Yet evaluation of medical educational games is uncommon even when published in medical literature. 5-Likert-Scale or a pre-post gaming knowledge evaluation have been performed for a few games, but more commonly, solely the players' opinion with regard to teaching success was asked. Even though this is undoubtedly of relevance, increases in knowledge, grades and skills should not remain unexplored.

Another major aspect of a game's success as yet disregarded is acceptance through the potential players. A game is only suitable for knowledge transfer if it is played at all. Is the game fun to play at all? Is there a replay appeal? A boring game that is not played because it does not cause excitement, cannot transfer knowledge. As an experiential learning cycle only works when the cycle is repeated, the motivation of playing and thus learning should be considered in future evaluations.

Conclusion

We conclude that medical games cover a wide field of topics and might be valuable tools for teaching in both, medical training and health education. Although some of the games developed for these purposes were evaluated by before-after tests and scale-ratings, controlled studies with a large group of subjects remain to be conducted.

Thus, for future evaluation, we propose a uniform categorization system for card and board games in medicine for better comparison, and evaluation of games with larger groups of players with regard to knowledge transfer as well as playing and replaying appeal.

Notes

1. <http://unsite.informatik.rwth-aachen.de/luding/>
2. <http://www.boardgamegeek.com/>
3. <http://wwwspotlightongames.com/>

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