# Infusing student-centered learning in a chemistry class with digital technology

# Incorporación del aprendizaje centrado en estudiantes con ayuda de la tecnología digital en clases de química

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***Abstract***

*Digital technology was introduced to a student-centered high school chemistry course and subsequent achievement was examined. Students completing a lab and pre-lab using video digital methods demonstrated a positive increase in acquisition of lower-knowledge level questions. However, higher-level questions, such as synthesis and evaluation, requiring prior knowledge, improved slightly. Challenges encountered while creating the digital media will be discussed.*

***Key words****: Digital technology, general chemistry, student-centered learning*

***Resumen***

*El artículo presenta datos sobre la utilización de la tecnología digital en un curso de química de escuela secundaria, con enfoque centrado en los estudiantes, a quienes se les examinó. Los estudiantes que completaron el laboratorio y prelaboratorio empleando métodos digitales, mostraron un aumento positivo en la adquisición de conocimientos en preguntas de nivel elemental. Sin embargo, para preguntas que reflejan capacidades de alto nivel, como síntesis y evaluación, que requieren un conocimiento previo, la mejoría fue muy ligera. Será tema a discutir los desafíos encontrados, mientras se crea un medio digital apropiado.*

***Palabras clave****: tecnología digital, química general, aprendizaje centrado en estudiantes*

## INTRODUCCIÓN

Terry Parker High School is a public school located in north Florida. It is a comprehensive block schedule school composed of a student body with no racial majority and located in a middle class neighborhood in a metropolitan area of over one million in population. A majority of the students enrolled in a chemistry course are in the tenth grade (age 15-16), although some are in the eleventh and twelfth grade. Students attend class for four 1.5-hour blocks each day. This particular class schedule (block) has promoted my personal teaching methodology to change over the years from a teacher-oriented focus with intermittent lab activities to mixing both teacher and student oriented learning styles into the classroom.

One of the concepts historically provided to students in a general chemistry class is the topic of acid and base properties. Specifically, what is an acid and a base, what are indicators, and what type of reaction occurs during an acid and base reaction? For this action research, rather than providing direct instruction, a videotape was created and shared with the students which described the laboratory procedures. To focus on the videotaped approach, very little teacher student interface was made prior to the lab, except to emphasize safety concerns. The lab itself had some basic knowledge-level questions and a few higher-level critical thinking items, which required the students to adapt prior knowledge to a new concept.

A pretest was provided at the beginning of the period, and a posttest at the conclusion of the lab. The questions are shown in table 1. The results demonstrated an improvement in several areas. However, two of the items (#4 and #5), which were indirectly covered by the lab activity, resulted in little or no improvement.

**Table 1**
**Pre/Post Test Questions**

1. What is an acid?
2. What is a base?
3. What is an indicator
4. Write a balanced equation for: $HNO_3$(aq) + NaOH(aq)
5. What gas is emitted when a metal reacts with HCl?

With block schedules, it is important to plan at least three activities to keep the students' attention focused on the learning experience. The student-centered learning experience flows directly from the humanistic educational philosophy to enhance the development of individuals and improve their learning style for future years (NUCKLES, 2000). A review of current literature suggests a number of educators are developing case study materials showing successes at using student centered, constructivists educational philosophies (HENDERSON, 1999 and PENTECOST, 2000). ALSO, PASSMAN (2001) noted positive results when assisting teachers to develop student-centered models of instruction where emphasis is placed on small group inquiries, and activities, which deeply investigate the concept. The idea is that students are the "active constructor of knowledge" (DEWEY, 1916; PIAGET, 1952; and PRAWAT, 1996).

## PROCESS AND PROCEDURE

Student knowledge level was established by administering a pretest prior to any dissemination of information. As expected students' knowledge of acids and bases was minimal. The lab selected was a standard acid/base lab prepared by a science textbook publisher (Bridges et. al., 1996); however, there were several issues that required attention prior to presentation. Initially, this study included transferring standard video into a digital format via a converter. The video contained a detailed review of the procedures, which are specified in the lab activity. The video includes the four procedures used to explore acid base properties, specifically the use of indicators, how acids react with metals and carbonates and acid base neutralization. After viewing the video, the students performed the lab and completed an posttest to ascertain improvements via the video and lab activity.

## RESULTS

After viewing the video and completing the activity, an increase in student performance on a posttest was observed. Blooms "Knowledge Level" items (questions 1-3: see table 1), which the students could get directly from the activity without any deductive reasoning showed an improvement from an average pretest score of 48% to an average posttest score of 70%. Conversely, items which required deductive reasoning based on prior knowledge showed significantly less improvement from an average pretest score of 4% to an average posttest score of 43%.

**Table 2**
**Percent Change Between Pretest and Posttest for each Block**

| Question | Block 1 | Block 3 | Block 4 |
|---|---|---|---|
| **1.** | 50.0 | 69.6 | 70.4 |
| **2.** | 43.8 | 65.2 | 59.3 |
| **3.** | 62.5 | 63.0 | 48.2 |
| **4.** | 12.5 | 4.4 | 37.0 |
| **5.** | 12.5 | 43.5 | 33.3 |

Table 2 presents the pretest to posttest average changes for each of the five questions provided. There is a dramatic difference between block 1 (standard chemistry) and block 3 and 4 (honors chemistry) due to the academic levels of the students. Block 3 and 4 students were expected to score higher on the pretest due to their academic skills. However, greater improvement was expected than was achieved on the posttest. Perhaps if the class had discussed the lab results as a group after the lab activity, but prior to the posttest there would have been greater improvement. The students did work together as a team in small groups of 3-4 students while they were collecting the data. They also discussed the various questions

posed in the lab as a group among themselves. If students did not understand a question they were instructed to skip it and proceed. In the standard class there were many questions that were skipped. The honors classes were able to answer more questions as a group; however there were still questions they could not complete correctly. Knowledge level questions (questions 1-3) where answers are found embedded in the text of the lab were questions easily answered by the groups. However, when assimilation of information previously taught was required, performance decreased. For example, performance dropped when students were asked to balance the following reaction:

$$HNO_3 + NaOH \rightarrow$$

Most of them could not do this after the lab even though the concept was provided to them three weeks prior. It appears that students find predicting and balancing equations to be a very difficult concept. When this was discussed later in class and they were asked to determine the reaction type, many of the students could identify it as a double replacement and then predict the correct products.

## CONCLUSIONS AND DISCUSSION

Student-centered learning can be effective if the teacher is willing to allow the students to interact and collaborate with one another. The teacher may wish to assist and possibly instigate the discussion if a catalyst seems to be beneficial. The optimal approach is to maximize wait time and allow the students to discover the solution, which will increase transfer of the information from working memory into long-term memory for more accurate subsequent retrieval. Lab activities with videos encourage a deeper, life long behavioral change in students' ability to learn because it places the emphasis on the student seeking the information rather than the teacher providing it. The action of having the student perform an activity increases the probability that the concept will be retained because their attention is focused on the task and they are more intrinsically motivated. If student-centered learning through lab activities and technology is commonly used throughout the course, students can become more proficient and familiar with this practice as part of their research and explorative skills. Also, ample time needs to be afforded for the discovery phase; otherwise the more complex concepts are glossed over and not thoroughly investigated by the students. Additional resources, such as textbooks, trade publications and Internet access to specific web sites covering the concept could also be used during the exploratory phase to answer the conceptually difficult questions.

The pre-lab video demonstrating the procedures to the students was well received. Many positive qualitative comments were made. Students asked fewer questions pertaining to the lab after viewing the tape, than they have on other occasions where a discussion of the lab procedures was provided orally. This provides one indication that students were more attentive to the video and comprehended the contents. This could be expanded to incorporate digital video clips of other demonstrations, lab procedures, and safety precautions within electronic presentations. Students also enjoy the affective realm of being videotaped or having their pictures taken while performing a lab. In summary, using digital technology in a chemistry class has shown to be an effective method to stimulate and successfully increase student awareness and achievement.

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