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DanceChemistry: A Visual Teaching Aid

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5ABSTRACT

A visual aid teaching tool, the DanceChemistry video series, has been developed to teach fundamental chemistry concepts through dance. These educational videos present chemical interactions at the 10molecular level using dancers to represent molecules. The DanceChemistry videos help students visualize chemistry ideas in a new and memorable way. Surveying the general laboratory course at the University of California–Irvine ($n = 1266$), 75% of the students said they wanted to use these videos to learn additional chemistry topics in 15the future. Data from a pre- and post-test show that there was an increase in students providing the correct answer after watching a five minute DanceChemistry video. These instructional videos are disseminated broadly through the specifically dedicated YouTube channel, DanceChemistry.

20KEYWORDS

General Public, High School, First-Year Undergraduate, Second-Year Undergraduate, Testing/Assessment, Thin Layer Chromatography, Molecular Properties

The DanceChemistry videos are fun, memorable educational visual aids that combine the fine arts and science. The visual teaching aid presents chemical interactions at the molecular level using dancers to represent molecules. These videos are more memorable than the more common graphical or animation based representation because of the unusual depiction of molecules with dancers. Because DanceChemistry videos use simplified terms and dancers to represent molecules, the videos can be used as early on as in high school chemistry classes all the way up to college organic chemistry courses. Because art is often considered a universal language, this is a way to educate society in an “outside of the box” way.

DanceChemistry videos often pair footage of real experiments with explanations on the molecular level using dancers to portray individual molecules. For example one of the DanceChemistry videos explores the concept of thin-layer chromatography (TLC). The video demonstrates how to correctly set up and develop a TLC plate. Throughout the video, viewers examine what would be occurring on the molecular level, represented with dancers. Fourteen dancers in white makeup the TLC plate; each dancer wears a black armband to represent the plate’s hydrogen bonding abilities. Two dancers in orange

are “spotted” onto the plate; one is polar and wears a black armband, the other one is nonpolar and does not. Dancers in blue, representing solvent, move up the plate and push the two dancers in orange up the plate. The orange compound with the black armband interacts with the white TLC plate dancers via dance lifts resulting in less movement up the plate.

These instructional videos are disseminated broadly through the specifically dedicated YouTube channel, DanceChemistry.¹ This broad distribution should enhance the infrastructure for education at secondary schools and provide underserved communities in science with free instructional videos that can be used to improve scientific understanding from a creative viewpoint.

RESULTS AND DISCUSSION

To determine the effectiveness of the DanceChemistry videos, 601,266 undergraduate students taking general chemistry laboratory at the University of California, Irvine were surveyed. Three different videos on the topics: thin-layer chromatography, melting point, and miscibility were examined. The topics, thin-layer chromatography and melting point, were unfamiliar to most students and not covered prior to this study. The concept of miscibility was discussed in a previous chemistry course taken by the students earlier in their studies.

Students took a short surveysⁱⁱ on two of the chemistry topics (thin-layer chromatography, melting point, or miscibility) without watching any DanceChemistry video. After four weeks, the students 70 watched a DanceChemistry video on one of the topics and retook the same two surveys, therefore acting as a control group for the other DanceChemistry video.

[Video #1: Thin-Layer Chromatography](#)

For the video that discussed the concept of thin-layer chromatography, 75 two questions were asked on the surveyⁱⁱⁱ. The first question provided an image of a TLC plate with two spots and asked students to determine what the TLC plate would look like if run in a less polar solvent. Fifteen percent of students from the study group and 16% of students from the control group answered the question correctly (Table 801). The study group watched the five-minute TLC video and 50% of students correctly answered the question on the postsurvey. The second question on the survey asked students to rank five spots on a TLC plate in order of polarity. Twenty-two percent of students from the study group and 25% of students from the control group answered the 85 question correctly. After the study group watched the DanceChemistry video, 60% of students provided the correct answer on the postsurvey. The control group did not watch the video and only 13% and 27% of students correctly answered the first and second question, relatively.

There was no significant improvement from the presurvey to postsurvey in the control group indicating that the improvement seen with study group was solely due to the DanceChemistry video.

Table 1. Results of the pre and postsurvey for the thin-layer chromatography DanceChemistry video. There were 460 students in the study group and 345 students in the control group

	Percentage of Students that Provided the Correct Answer	
	Question #1	Question #2
Study Group (before video, presurvey)	15%	22%
Study Group (after video, postsurvey)	50%	60%
Control Group (presurvey)	16%	25%
Control Group (postsurvey)	13%	27%

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Video #2: Melting Point

Three questions were asked on the survey about melting point. The first question provided four images of different crystal lattice with varying degrees of impurities and asked students to rank their melting point. Less than 1% of students from the study and control group answered the question correctly (Table 2). After the study group watched the melting point DanceChemistry video, 27% of students correctly answered the question. The second question on the survey asked students to determine which statements were true about a mixed melting point experiment. Seventeen percent of students from the study group and 24% of students from the control group answered the second question correctly. After the study group watched the DanceChemistry visual aid, 53% of the students answered the question correctly. The third question on the survey was probing the relationship

110of stack ability of a compound and its melting point. In the study group, 9% of students correctly answered this question; 8% of the students in the control group answer this question correctly. After watching the video, 33% of students in the study group provided the correct answer. Again there was no significant improvement from the pre to postsurvey 115in the control group.

Table 2. Results of the pre and postsurvey for the melting point DanceChemistry video. There were 415 students in the study group and 415 students in the control.

	Percentage of Students that Provided a Correct Answer		
	Question #1	Question #2	Question #3
Study Group (before video, presurvey)	0.2%	17%	9%
Study Group (after video, postsurvey)	27%	53%	33%
Control Group (presurvey)	0.7%	24%	8%
Control Group (postsurvey)	0.3%	25%	12%

Video #3: Melting Point

120A survey with four multiple choice questions about ΔG , ΔH , and ΔS was given to the students to measure the effectiveness of the miscibility DanceChemistry video. Sixty four percent of students from the study group and 57% from the control group correctly answered the first question (Table 3). After watching the DanceChemistry video on 125miscibility, 96% of students answered the question correctly. For the second question on the survey, 38% of students from the study group and 36% of students from the control group provided the correct answer. On the postsurvey, 73% of students in the study group answered the second question correctly. For the third question, a large 130majority of students in both groups provided the correct answer. There

was no obvious difference from the pre and postsurvey because there was not much room for improvement for this question. The survey also asked students to check a box if they guessed the answer to the question. On the presurvey, 35% of students in the study group and 13526% of students in the control group admitted to guessing the correct answer. On the postsurvey, only 1% of students in the study group admitted to guessing the correct answer while 18% of students in the control group still admitted to obtaining the correct answer simply though guessing. For the fourth question on the presurvey, 60% of 140students in the control group and 67% of students in the study group correctly answered the question. After watching the DanceChemistry video, 74% of students in the study group provided the correct answer. There was still no significant difference for the control group when comparing the pre and postsurvey, again indicating that the increased 145number of correct answers received from the study group was due exclusively to the DanceChemistry video.

Table 3. Results of the pre and postsurvey for the miscibility DanceChemistry video. There were 391 students in the study group and 419 students in the control.

	Percentage of Students that Provided a Correct Answer			
	Question #1	Question #2	Question #3	Question #4
Study Group (before video, presurvey)	64%	38%	94%	60%
Study Group (after video, postsurvey)	96%	73%	96%	74%
Control Group (presurvey)	57%	36%	94%	67%
Control Group (postsurvey)	66%	45%	95%	64%

150 Overall, there was a smaller improvement when comparing the pre and postsurvey of the miscibility video than with the thin-layer chromatography and melting point video. This is probably due to the fact that the students had previously learned about miscibility before being exposed to the DanceChemistry video. Nevertheless, there was 155 still an improvement in all three cases suggesting that these videos can be used to introduce a topic, or used after a topic has already been introduced as a supplementary learning tool.

To ensure that the DanceChemistry videos were not too abstract for students, the postsurvey also asked students to correctly identify 160 what a specific dancer represented. For the thin-layer chromatography video, only 66% of the students correctly answered the question, but for the melting point and miscibility videos, 96% and 92% of students provided the correct answer, respectively. The lower correct response for thin-layer chromatography video may be due to the fact that the 165 topic of TLC has too many components and is inherently a topic that many students struggle with. One of the limitations to the DanceChemistry videos is that the representation of molecules with dancers gets convoluted when the chemistry concept is more advanced. Not all chemistry topics can be easily transformed into 170 DanceChemistry videos.

For the three videos, 79% (thin-layer chromatography), 85% (melting point), and 78% (miscibility) of students stated that they felt they had a better understanding of the topic after watching the DanceChemistry visual aid. Of the 1266 students surveyed, 75% of them said they wanted to use DanceChemistry videos to learn additional chemistry topics in the future. Many of the students commented on the engaging nature of the videos, below are a few select statements.

- 180 • It was a visual representation of how it works. Students whom are visual learners will appreciate this style of teaching.
- It was an excellent way to visualize the process. Every note was thoroughly addressed and understood.
- The video was both educational and entertaining.
- 185 • The video grabbed my attention better than traditional classroom setting would have.
- It was entertaining and got me more excited for the topic.
- The video was silly but that is why I'll remember the information. It was helpful.
- The video is interesting. It makes chemistry easy.
- 190 • It was a very random way to teach a lesson but because it is so absurd and usual, I wont forget it.

CONCLUSION

This study shows that the DanceChemistry videos are an effective way to introduce or supplement a chemistry topic. Students surveyed enjoyed the videos and their ability to correctly answer questions about the topic improved. To date, seven DanceChemistry videos have

been created covering the topics: Thin-layer chromatography, melting point, miscibility, relationship between temperature and pressure, solvent dependency of fluoride as a nucleophile, recrystallization, and solubility. More videos on varying chemistry topics are currently being made and further benefits of the usage of DanceChemistry videos in the classroom are being studied.

ASSOCIATED CONTENT

Supporting Information

205 Surveys and detailed data collected from the study are available in the Supporting Information.

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215 REFERENCES

i www.youtube.com/user/DanceChemistry

ii Survey questions can be found in the supporting information

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