TEACHING STUDENTS ABOUT CHEMICAL ELEMENTS USING DAILY-LIFE CONTEXTS

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Abstract: Learning the names and symbols for chemical elements is a task that students often find dull, although it is of crucial importance for understanding chemistry. In this respect, the use of games or similar play activities could make the learning experience more enjoyable. This paper presents the results of a study in which two tasks involving play (TIPs) and based on daily-life contexts (football and the home) were used to teach the names and symbols of chemical elements. The experimental group comprised 38 year-10 students who studied this topic through a teaching unit built around the TIPs. A control group of 67 year-10 students followed a traditional teaching approach to the same topic. The effectiveness of the TIPs was assessed using three items, administered pre- and post-test, that explored students' knowledge about metallic and non-metallic elements and their ability to identify them in their everyday environment. Following the TIP-based teaching unit, students in the experimental group gave a higher percentage of appropriate answers, with the Wilcoxon test indicating significant post-test differences for all three items. However, the Kolgomorov-Smirnov test indicated that the experimental and control groups only differed significantly at post-test in their ability to give the names and symbols of non-metals, with the experimental group performing better. Memorising the names and symbols of chemical elements is a complex task for students, and identifying their presence in everyday environments appears to be particularly difficult. However, the results suggest that the use of TIPs linked to daily-life contexts could help students with their learning of this topic.

Keywords: periodic table, educational games, daily-life contexts

INTRODUCTION

In the context of school chemistry the use of the periodic table presents students with a large amount of information about the chemical elements as building blocks of matter. Consequently, its study is an important part of the school curriculum (Quinn et al., 2012; NGSS, 2013). However, as this often entails memorising a long list of names and symbols with no apparent link to everyday life, students consider the task to be dull one. In this respect, the use of teaching strategies such as games (Tan and Chee, 2014) or daily-life contexts could help to enhance students' learning.

With the aim of improving the teaching of chemical elements in the secondary school context we designed a teaching unit comprising 24 one-hour sessions (Franco-Mariscal, Oliva, Blanco and España, 2016) in which educational games and other play activities had a central role. A new type of educational resource, namely tasks involving play (TIPs), were included in this teaching unit. TIPs can be regarded as intermediate between play and game scenarios and may include artistic or technological creations by the student; they also allow the student to take an active role in the learning process. Many TIPs are based on daily-life contexts.

METHODS

This paper presents the results of a study in which two TIPs based on daily-life contexts were used to teach the names and symbols of chemical elements. In the TIP called 'national football manager, students were randomly assigned the name of a country that was going to compete in the World Cup, and their task was to select a team of players, represented in this case by chemical elements. Using the periodic table each student

had to select as many elements as possible by combining the letters that made up the name of the country they were manager of. Once they had formed their team, the task became an educational game in which students competed with one another in the different stages of the tournament.

In the other TIP, called 'identifying household objects and materials', students had to produce a drawing of an everyday environment with which they were familiar and to indicate different objects and materials in which chemical elements are present. To help students with this task, the teacher gave them a handout they could consult. In the following session, the students described their drawing to their classmates, indicating the object or material in which different elements could be found.

The effectiveness of this approach as a way of helping students to learn the names and symbols of chemical elements was assessed by means of three items: a) Give the names and symbols of five metallic chemical elements; b) Give the names and symbols of five non-metals; and c) A large proportion of the chemical elements form part of objects and materials that are present in our daily lives. Try to identify all the chemicals you know (up to a maximum of ten), along with the materials or objects in which they are present in items that you have at home. It does not matter if the elements are components of chemical compounds.

These items were administered as part of a longer questionnaire to two groups of students: an experimental group, who studied the topic of chemical elements via a teaching unit built around the two TIPs, and a control group, who followed a traditional teaching approach to the same topic. Students in the experimental group (38 year-10 students) answered the three assessment items before taking part in the teaching unit (pre-test) and again one month after its completion (post-test). Students in the control group (67 year-10 students from three different secondary schools in Spain) responded to the same items one month after receiving the traditional teaching approach.

Students' responses at pre-test and post-test were assessed by establishing a system of categories (appropriate, partially appropriate and inappropriate) (Franco-Mariscal, Oliva and Gil, 2016). For the 'football manager' task an appropriate response for both metals and non-metals was when the student could give the names and symbols of five elements; in both cases, giving four names and symbols was considered to be a partially appropriate response. For the 'household objects' task a list of 9 or 10 elements or materials was considered an appropriate response, while between 5 and 8 was regarded as partially appropriate.

Data were processed with the statistical software package SPSS 21.0. The Wilcoxon test was used to verify the existence of significant differences in the quantitative comparisons between pre-test and post-test in the experimental group. The Kolmogorov−Smirnov test was used to verify the existence of significant differences in the quantitative comparisons between the experimental and control groups.

RESULTS

Table 1 shows the percentages of responses in each category for the experimental group at pre-test and post-test. It can be seen that implementation of the teaching unit in this group led to an increase in the proportion of appropriate responses, with significant improvements being observed for all three test items.

Table 1. Percentages of appropriate and partially appropriate responses at pre-test and post-test in the experimental group, with results of the Wilcoxon test

Context	Task	Pre-test (%)		Post-test (%)		Wilcoxon Test	
		Appropriate	Partially Appropriate	Appropriate	Partially Appropriate	Z (df = 2)	p-values (N=38)
Football	a) Give names and symbols of a series of metals	34	16	74	13	-3.536	.000
	b) Give names and symbols of a series of non-metals	18	21	63	16	-3.707	.000
Home	c) Identify chemical elements	21	63	63	34	-3.424	.001

objects	in materials in the home environment	

Significance set at $p < .05$

In Table 2, which compares the post-test results obtained in the experimental and control groups, it can be seen that the two groups only differed significantly with respect to their ability to give the names and symbols of non-metals, with the experimental group performing better.

Table 2. Final student performance in the experimental and control groups, and results of the Kolgomorov-Smirnov test

		Control Group (%) (N=67)		Experimental Group (N=38)		Kolgomorov-Smirnov Test	
Context	Task	Appropriate	Partially Appropriate	Appropriate	Partially Appropriate	Z (df = 2)	p-value
Football	a) Give names and symbols of a series of metals	48	16	74	13	1.276	NS
	b) Give names and symbols of a series of non-metals	34	22	63	16	1.420	.036
Home	c) Identify chemical elements in materials in the home environment	63	36	63	34	0.056	NS

Significance set at $p < .05$; NS indicates no statistically significant difference.

CONCLUSIONS

Overall, the results suggest that memorising the names and symbols of chemical elements is a complex task for students, and identifying their presence in everyday environments appears to be particularly difficult. However, the significant difference observed between the experimental and control groups on one of the post-test assessment items suggests that the use of TIPs linked to daily-life contexts could help students with their learning of this topic. Although this result cannot be linked exclusively to the TIPs, the fact that the tasks were well received by students supports the conclusion that the game-based approach did at least make a contribution to the observed improvement in learning.

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