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WHO'S WHO?" TEACHING RISK PHRASES THROUGH DANGER SYMBOLS AND SIGNS OF SOME ACIDS

WHO'S WHO? ASİTLERİN TEHLİKE SEMBOL VE İŞARETLERİ İLE RİSK DEYİMLERİNİN ÖĞRETİMİ

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Abstract: A game, "Who's who" has been developed to be used in science and technology courses and in physics, chemistry and biology courses. The game is about acids. The purpose is to teach chemical danger symbols and meaning of some acids. Since the game improves the students' cognitive development and interaction among them, it will provide the children with an effective learning process. Through the game, students will have opportunity to learn the chemicals that they will use in laboratories repeating the related information whenever they wish and to reinforce their knowledge. "Students will learn through playing and will be saved through learning."

Keywords: Chemistry Education, Educational Games, Acids, Risk Phrases, Chemical Hazards.

ÖZET: Bu "Who is who" oyunu, fen ve teknoloji, fizik, kimya ve biyoloji derslerinde kullanılmak üzere geliştirilmiş bir oyundur. Oyun asitler ile ilgilidir. Amacı bazı asitlerin kimyasal tehlike sembolleri ve bunların anlamlarını öğretmektir. Bu oyun ile etkili bir öğrenme süreci sağlayarak, öğrencilerin bilişsel gelişim ve etkileşimi geliştirmek amacıyla planlanmıştır. Oyunu sayesinde, öğrenciler istedikleri zaman istedikleri yerde laboratuvarlarında kullanılan kimyasallar tehlikeleri ve sembolleri ile ilgili bilgileri öğrenme fırsatı bulabileceklerdir. "Öğrenciler oynayarak öğrenecekler ve öğrenme yoluyla kaydedilir."

Anahtar Sözcükler: Kimya eğitimi, eğitsel oyunlar, asitler, risk cümleleri, kimyasal tehlikeler.

1. INTRODUCTION

Dictionaries define "game" as "a fun activity with certain rules played in order to spend good time". The literature contains a lot of references to the role of games in education. Rixon (1988) defined game as a source of fun, which has certain rules, could be repeated and has a certain purpose. Games create the most natural learning environment for children. With the help of games, children could try what they have heard or seen as well as reinforcing their knowledge. Games have great contributions to the mental development of children (Kaya, 2007). According to Piaget, games are mediating tools to comprehend what is perceived from the environment and set them within the adaptation system. Games support the mental development of children and exist in all human behaviors. Children are active learners and thinkers. They structure their own learning through the items in their environment (Cameron, 2001). They make use of the classroom and outside activities. A general definition for game is the most effective learning process for children, which sets up their physical, cognitive, emotional and social developments in an environment, where they participate voluntarily with or without certain rules, while enjoying at the same time (Dönmez, 1992). Game ia phenomenon that already exists in a child's nature. Most important of all, game is a part of a child's educational development (Tekin, 1995). Carrier (1985), in his study, mentioned that games are invaluable activities for teachers as they take students away from the formal classroom environment while creating an atmosphere, where they could present their skills. Games do not only provide fun and happiness for individuals but also create a social environment, where everyone could interact. This environment allows students to develop not only their personalities but also social skills such as cooperation, friendship, self-confidence and responsibility (Aykutlu and Sen, 2004). With the help of games designed according to the content of the lessons, abstract concepts could become concrete and this would make lessons more enjoyable and understandable for students. Ellington et. all. (1981) have

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made important determinations related to the use and benefits of games and simulations in educational areas in their book called games and simulations in science education. These determinations are summarized as follows. According to Ellington (1981).

1) Game and simulations constitute a highly versatile and flexible medium whereby a wide range of educational aims and objectives can be achieved (Percivan, 1976, adapted by Ellington, 1981). They can be used to achieve objectives from all parts of Bloom's cognitive and affective domains (Bloom, 1964, adapted by Ellington, 1981) and simulations can also be used very effectively in the psychomotor area. It has been found that gaming and simulation techniques are no more effective than other, more traditional, methods when used to teach the basic facts of a subject (Wentworth and Lewis, 1973, adapted by Ellington, 1981), but are particularly useful for achieving high-level cognitive objectives relating to such things as analysis, synthesis and evaluation and also for achieving affective objectives of all types (Percivan, 1976, adapted by Ellington, 1981).

2) The use of a simulated as opposed to a real situation as the basis of an educational exercise allows the situation to be tailored to meet the needs of the exercise rather than requiring the exercise to be designed within constraints imposed by the situation.

3) Research indicates (Welker, 1971, adapted by Ellington, 1981) that well designed games and simulations can achieve positive transfer of learning the ability of participants to apply skills acquired during the exercise in other situations (Gagne, 1970, adapted by Ellington, 1981). It would, in fact, be difficult to justify the use of many simulation-type exercises if no such transfer of learning occurred. The whole point of the various types of cockpit simulator, for example, is to enable aircrew to acquire the various skill needed to operate a particular type of aircraft in a safe, controlled environment and then to be able to use these skills when flying the actual aircraft. The same is true of virtually all other training simulators (Ellington, 1981).

4) In many cases, games and simulations constitute a vehicle whereby participants can use and develop their initiative and powers of creative though (Ellington, 1981).

5) One advantage which games and simulations appear to have over more traditional teaching methods is that pupil or student involvement is normally very high a feature that is particularly beneficial for the less able. In addition, most participants find games and simulations extremely enjoyable.

6) Many games and simulations have a feature which can help the participants to integrate concept from otherwise related areas in to a cohesive and balanced world picture. This is one of the main overall aims of any worthwhile educational system (Daniels 1975, adapted by: Ellington, 1981).

7) Another characteristic of multi-disciplinary exercises is that they provide a situation. In this situation, participants with expertise in different subject areas have to work together efficiently and harmoniously to accomplish a common end. This kind of inter-personal skills is very important for success in later life and constitutes an area of education. In this area of education, the multi-disciplinary simulation and simulation game are the only means of providing practical experience in a classroom (Ellington, 1981).

There are three ways in which science based games and simulations can be used in secondary and tertiary education; (Ellington, 1981).

- as aids to the teaching of the basic content of science courses,
- for educating through science,
- For teaching about science and technology and their importance to modern society.

There are two basic ways in which the computer can contribute to the teaching/learning process, namely as a tutorial teaching machine and as a laboratory substitute. In the “tutor” mode, the student interacts with the computer, which is programmed to react to responses to questions that it stets. It is essentially similar to branching programmed learning, but is capable of being much more sophisticated

than the latter because of the greater flexibility and data handling capacity of computers compared with teaching machines or programmed texts.

In the "laboratory" mode, the computer is essentially a learning resource rather than a direct teaching device. The computer can, of course, also be used in a combination of these two basic roles and many of the most useful computer assisted learning exercises do in fact incorporate both forms of usage. In chemistry education there are many examples of studies to be used in teaching at various levels of education. As Russel (1999) mentioned in his study, many chemistry instructors use games and puzzles to make learning chemistry more fun and interesting. The study also involved related literature for the games to be played in teaching chemistry. Some of these publications consisted of games, simulations and puzzles that reflect on general knowledge while others were games and simulations about elements, atomic structures, naming, writing formulas and equations, chemical reactions and organic chemistry. In this study, Russel talked about various games and simulations produced and used between 1929 and 1999. Body (2007) designed a puzzle to be used in general chemistry classes. These puzzles and games, which are in line with the curriculum, aim to enable students to overcome their misconceptions, facilitate learning and make topics more fun for the students. These puzzles target at making the teaching tools more attractive in order to support students in learning and comprehending concepts. Follows (2010) prepared a multi-dimensional puzzle to be used in secondary level chemistry courses, which made the teaching of organic chemistry more enjoyable and effective. Angelin and Ramstrom (2010) in the game they designed for esters, asked students to find structures hidden behind their traditional names. The game was called "where is the ester?". This game aimed to teach the traditional names and structures of chemical components. The game was played by two players, each of whom drew a component randomly amongst 24 components while the other tried to guess the component. Woelk (2009) aimed to teach the symbols by matching the collocations for State names with the element symbols. The aim of this application was to teach the periodical table built up with more than 100 combinations of the letters while decreasing students' potential negative attitudes or anxieties. It was mentioned in the study that this game could be adopted for the cities or states in other countries as well. Ooi and Sanger (2009) used a game in their study on biochemical mechanisms, which aimed to teach the topic to the students in an interactive approach. In the game students asked simple questions to each other in order to find out the pathways attached to the back of their t-shirts. This was a study planned to supplement the traditional biochemistry classes.

In the study by Gredler (2003), an alternative way of learning biochemical reactions was designed. Students played the game in groups of two and tried to find the pathways attached to the back of their t-shirts by asking each other simple "yes/no" questions. This game could be used as a follow up activity after traditional biochemistry classes in order to strengthen students' knowledge of pathways. Ragers (2000) traced a systematic approach to the teaching of chemical balance with the help of simulation experiments. The study involved graphics displaying same conclusions with the experiments preceded by both simulations and real laboratory experiments about the reactions that created balance. The pilot study made using simulations was followed by the minor changes obtained as a result of these studies. Bell, et.al. (2009) developed the "Enthalpy Cost" game in his study with the aim of improving students' skills in drawing Lewis structures. Students were expected both to draw correct Lewis structures and calculate the enthalpy changes regarding chemical bounds. Despite quite a few numbers of studies on safety in laboratories, Raddo (2006) introduced a new approach to teaching of safety in laboratories in order to create awareness in students. Students were handed out comic books involving laboratory scenes with familiar cartoon characters and were asked to discuss about the situations. Students were than shown visual materials displaying laboratory safety specialists in scenes taken from chemistry journals. Finally the need to adhere to copyright regulations for the use of the images is discussed so as to increase students' awareness of academic honesty and copyright issues. This study involved the design and development of the "Who is who?" game aiming to teach the acids and their dangers within the laboratory safety subject as an elementary and secondary level topic. The game was created through the Flash Software and designed to be easily played in any computer environment.

1.1. The method and purpose of the study

The aim of the game is to teach basic danger signs and symbols of T/T^+, O, C, N, F^+ that belong to $HClO_4$, HNO_3, HCl, H_2SO_4, HF, HCN, H_3PO_4 acids, which commonly take place in elementary and secondary level chemistry courses. It was also aimed to teach the danger phrases of R5, R8, R23, R26/ 27/ 28, R34 and R37 that belong to the same acids. These symbols, signs and R phrases carry the following meanings.

Table 1: Symbol, abbreviation/description of hazard

Symbol	Abbreviation	Hazard	Description of hazard
(Physicochemical)			
	O	oxidizing	Chemicals that react exothermically with other chemicals.
	F+	extremely flammable	Chemicals that have an extremely low flash point and boiling point, and gases that catch fire in contact with air.
(Health)			
	T+	very toxic	Chemicals that at very low levels cause damage to health.
	T	toxic	Chemicals that at low levels cause damage to health.
	C	corrosive	Chemicals that may destroy living tissue on contact.
(Environmental)			
	N	dangerous for the environment	Chemicals that may present an immediate or delayed danger to one or more components of the environment

Table 2: Risk phrases

R5	Heating may cause an explosion
R8	Contact with combustible material may cause fire
R23	Toxic by inhalation
R26/27/28	Very toxic by inhalation, in contact with skin and if swallowed
R34	Causes burns
R37	Irritating to respiratory system

The game involved danger symbols, meanings and R phrases related to acids as well as labels made on bottles by Merck (http://www.merck-chemicals.com/) and the Dangerous Substances Directive (67/548/EEC) (http://ec.europa.eu/environment/chemicals/), which (as amended) is one of the main European Union laws concerning chemical safety. The game could be played by two students or two groups of students in little numbers. Both students choose one of the 7 acids in their minds and start the game using the following questions to each other in order to make guesses.

- Is it oxidizing?
- Is it toxic or very toxic?
- Is it corrosive?
- Is it dangerous for the environment?
- Is it easily flammable?

As the game begins with these questions, the student is expected to choose one of the following flowcharts in order to find the acid chosen by the other students. Each answer the student gets directs him/her to another question. The alternative flowcharts within five question formats are displayed below in Figures (appendix 1) and the game available at the following address:

http://yunus.hacettepe.edu.tr/~nsecken/wordpress/wp-content/uploads/2012/04/acids1.swf

1. Discussion and Suggestions

Education researchers find laboratories as important tools in learning and comprehending the scientific thinking process. According to Lucas (1971) students could understand how scientists thought, studied and acquired new knowledge through their research in the laboratory classes. Suitable laboratory activities are effective in developing students' researching, problem solving and reasoning skills. Students attain various cognitive, affective and psychomotor skills in the laboratories. Starting laboratory studies without the required pre knowledge could cause serious problems. Students experience laboratory studies in science and technology courses at the elementary level and in physics, chemistry and biology classes at the secondary level. These laboratories contribute students in achieving their aims by enabling them to learning by doing and experiencing. Learning in the laboratories is actualized through interaction of students with the chemicals in person. Knowing the chemicals and dangers of their reactions would enable students to attain skills to protect themselves from these dangers. Therefore, the "Who is who?" game about the acids as parts of the chemicals to be used in science and technology, physics, biology and chemistry classes would be very effective in teaching the chemical danger symbols and their meanings. The game would also increase the level of interaction between the students and create effective learning environment by contributing to their socialization. Students would have the opportunity to reuse and revise their knowledge about the chemicals to be used in laboratories while reinforcing the knowledge they learnt in other science

classes. This could enable students to take necessary precautions for their safety in the laboratory environment. "Students could learn while playing and get protected through learning". This controlled game could be used as a reinforcing activity for the laboratories by creating visually enriched learning environments. Teachers could contribute to the teaching of laboratory safety by enabling their students to play this game in their classrooms.

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APPENDIX

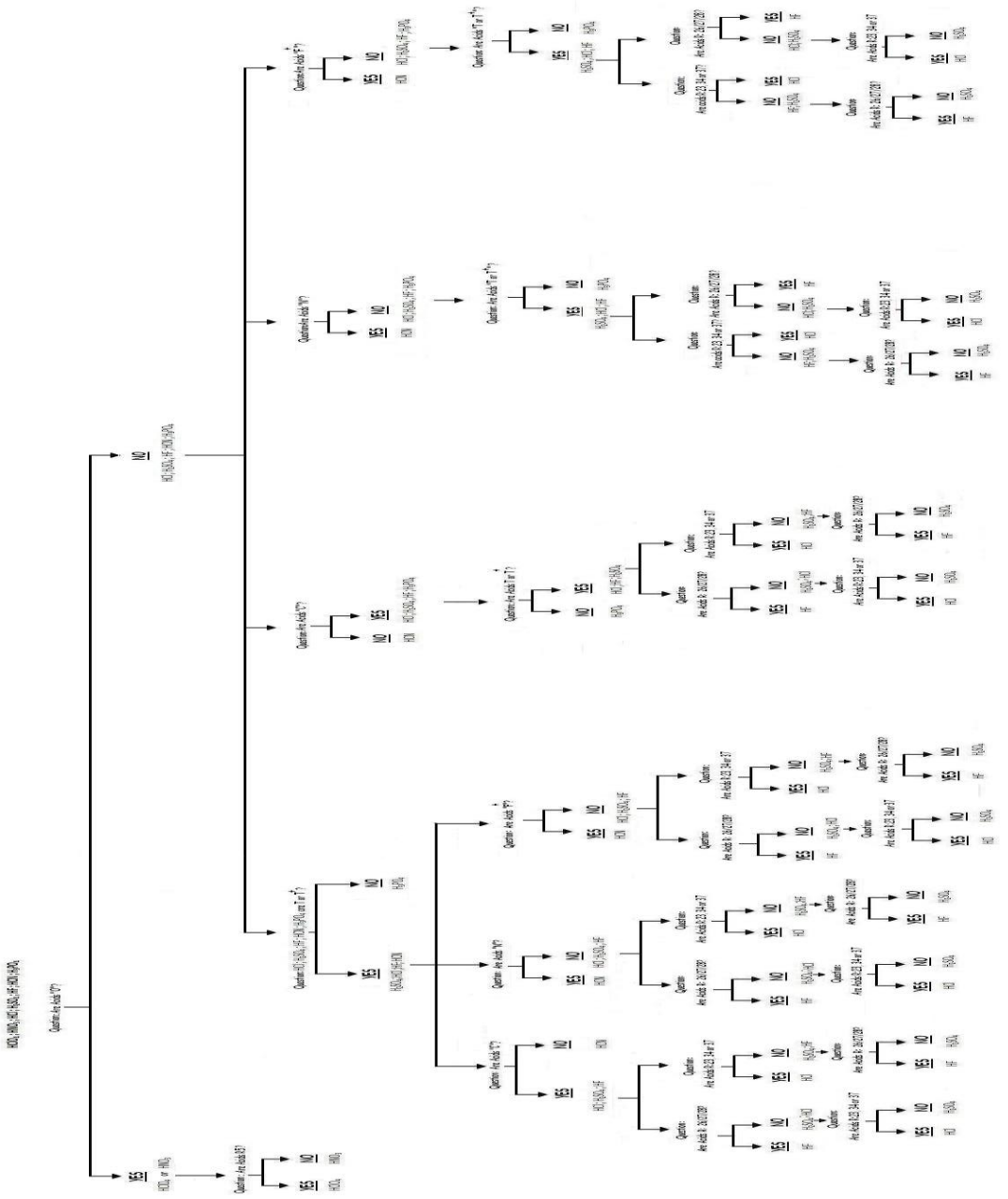

Figure 1. The flowchart starting with the question "Is it oxidizing?"

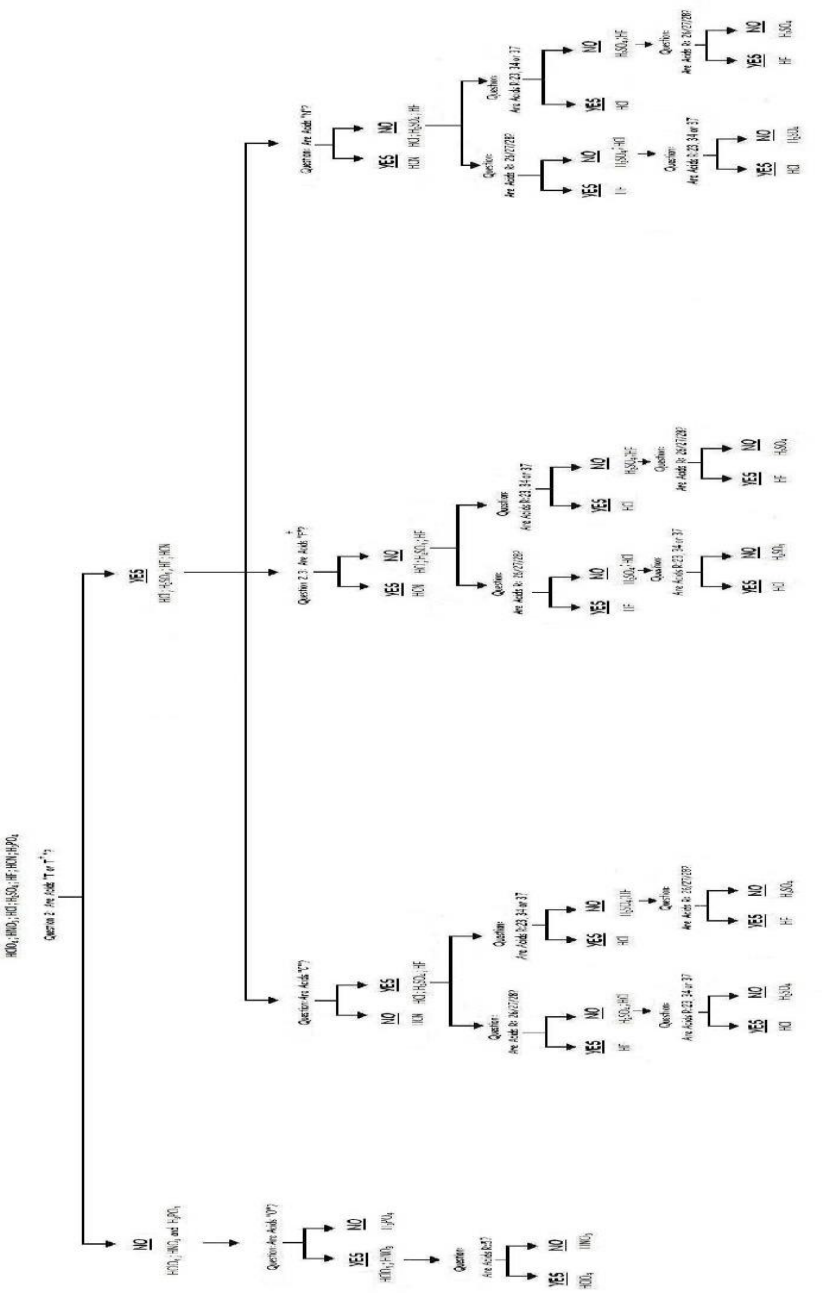

Figure 2. The flowchart starting with the question "Is it toxic or very toxic?"

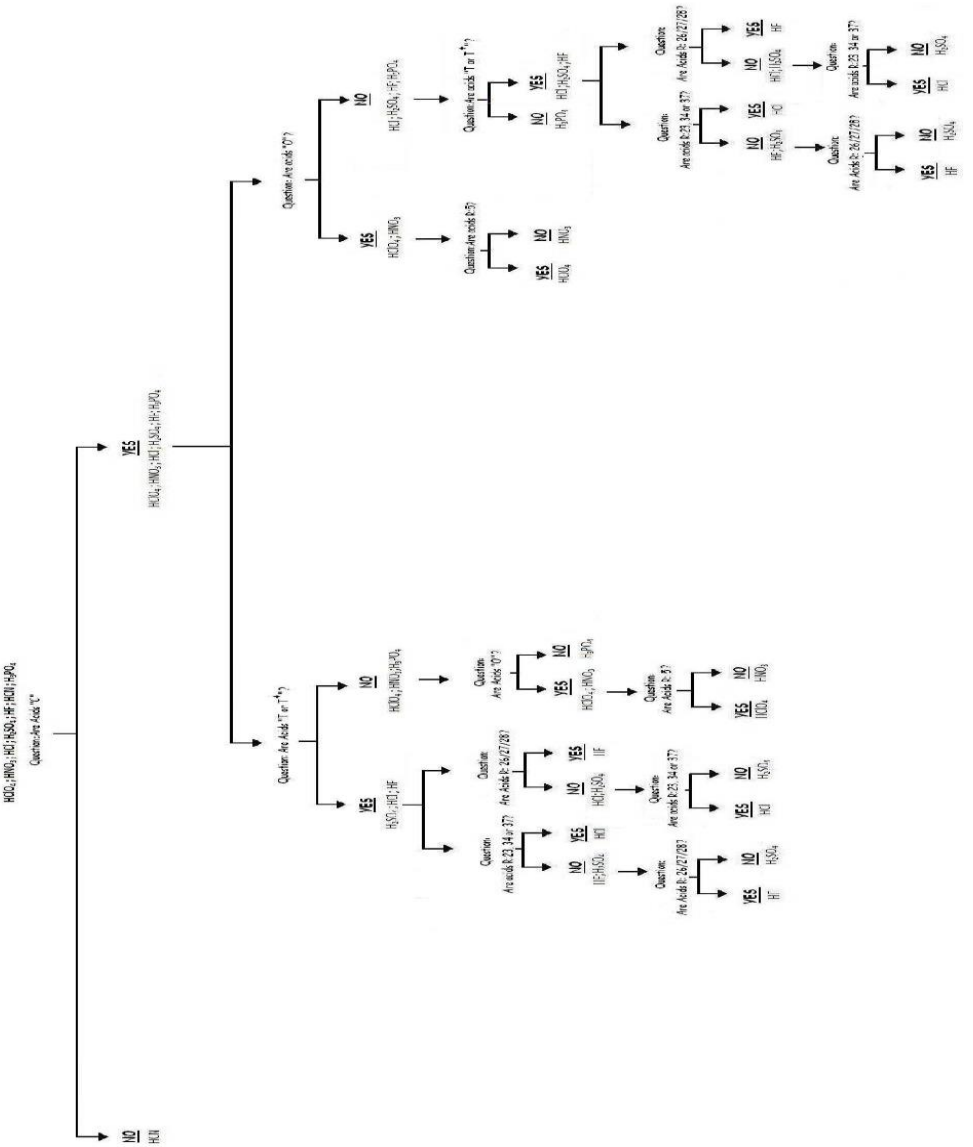

Figure 3. The flowchart starting with the question "Is it corrosive?"

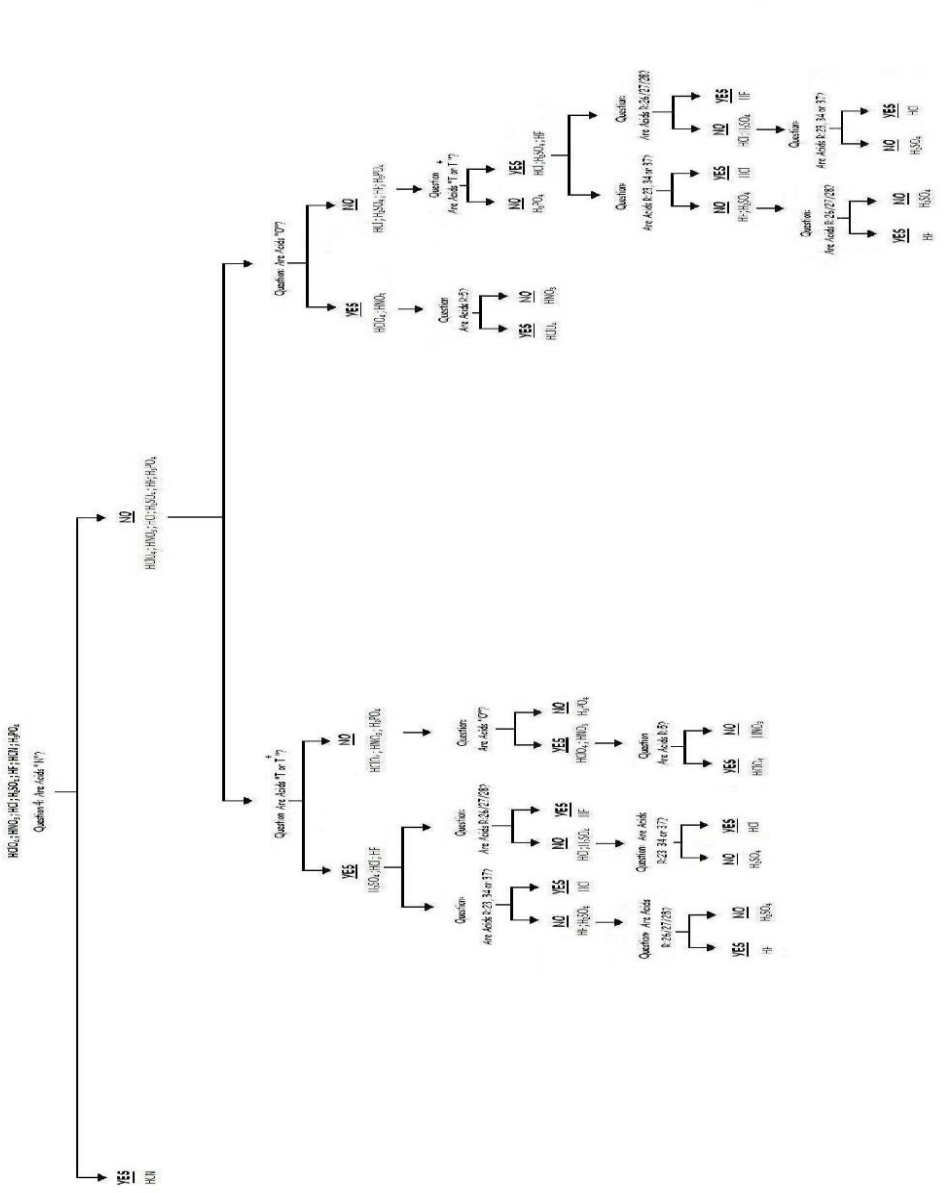

Figure 4. The flowchart starting with the question "Is it dangerous for the environment?"

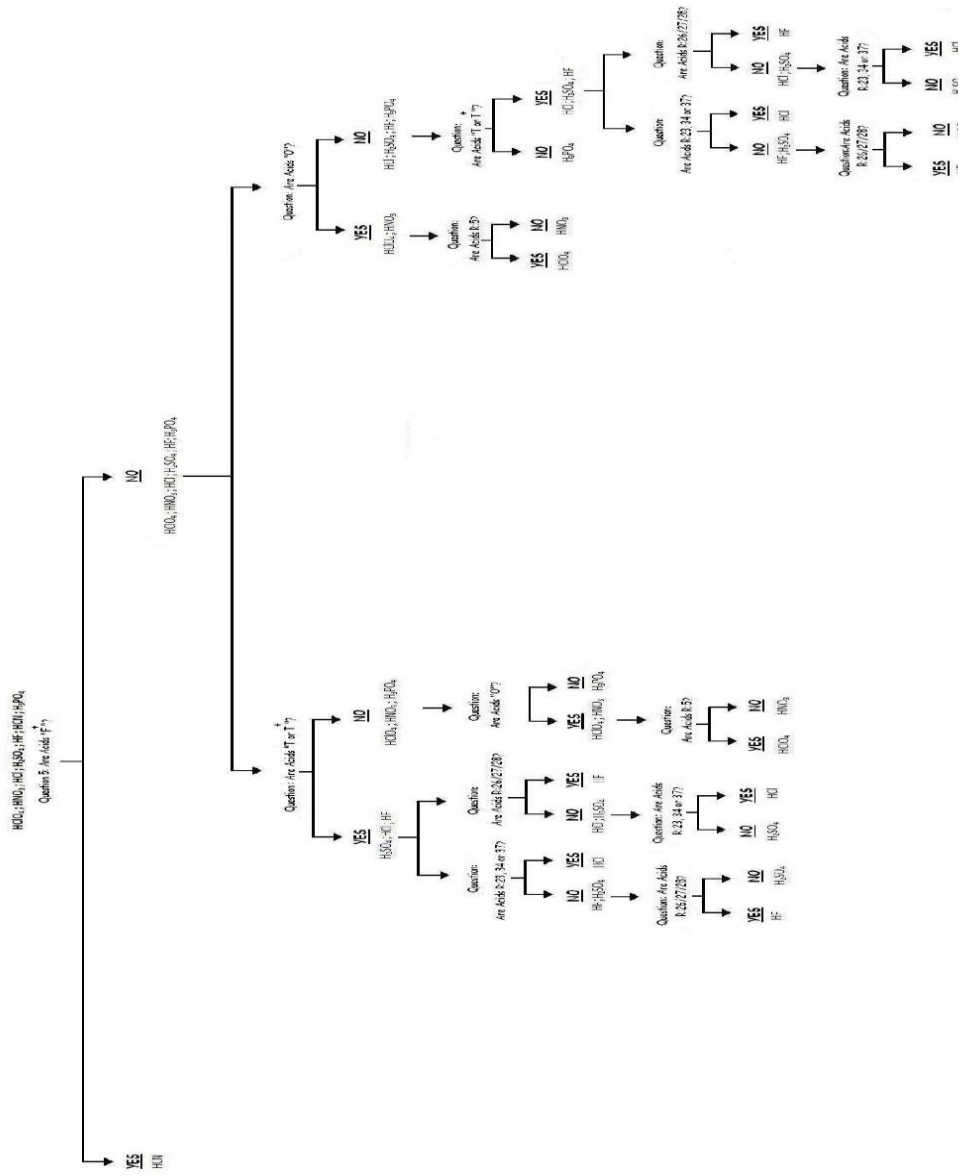

Figure 5. The flowchart starting with the question "Is it easily flammable?"

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