Non-traditional interventions to stimulate discussion: the use of games and puzzles

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There is substantial literature on the use of non-conventional approaches to promote learning, such as games and crosswords, but there has been little investigation into how useful students find them. This paper outlines the results of an investigation into whether first year biology students used card game discussions and crosswords provided to help them in their learning, and how useful these resources were perceived to be. The perceptions of teaching staff with respect to the resources were also evaluated.

Use of the resources varied, with 81% using the curriculum-embedded 'card game discussions' and 54% using the non-compulsory crosswords. Students who used these resources found them of benefit to their learning, whilst those who did not use them indicated a preference for other learning resources. Staff perceived that the card game discussions were designed for active learning, integration of content and revision, but that the main use of crosswords was for revision, terminology and fun.

The positive response of the majority of students about the usefulness of the learning opportunities encourages the development of further resources, but the fact that some students did not use the materials reminds academics that a variety of learning resources need to be available for students.

Key words: Card game discussions, Crossword puzzles, Effectiveness, Evaluation.

Introduction

For over a decade the First Year Biology Curriculum Committee at The University of Sydney has, within the large first year cohort, recognised the value of small group discussions in the promotion of peer-assisted learning and the development of communication skills. The Committee has also acknowledged that students have different learning styles and therefore we, as teachers, need to use a variety of techniques, embedded in the teaching and learning environment, to assist their learning. The work of De Vito (2001) and Heffler (2001) endorses this perception. The strategies used to set up learning communities in these first year biology courses are thus varied to accommodate the range of learning skills of students and to minimise repetition and boredom. Over the years, as part of curriculum change, various activities (interventions) have been introduced that involve students taking a greater degree of responsibility for their learning (Franklin and Peat, 1996). Among the activities used to promote active learning in the first year biology laboratory classes is the use of discussion games and crossword puzzles. It is argued that games foster group cooperation (Chung, 1996), and typically create a high level of student involvement that makes them useful tools for effective teaching (McKeachie et al., 1990). One of the chief advantages of games, simulations and puzzles in an educational setting is that students are active participants rather than passive observers, making decisions, solving problems and reacting to the results of their decisions.

There is substantial literature on the use of innovative and non-conventional approaches to promote interest and learning in education and many of these focus on case studies, role-play and simulation games, in particular in the area of business studies and health related areas (e.g. Beard and Hartley, 1984; Leigh and Kinder, 1999; Lundy, 1991). There is less literature on the use of (smaller) games and puzzles in education, although it has been suggested that such aids can offer students an alternative strategy to help slot concepts into place (Childers, 1996). Such approaches help enrich the formal curriculum by exposing students to a creative form of learning and introduce a fun element into the lesson, thus diminishing drudgery in learning contexts, as well as reviving flagging enthusiasm among students when attention is waning (Subramaniam et al., 1999). A variety of games and puzzles have been described in the biological, chemical and geological sciences (McKenny, 1970; McTiffin, 1996; Mambrela et al., 1993; Subramaniam et al., 1999; Russell, 1999; Reuss and Gardulski, 2001), all designed to make the subject more interesting and fun and improve student learning outcomes. However, there is very little data on the students’ perceptions of the usefulness of these games to their learning. Reuss and Gardulski (2001), who used an interactive board game in tertiary first year geology classes, in conjunction with traditional laboratory work, group discussions, etc., report that students rate the game-format course significantly higher than the traditional-format course, indicating that it is an effective teaching tool.

Crossword puzzles have been used as a teaching technique in disciplines such as communications (Haun, 1985), health (Dannrosch, 1994), psychology (Crossman and Crossman,
1983) and reading (Hyde, 1983), resulting in improved retention of facts and association of concepts, as well as increased levels of confidence. In particular, crosswords are useful in reinforcing definitions and spelling of terms (Hyde, 1983), which are considered to be an important skill in the biological sciences. Currently, with the use of computer-based crossword makers, producing the puzzles is much less time consuming than the previous mechanical methods of construction. As with the use of games in an educational setting, there is very little literature on the effectiveness of crossword puzzles on student learning. Crossman and Crossman (1983) in their evaluation of the effectiveness of crossword puzzles reported that students enjoyed the puzzles, were more motivated to work and retained the material better than prior to the introduction of the puzzles. Childers (1996) indicates that the use of the crosswords increased students' confidence in their ability, helped them in understanding some of the concepts and stimulated them to think about what they were learning.

This paper examines the role of discussion games and crossword puzzles within the learning opportunities for a large group (1300) of first-year biology undergraduate students. The students are campus-based and attend lectures and laboratory sessions in most weeks of the semester. Due to the large size of the cohort, students are mainly taught in the laboratory sessions by casual teachers, who are often postgraduate students without a great deal of teaching experience and who may only teach for a couple of years. The paper addresses questions about the use and usefulness of these materials from the point of view of both students and staff rather than investigating what or how much the students had learned from them. With respect to student use of these resources, the investigation concentrated on how many of the students were using them, what their perceptions were of the usefulness of these resources, and, if they did not use them, why not. With respect to the laboratory teaching staff, the investigation asked about their perceptions of the rationale behind the development of the resources, how they thought the students would use them and how they interacted with the students during their use of the card game discussions. The authors were particularly interested in the alignment between the teaching staff perceptions of, and the developers' aims for, these resources.

**Description of discussion card games and crossword puzzles**

Over the last decade we have developed a variety of 'card games' (described in Franklin and Peat, 1996), used as aids to stimulate group discussion, by bringing together information and concepts from a number of sources to assist students in the pulling together and linking of material. The 'card game' elements include logic, memory, visualisation and problem solving as described by Amory et al. (1999) in their study of game types in biology. In the context of this paper, 'game' does not refer to a simulation or competition (as in the strict sense) but to an activity played using a series of cards that is intended to stimulate active learning through problem solving. Each card game, known as a card game discussion, is described within the student notes with directions as to how to 'play' the game, and with questions for the students to complete during play. The 'games' are embedded in the curriculum and there is an expectation that all students will use these resources during the relevant laboratory session. One of the primary aims of these resources is to be a fun activity for the students and encourage group discussion as well as being an active learning experience. It is hoped that, when used in this way, these card game discussions would help students develop a confidence with integrating the content of the course. They are designed to be very flexible in their use and to be interactive, requiring no real staff input except as a moderator at times during the game. Examples of the different types of card game discussions are:

- **The Animal Reproduction Game**: students in groups of five are provided with a pack of playing cards depicting, in picture or text form, the life cycles of frog, earthworm, chicken, rat and human. Within the pack are five sets of cards, each set comprising six cards, which together contain the complete life cycle of one of the organisms. The game is played like 'Happy Families' with cards being exchanged between players until one player holds a complete set and is declared the winner. The game therefore requires that the students are familiar with the life cycles of all the organisms.

- **The Cell Game**: students are provided with a package containing a variety of cards depicting the parts of a cell, the names of structures within a cell and the functions of structures within a cell. The students draw the outline of a cell on a large sheet of paper and arrange the cards as a collage to create a functioning cell.

- **The Digestion Game**: students are provided with a package containing sets of coloured cards. One colour set comprises the anatomical structures within the digestive tract, another colour set comprises the secretions involved in digestion and another the components of a meal and their breakdown products. The students arrange the anatomy cards on a large sheet of paper in the form of a flow chart and add the secretions to the structures that produce them. Then they trace the passage of the food items as they pass through the digestive tract, indicating the action of the secretions and where they are absorbed. As the flow chart is built up showing the process of digestion, the students can write or draw additional information on the sheet of paper.

More recently, crossword puzzles have been developed using CrossWord Maker98 software, and included in several courses. The aim of introducing crosswords was to provide another fun exercise that would give students a 'quiz' on some of the course content, in order to help them identify areas of weakness. In particular, the crosswords contained clues pertaining to definitions and terminology. Each crossword was handed out in a practical session to be completed in the laboratory or at home. It was expected that most students would use this type of resource individually and that not all students would choose to use them as they were provided as a non-compulsory learning/revision resource. Initially solutions were not provided, but it quickly became apparent that the students needed this type of feedback. Consequently, a solution is provided on the students' Virtual Learning Environment (http://FYBio.bio.usyd.edu.au/VLE/L1/) two weeks after the crossword puzzle has been handed out.

Whilst the card game discussions are used within the laboratory situation and focus on a specific biological topic that has been studied in the laboratory, they are not the only laboratory-
related activity to help stimulate student motivation and learning. There are computer programs available in the laboratory on biological topics and these are used in conjunction with handson materials as well as replacement in some cases (Franklin, Peat and Lewis, 2002). The laboratory notes also have a quiz section at the end of each session that provides an opportunity to assess knowledge and understanding. In comparison, the crossword puzzles are provided as voluntary activities to do outside formal teaching time and give students another way of self-assessing their knowledge and understanding. Each crossword covers three or four biological topics.

Methods

The students (n=1300) enrolled in the first year biology courses are randomly timetabled into 21 laboratory sessions by the university timetabling computer. In 2001, quantitative and qualitative evaluation of student perceptions of their experiences of using the card game discussions and crossword puzzles for learning were carried out, during randomly selected laboratory sessions, at the end of the appropriate courses. The card games paper-based survey was administered in five laboratory sessions to 270 students and the crossword paper-based survey to 180 students in three laboratory sessions. Participation was voluntary and anonymous. Students were questioned about their use of the resources, and in particular their reasons for non-use. For those students who used the resources, their perceptions of the usefulness were investigated using a five-point Likert scale, with students classifying statements according to whether they strongly agreed, agreed, were uncertain, disagreed or strongly disagreed with them. Their responses were analysed as Likert means. Open-ended questions asking students how they had used the resources and what they learnt from using them were thematically analysed and categorised (according to Denzin and Lincoln, 1994).

The perceptions of laboratory teaching staff (n=21) of the use of games and puzzles for student learning were investigated using a qualitative survey instrument at the end of the courses.

Results and discussion

The response rate of the students to each survey was approximately 80%. Since the students are randomly assigned to laboratory sessions it was assumed that this sample was representative of the entire cohort. All the relevant teaching staff completed the questionnaire.

Student usage of resources

Student use of the resources varied. The data show that 81% of students surveyed used the card game discussions and 54% of students used the crossword. This may be a reflection of the nature of the activity. The crossword puzzles were handed out in practical classes as a voluntary activity, whereas games were scheduled parts of the practical session. Encouragingly, of the 46% of surveyed students who had not used the crossword, half indicated that they had not had time yet and that they would do them later for revision, suggesting that approximately 77% of students might use the crossword puzzles. This is similar to the Childers (1996) study of sociology students, 83% of who used the crossword puzzles provided.

Of the students surveyed, 19% did not use the card game discussions, which are embedded in the curriculum and should be perceived as compulsory, and potentially 23% of students would not have used the crossword puzzles. Previous work by Franklin et al. (unpublished) indicates that our first year biology students are not always using all the learning resources provided. This unpublished study shows that between 9 - 21% of students are choosing not to use at least one of the learning opportunities provided. This non-use of the resources mirrors the research of Oliver and Omari (2001) and previous work by Franklin et al. (2001), who found that in their studies approximately 20% of students were not using computer-based resources. Non-use of particular resources may be due to a number of reasons, including students preferring to concentrate only on the set course materials and not using any additional materials to support their learning, or preferences for certain types of resource according to learning style.

Student perceptions of usefulness of resources

Student responses about the usefulness of the resources are shown in Table 1 as Likert means, with a mean of 5 indicating strong agreement with the statement.

With respect to the four common statements about the usefulness of the resources, the data indicate that there was stronger positive response to the use of crossword puzzles, which may reflect the voluntary nature of the activity and that they may appeal to the more motivated student. However, there is still a positive student response to the use of card game discussions. It is interesting to note that the students did not rate the card game discussions very useful for helping them to integrate the content for a particular topic or to develop confidence in the topic, even though the curriculum team considered these to be important aims of this type of resource.

Of the 81% of students who played the card game discussions, only 28% rated them as very good/ good and 50% as OK. However 45% reported that they were fun to do (in agreement with the curriculum team aims), and 47% would like a card game on each of the major topic areas in the course. Responses to open-ended questions, asking students about the usefulness of the card game discussions in their learning, were thematically categorised.

In response to the question 'What did you learn (from the resource)?', 20% indicated a knowledge of flowcharts, 18% indicated a use in revision, and 13% indicated an understanding about the concepts of the course:

'...helped sort out ideas by using flowcharts' 
'...great to help revise and sort out problems'

Responses indicating how the card game discussions helped in learning/ understanding specific biological topics included:

'How everything fits together in an overall picture, especially for the digestion system' 
'It helped me get a better understanding of the topics. It helped me understand digestion + circulation better.' 
'A great understanding of the processes involved in digestion, immunity and circulation.' 
'Revision and an overall view of the "layout" of the various organs and [circulation] vessels interconnecting them, and the path of nutrients/oxygen + CO₂ etc through them'

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Table 1 Perceptions of the usefulness of resources in enhancing learning (Likert means where 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree).

<table>
<thead>
<tr>
<th>Card games</th>
<th>Crossword puzzles</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 163</td>
<td>n = 51</td>
</tr>
<tr>
<td>The resources help me assess my understanding</td>
<td>3.58</td>
</tr>
<tr>
<td>The resources make revision easier</td>
<td>3.21</td>
</tr>
<tr>
<td>The resources are useful in helping me learn</td>
<td>3.39</td>
</tr>
<tr>
<td>The resources help with my recall of definitions/terms</td>
<td>3.31</td>
</tr>
<tr>
<td>The card games help me to integrate the content for a particular topic</td>
<td>3.31</td>
</tr>
<tr>
<td>The card games increase my confidence in the topics</td>
<td>2.79</td>
</tr>
<tr>
<td>The crosswords help with my spelling of terms</td>
<td>n/a</td>
</tr>
<tr>
<td>The crosswords prompt me to revise a particular topic</td>
<td>n/a</td>
</tr>
</tbody>
</table>

The reasons given by the 36% of students who indicated the resources were not very helpful to them included: were too difficult/ too long (42% of responses); confusing (24%); not enough help (11%); boring (10%); with miscellaneous comments (13%):

"...they were too complicated to do; too confusing; didn’t know what we were doing"

In answer to why students had not participated in the card game discussions (19% of the survey returns), the reasons given were not enough time (32% of responses), not like/ prefer other modes of learning (30%) and confusing/ boring (26%):

"...ran out of time"
"...not interesting enough to do"
"...prefer to use other resources; don’t like this type of material"

With respect to the lack of time, the laboratory classes are being restructured so that the use of the card game discussions will be scheduled at the beginning of the next week's laboratory session, rather than at the final activity, so time should not be an issue in future. In addition the students will have had a chance to revise/ reflect on both the relevant practical and lecture content before using the card game discussions, enabling better integration of concepts. Some of the open-ended responses indicate that students would have preferred more help with the card game discussions both during and after using the game. This suggests that debriefing after using the card game discussions may be more important than originally recognised in the initial design. Lundy's research (1991) stresses the importance of time being allocated for feedback/ debriefing after the game. She also indicates that while this point is often accepted in theory, in practice it is often neglected leaving students confused and unhappy. It is suggested that during a debriefing tutors should spend time resolving difficulties and confusions that have arisen from the game, so that students may feel confident they can understand the concepts encountered and that they can apply them in future.

In summary, those card game discussion resources are available to be used in scheduled laboratory classes (expect a usage figure of 100%). Reasons given for not using them (19% of students did not use them) suggest that they do not suit all learning styles ('prefer other modes of learning'), and that the way they are presented in class could be improved ('confusing/boring' — a statement made by students who had not actually tried them).

Of the 54% of students surveyed who attempted the crossword puzzles, 88% rated them as very good/ good and the majority (91%) wanted more puzzles, in particular ones focusing on each topic in the course. This is similar to the data from the study by Childers (1996), who found that the majority (96%) of students perceived the crossword puzzles as helpful in their learning and that half reported that they helped them study for the final exam. Three quarters of the current study's students tried to complete most of the puzzles and found them fun to do. Most students (68%) also indicated that they were easily able to find answers to clues they were not sure of in the notes or textbook.

Responses to open-ended questions, asking students about the usefulness of the crossword puzzles in their learning, were thematically categorised. Asked about the usefulness of the crossword puzzles, students indicated they were enjoyable/ fun to do (40% of responses), they helped identify areas for revision (28% of responses) and helped reinforce content/ topics/ ideas (28% of responses):

"...fun way to revise; enjoyable"
"...help focus on major areas/topics/reinforces ideas"

As a result of the data from the puzzles, this cohort of students stated that they were helpful in the areas of terminology, spelling and/ or definitions (69% of responses). This is also reflected in the Likert means of 4.18 for recall of definitions/ terms and 3.65 for spelling (Table 1). In a similar study Crossman and Crossman (1983) found students noted changes in spelling awareness and working for greater accuracy while using crossword puzzles.

It was apparent that students who used but did not find the crossword puzzles useful thought them to be too hard (47% of responses) or too meaningless (33% of responses) or that they were not interested in doing them (20% of responses):

"...too hard"
"...encouraged rote learning"

Reasons for the 46% of students not doing crosswords included: had no time (55% of responses); had not realised they existed (25% of responses); or thought they were too trivial to bother with (20% of responses):

"...too easy/trivial"
"...not realised they existed"

In summary, for those students who attempted the crosswords the resource is useful, particularly in helping them to focus on each topic and test themselves on their overall knowledge in the topic area.

Laboratory teaching staff perceptions of the learning resources

Teaching staff perceptions of the use of card game discussions and crossword puzzles in student learning were surveyed using open-ended questions. Their responses were thematically categorised.
In answer to the question ‘What do you think was the purpose of the card game discussions?’, only 20% of the 21 responses indicated teamwork and active learning as the purpose, suggesting that the perceptions of the majority of staff are not in alignment with one of the primary aims of the curriculum development team. However, 40% of the staff suggested that the purpose was to offer the opportunity to gain an overview of the material by integrating and sequencing the content within the framework of the topic. A further 40% of staff perceived that the card game discussions provide an opportunity for immediate revision of the material.

There appears to be some misalignment between staff and student perceptions of the requirement for some briefing and debriefing of the participants during the card game discussions. This is reflected in staff responses to the open-ended question ‘How did you interact with the students while they were doing the card game discussions?’. Staff indicated they were acting more at an administrative level to give explanation/instructions of how to use the resource (95%) and to encourage them to use the resource (5%), rather than at an academic level. There was no mention of a feedback or debriefing session by the staff. These responses also indicate that the card game discussions would probably benefit from better alignment in the student notes and better instructions on how to play each card game discussion.

Teaching staff had little involvement with the way students used the crossword puzzles, as it was not intended that they should be used during class time. Staff, however, were asked by open-ended questions what they thought students would gain from using the crossword puzzles and their responses were theoretically categorised. Staff considered that students would find the resource interesting and fun to use (32% of the responses), a useful revision resource (32%), a means of self-testing (18%), and a help with terminology/ spelling (14%). This is in alignment with the purpose and reasons for developing this type of resource. It is interesting to note that students and staff responses were similar except that students considered this resource to be much more useful for the recall of definitions, terminology and spelling (69% of student responses) than the staff did (14% of responses).

Staff comments to the question ‘What do you think the students gained from using the crossword puzzles?’ included:

‘The opportunity to use knowledge they have gained in a way which is not simple regurgitating the answer to a question which they have already seen’
‘Fun revision sometimes they asked for answers they didn’t know, so it prompted asking question and they would offer responses so it also prompted research’
‘Found them fun, prompted memory for terms. Learning terminology was daunting for many!’

Educational implications

In the biological sciences, the use of games and puzzles as a pedagogical tool is relatively common, but there is very little research as to their effectiveness in learning, or student and staff perceptions of their usefulness. This study focused on the value of games and puzzles in a tertiary setting. Overall, first year biology students believe that the card game discussions and the crossword puzzles are useful aids to their learning and this finding encourages us to continue with their use, and develop more. However, some of the evaluations suggest that a number of the card game discussions, originally designed about 10 years ago, are in need of renewal/modernisation, including making them more visually appealing for the student of the 21st century. Feedback from both staff and students indicate the games would benefit from a more overt description of the activity within the student notes, including directions on how to ‘play’ the game and an exercise that draws on the completed game or puzzle to create a synthesis of the concepts. As the data suggest that debriefing after using the game may be more important than originally recognised in the initial design of the games, there is a need to improve the information and instructions given to staff. It is considered that remodelling will enhance the assimilation of these materials into the biology courses, all of which have changed considerably since the introduction in 1996 of semester-length courses. The remodelling will take into account feedback from students and staff, in particular incorporating novel ways of using the materials. In addition to refurbishing the games, they will be used at the beginning of a laboratory session, allowing time for reflecting on the previous week’s work, with time for a suitable debriefing session. This change will be in line with Lundy’s argument about the educational benefits of such sessions (Lundy, 1991).

As our study was based on student perceptions of the usefulness of games and puzzles to their learning in first year biology, we need to determine whether use of these resources has an impact on student learning outcomes, in order to better inform students of the effectiveness of learning materials. Further research will focus on use/non-use in relation to outcomes such as performance in assessment items. However, this may be difficult to address, as these resources are part of an integrated suite of resources that students may choose to use or not use in the learning process.

References


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