

Ionic Cards: A Multipurpose Game to Study Ionic Formula in Chemistry

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Abstract: The traditional teaching of ionic formulas in Chemistry is insufficient for students to grasp the concept of ionic Formulas. Formula writing needs practice and understanding if a student wants to get the idea. In today's education, it is emphasised that students should be engaged collaboratively in the learning process, while teachers should serve as guides for the students. In this quantitative research, a proposed game-based learning approach is the collaborative learning process of ionic formula writing. The card comprises 26 round cards made of thin woods with two different colours to differentiate the positive and negative ions. Using the ionic cards in formula writing by 37 form four secondary school students in Cheras found that card games positively affect perceived learning effectiveness and Satisfaction. There is also an association between learning effectiveness and satisfaction. The game will start with students playing the memory game to test their understanding of the 26 ionic in their chemistry syllabus. Once the students have mastered the name of all 26 ions, they will move to the second phase of the game, formula building, and finally, calculation of the Molar Mass. Students will incorporate mathematics in this game-based learning, where they will calculate the molar mass of the ionic compound. The ionic card is in a dual language of Bahasa Melayu and English, making it a multilingual card game besides being a multipurpose card game.

Keywords: Gamification, Chemistry, Collaborative learning

1. Introduction

Swift technological development and changes have shifted the roles of students and teachers, followed by environmental changes in classrooms and schools[1]. The Ionic Card game is utilised as a formative assessment parallel for playing a memory card game, a formula-building game, and determining the molar mass of the compound in a gamification style. The definition of gamification is an educational activity that fosters learners' motivations and provides views and incentives [2]. The development of cognitive skills and problem-solving ability, an essential part of knowledge construction, can be developed using games in the teaching and learning [3]. Research indicates games' effectiveness in the education field [4]. The pedagogical approach with serious games is a growing trend

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in today's systems in the teaching and learning [5]. The 21st-century classroom pedagogical advances provide an adequate good choice for students who may feel convenient to attain knowledge aided by teachers and peers. The games in this study are not only entertaining material but the foster active engagement of all students who will cultivate mastery learning of ionic formula while playing and having fun. The conversation between peers is an essential introductory section in mounting thinking and evaluation. This study will explore using educational games in various pedagogical approaches, including memory games, formula building, and calculation. A Likert five-scale questionnaire implemented in this research is classified into two categories, effectiveness and student satisfaction. Game-based approach is based on a constructivist theory of the learning [6]. Students are challenged and engaged, and each student is enabled to construct their knowledge. Interaction with other students plays a significant role in developing new knowledge and skills. Collaborative or cooperative learning allows participants to exchange information to solve a particular problem which can result in the production of solving a specific issue, which can produce new ideas. There are many definitions of student satisfaction available in the literature. In this paper, student satisfaction is how a student sees that his needs, goals, and desires have been fully fulfilled using the ionic card to formula building, and finally, calculation of the Molar Mass.

2. Materials and Methods

2.1 Materials

The ionic card consists of blue and red colours for the differential of the positive and negative ions. Materials used to make the cards are rounded wooden materials with a diameter of 8 cm. Printed on one side is the symbol of the ions plus its name in Malay and English. Meanwhile, on the reverse side is the card's colour, red for negative ions and blue for positive ions.

2.2 Methods

Students are divided into two groups, each consisting of at least four. Students will first need to play the memory game to know the formula and names of all the positive and negative ions. This is achieved with students playing the memory game. Each group will take turns in opening the same ions. Each same ion opened will get one point. The first part of the game is to ensure the students know the basics of formula building. Once students finish opening all cards in the memory game, they will start formulating the ionic formula in the second part.

The second part of the game will further incorporate the basic knowledge to build the ionic formula. In this game, each student from each group will pick one positive and one negative ion; on a piece of paper, they will write the formula and name. Each correct recipe gets the point, wheels each right name will also get the point. If either one of the answers is incorrect, then the other group may attempt to answer where there will be awarded one point if correct. If the group got the wrong answer, they might scan the QR code provided to check for the right answer. The Teacher, as the facilitator, will provide the proper scaffolding for the student in ionic formula constructions. The basics are (i) the total charge of an ionic compound is always equal to zero: and (ii) poly atomic ions are to be written in brackets if it is more than one in the ionic compound.

Finally, the third part of the game will require students to build the ionic formula and calculate the correct molar mass. If either one of the answers is incorrect, then the other group may attempt to answer where there will be awarded one point if correct. If the group got the wrong answer, they would scan the QR code provided to check for the right answer.

At the end of the game, students will answer an online questionnaire using Google Form consisting of two parts; the first part of the questionnaire is seven items in the questionnaire to find out the perceived learning effectiveness of the game. The second part of the Google Form consisted of seven

questions regarding satisfaction in playing the game. The instrument uses the Likert scale with the choice of "Strongly Agree," "Agree," "Neutral," "Disagree," and "Strongly Disagree." The Likert Scale is commonly used in social sciences to measure attitudes [7]. The questionnaire in Table 1 was adopted from research by scholars studying the effectiveness of the games field [8-10]. All the adopted items in the past research were used in quantitative research. Research to find out the effectiveness of online learning is one example of the past use of the instrument field field [9]. Apart from that, the same items were used to find out the effectiveness of synchronous and asynchronous learning field field [8]. Besides that, it was also used in determining the effectiveness of an online virtual reality game, [10].

Additionally, the second part of the instrument consists of seven survey questions to find students' satisfaction with gamification in Chemistry. The questionnaire on satisfaction in Table 2 was adopted to determine satisfaction. The researcher's data was collected from 210 junior high school students from Taiwan. Notably, the research is based on the effectiveness of a technology-mediated virtual learning environment (TVLE) [5].

3. Results and Discussion

Based on **Table 1**, the calculated mean value for the seven items measuring the Perceived learning effectiveness is between 1(Strongly Agree) to 2(Agree). This indicates that students either strongly agreed or agreed that they learned much factual information about the topics and were interested to learn about the issues after playing the game. Students were also happy with the immediate information gained in this game-based learning environment, the teaching methods in this game-based learning environment, the learning environment, and the overall learning effectiveness.

Table 1: Calculated mean value for the seven items measuring the Perceived learning effectiveness is between 1(Strongly Agree) to 2(Agree).

		Mean	Median
1	I was satisfied with this type of game-based learning experience.	1.53	1
2	This game-based learning environment provides a wide variety of learning materials.	1.61	2
3	I don't think this game-based learning environment would benefit my learning achievement	2.33	2
4	I was satisfied with the immediate information gained in this gamebased learning environment	1.36	1
5	I was satisfied with the teaching methods in this game-based learning environment.	1.56	2
6	I was satisfied with this type of game-based learning environment	1.64	2
7	I was satisfied with the overall learning effectiveness	1.44	1

Additionally, based on **Table 2**, students either strongly agree(1) or agree(2), based on the mean score. This resulted in satisfaction with the game. Students understood the basic concepts of the materials, knew to identify the main and important issues of the topics, and the learning activities were meaningful. The survey on Satisfaction indicates that students either strongly agree or agree that they were satisfied with this type of game-based learning experience and this game-based learning environment provides a wide variety of learning materials

Table 2: Satisfaction survey results from the calculated mean value for the seven items measuring the Perceived learning effectiveness is between 1(Strongly Agree) to 2(Agree)

		Mean	Median
1	I was more interested to learn the topics	1.5	1.5
2	I learned much factual information about the topics.	1.72	2
3	I gained a good understanding of the basic concepts of the materials.	1.61	2
4	I learned to identify the main and important issues of the topics.	1.69	2
5	I was interested and stimulated to learn more.	1.64	2
6	I was able to summarise and conclude what I learned.	1.64	2
7	The learning activities were meaningful.	1.53	2

A Spearman correlation test using SPSS was performed to test whether there was an association between learning effectiveness and Satisfaction. **Figure 1** shows the Correlation between satisfaction and learning effectiveness. The result of the Spearman correlation showed a significant association between learning effectiveness and Satisfaction, $r(34) = 0.8, p = <.001$. There is a very high, positive correlation between learning effectiveness variables and Satisfaction with $r = 0.8$. Thus, this sample has a very high positive association between learning effectiveness and Satisfaction.

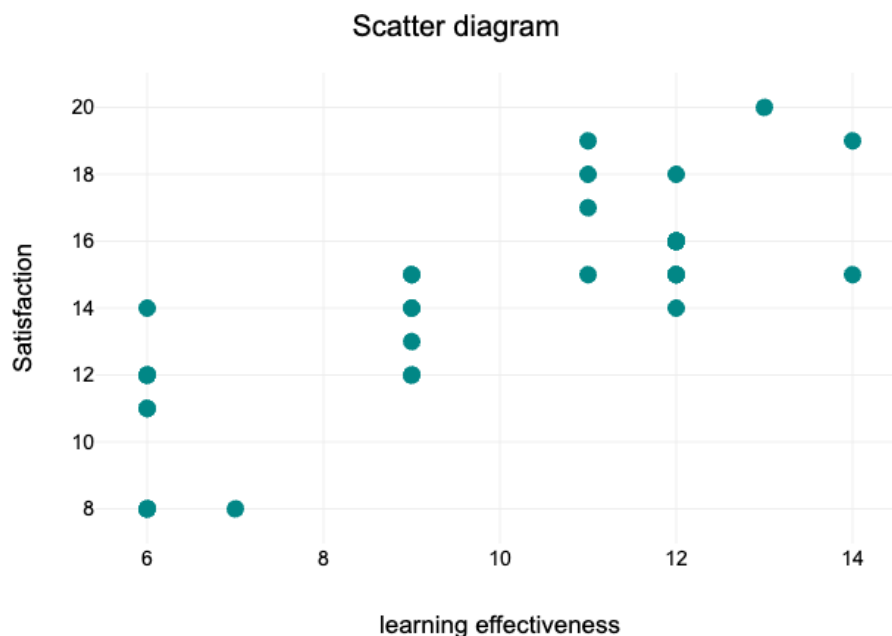


Figure 1: The scatter diagram to show the Correlation between satisfaction and learning effectiveness

4. Conclusion

The research indicates that developed card games positively affect perceived learning effectiveness and Satisfaction. There is also an association between learning effectiveness and satisfaction. In conclusion, as the essential aspect of learning chemistry topics that are abstract to students, ionic card games can be considerably a choice for teachers in the classroom. The association between perceived learning effectiveness and satisfaction can be addressed in future research related to game-based learning. This research only covers ionic card games in secondary school children

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