Gifted are lifted higher: An exploration of the development of higher order thinking skills of gifted students playing strategy games

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Abstract

Strategy games can provide an opportunity to develop higher order thinking skills in students gifted in mathematics. Extending and engaging gifted students is a demanding task. This paper reports on a twelve-week project undertaken with a group of nine gifted lower secondary school students. These students played and analysed five traditional strategy games. Following this experience, they were asked to create a challenging strategy game of their own. This paper discusses the rationale for the use of traditional strategy games, outlines the methodology employed, explains the selection of specific games and describes the observed improvement in students' higher order thinking skills.

Introduction

Schools have the responsibly to assist all students in developing thinking skills. As part of this, gifted students require opportunities to develop their higher order thinking. However, it is commonly observed that gifted students are often not challenged in mixed ability classes. Extending the higher order thinking skills of gifted students, in an engaging

way rather than setting extra practice on standard classroom mathematics exercises, can be a demanding task.

An opportunity to work with a group of gifted middle school students provided a forum in which to explore the potential for simple, traditional, strategy games to engage and extend the higher order thinking skills of gifted students. This paper reports on this experience. It discusses the background and rationale for using strategy games, outlines the games used and the methodology of this study, and describes the impact of this learning activity on the development of these students' thinking skills.

Giftedness in Mathematics

Students exhibit variation in the level of their different abilities making giftedness difficult to define. However the definition of giftedness typified by Renzulli's (2002, p. 67) "three-ring" conception will be used in this paper. This definition sees "above-average ability, task commitment, and creativity" as clusters of traits of gifted students. It is apparent that able students "are in need of instruction and educational opportunities that stretch their academic potential and meet their unique needs" (Rief & Heimburge, 1996, p. 185).

The particular project, reported in this paper, focuses on giftedness in mathematics. The mathematically gifted may also be gifted in a more general sense, however they will exhibit some particular traits related to mathematics. The Qualifications and Curriculum Authority of the UK (2002) considered that "Pupils show their special talents in mathematics in a range of ways and at varying points in their development". Their list of attributes expected of mathematically gifted students include more analytical, systematic and accurate; think logically; make connections; identify patterns; sustained concentration

and persistence in seeking solutions. These have been accepted as the criteria for identifying mathematical giftedness. The series of classes for the extension program were developed with these characteristics in mind. The planning was also guided by the thoughts of Geake and Vialle (2002, p.17) who suggest that mathematically talented students require “activities that cause them to reinforce or adjust their mathematical knowledge structure” and need “far less repetition than their peers" (p.313).

Importance of higher order thinking skills

The plan for this extension program for gifted students acknowledged that the transference of the knowledge and skills learnt at school to post-school experiences requires the ability to reason and think on a higher level than just comprehension and recall. Consequently, all students, and particularly gifted students, need to be able to think clearly, logically and creatively, as well as to successfully tackle non-standard problems where the solution does not fit into any pre-learnt or standard method or approach. Indeed Higgins and Boone (2003, p. 142) consider “critical thinking, logic skills, creative thinking, problem solving, decision making, and meta-cognitive thinking” to be important skills for gifted students to develop in order to ease their transition from school to the world of work. Schools can provide a learning environment which encourages the development of a thinking culture to support the growth of students in these higher order thinking skills (Pohl, 2000).

Extending gifted students through playing games

Experienced teachers commonly report that if an activity with an educational objective can also be interesting and enjoyable, then it is more likely to be successful in achieving

that objective (Rea, 2001; Minchew, 2001). In particular, one context in which this can be achieved, with some students, is the use of games in the teaching and learning of mathematics. For example, Randel, Morris, Wetzel and Whitehill (1992, p. 270) noted that "Because games require the active participation of students, the material has a greater chance of being integrated into the cognitive structures of the individuals and thus being retained". Students can be enticed to think harder in their quest to develop winning strategies, an example of the active participation to which Randel et al. refer. The study, reported in this paper, investigated the effectiveness of strategy games in developing higher order thinking skills with a convenience sample of "gifted and talented" students at an Australian secondary school.

Strategy games were chosen for the extension program as they are completely different from the activities usually undertaken in mathematics classes. According to Hiebert et. al. (2003, p.41), a “considerable portion of [mathematics] lesson time in every country was spent solving mathematics problems … by applying a mathematical operation.” The games added a new dimension to these students’ learning. Strategy games have little or no element of chance so, to be successful, players must develop better strategies than their opponents. Their strategies may involve the analysis of the game, knowledge and understanding of the rules, the selection of appropriate moves according to the rules of the game, formulation of a plan which considers more than just the next move, and re-assessment of the game plan in response to an opponent’s move.

Such games have been thought to have the potential to enhance the thinking skills of analysis, synthesis and evaluation. As noted by Kohl (1974, p. 157), “Strategy games require the ability to think through several alternatives simultaneously and to develop overall plans and then devise specific steps to carry out these plans”. This suggests that

strategy games may be used with the specific intent of developing these thinking skills. Similar skills are needed in mathematics to work through standard problems in a logical manner. The visualization of the playing board in strategy games may also assist in developing the spatial visualization skills of mathematics necessary, for example, when students work on 2-D or 3-D problems or linking the symbolic and graphical representations of functions.

Selection of games to extend higher order thinking mathematics

One of the main reasons for the use of games in the classroom is their motivational aspects for some students. Gifted students are not necessarily highly motivated. As noted by Begg (1997, p.3), "There is the intrinsic mathematics which is always present … [in a game and] there is the high level of interest and motivation which games-playing generates" The motivation of the game leads to mathematical outcomes not considered as central to the game by the participants. As well, it has been suggested that the use of strategy games can be an intellectually challenging, fun, leisure pursuit for students.

"Games" encompass a wide range of activities and care should be taken in selecting appropriate games to ensure that the learning of the intended concepts or processes is enhanced. So, "For a game to be a useful educational tool, it should lend itself to some analysis to enable the student to increase his chances of winning through the development of a strategy" (Kennedy & Kennedy, 1974, p.3). Karnes and Riley (cited in Udvari & Schneider, 2000) believe that competition is important for gifted children. However, like any classroom activity, games should be carefully chosen to meet the needs of the specific group. Callahan (2001) asserts that all gifted students are not the same and that it is a mistake to design a programme for them based on that assumption. There may well be

students within the group who do not enjoy games, so it would be inappropriate to use only a game-based teaching approach. Since the project group spent only one session per week away from their normal classes the emphasis on games was not excessive.

Much of the research into the use of games focuses on their use in the teaching of specific mathematical concepts (see for example: Begg, 1997; Booker, 2000; Bright, Harvey, & Wheeler, 1985; Hildebrandt, 1998; National Council of Teachers of Mathematics, 1973). However it appears that there has been little research into the use of games to enhance more general thinking skills. Bright et. al. (1985) do acknowledge the need for further research into games which do not have a specific conceptual focus, but in fact do have as their rationale this more general thinking aim. This background provides justification for this project, which examined the effectiveness of the use of strategy games in teaching higher order thinking skills.

In the project, traditional strategy games were chosen so that, in addition to extending students' mathematical thinking they would become aware "that people can create their own challenges and entertainments" (Ascher, 2001, p.96). These games can be played with minimal and easily obtainable equipment. Buttons were used for counters and photocopied game boards or constructed them from egg-cartons.

Selection of specific traditional strategy games

There are some well-known games that do lend themselves to teaching higher order thinking skills. Williford (1992, p. 98), for example, suggests "Solomon's Game, nine men's morris and nim-with-cards offer … high student interest and strong mathematical value". Also Orlando (1993) asserts "Mancala and Sungka teach thinking, planning and strategy skills" (Orlando, 1993 cited in Cruz, Cage, & Lian, 2000, p.4). So these and

perhaps other similar games could be used to help develop the higher order thinking skills of analysis, synthesis and evaluation. Likewise, Naylor (2002, p.28) also asserts that "Games are a great way to learn mathematical concepts such as strategy, thinking ahead, spatial sense and logical reasoning". The direction of this strategy games project was to test the use of games to promote such higher order thinking skills by collecting classroom based data.

Most traditional board games were designed for two players. Five such games were selected: Mancala, Go Moku, Bagha-Chal, Backgammon and Nine Men's Morris. There was also a game for one player: Solitaire. Solitaire was included so that if an odd number of students were present then every child had a game to play. Games like Chess and Chinese Checkers were avoided as students may have brought too much prior knowledge to them. The selection of games was based on a comment that Kohl (1974, p.122) made from the experience of his study, "None of the children [he observed] had played Wari [Mancala] before and so (unlike chess) everyone started out as equals". Williford (1992, p. 98) also suggested that "simple rules and ease of construction" should be a consideration in the selection of useful games.

Mancala is an African game (though variations can be found in other cultures) in which counters are collected. *Bahga-Chal* is from India and is an entrapment game. *Nine Men's Morris* is from Britain. It is a game in which counters are removed from the board until only the winner's are left. This game belongs to the class of games which have two stages of play and where the strategies in the first stage are critical to the outcome of the game. It is interesting to note that a very similar game was also played in Mongolia (Ascher, 2001). *Go Moku* is the Japanese variation of the Chinese game, Go, in which the winner lines up five counters in a row. A version of *Backgammon* was originally played in

Egypt and involves the movement of counters according to the values on a pair of dice. A more detailed description of these games can be found at the Internet site http://www.ahs.uwaterloo.ca/~museum/index.html (University of Waterloo, 1971). The following sections outline the methodology employed in this study of the impact of using these games.

Methodology

Two-stage project

This study investigated the effect of strategy games on the development of higher order thinking skills of a selected group of nine students over a twelve-week period. The study was divided into two stages. The first stage involved students playing a variety of traditional strategy games then, during the second stage, students designed, constructed and trialled their own strategy games.

Data collection

The data for the project were collected from a variety of sources. Throughout the project, detailed notes were recorded based on the observation by the first author of the game-play of individual students, discussions with individuals and whole group discussions. After discussion with their playing partner about their strategies, the students recorded their reflections on weekly, dated, game evaluation sheets that together formed a journal of their reflections. The games produced in the second stage were collected, examined and photographed. These data have been used as a basis for the discussion of the project that follows.

The project cohort

The research subjects were a group of nine Year 8 (age 12-13) "gifted and talented" students at an Australian secondary school located in a provincial city. The co-ordinator of the gifted program selected the students for the group on the basis their results on the Year 7 AIM test, teacher recommendation, and the willingness of the students to participate in the research project. The group met for a total of twelve, fifty-minute sessions during class time. Students were required to “catch up” any work that they missed from their normal class.

Stage 1 – Playing the games

Each week the students played the same game for the entire session. This approach was taken following Begg’s (1997) advice that a deeper understanding of the situation can be gained only by playing through the same game several times. Near the end of each session students were given the opportunity to discuss their winning strategies with their playing partner in order to assist them verbalise their thinking and so give them an opportunity to reflect on their thinking. This idea was prompted by a comment from Booker (2000, p.2), “Children can learn as much from one another as from the game itself, by sharing the strategies, consequences and needs of the game”. They recorded their reflections on the game evaluation form. It was anticipated that an analysis of these forms might provide evidence of the development in their thinking. The intention of the evaluation form was to assist students in articulating their strategies for each game they played. It gave them a focus for discussion with their playing partner. They were asked to give details of the date, the game played and the people playing the game. This enabled tracking of information in order to ensure that all students played all games and competed against a variety of

partners. It was hoped that as the weeks progressed there would be a change in the detail and content of student responses. The students were asked first for a description of the game. This was to help ease them into their reflections on the strategies they used, which they recorded in their journal.

It was intended that each student would play a different game with a different partner in order to prevent students becoming too familiar with the way their opponent thought. Familiarity may have inhibited a wider seeking of strategies necessary with a broader range of partners. It also hopefully gave all students the opportunity to win. A student who is always beaten may give up and not strive to develop winning strategies.

The playing of games was intended to provide insights into students' thinking as they played and to show the depth of their analysis of the games whilst tracking any changes in the manner in which they approached them. It was anticipated that students would develop their own strategies as they played each game. Transferability of strategies from game to game was a possibility. Perhaps the techniques used to develop strategies were transferable rather than the strategies themselves.

Stage 2 – Construction of games

Hildebrandt (1998, p.191) has asserted that "Invented games promote mathematical reasoning and problem solving … and encourage initiative, reasoning and experimentation". So, during the second phase of the project, students were asked to invent their own games in order to observe the capacity of the students to synthesise their own ideas resulting from the previous analysis of the traditional games.

Hildebrandt (1998, p.194) suggests that "Allowing children to modify old games and invent new ones gives them [children] a feeling of ownership and an opportunity to

regulate their own learning." Following this advice, the students were shown some modern, commercial strategy games which displayed some elements of the traditional games they had been playing. Supplying a variety of game boards for students to examine emphasized that both the design and rules that are necessary elements for a successful product. It also ensured that the students had a foundation of prior knowledge and experience in playing games on which to base their created games (Joseph, 2002).

During the rest of the first session of the second phase, the students examined the modern, commercial strategy games and discussed what their game might entail. The second session was devoted to developing their ideas and beginning production. It was anticipated that the production of these games would indicate developmental change in their higher order thinking skills. Evidence of deeper analysis of the genre of strategy games and the synthesis of new ideas based on this was expected.

Results

Stage 1 – Playing traditional games

It was not always possible for each student to play a different game with a different partner during each session as planned. However, almost all students played all the games. At the beginning of the project, students required a great deal of assistance to be able to play the games. Interpretation of rules and demonstration of game play was necessary .Suggestions were made regarding the choice of moves available, but not necessarily the best moves, in order not to prevent them from developing their own strategies.

During the first session the students commented that the games were "hard" and in particular, Bronwyn and Adam declared that they had not played these kinds of games before. As the weeks passed by, students needed less and less help to get started with the

games even though they played a different game each week and the games represented different types of strategy games. They no longer commented on the difficulty of the games even though the games had been presented in order of difficulty. This indicated that they were getting better at playing strategy games; however other factors, such as competitiveness or desire to please the teacher, may have been influencing this result. They expressed a growing interest in and enjoyment of the games. John often asked “What game will we play next week?”

During each session improved strategies were shown as students repeatedly played the same game. Initially their moves appeared quite random as they came to terms with the rules of the game. As the students became more familiar with the rules they began to move their counters in a manner that indicated that they were beginning to think about strategies which were likely to lead to a stronger position than their opponent in the short term. By the end of stage one of the project, moves were made which showed longer term strategies being developed. Students appeared to be thinking a number of moves ahead. However, even then, it was surprising to see that they often did not make the best possible moves and often missed opportunities obvious to the observer and made bad mistakes resulting in the loss of the game

Over the duration of the project the students’ playing strategies did improve, as they required less assistance in playing the games even though they played a different game each session. They displayed high task-commitment and there was little discussion of matters unrelated to the game. The length of the games increased as students became more adept at formulating if-then strategies. They demonstrated transfer of strategies used in earlier games to later games and made comments relating to the similarities they had noticed. Some strategies from earlier games could be applied to the new games: for

example, visualizing the state of play several moves in advance. This was demonstrated by a decrease in time for the transition from beginning a new game to displaying strategic play. However, no student was able to clearly articulate their winning strategies. A similar problem was noted by Kieran (2001, p. 187) in her comment "that adolescents within novel problem situations can experience some difficulty in making their emergent thinking available to their partners".

The games were discussed with the students and they were asked which one they liked best. Their answers both provided some insights into how they were thinking about the games and seeded some ideas for the game creation stage of the project. Mancala was most popular by a clear majority. Although the students were unable to explain their choice clearly they indicated that they were able to plan ahead more easily by counting the buttons in each well. Judy expressed a contrary opinion stating she liked Nine Men's Morris because it was in two stages and that a winning position could be set up during the first stage.

Some students didn't like Backgammon because each game took too long and they were only able to fit one game of it into a session. Students seemed to have most difficulty developing strategies for Go Moku where the size of the board creates many possible moves. Bagha – chal was difficult to win for the 'goats player', who needed to entrap the tigers in the early stages of the game without losing any goats. So the students didn't like taking the goat's role. Their preference for particular games seemed to be based on how many moves in advance they needed to visualize in order to formulate winning strategies.

Over the sessions of the first phase improvement was observed in game playing strategies. Students were less hurried in their moves and the moves they made showed evidence of the development of well thought out strategies. Over time, the number of

mistakes decreased and the duration of the games increased as each player countered the strategies of the other.

Stage 2 – Construction of games

It was originally planned that students would work independently on individual games so that the development of their higher order thinking skills could be clearly evaluated. However, they were most unwilling to work alone, so the students were organized into three pairs and one group of three. Students' willingness to continue with the project was seen to be more important than insisting on them making their own individual games. However, social collaboration can be encouraged by students working together to make games (Hildebrandt, 1998). The classroom culture that had developed was based on social interaction between the students and discussion of the games, so it was appropriate to continue to take advantage of the social context for learning which Booker (2000) suggests can be optimized by providing activities that foster engagement and discussion. Working in groups also indicates the facility of the students to articulate their ideas and work co-operatively on a project to demonstrate their combined development of an idea. In fact, it appeared that the discourse which developed amongst the members of the small groups assisted them to formulate and develop ideas for their games.

Students needed more time to complete both their games and their reports on their games than was originally planned, but they still spent two sessions trying out the games the other students had created.

Initially the students modeled their created games on the traditional games they had played in the first phase of the project. However, the discussions between students led to the production of games that differed significantly from the original idea.

All games created used a playing board. This is not surprising as the traditional games the students played all used a playing board. Perhaps experience with a traditional dice game may have led to the use of dice in their created games. Three of the four created games utilized a flat square grid as a playing board. Students displayed some difficulty in applying their previously acquired mathematical knowledge to the unfamiliar context of strategy games. For example, students were expected to be sufficiently adept at measurement principles to draw up their playing boards unassisted, but they were unable to do so. The fourth created game used a circular board with small cups around the circumference and a larger cup in the center. This game was based on Mancala in that the playing pieces were moved from cup to cup around the circle, eventually all ending up in the central cup.

The other three games were all variations on a combination of Go Moku and Bagha – Chal. Counters were placed onto the square grid, but could be captured and removed from the board. The aim of one game was to get as many counters into a central safe haven whilst preventing the opponent's counters entering the safe haven. Another game's aim was to move counters from one corner of the board to the diagonally opposite corner. Adam was one of the group who created this game. His commitment to the task was indicated by the quality of the wooden playing board with wooden figurines as the main playing pieces he had produced by working on them at home.

Key features of the students' games, such as simple rules requiring the development of strategies for successful play, rather than chance, provide evidence that the students saw strategic play as an important factor in an engaging game. Their enthusiasm for such features is an encouraging sign of their cognitive development since this aspect of the games caused them great difficulty at the beginning of the project.

Reflections on Teaching Strategies

As a result of student absences or preferences, most students played the games with the same people each session and came to understand their opponent's playing style very well. Perhaps the sessions would have been more effective in providing a range of opponents if the games were played on a 'round robin' basis where all students play the same game with every other student before moving onto the next game. This would allow the students the advantages of a variety of playing partners and playing the same game several times in order to develop more successful playing strategies. It would introduce an element of competition, which may assist in motivating reluctant players, though Udvari and Schneider (2000) considered it important to distinguish between competition only for winning and competition to improve one's personal best.

Whilst the students' playing strategies improved over the sessions, the students did not appear to improve in their ability to verbalise their strategies. This may have been because they did not regard a mathematics lesson to be the appropriate place for written work. They were often reluctant to talk about their strategies and even more reluctant to write very much, even though such discussions would not have advantaged other students as a new game was played each week. A better approach would be to draw out their strategies in a full-group discussion. It may be they have no ready language for this kind of analysis because they have never been asked to do it before. They may have experienced difficulty in making their emergent thinking available to their partners as suggested by Kieran (2001). A guided discussion in an open forum may have assisted the students to express their ideas better. Such a discussion would ideally take place after a particular game had been played, so a discussion of strategies at this stage would not advantage or disadvantage any student during the game itself.

Conclusions

Students displayed their development in the higher order thinking skills of analysis and synthesis as they played games and planned strategies of increasing complexity. They showed an improvement in the higher order skills of spatial visualization and logical reasoning as they visualized the possible outcomes of their opponent's moves and constructed a countering plan a number of moves in advance. Each turn required an if-then analysis of many possible alternative moves using inductive and deductive reasoning, along with a re-evaluation of their game plan in response to their opponent's moves. Competition was an important factor in the success of the program. Students formulated ever more complex strategies as they strived to win the games.

The students' creation of their own games was not a trivial exercise. They synthesised concepts from both their experience of playing the traditional games and the examination of the modern commercial games. The creation of games by students demonstrates their ability to use the ideas found in other games to develop an original, functioning game. An important feature of these games was that the development of successful strategies required high levels of thinking. The students were able to transfer ideas embedded in these games into a finished product.

These games could be used for early-finishing students in a mixed ability classroom could easily be given these games to play rather than unnecessary repetition of material already mastered. This study demonstrates that traditional strategy games provide a convenient, engaging, low cost alternative with the potential to extend students' higher order thinking.

References

Ascher, M. (2001). Learning with games of strategy from Mongolia. *Teaching Children Mathematics, 8*(2), 96-99.

Begg, A. J. (1997). *Games in the classroom*. Retrieved November 13, 2002, from the World Wide Web: http://www.ex.ac.uk/cimt/games/gameclas.htm

Booker, G. (2000). *The maths game: using instructional games to teach mathematics*. Wellington, N.Z.: NZCER.

Bright, G. W., Harvey, J. G., & Wheeler, M. M. (1985). *Learning and mathematics games*. Reston, Va.: National Council of Teachers of Mathematics.

Callahan, C. M. (2001). Beyond the gifted stereotype. *Educational Leadership, 59*(3), 42.

Cruz, R. E. de la, Cage, C. E., & Lian, M. J. (2000). Let's play mancala and sungka. *Teaching Exceptional Children, 32*(3), 38-42.

Dixit, A. K., & Skeath, S. (1999). *Games of strategy*. New York: Norton.

Geake, J., & Vialle, W. (2002). *The gifted enigma: a collection of articles originally published in the Australasian Journal of Gifted Education*. Cheltenham, Vic.: Hawker Brownlow Education.

Gough, J. (1999). Playing mathematical games. *Australian Primary Mathematics Classroom, 4*(2), 12-15.

Hiebert, J., Gallimore, R., Garnier, H., Giwin, K. B., Hollingsworth, H., Jacobs, J., Chui, A. M.-Y., Wearne, D., Smith, M., Kersting, N., Manaster, A., Tseng, E., Etterbeek, W., Manaster, C., Gonzales, P., & Stigler, J. (2003). *Teaching mathematics in seven countries: Results from the TIMSS 1999 video study*. Washington DC: US Dept of Education, National Centre for Education Statistics.

Higgins, K., & Boone, R. (2003). Beyond the Boundaries of School. *Intervention in School & Clinic, 38*(3), 138.

Hildebrandt, C. (1998). Developing mathematical understanding through invented games. *Teaching Children Mathematics, 5*(3), 191.

Joseph, L. (2002, September). Games children play. Retrieved November 13, 2002, from the World Wide Web: http:www.infotoday.com/mmschools

Kieran, C. (2001). The mathematical discourse of 13-year-old partnered problem solving and its relation to the mathematics that emerges. *Educational Studies in Mathematics, 46*(1-3), 187.

Kennedy, D. C., & Kennedy, J. A. (1974). *Blanks bring out the best in us*. East Bentley, Victoria: L&S Publishing.

Kohl, H. (1974). *Writing maths & games: In the open classroom*. London, Great Britain: Cambridge University Press.

Minchew, S. S. (2001). Teaching English with humor and fun. *American Secondary Education, 30*(1), 58-70.

National Council of Teachers of Mathematics. (1973). *Instructional aids in mathematics* (Vol. 34). Washington, USA: National Council of Teachers of Mathematics.

Naylor, M. (2002). Strategy games with paper. Retrieved November 13, 2002, from the World Wide Web: http://www.TeachingK-8.com

Pohl, M. (2000). *Learning to think thinking to learn*. Australia: Hawker Brownlow Education.

Randel, J., Morris, B., Wetzel, C., & Whitehall, B. (1992). The effectiveness of games for educational purposes: a review of recent research. *Simulation and Gaming, 23*(3), 261-276.

Rea, D. (2001). Maximizing the motivated mind for emergent giftedness. *Roeper Review, 23*(3), 157-164.

Renzulli, J. (2002). Emerging conceptions of giftedness: Building a bridge to the new century. *Exceptionality, 10*(2), 67-75.

Rief, S. F., & Heimburge, J. A. (1996). *How to reach & teach all students in the inclusive classroom: ready-to-use strategies, lessons, and activities for teaching students with diverse learning needs*. West Nyack, N.Y.: Center for Applied Research in Education.

Udvari, S. J., & Schneider, B. H. (2000). Competition and the adjustment of gifted children: A matter of motivation. *Roeper Review [H.W. Wilson - EDUC], 22*(4), 212.

United Kingdom Qualifications and Curriculum Authority. (2002). *Guidance on teaching gifted and talented pupils*. Retrieved November 13, 2002, from the World Wide Web: http://www.nc.uk.net/gt/mathematics/index.htm

University of Waterloo. (1971, 15/6/2003). *Elliott Avedon Museum and archive of games*. University of Waterloo, Ontario, Canada. Retrieved 30 September, 2003, from the World Wide Web: http://www.ahs.uwaterloo.ca/~museum/index.html

Williford, H. (1992). Games for developing mathematical strategy. *Mathematics Teacher, 85*(2), 96-98.

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